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Network Operations Subcommittee

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ANSI/SCTE 168-4 2019

Recommended Practice for Transport Stream Verification Metrics

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1.0 SCOPE

This document is identical to SCTE 168-4 2010 except for informative components which may have been updated such as the title page, NOTICE text, headers and footers. No normative changes have been made to this document.

This Recommended Practice provides a common methodology for defining the measurement points and metrics of interest in digital cable networks that impair the compressed multimedia (video/audio/data) quality end to end. Uncompressed content and those metrics not related to "quality" are not included in this Recommended Practice,

Issues related to the IP network are addressed in SCTE 168-7.

2.0 INFORMATIVE REFERENCES

The following documents contain provisions, which, through reference in this text, constitute provisions of this standard. At the time of subcommittee approval, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of the documents listed below.

2.1 SCTE References

[1] SCTE: ANSI/SCTE 18-2007, Emergency Alert Messaging for Cable

[2] SCTE: ANSI/SCTE 35-2007, Digital Program Insertion Cueing Message for Cable

[3] SCTE: ANSI/SCTE 54-2009, Digital Video Service Multiplex and Transport System Standard for Cable Television

[4] SCTE: ANSI/SCTE 65-2008, Service Information Delivered Out-Of-Band for Digital Cable Television

[5] SCTE: SCTE-142-2009, Recommended Practice for Transport Stream Verification

2.2 Standards from other Organizations

[6] ATSC: "ATSC Digital Television Standard: Part 3 - Service Multiplex and Transport Subsystem Characteristics," Document A/53 Part 3:2009, 7 August 2009

[7] ATSC: "ATSC Standard: Program and System Information Protocol for Terrestrial Broadcast and Cable (PSIP)", Document A/65:2009, 14 April 2009".

[8] ATSC: "ATSC Recommended Practice: Transport Stream Verification" Document ATSC A/78A, 9 May 2007

[9] ISO: "ISO/IEC IS 13818-1:2007 (E), International Standard, Information technology – Generic coding of moving pictures and associated audio information: systems".

3.0 COMPLIANCE NOTATION

"SHOULD"	This word or the adjective "RECOMMENDED" means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully

	weighted before choosing a different course.
"SHOULD NOT"	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
"MAY"	This word or the adjective "OPTIONAL" means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.

4.0 DEFINITIONS AND ACRONYMS

8-VSB – Acronym for 8-Level Vestigial Sideband (Digital TV RF modulation format)

AEIT - Acronym for Aggregate Event Information Table, defined in SCTE-65 [4].

AETT - Acronym for Aggregate Extended Text Table, defined in SCTE-65 [4].

CM - Acronym for Component Missing, defined in SCTE-142 [8].

CRC - Acronym for Cyclic Redundancy Check, defined in ISO/IEC 13818-1 [9].

CVCT - Acronym for Cable Virtual Channel Table, defined in ATSC A/65 [7].

DPI - Acronym for Digital Program Insertion, defined in SCTE 35[2].

DTS - Acronym for Decoding Timestamp, defined in ISO/IEC 13818-1 [9].

DTV - Acronym for Digital Television.

EAS - Acronym for Emergency Alert System, defined in SCTE 18[1].

EIT - Acronym for Event Information Table, defined in ATSC A/65 [7].

EPG - Acronym for Electronic Program Guide.

ES - Acronym for Elementary Stream, defined in ISO/IEC 13818-1 [9].

ETT - Acronym for Extended Text Table, defined in ATSC A/65 [7].

GPS - Acronym for Global Positioning System.

L-VCT - Acronym for Long-form Virtual Channel Table, defined in SCTE-65 [4].

MPEG - Acronym for Moving Picture Experts Group.

MGT - Acronym for Master Guide Table, defined in ATSC A/65 [7].

MRD – Acronym for MPEG-2 Registration Descriptor, defined in ISO/IEC 13818-1 [9].

Mux – Multiplexer.

OOB-SI - Acronym for Out of Band - SI, defined in SCTE-65 [4].

PAT - Acronym for Program Association Table, defined in ISO/IEC 13818-1 [9].

PCR - Acronym for Program Clock Reference, defined in ISO/IEC 13818-1 [9].

PES - Acronym for Packetized Elementary Streams, defined in ISO/IEC 13818-1 [9].

PID - Acronym for Packet ID, defined in ISO/IEC 13818-1 [9].

PMT - Acronym for Program Map Table, defined in ISO/IEC 13818-1 [9].

POA - Acronym for Program Off Air, defined in SCTE-142 [8].

PSI - Acronym for Program Specific Information, defined in ISO/IEC 13818-1 [9].

PSIP - Acronym for Program and System Information Protocol, defined in ATSC A/65 [7].

PTS - Acronym for Presentation Time-Stamp, defined in ISO/IEC 13818-1 [9].

PVR - Acronym for Personal Video Recorder.

QAM - Acronym for Quadrature Amplitude Modulation.

QoS - Acronym for Quality of Service, defined in SCTE-142 [8].

RF - Acronym for Radio Frequency.

RP - Acronym for Recommended Practice.

RRT - Acronym for Rating Region Table, defined in ATSC A/65 [7].

SCTE - Acronym for Society of Cable Telecommunications Engineers.

SI - Acronym for Service Information, defined in SCTE 54 [3].

SLD - Acronym for Service Location Descriptor, defined in ATSC A/65 [7].

STT - Acronym for System Time Table, defined in ATSC A/65 [7].

S-VCT - Acronym for Short-form Virtual Channel Table, defined in SCTE-65 [4].

TNC - Acronym for Technically Non-Conformant, defined in SCTE-142 [8].

TOA - Acronym for Transport Stream Off Air, defined in SCTE-142 [8].

TVCT - Acronym for Terrestrial Virtual Channel Table, defined in ATSC A/65 [7].

TS - Acronym for Transport Stream, defined in SCTE 54 [3].

TSID – Transport Stream ID, defined in ISO/IEC 13818-1 [9].

T-STD - Acronym for Transport Stream System Target Decoder, defined in ISO/IEC 13818-1 [9].

TVCT- Acronym for Cable Virtual Channel Table, defined in ATSC A/65 [7].

VCT - Acronym for Virtual Channel Table, defined in ATSC A/65 [7].

5.0 INTRODUCTION

This Recommended Practice provides a common methodology for associating transport stream verification metrics with functional subsystems in cable architectures. Appropriate metrics are grouped into sets specific to functional areas within the cable network.

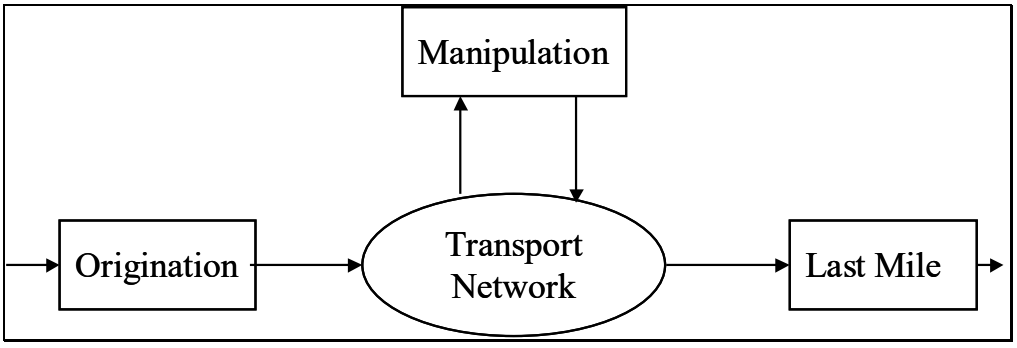

Figure 5-1 : Topology View of Metric Categories

Metrics are measurements aimed at determining the presence of impairments (errors in the transport streams carrying compressed content that can affect the perceived quality of the delivered content). The location of these metrics can be used to determine the source of the impairment, which is a key step in troubleshooting and resolving problems. As shown in Figure 5.2, below, a cable architecture is quite complex. However, it is composed of a number of functional blocks – each performing a specific function in the flow of content through the system. These blocks may be organized into common functional categories of operations which can be further organized into groups which perform similar operations from the viewpoint of metrics (by nature of the operations performed by the components of the category, the impairments that can be created are in common). Section 6.0 explains the categories used in this RP.

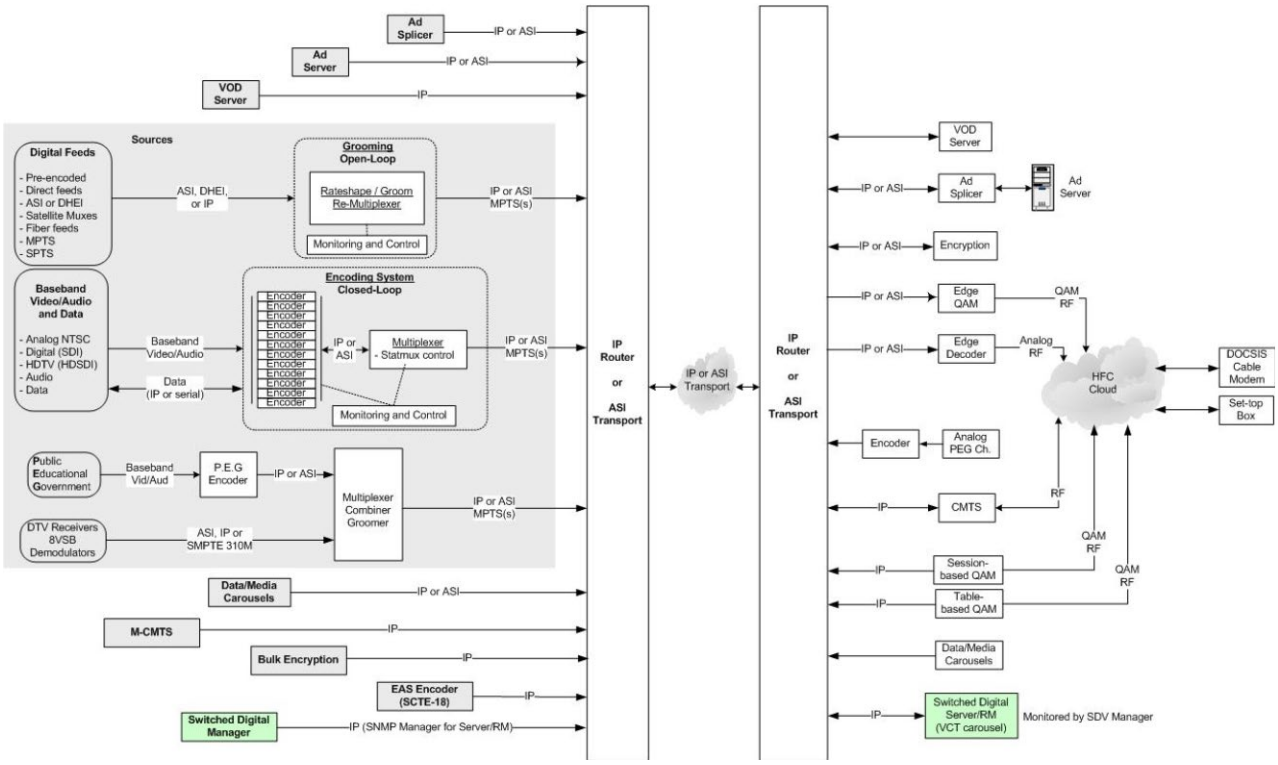

Figure 5-2 : Representative Cable Architecture

The metrics are used to provide insight to video/audio impairments while the categories help to define the location of the impairment and ultimately the root cause based on the type of equipment introducing the impairment. SCTE 142 [5] provides a methodology for transport stream conformance criteria, describing the elements and parameters that should be verified in an SCTE Transport Stream for it to be considered a proper emission. SCTE 142 also establishes severity ranges for deviations from the standardized limits found in SCTE 54 [3], ATSC A/53-3 [6] and ATSC A/65 [7]. SCTE 142, however, does not provide recommendations about where in a cable plant particular metrics would be useful, especially in the determination that impairments exist and the ability to localize them.

The target audience for this RP is the members of the cable community responsible for quality control for the compressed content flowing through the cable plant, as well as those who determine the strategy and approach for deploying monitoring equipment aimed at ensuring things run smoothly. As is usual with recommended practices, the recommendations in this document do not represent the only way to achieve this goal, but one that, if followed, will work. Other approaches may be used.

Since this recommended practice draws from SCTE-142, a brief summary of the major aspects of the methodology established therein follows:

SCTE-142 identifies transport stream issues by type, dividing errors into the following categories:

- PSI tables (PAT and PMT): An SCTE transport stream is also required to be MPEG-2 conformant. Therefore, an SCTE transport stream must include the two mandatory Program Specific Information (PSI) tables. These two tables are known as the Program Association Table (PAT) and the Program Map Table (PMT). The syntax is defined within ISO/IEC 13818-1 [9].
- Out-Of-Band Tables: ANSI/SCTE 65 [4] defines out-of-band service information for cable. The service information is designed to support "navigation devices" on cable. There are two main categories of information in the ANSI/SCTE 65 Standard, system information and schedule data. System information allows navigation among and access to the channels currently within the DTV transport stream. It is similar to the PSI data discussed elsewhere in this document. The schedule data provides necessary information for efficient browsing and selection of current and future events.
- In-Band Tables: In band tables include EAS messages (SCTE-18 [1]) and DPI messages (SCTE-35 [2]).
- PSIP tables (MGT, VCT, etc.): PSIP (ATSC A/65) [7] is the glue that holds the digital television (DTV) signal together. PSIP is a voluntary standard of ATSC and the SCTE and it has been fully and completely adopted into the regulations of the Federal Communications Commission (FCC), so it is, in fact, a requirement in terms of actual real-world operation[1]. In most locations, multiple DTV stations can be received, and in some cases, from multiple markets. The purpose of PSIP is to describe the information at the system and event levels and to enable an abstract of the collection of programs called a virtual channel. There are two main categories of information in the ATSC PSIP Standard, system information and schedule data. System information allows navigation among and access to the channels currently within the DTV transport stream. It is similar to the PSI data discussed elsewhere in this document. The schedule data provides necessary information for efficient browsing and selection of current and future events.
- Timing Model and Buffering: Timing is the key to the MPEG-2 encoding and decoding processes. MPEG-2 Systems (ISO/IEC 13818-1) [9] defines a model for the system timing, adherence to which allows independent design of encoders and decoders that can interoperate. An MPEG-2 decoder's 27 MHz reference clock needs to be synchronized with the equipment that is creating the encoded stream. In order to achieve this synchronization, PCR (Program Clock Reference) 27 MHz clock timestamps are sent within the stream at a rate frequent enough to re-synchronize the decoder with the encoder clock. The incorporation and use of Presentation and Decoding Time Stamps (PTS & DTS) enables synchronization between elements of a program (lip synch). The buffer model ensures that sufficient storage will be available in the receiver to hold the frames of audio and video until they need to be decoded.
- Consistency: Before a receiver can decode a transport stream, it must identify the relationship between components in the stream. Some components contain audio and video (Elementary Streams), and other components contain information describing the relationship between them (Metadata). The receiver uses metadata to identify each component, determine its function and select an appropriate set of components when the

[1] The current version of ATSC A/65 contains additional features and capabilities that are not covered by this RP.

user selects a virtual channel for decoding. Conflicts and problems within the structure of metadata are called 'consistency errors.' Consistency errors can result in broken decoding, missing system components (such as closed captioning), and/or missing program guide information. This section covers the types of errors that can cause these problems.

- General Errors: General errors cover a variety of types of problems (typically transport-related). For those listed in only the QOS and TNC columns, a single occurrence should be treated merely as a minor problem, which, unless periodically re-occurring, is not of concern. A repeated occurrence should warrant investigation, as it might be indicative of a device approaching total failure.

5.1 Discussion of Error Severity Classification

In addition to categorizing types of errors, SCTE-142 established a classification of error severities. While all variations from values established in the appropriate standards should be avoided (impairments), the impact of a particular impairment varies depending upon how large the variation is. Minor excursions from a standardized limit may produce no viewer perceived quality issue (for example, a PAT cycle time of 102ms). Major excursions typically represent serious quality issues. From an operational viewpoint, placing equal emphasis on all errors, no matter the severity will lead to operator fatigue (i.e. ignore red lights on the alarm screen, because there are always some lit). The error severity classification established in SCTE-142 is described below and offers a means to alleviate the problem just described:

- **Transport Stream Off Air (TOA)**: The transport is effectively off-air as the Transport Stream errors are severe enough that transport level logical constructs are damaged beyond utility. Receivers will not be able to tune and decode anything within the transport. The complete or repeated absence of sync bytes would be an example of this level of error.
- **Program Off Air (POA):** A main service (virtual channel) is flawed to the point that that service is effectively off air for conformant/reasonable receiver designs. This could involve all of the program elements being improperly constructed or incorrect/missing signaling about elements. The absence of a PMT instance for a service would be an example of this type of error.
- **Component missing (CM):** One of the program components that is signaled by PSIP or PSI as present is either not present or cannot be found and decoded. One example would be a mismatch between the video PID signaled in the PMT and the actual PID used for the video elementary stream.
- **Quality of Service (QOS)**: Parameters are out of specification by such a margin that a significant fraction of the receivers can be expected to produce flawed outputs. In many cases, the broadcast is viewable, but may exhibit some form of degradation to the viewer. An example might be the PAT cycle time being somewhat longer than the specification, which would cause slower than normal tuning.
- **Technically Non-Conformant (TNC)**: Violates the letter of the standard, but in practice will have little effect on the viewing experience. Errors of this type may need to be corrected, but do not have the urgency of higher severity errors, while oters are due to

"shall statement" collisions. An example might be a single instance of a 102 ms PAT cycle time (with the remainder of the PATs coming at less than 100 ms intervals).

In most cases the error threshold for what may appear to be escalating categorization is based on: 1) the official metric to twice the metric, 2) twice the official metric to 5 times the metric, and 3) over five times the metric. The nominal mathematical expression of this is shown below, where Tc is the metric for the cycle time and t is the time since the last arrival (note that for clarity of expression of the time intervals, this document ignores time advances during each millisecond increment):

1. $Tc < t \leq 2Tc$
2. $2Tc < t \leq 5Tc$
3. $5Tc < t$

This scale can prevent "shall-statement collisions" from producing meaningless error alarms, yet provides guidance to equipment makers and users regarding severities.

6.0 METRICS ORGANIZATION

For practicality, this document has decomposed the system in figure 5.2 above into a small number of major functional categories; each consisting of a number of functional blocks (devices) with characteristics and types of compressed streams in common. The presence of common characteristics allows a grouping of impairments (metrics) that would be appropriate to capture for different devices in order to allow localization to take place. In all cases, the measurement point for these metrics for each device is the output of the device.

Table 6.1 lists the major functional categories, classifies each functional block (along with a brief explanation of the function of that block) and then groups each functional block by characteristics of the manipulations and transport streams.

The major functional categories are:

- Origination – Sources of compressed content distributed by the cable system, including encoders, video servers and external sources of compressed content coming from outside of the digital cable plant. (Example: video/audio encoding from analog.)
- Manipulation – Receives streams of compressed content, processes it and outputs the modified form. (example: remultiplexing to change the markup of transport streams).
- Last Mile – Transforms compressed content to a form that can be distributed to the receiver. (example: QAM modulation onto HFC).

Table 6-1 : Category/Functional Block/Metrics Mapping

Functional Category	Functional Block	Description	Metrics Set * Naming convention is to group functions.
Origination	8-VSB Demod	Receiver for ATSC DTV broadcast taking in 8-VSB RF signals and outputting digital MPEG-2 Transport Streams.	Metrics A
Origination	Ad Server	Video Server that plays out Advertising clips for insertion.	Metrics B
Origination	VOD Server	Video Server for Video on Demand playout.	Metrics B
Origination	Encoder	MPEG compression of video and audio sources that make up a program	Metrics B
Manipulation	Encryptor	Encryption of subscription services	Metrics C
Manipulation	Groomer/ Rateshaper	Device that allows selection of programs from an existing MPTS sources, as well as modification of the bit rate for each program.	Metrics C
Origination	Mux	Device that combines a number of SPTS streams into an MPTS stream	Metrics C
Last Mile	QAM Modulator	Device that modulates and upconverts digital transports for carriage over an HFC distribution system using QAM	Metrics C
Origination	Satellite Receiver	Receiver for digital satellite broadcast signals (typically using QPSK or xPSK modulation), which outputs digital MPEG-2 Transport Streams	Metrics C

Manipulation	Remux	Device that combines one or more MPTS streams into a single MPTS output, allowing the selection of which programs are included	Metrics C
Manipulation	Ad Splicer	Device that inserts ad clips directly into a compressed transport stream (refer to SCTE 35 [2])	Metrics C
Last Mile	CPE/STB	Consumer Premises Equipment/Set-Top Box (receiving device)	Metrics C
Origination	Digital Feeds	Compressed Mpeg-2 Transport Streams from external sources entering the cable system.	Metrics C
Origination	DPI Encoder	Device (typically an MPEG encoder) that creates/inserts Digital Program Insertion (SCTE 35) messages, usually in response to SCTE104 trigger messages	Metrics D[2]
Origination	EAS Generator	Device that creates/inserts Emergency Alert Messages (SCTE 18)	Metrics E

[2] Note: The DPI Encoder is not show in Figure 5-2 or Figure 6-1

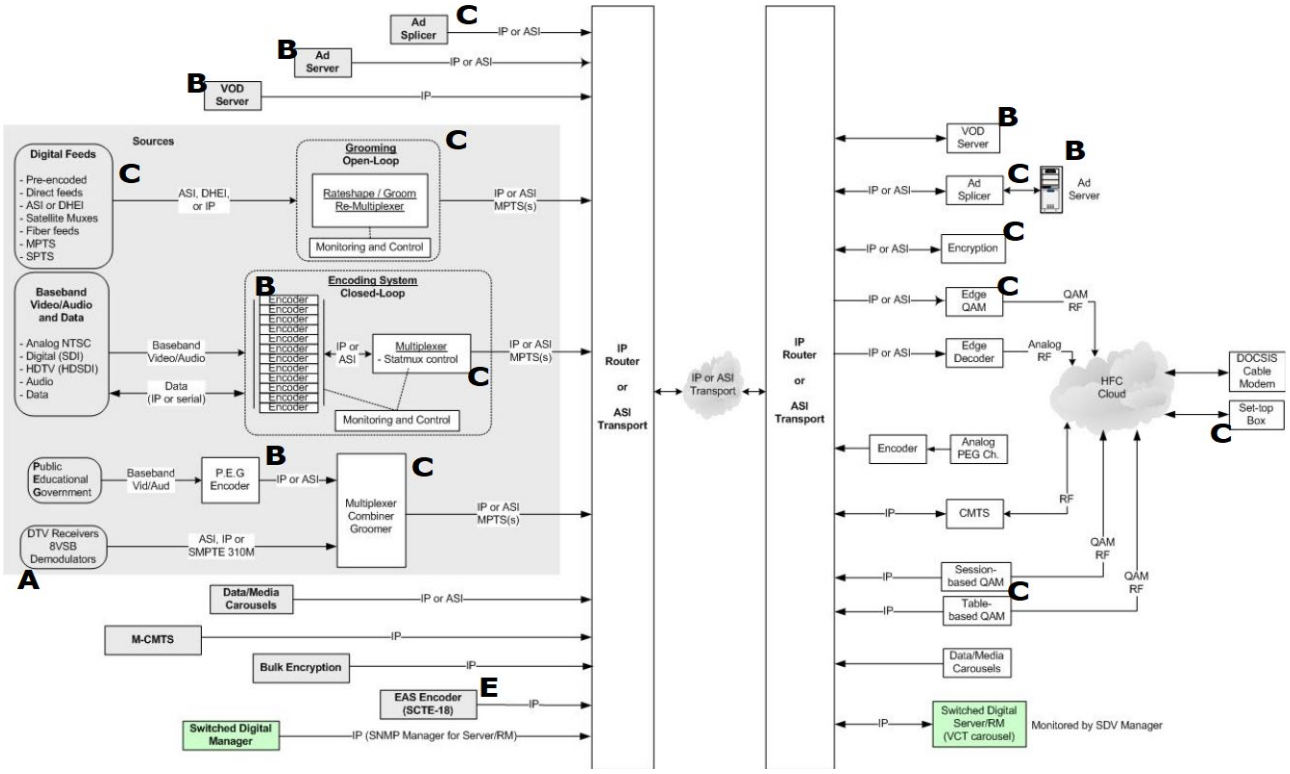

Figure 6-1 : Metrics groupings

7.0 METRICS A

Metrics A is a member of the Origination category and is appropriate for the 8-VSB Demodulator only. This collection of metrics is appropriate for ingest of ATSC terrestrial broadcast signals (sometimes referred to as OTA (Over The Air) signals) that are meant for carriage within the cable system. The set of metrics in the table below replicates what is in ATSC A/78 [8], which is an ATSC recommended practice for bitstream verification. The ability to determine the presence of impairments in compressed material coming from outside of the cable plant is important – clearly, if there are impairments in the incoming stream(s), then it is likely that problems also lie outside of the cable plant.

Because of the need to carry portions of the PSIP metadata through the cable plant (under certain circumstances) besides validating the MPEG transport characteristics, it is important to ensure that the PSIP information is valid as well

Metrics A includes nearly all Impairment Categories

- General

- PSI Errors
- PSIP Errors
- Timing and Buffer Errors
- Consistency Errors

Table 7-1 : Metrics A

Functional Blocks	**8-VSB Demod**				
Impairment Category	**Metric**	**Measurement**		**Qualifier**	**Severity**
General	TS Synch Loss	Presence	Boolean	Two or More Synch Bytes Corrupt	TOA
General	Synch Byte Error	Presence	Boolean	Single Synch Byte not 0x47	QOS
General	Continuity Count Errors	Count/sec	Integer	None	QOS
General	Transport error	Presence	Boolean	transport_error_indicator in TS packet header is set	TNC
General	Multiple registration descriptors	Presence	Boolean	Multiple registration descriptors in any given iteration of a descriptor loop	TNC
General	Missing Descriptors	Presence	Boolean	One or more required descriptors were not found in the stream	CM
PSI Errors	PAT repetition interval error	Cycle Time (ms)	Integer	100ms < cycle time □ 200ms	TNC
PSI Errors	PAT repetition interval error	Cycle Time (ms)	Integer	200ms < cycle time □ 500ms	QOS
PSI Errors	PAT absence error: PAT not found	Cycle Time (ms)	Integer	cycle time > 500ms	TOA
PSI Errors	PAT syntax error:	Presence	Boolean	Packet with PID 0x0000 doesn't have table_id 0x00	TOA

PSI Errors	PAT syntax error	Presence	Boolean	CRC is incorrect for table_id 0x00 within PID 0x0000	TNC
PSI Errors	PAT syntax error	Presence	Boolean	scrambling_control_field is not ‘00’ for packet within PID 0x0000	TOA
PSI Errors	PMT repetition interval error	Cycle Time (ms)	Integer	400ms < cycle time □ 800ms	TNC
PSI Errors	PMT repetition interval error	Cycle Time (ms)	Integer	800ms < cycle time □ 2000ms	QOS
PSI Errors	PMT absence error: PMT not found	Cycle Time (ms)	Integer	cycle time > 2000ms	POA
PSI Errors	PMT syntax error	Presence	Boolean	Packet with PID 0x0000 doesn’t have table_id 0x00	POA
PSI Errors	PMT syntax error	Presence	Boolean	CRC is incorrect for table_id	POA
PSI Errors	PMT syntax error	Presence	Boolean	scrambling_control_field is not ‘00’ for packets containing PMT	POA
PSI Errors	PMT syntax error	Presence	Boolean	“PMT_PID” referenced by PAT not found	POA
PSIP Errors	MGT repetition interval error	Cycle Time (ms)	Integer	150ms < cycle time □ 300ms	TNC
PSIP Errors	MGT repetition interval error	Cycle Time (ms)	Integer	300ms < cycle time □ 750ms	QOS
PSIP Errors	MGT absence error	Cycle Time (ms)	Integer	cycle time > 750ms	TOA
PSIP Errors	MGT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xC7	TNC
PSIP Errors	MGT syntax error	Presence	Boolean	scrambling_control_field is not ‘00’ for packets containing MGT	TOA
PSIP Errors	TVCT repetition interval error	Cycle Time (ms)	Integer	400ms < cycle time □ 800ms	TNC
PSIP Errors	TVCT repetition interval error	Cycle Time (ms)	Integer	800ms < cycle time □ 2000ms	QOS

PSIP Errors	TVCT absence error: TVCT not found	Cycle Time (ms)	Integer	cycle time > 2000ms	TOA
PSIP Errors	TVCT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xC8	TNC
PSIP Errors	TVCT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing TVCT	TOA
PSIP Errors	CVCT repetition interval error	Cycle Time (ms)	Integer	400ms < cycle time □ 800ms	TNC
PSIP Errors	CVCT repetition interval error	Cycle Time (ms)	Integer	800ms < cycle time □ 2000ms	QOS
PSIP Errors	CVCT absence error	Cycle Time (ms)	Integer	cycle time > 2000ms	POA
PSIP Errors	CVCT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xC8	TNC
PSIP Errors	CVCT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing CVCT	POA
PSIP Errors	RRT repetition interval error	Cycle Time (ms)	Integer	60,000ms < cycle time □120,000ms	TNC
PSIP Errors	RRT repetition interval error	Cycle Time (ms)	Integer	120,000ms < cycle time □ 300,000ms	QOS
PSIP Errors	RRT absence error	Cycle Time (ms)	Integer	cycle time > 300,000ms	CM
PSIP Errors	RRT syntax error	Cycle Time (ms)	Integer	CRC is incorrect for table_id 0xCA	TNC
PSIP Errors	RRT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing RRT	CM
PSIP Errors	EIT-0 repetition interval error	Cycle Time (ms)	Integer	500ms < cycle time □ 1000ms	TNC
PSIP Errors	EIT-0 repetition interval error	Cycle Time (ms)	Integer	1000ms < cycle time □ 2500ms	QOS
PSIP Errors	EIT-0 absence error	Cycle Time (ms)	Integer	cycle time > 2500ms	POA
PSIP Errors	EIT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xCB	TNC

PSIP Errors	EIT syntax error	Presence	Boolean	scrambling_control_field is not ‘00’ for packets containing EIT	CM
PSIP Errors	EIT-1 repetition interval error		Integer	3 seconds < cycle time □ 6 seconds	TNC
PSIP Errors	EIT-1 repetition interval error	Cycle Time (s)	Integer	6 seconds < cycle time □ 15 seconds	QOS
PSIP Errors	EIT-1 absence error	Cycle Time (s)	Integer	cycle time > 15 seconds	CM
PSIP Errors	EIT-2, EIT-3 repetition interval error	Cycle Time (minutes)	Integer	1 minute < cycle time □ 2 minutes	TNC
PSIP Errors	EIT-2, EIT-3 repetition interval error	Cycle Time (minutes)	Integer	2 minutes < cycle time □ 5 minutes	QOS
PSIP Errors	EIT-2, EIT-3 absence error	Cycle Time (minutes)	Integer	cycle time > 5 minutes	CM
PSIP Errors	ETT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xCC	TNC
PSIP Errors	ETT syntax error	Presence	Boolean	scrambling_control_field is not ‘00’ for packets containing ETT	CM
PSIP Errors	STT repetition interval error	Cycle Time (ms)	Integer	1000ms < cycle time □ 2000ms	TNC
PSIP Errors	STT repetition interval error	Cycle Time (ms)	Integer	2000ms < cycle time □ 5000ms	QOS
PSIP Errors	STT absence error	Cycle Time (ms)	Integer	cycle time > 5000ms	CM
PSIP Errors	STT syntax errors	Presence	Boolean	CRC is incorrect for table_id 0xCD	TNC
PSIP Errors	STT time value error	STT time delta (seconds)	Integer	STT time value is more than 30 seconds away from current correct GPS second_count (including GPS_UTC_offset impact)	CM
Timing and Buffer Errors	PCR error	Presence	Boolean	Unsignaled PCR discontinuity	QOS
Timing and Buffer Errors	PCR repetition error	Cycle Time (ms)	Integer	100ms < cycle time □ 200ms	TNC
Timing and	PCR repetition	Cycle Time	Integer	200ms < cycle time □ 500ms	QOS

Buffer Errors	error	(ms)			
Timing and Buffer Errors	PCR absence error: PCR not found	Cycle Time (ms)	Integer	cycle time > 500ms	POA
Timing and Buffer Errors	PCR error	PCR inaccuracy (ns)	Integer	500 ns < □PCR inaccuracy□ □ 2500 ns	TNC
Timing and Buffer Errors	PCR error	PCR inaccuracy (ns)	Integer	□PCR inaccuracy□ > 2500 ns	QOS
Timing and Buffer Errors	PCR related parameters	PCR frequency offset (Hz)	Integer	810 Hz < PCR frequency offset □ 4050 Hz	TNC
Timing and Buffer Errors	PCR related parameters	PCR frequency offset (Hz)	Integer	PCR frequency offset > 4050 Hz)	QOS
Timing and Buffer Errors	PCR related parameters	PCR Frequency Drift (mHz/s)	Integer	75 milliHerz/second (mHz/s) < PCR frequency drift □ 375 mHz/s	TNC
Timing and Buffer Errors	PCR related parameters	PCR Frequency Drift (mHz/s)	Integer	PCR frequency drift > 375 mHz/s	QOS
Timing and Buffer Errors	PCR related parameters	PCR jitter (□s)	Integer	25 □S < PCR overall jitter □ 125 □s	TNC
Timing and Buffer Errors	PCR related parameters	PCR jitter (□s)	Integer	PCR overall jitter > 125 □S	QOS
Timing and Buffer Errors	PTS interval error	Time interval (ms)	Integer	700 ms < Interval between coded PTS values □ 1400 ms	TNC
Timing and Buffer Errors	PTS interval error	Time interval (ms)	Integer	1400 ms < Interval between coded PTS values □ 3500 ms	QOS
Timing and Buffer Errors	PTS absence error	Time interval (ms)	Integer	Interval between coded PTS values > 3500 ms	CM
Timing and Buffer Errors	PTS increment error	Presence	Boolean	PTS time not incrementing at the reciprocal of the frame rate	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	PTS time not incrementing at the reciprocal of the frame rate	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of transport buffer	TNC

Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of system information buffer	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of MPEG-2 Video buffer	QOS
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Underflow of MPEG-2 Video buffer	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of AC-3 Audio buffer	QOS
Consistency Errors	TSID values in PAT and VCT (transport_stream_id) do not match	Presence	Boolean	None	TOA
Consistency Errors	PAT/VCT mismatch	Presence	Boolean	Different number of programs found in VCT than signaled in PAT	POA
Consistency Errors	VCT/PMT mismatch	Presence	Boolean	SLD/PMT mismatch (number of services)	POA
Consistency Errors	VCT/PMT mismatch	Presence	Boolean	SLD/PMT element mismatch (different “parameters” for matching program elements)	CM
Consistency Errors	PMT/EIT-0 descriptor mismatch	Presence	Boolean	Mismatch in duplicated descriptors for current event between PMT and EIT-0	CM
Consistency Errors	ETT syntax errors	Presence	Boolean	ETT has invalid ETM_ID or ETM_ID does not match existing event_id in EIT (excludes channel ETT)	CM
Consistency Errors	ETT syntax errors	Presence	Boolean	ETT has ETM_ID of channel ETT, but MGT does not flag channel ETT on this PID	QOS
Consistency Errors	Multiple sources of PSI	Presence	Boolean	Version numbers for particular PSI tables should never decrease (except at wraparound)	TOA
Consistency Errors	Daylight Savings time settings	Presence	Boolean	STT contains invalid values for Daylight Savings time switchover	TNC
Consistency Errors	Service Location Descriptor missing from VCT	Presence	Boolean	No Service Location Descriptor in VCT	POA

Consistency Errors	Dangling source_id	Presence	Boolean	source_id mismatch (either source_id in VCT does not have a corresponding source_id in EIT or source_id in EIT does not have a corresponding source_id in VCT)	POA
Consistency Errors	MGT mismatch	Presence	Boolean	Version number and/or size of tables signaled in MTG does not match with actual table	QOS
Consistency Errors	MGT mismatch	Presence	Boolean	PSIP table found in stream, but not signaled in MGT	TNC

8.0 METRICS B

Metrics B includes Ad Servers, Video/Audio Encoders and VOD Servers. These devices act as originators of compressed content, carried via MPEG-2 Transport Streams. As such, the compressed streams from these devices typically carry only the minimum necessary set of metadata (MPEG-2 PSI). For this reason, only the following impairment categories are included:

- General
- PSI Errors
- Timing and Buffer Errors
- Consistency Errors (partial)

Table 8-1 : Metrics B

Functional Blocks	**Ad Server, Encoder, VOD Server**				
Impairment Category	**Metric**	**Measurement**		**Qualifier**	**Severity**
General	TS Synch Loss	Presence	Boolean	Two or More Synch Bytes Corrupt	TOA
General	Synch Byte Error	Presence	Boolean	Single Synch Byte not 0x47	QOS
General	Continuity Count Errors	Count/sec	Integer	None	QOS

General	Transport error	Presence	Boolean	transport_error_indicator in TS packet header is set	TNC
General	Multiple registration descriptors	Presence	Boolean	Multiple registration descriptors in any given iteration of a descriptor loop	TNC
General	Missing Descriptors	Presence	Boolean	One or more required descriptors were not found in the stream	CM
PSI Errors	PAT repetition interval error	Cycle Time (ms)	Integer	100ms < cycle time □ 200ms	TNC
PSI Errors	PAT repetition interval error	Cycle Time (ms)	Integer	200ms < cycle time □ 500ms	QOS
PSI Errors	PAT absence error: PAT not found	Cycle Time (ms)	Integer	cycle time > 500ms	TOA
PSI Errors	PAT syntax error:	Presence	Boolean	Packet with PID 0x0000 doesn't have table_id 0x00	TOA
PSI Errors	PAT syntax error	Presence	Boolean	CRC is incorrect for table_id 0x00 within PID 0x0000	TNC
PSI Errors	PAT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packet within PID 0x0000	TOA
PSI Errors	PMT repetition interval error	Cycle Time (ms)	Integer	400ms < cycle time □ 800ms	TNC
PSI Errors	PMT repetition interval error	Cycle Time (ms)	Integer	800ms < cycle time □ 2000ms	QOS
PSI Errors	PMT absence error: PMT not found	Cycle Time (ms)	Integer	cycle time > 2000ms	POA
PSI Errors	PMT syntax error	Presence	Boolean	Packet with PID 0x0000 doesn't have table_id 0x00	POA
PSI Errors	PMT syntax error	Presence	Boolean	CRC is incorrect for table_id	POA
PSI Errors	PMT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing PMT	POA
PSI Errors	PMT syntax error	Presence	Boolean	"PMT_PID" referenced by PAT not found	POA

Timing and Buffer Errors	PCR error	Presence	Boolean	Unsignaled PCR discontinuity	QOS
Timing and Buffer Errors	PCR repetition error	Cycle Time (ms)	Integer	100ms < cycle time □ 200ms	TNC
Timing and Buffer Errors	PCR repetition error	Cycle Time (ms)	Integer	200ms < cycle time □ 500ms	QOS
Timing and Buffer Errors	PCR absence error: PCR not found	Cycle Time (ms)	Integer	cycle time > 500ms	POA
Timing and Buffer Errors	PCR error	PCR inaccuracy (ns)	Integer	500 ns < □PCR inaccuracy□ □ 2500 ns	TNC
Timing and Buffer Errors	PCR error	PCR inaccuracy (ns)	Integer	□PCR inaccuracy□ > 2500 ns	QOS
Timing and Buffer Errors	PCR related parameters	PCR frequency offset (Hz)	Integer	810 Hz < PCR frequency offset □ 4050 Hz	TNC
Timing and Buffer Errors	PCR related parameters	PCR frequency offset (Hz)	Integer	PCR frequency offset > 4050 Hz)	QOS
Timing and Buffer Errors	PCR related parameters	PCR Frequency Drift (mHz/s)	Integer	75 milliHerz/second (mHz/s) < PCR frequency drift □ 375 mHz/s	TNC
Timing and Buffer Errors	PCR related parameters	PCR Frequency Drift (mHz/s)	Integer	PCR frequency drift > 375 mHz/s	QOS
Timing and Buffer Errors	PCR related parameters	PCR jitter (□s)	Integer	25 □S < PCR overall jitter □ 125 □s	TNC
Timing and Buffer Errors	PCR related parameters	PCR jitter (□s)	Integer	PCR overall jitter > 125 □S	QOS
Timing and Buffer Errors	PTS interval error	Time interval (ms)	Integer	700 ms < Interval between coded PTS values □ 1400 ms	TNC
Timing and Buffer Errors	PTS interval error	Time interval (ms)	Integer	1400 ms < Interval between coded PTS values □ 3500 ms	QOS
Timing and Buffer Errors	PTS absence error	Time interval (ms)	Integer	Interval between coded PTS values > 3500 ms	CM

Timing and Buffer Errors	PTS increment error	Presence	Boolean	PTS time not incrementing at the reciprocal of the frame rate	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	PTS time not incrementing at the reciprocal of the frame rate	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of transport buffer	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of system information buffer	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of MPEG-2 Video buffer	QOS
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Underflow of MPEG-2 Video buffer	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of AC-3 Audio buffer	QOS
Consistency Errors	Multiple sources of PSI	Presence	Boolean	Version numbers for particular PSI tables should never decrease (except at wraparound)	TOA

9.0 METRICS C

Metrics C includes devices that manipulate, modify, process or decode MPEG-2 Transport Streams. Devices included in this category are: Ad Splicer, CPE/STB, Digital Feeds, Encryptor, Groomer/Rateshaper, Mux, QAM modulator and Remux. The Transport Streams flowing through these devices typically represent complete services and contain a complete set of metadata. For this reason, all of the Impairment Categories are included:

- General
- PSI Errors
- SCTE-65 Out Of Band Table Errors
- In Band Table Errors
- PSIP Errors
- Timing and Buffer Errors
- Consistency Errors

Table 9-1 : Metrics C

Functional Blocks	**Ad Splicer, CPE/STB, Digital Feeds, Encryptor, Groomer/Rateshaper, Mux, QAM Modulator, Remux**				
Impairment Category	**Metric**	**Measurement**		**Qualifier**	**Severity**
General	TS Synch Loss	Presence	Boolean	Two or More Synch Bytes Corrupt	TOA
General	Synch Byte Error	Presence	Boolean	Single Synch Byte not 0x47	QOS
General	Continuity Count Errors	Count/sec	Integer	None	QOS
General	Transport error	Presence	Boolean	transport_error_indicator in TS packet header is set	TNC
General	Multiple registration descriptors	Presence	Boolean	Multiple registration descriptors in any given iteration of a descriptor loop	TNC
General	Missing Descriptors	Presence	Boolean	One or more required descriptors were not found in the stream	CM

PSI Errors	PAT repetition interval error	Cycle Time (ms)	Integer	100ms < cycle time □ 200ms	TNC
PSI Errors	PAT repetition interval error	Cycle Time (ms)	Integer	200ms < cycle time □ 500ms	QOS
PSI Errors	PAT absence error: PAT not found	Cycle Time (ms)	Integer	cycle time > 500ms	TOA
PSI Errors	PAT syntax error:	Presence	Boolean	Packet with PID 0x0000 doesn't have table_id 0x00	TOA
PSI Errors	PAT syntax error	Presence	Boolean	CRC is incorrect for table_id 0x00 within PID 0x0000	TNC
PSI Errors	PAT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packet within PID 0x0000	TOA
PSI Errors	PMT repetition interval error	Cycle Time (ms)	Integer	400ms < cycle time □ 800ms	TNC
PSI Errors	PMT repetition interval error	Cycle Time (ms)	Integer	800ms < cycle time □ 2000ms	QOS
PSI Errors	PMT absence error: PMT not found	Cycle Time (ms)	Integer	cycle time > 2000ms	POA
PSI Errors	PMT syntax error	Presence	Boolean	Packet with PID 0x0000 doesn't have table_id 0x00	POA
PSI Errors	PMT syntax error	Presence	Boolean	CRC is incorrect for table_id	POA
PSI Errors	PMT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing PMT	POA
PSI Errors	PMT syntax error	Presence	Boolean	"PMT_PID" referenced by PAT not found	POA
SCTE 65 Out-Of-Band Table Errors	MGT repetition interval error	Cycle Time (ms)	Integer	500ms < cycle time □ 1000ms	TNC

SCTE-65 Out-Of-Band Table Errors	MGT repetition interval error	Cycle Time (ms)	Integer	1000ms < cycle time □ 5000ms	QOS
SCTE-65 Out-Of-Band Table Errors	MGT absence error: MGT not found	Cycle Time (ms)	Integer	cycle time > 5000ms	TOA
SCTE-65 Out-Of-Band Table Errors	MGT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xC7	TNC
SCTE-65 Out-Of-Band Table Errors	MGT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing MGT	TOA
SCTE-65 Out-Of-Band Table Errors	S-VCT repetition interval error	Cycle Time (minutes)	Integer	2 minutes < cycle time □ 4 minutes	TNC
SCTE-65 Out-Of-Band Table Errors	S-VCT repetition interval error	Cycle Time (minutes)	Integer	4 minutes < cycle time □ 10 minutes	QOS
SCTE-65 Out-Of-Band Table Errors	S-VCT absence error	Cycle Time (minutes)	Integer	cycle time > 10 minutes	POA
SCTE-65 Out-Of-Band Table Errors	S-VCT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xC4	TNC
SCTE-65 Out-Of-Band Table Errors	S-VCT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing S-VCT	POA
SCTE-65 Out-Of-Band Table Errors	L-VCT repetition interval error	Cycle Time (minutes)	Integer	2 minutes < cycle time □ 4 minutes	TNC
SCTE-65 Out-Of-Band Table Errors	L-VCT repetition interval error	Cycle Time (minutes)	Integer	4 minutes < cycle time □ 10 minutes	QOS
SCTE-65 Out-Of-Band Table Errors	L-VCT absence error: L-VCT not found	Cycle Time (minutes)	Integer	cycle time > 10 minutes	POA
SCTE-65 Out-Of-Band Table	L-VCT syntax error: CRC is	Presence	Boolean	None	TNC

Errors	incorrect for table_id 0xC9				
SCTE-65 Out-Of-Band Table Errors	L-VCT syntax error: scrambling_control_field is not '00' for packets containing L-VCT	Presence	Boolean	None	POA
SCTE-65 Out-Of-Band Table Errors	RRT repetition interval error	Cycle Time (minutes)	Integer	1 minute < cycle time □ 2 minutes	TNC
SCTE-65 Out-Of-Band Table Errors	RRT repetition interval error	Cycle Time (minutes)	Integer	2 minutes < cycle time □ 5 minutes	QOS
SCTE-65 Out-Of-Band Table Errors	RRT absence error: RRT not found	Cycle Time (minutes)	Integer	cycle time > 5 minutes	CM
SCTE-65 Out-Of-Band Table Errors	RRT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xC9	TNC
SCTE-65 Out-Of-Band Table Errors	RRT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing RRT	CM
SCTE-65 Out-Of-Band Table Errors	AEIT-0,1/AETT-0,1 syntax error	Presence	Boolean	sections with common MGT_tag values do not share a common PID	CM
SCTE-65 Out-Of-Band Table Errors	AEIT-2,3/AETT-2,3 syntax error	Presence	Boolean	sections with common MGT_tag values do not share a common PID	CM
SCTE-65 Out-Of-Band Table Errors	AEIT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xD6	TNC
SCTE-65 Out-Of-Band Table Errors	AEIT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing AEIT	CM
SCTE-65 Out-Of-Band Table Errors	AETT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xD7	TNC
SCTE-65 Out-Of-Band Table	AETT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing	CM

Errors				AETT	
SCTE-65 Out-Of-Band Table Errors	STT repetition interval error	Cycle Time (minutes)	Integer	1 minute < cycle time □ 2 minutes	TNC
SCTE-65 Out-Of-Band Table Errors	STT repetition interval error	Cycle Time (minutes)	Integer	2 minutes < cycle time □ 5 minutes	QOS
SCTE-65 Out-Of-Band Table Errors	STT absence error: STT not found	Cycle Time (minutes)	Integer	cycle time > 5 minutes	CM
SCTE-65 Out-Of-Band Table Errors	STT syntax errors	Presence	Boolean	CRC is incorrect for table_id 0xC5	TNC
SCTE-65 Out-Of-Band Table Errors	STT time value error	Presence	Boolean	STT time value is more than 30 seconds away from current correct GPS second_count (including GPS_UTC_offset impact)	CM
In-Band Tables	SCTE 35 missing MRD	Presence	Boolean	Section with table_id 0xFC found on PID not associated with an SCTE 35 registration descriptor in the PMT	CM
In-Band Tables	SCTE 35 CRC error	Presence	Boolean	CRC is incorrect for table_id 0xFC	CM
In-Band Tables	EAS syntax error	Presence	Boolean	Section with table_id 0xD8 found on PID other than 0x1FFB or 0x1FFC	
In-Band Tables	EAS syntax error	Presence	Boolean	CRC is incorrect for table_id 0xD8	
PSIP Errors	MGT repetition interval error	Cycle Time (ms)	Integer	150ms < cycle time □ 300ms	TNC
PSIP Errors	MGT repetition interval error	Cycle Time (ms)	Integer	300ms < cycle time □ 750ms	QOS
PSIP Errors	MGT absence error	Cycle Time (ms)	Integer	cycle time > 750ms	TOA

PSIP Errors	MGT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xC7	TNC
PSIP Errors	MGT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing MGT	TOA
PSIP Errors	TVCT repetition interval error	Cycle Time (ms)	Integer	400ms < cycle time □ 800ms	TNC
PSIP Errors	TVCT repetition interval error	Cycle Time (ms)	Integer	800ms < cycle time □ 2000ms	QOS
PSIP Errors	TVCT absence error: TVCT not found	Cycle Time (ms)	Integer	cycle time > 2000ms	TOA
PSIP Errors	TVCT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xC8	TNC
PSIP Errors	TVCT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing TVCT	TOA
PSIP Errors	CVCT repetition interval error	Cycle Time (ms)	Integer	400ms < cycle time □ 800ms	TNC
PSIP Errors	CVCT repetition interval error	Cycle Time (ms)	Integer	800ms < cycle time □ 2000ms	QOS
PSIP Errors	CVCT absence error	Cycle Time (ms)	Integer	cycle time > 2000ms	POA
PSIP Errors	CVCT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xC8	TNC
PSIP Errors	CVCT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing CVCT	POA
PSIP Errors	RRT repetition interval error	Cycle Time (ms)	Integer	60,000ms < cycle time □120,000ms	TNC
PSIP Errors	RRT repetition interval error	Cycle Time (ms)	Integer	120,000ms < cycle time □ 300,000ms	QOS

PSIP Errors	RRT absence error	Cycle Time (ms)	Integer	cycle time > 300,000ms	CM
PSIP Errors	RRT syntax error	Cycle Time (ms)	Integer	CRC is incorrect for table_id 0xCA	TNC
PSIP Errors	RRT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing RRT	CM
PSIP Errors	EIT-0 repetition interval error	Cycle Time (ms)	Integer	500ms < cycle time □ 1000ms	TNC
PSIP Errors	EIT-0 repetition interval error	Cycle Time (ms)	Integer	1000ms < cycle time □ 2500ms	QOS
PSIP Errors	EIT-0 absence error	Cycle Time (ms)	Integer	cycle time > 2500ms	POA
PSIP Errors	EIT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xCB	TNC
PSIP Errors	EIT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing EIT	CM
PSIP Errors	EIT-1 repetition interval error	Presence	Boolean	3 seconds < cycle time □ 6 seconds	TNC
PSIP Errors	EIT-1 repetition interval error	Cycle Time (s)	Integer	6 seconds < cycle time □ 15 seconds	QOS
PSIP Errors	EIT-1 absence error	Cycle Time (s)	Integer	cycle time > 15 seconds	CM
PSIP Errors	EIT-2, EIT-3 repetition interval error	Cycle Time (minutes)	Integer	1 minute < cycle time □ 2 minutes	TNC
PSIP Errors	EIT-2, EIT-3 repetition interval error	Cycle Time (minutes)	Integer	2 minutes < cycle time □ 5 minutes	QOS
PSIP Errors	EIT-2, EIT-3 absence error	Cycle Time (minutes)	Integer	cycle time > 5 minutes	CM
PSIP Errors	ETT syntax error	Presence	Boolean	CRC is incorrect for table_id 0xCC	TNC

PSIP Errors	ETT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing ETT	CM
PSIP Errors	STT repetition interval error	Cycle Time (ms)	Integer	1000ms < cycle time □ 2000ms	TNC
PSIP Errors	STT repetition interval error	Cycle Time (ms)	Integer	2000ms < cycle time □ 5000ms	QOS
PSIP Errors	STT absence error	Cycle Time (ms)	Integer	cycle time > 5000ms	CM
PSIP Errors	STT syntax errors	Presence	Boolean	CRC is incorrect for table_id 0xCD	TNC
PSIP Errors	STT time value error	STT time delta (seconds)	Integer	STT time value is more than 30 seconds away from current correct GPS second_count (including GPS_UTC_offset impact)	CM
Timing and Buffer Errors	PCR error	Presence	Boolean	Unsignaled PCR discontinuity	QOS
Timing and Buffer Errors	PCR repetition error	Cycle Time (ms)	Integer	100ms < cycle time □ 200ms	TNC
Timing and Buffer Errors	PCR repetition error	Cycle Time (ms)	Integer	200ms < cycle time □ 500ms	QOS
Timing and Buffer Errors	PCR absence error: PCR not found	Cycle Time (ms)	Integer	cycle time > 500ms	POA
Timing and Buffer Errors	PCR error	PCR inaccuracy (ns)	Integer	500 ns < □PCR inaccuracy□ □ 2500 ns	TNC
Timing and Buffer Errors	PCR error	PCR inaccuracy (ns)	Integer	□PCR inaccuracy□ > 2500 ns	QOS
Timing and Buffer Errors	PCR related parameters	PCR frequency offset (Hz)	Integer	810 Hz < PCR frequency offset □ 4050 Hz	TNC
Timing and Buffer Errors	PCR related parameters	PCR frequency offset (Hz)	Integer	PCR frequency offset > 4050 Hz)	QOS

Timing and Buffer Errors	PCR related parameters	PCR Frequency Drift (mHz/s)	Integer	75 milliHerz/second (mHz/s) < PCR frequency drift □ 375 mHz/s	TNC
Timing and Buffer Errors	PCR related parameters	PCR Frequency Drift (mHz/s)	Integer	PCR frequency drift > 375 mHz/s	QOS
Timing and Buffer Errors	PCR related parameters	PCR jitter (□s)	Integer	25 □S < PCR overall jitter □ 125 □s	TNC
Timing and Buffer Errors	PCR related parameters	PCR jitter (□s)	Integer	PCR overall jitter > 125 □S	QOS
Timing and Buffer Errors	PTS interval error	Time interval (ms)	Integer	700 ms < Interval between coded PTS values □ 1400 ms	TNC
Timing and Buffer Errors	PTS interval error	Time interval (ms)	Integer	1400 ms < Interval between coded PTS values □ 3500 ms	QOS
Timing and Buffer Errors	PTS absence error	Time interval (ms)	Integer	Interval between coded PTS values > 3500 ms	CM
Timing and Buffer Errors	PTS increment error	Presence	Boolean	PTS time not incrementing at the reciprocal of the frame rate	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	PTS time not incrementing at the reciprocal of the frame rate	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of transport buffer	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of system information buffer	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of MPEG-2 Video buffer	QOS
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Underflow of MPEG-2 Video buffer	TNC
Timing and Buffer Errors	Buffer errors	Presence	Boolean	Overflow of AC-3 Audio buffer	QOS
Timing and Buffer Errors	OOB-SI bandwidth	Presence	Boolean	When present, SCTE-65 maximum OOB-SI bandwidth (150kb/s for base PID, 150kb/s for any AEIT/AETT PID)	QOS

Timing and Buffer Errors	OOB-SI bandwidth	Presence	Boolean	When present, SCTE-65 minimum OOB-SI bandwidth (10kb/s for AEIT-0,1/AETT-0,1 PID)	QOS
Consistency Errors	TSID values in PAT and VCT (transport_stream_id) do not match	Presence	Boolean	None	TOA
Consistency Errors	PAT/VCT mismatch	Presence	Boolean	Different number of programs found in VCT than signaled in PAT	POA
Consistency Errors	VCT/PMT mismatch	Presence	Boolean	SLD/PMT mismatch (number of services)	POA
Consistency Errors	VCT/PMT mismatch	Presence	Boolean	SLD/PMT element mismatch (different “parameters” for matching program elements)	CM
Consistency Errors	PMT/EIT-0 descriptor mismatch	Presence	Boolean	Mismatch in duplicated descriptors for current event between PMT and EIT-0	CM
Consistency Errors	ETT syntax errors	Presence	Boolean	ETT has invalid ETM_ID or ETM_ID does not match existing event_id in EIT (excludes channel ETT)	CM
Consistency Errors	ETT syntax errors	Presence	Boolean	ETT has ETM_ID of channel ETT, but MGT does not flag channel ETT on this PID	QOS
Consistency Errors	Multiple sources of PSI	Presence	Boolean	Version numbers for particular PSI tables should never decrease (except at wraparound)	TOA
Consistency Errors	Daylight Savings time settings	Presence	Boolean	STT contains invalid values for Daylight Savings time switchover	TNC
Consistency Errors	Service Location Descriptor missing from VCT	Presence	Boolean	No Service Location Descriptor in VCT	POA
Consistency Errors	Dangling source_id	Presence	Boolean	source_id mismatch (either source_id in VCT does not have a corresponding source_id in EIT or source_id in EIT does not have a corresponding source_id in VCT)	POA

Consistency Errors	MGT mismatch	Presence	Boolean	Version number and/or size of tables signaled in MTG does not match with actual table	QOS
Consistency Errors	MGT mismatch	Presence	Boolean	PSIP table found in stream, but not signaled in MGT	TNC

10.0 METRICS D

Metrics D includes only the DPI generator – a device that creates DPI messages according to SCTE-35. In practice, most current DPI insertion is done with a normal MPEG encoder triggered by SCTE-104 messages from Automation (or a surrogate thereof). These messages are encoded in MPEG-2 sections and carry instructions and timing information for use by digital splicing equipment. Metrics D includes the following Impairment Categories:

- General
- PSI Errors
- In Band Table Errors
- Consistency Errors (small subset)

Table 10-1 : Metrics D

Functional Blocks	**DPI Encoder**				
Impairment Category	**Metric**	**Measurement**		**Qualifier**	**Severity**
General	TS Synch Loss	Presence	Boolean	Two or More Synch Bytes Corrupt	TOA
General	Synch Byte Error	Presence	Boolean	Single Synch Byte not 0x47	QOS
General	Continuity Count Errors	Count/sec	Integer	None	QOS
General	Transport error	Presence	Boolean	transport_error_indicator in TS packet header is set	TNC
General	Multiple registration descriptors	Presence	Boolean	Multiple registration descriptors in any given iteration of a descriptor loop	TNC
General	Missing Descriptors	Presence	Boolean	One or more required descriptors were not found in the stream	CM
PSI Errors	PAT	Cycle Time	Integer	100ms < cycle time □ 200ms	TNC

	repetition interval error	(ms)			
PSI Errors	PAT repetition interval error	Cycle Time (ms)	Integer	200ms < cycle time □ 500ms	QOS
PSI Errors	PAT absence error: PAT not found	Cycle Time (ms)	Integer	cycle time > 500ms	TOA
PSI Errors	PAT syntax error:	Presence	Boolean	Packet with PID 0x0000 doesn't have table_id 0x00	TOA
PSI Errors	PAT syntax error	Presence	Boolean	CRC is incorrect for table_id 0x00 within PID 0x0000	TNC
PSI Errors	PAT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packet within PID 0x0000	TOA
PSI Errors	PMT repetition interval error	Cycle Time (ms)	Integer	400ms < cycle time □ 800ms	TNC
PSI Errors	PMT repetition interval error	Cycle Time (ms)	Integer	800ms < cycle time □ 2000ms	QOS
PSI Errors	PMT absence error: PMT not found	Cycle Time (ms)	Integer	cycle time > 2000ms	POA
PSI Errors	PMT syntax error	Presence	Boolean	Packet with PID 0x0000 doesn't have table_id 0x00	POA
PSI Errors	PMT syntax error	Presence	Boolean	CRC is incorrect for table_id	POA
PSI Errors	PMT syntax	Presence	Boolean	scrambling_control_field is not '00' for packets containing PMT	POA

	error				
PSI Errors	PMT syntax error	Presence	Boolean	"PMT_PID" referenced by PAT not found	POA
In-Band Tables	SCTE 35 missing MRD	Presence	Boolean	Section with table_id 0xFC found on PID not associated with an SCTE 35 registration descriptor in the PMT	CM
In-Band Tables	SCTE 35 CRC error	Presence	Boolean	CRC is incorrect for table_id 0xFC	CM
Consistency Errors	Multiple sources of PSI	Presence	Boolean	Version numbers for particular PSI tables should never decrease (except at wraparound)	TOA

11.0 METRICS E

Metrics E includes only the EAS Generator - a device that creates EAS messages (Emergency Alert messages encapsulated in MPEG-2 Sections following SCTE 18). The output of the EAS generator typically only includes the EAS messages themselves, which are muxed into a more complete transport stream by another device.

Metrics E includes the following Impairment Categories:

- General
- PSI Errors
- In Band Table Errors
- Consistency Errors (small subset)

Table 11-1 : Metrics E

Functional Blocks	**EAS Generator**				
Impairment Category	**Metric**	**Measurement**		**Qualifier**	**Severity**
General	TS Synch Loss	Presence	Boolean	Two or More Synch Bytes Corrupt	TOA
General	Synch Byte Error	Presence	Boolean	Single Synch Byte not 0x47	QOS
General	Continuity Count Errors	Count/sec	Integer	None	QOS
General	Transport error	Presence	Boolean	transport_error_indicator in TS packet header is set	TNC
General	Multiple registration descriptors	Presence	Boolean	Multiple registration descriptors in any given iteration of a descriptor loop	TNC
General	Missing Descriptors	Presence	Boolean	One or more required descriptors were not found in the stream	CM
PSI Errors	PAT repetition interval error	Cycle Time (ms)	Integer	100ms < cycle time □ 200ms	TNC
PSI Errors	PAT repetition	Cycle	Integer	200ms < cycle time □	QOS

	interval error	Time (ms)		500ms	
PSI Errors	PAT absence error: PAT not found	Cycle Time (ms)	Integer	cycle time > 500ms	TOA
PSI Errors	PAT syntax error:	Presence	Boolean	Packet with PID 0x0000 doesn't have table_id 0x00	TOA
PSI Errors	PAT syntax error	Presence	Boolean	CRC is incorrect for table_id 0x00 within PID 0x0000	TNC
PSI Errors	PAT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packet within PID 0x0000	TOA
PSI Errors	PMT repetition interval error	Cycle Time (ms)	Integer	400ms < cycle time □ 800ms	TNC
PSI Errors	PMT repetition interval error	Cycle Time (ms)	Integer	800ms < cycle time □ 2000ms	QOS
PSI Errors	PMT absence error: PMT not found	Cycle Time (ms)	Integer	cycle time > 2000ms	POA
PSI Errors	PMT syntax error	Presence	Boolean	Packet with PID 0x0000 doesn't have table_id 0x00	POA
PSI Errors	PMT syntax error	Presence	Boolean	CRC is incorrect for table_id	POA
PSI Errors	PMT syntax error	Presence	Boolean	scrambling_control_field is not '00' for packets containing PMT	POA
PSI Errors	PMT syntax error	Presence	Boolean	"PMT_PID" referenced by PAT not found	POA
In-Band Tables	EAS syntax error	Presence	Boolean	Section with table_id 0xD8 found on PID other than 0x1FFB or 0x1FFC	CM
In-Band Tables	EAS syntax error	Presence	Boolean	CRC is incorrect for table_id 0xD8	CM
Consistency Errors	Multiple sources of PSI	Presence	Boolean	Version numbers for particular PSI tables should never decrease (except at wraparound)	TOA

ANNEX A: USE CASES

This annex illustrates some use cases involving common impairments, showing how the metrics discussed in this document can be used to isolate the root causes. For purposes of this Annex, it will be assumed that monitoring can be performed at the output of each device (by either permanently or temporarily locating probes). Practical considerations may influence the strategy used for monitoring probe location. Furthermore, the approach described is based on full time monitoring (proactive), rather than troubleshooting after problems are reported (reactive). Please note that other parts of this recommended practice also play an integral role in the localization process (their presence will be assumed and the inner workings will not be described).

1. Tiling (aka: Macroblocking, Pixelization)

Tiling refers to a wide class of visual symptoms also known as blocking, pixelization or macroblocking. The visual characteristics of tiling range from visible rectangular blocks in the image all the way through a garbled image that is totally frozen. Tiling is usually the result of a problem decoding the video stream – which often has causes in the transport layer itself. The major causes can include:

- Loss of video stream data (continuity count errors)
- Video data streams arriving at too high or too low a rate (video buffer underflow or overflow)
- Timing issues (PCR jitter, accuracy and offset).

Problems of this sort can be introduced by nearly any device that touches the compressed transport stream.

For this use case, it is assumed that the compressed multimedia content originates at a digital feed and flows through the cable plant as illustrated in Figure 11-1 : Compressed content flow for Tiling Use Case, below. By examination, it can be seen that all of the devices are members of the Metrics C set described above in section 9.0. The metrics listed in this set would be appropriate for monitoring at the output of each of these devices.

For this particular use case, suppose that no errors are observed for the metrics from the origination point (Digital Feeds) up to the Ad Splicer. From the output of the Ad Splicer to the Set Top Box, the following error is observed:

Timing and Buffer Errors	PCR related parameters	PCR jitter (□s)	Integer	PCR overall jitter > 125 □S	QOS

From monitoring this set of metrics, it can be inferred that the Ad Splicer (marked with a "*" in Figure 6-1 : Metrics groupings below) is inducing jitter in the PCR, which can be a major contribution to tiling problems.

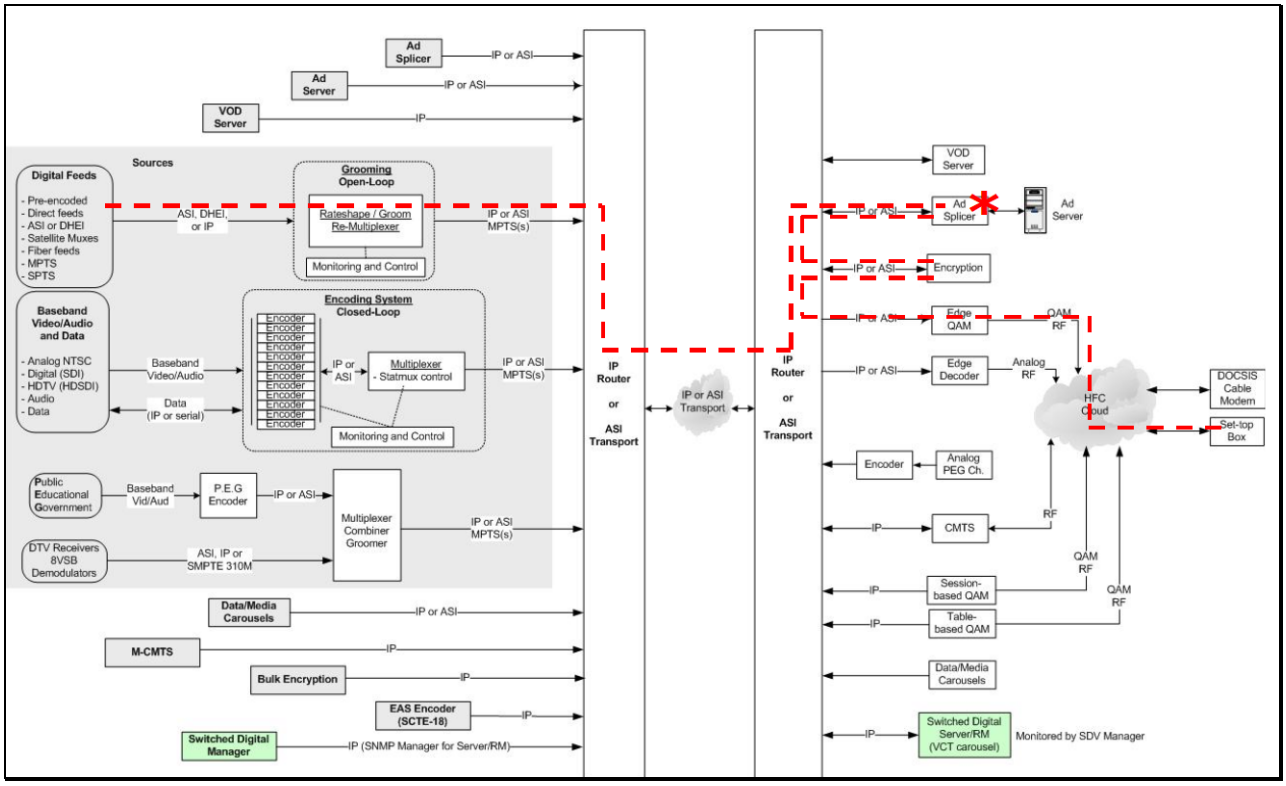

Figure 11-1 : Compressed content flow for Tiling Use Case

2. Missing audio

This use case refers to the situation where for a given program, video is displayed to the viewer, but the accompanying audio track is not played for some viewers (not all). In this particular case, viewers using cable ready televisions have no audio, but those with STBs from their cable supplier have no problems. This situation can come about through a number of situations, including:

- Audio not present at the input to the encoder
- Failure of the audio encoder – no compressed audio stream created
- Inconsistent metadata pointers which prevent the receiver from finding the audio stream

For this particular example, the flow of compressed content is illustrated in Figure 11-2 : Compressed Content Flow for Missing Audio Use Case

, below. The compressed multimedia content comes from an 8-VSB demodulator (in this case, a terrestrial DTV broadcast meant for distribution through the cable plant). After ingest, it flows through a Groomer for remultiplexing/rateshaping/remixing, through the core network

distribution system and to an Edge QAM for modulation into the HFC network. PSIP from the incoming feed is carried through the plant to the viewer.

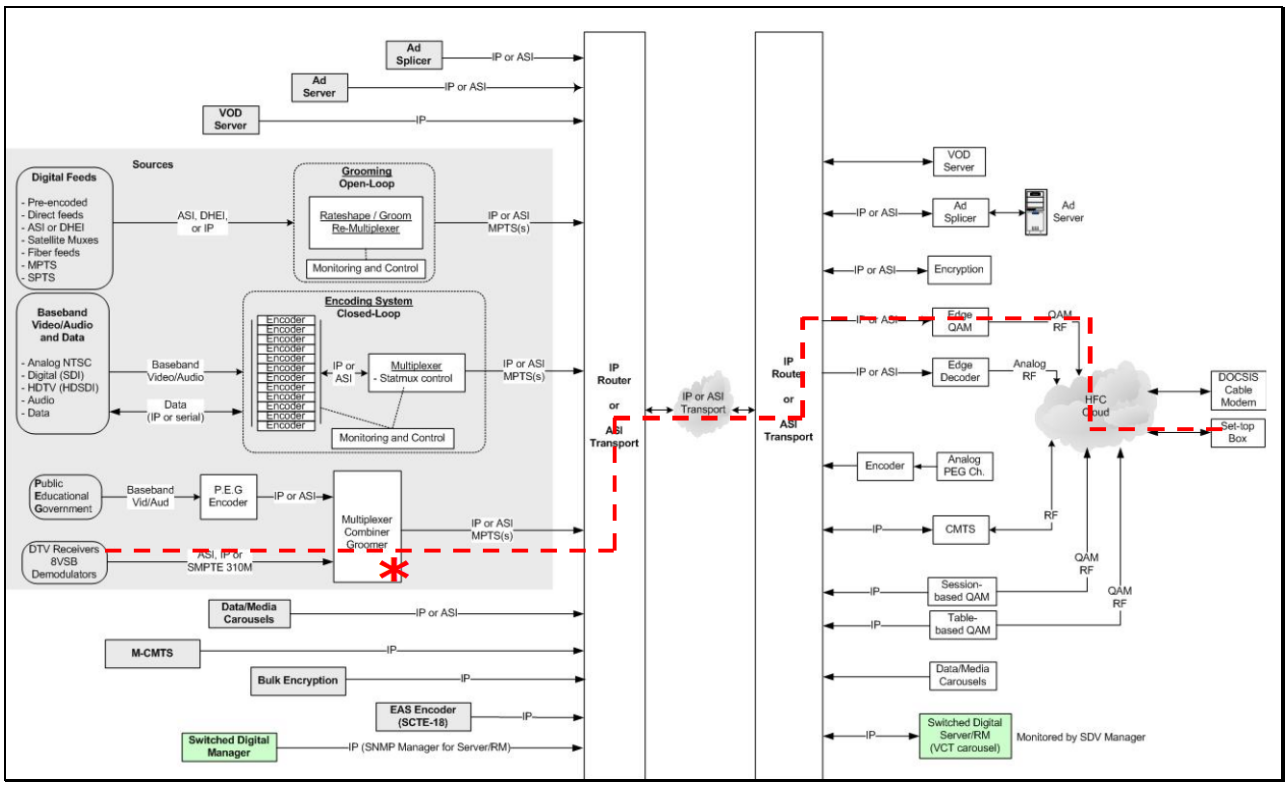

Figure 11-2 : Compressed Content Flow for Missing Audio Use Case

In this particular case, suppose that no errors were observed by monitoring at the output of the 8-VSB demodulator, but the following error was observed from the Groomer outwards.

Consistency Errors	VCT/PMT mismatch	Presence	Boolean	SLD/PMT element mismatch (different "parameters" for matching program elements)	CM

After seeing the error in monitoring, further examination showed that the SLD for a particular program did not include the audio program element, while the PMT did. For those receivers that utilize PSIP as a primary tuning mechanism (such as a cable ready television, without a Tru2Way card), the end result would be no audio – even if an audio stream is present. The groomer was found to be misconfigured as far as passing PSIP was concerned.

3. Technically Non-Conformant (TNC)

This use case involves content being encoded within the cable plant, muxed, encrypted and sent to the viewer over QAM. Monitoring after the encoder would utilize Metrics B – further into the system, Metrics C would be the appropriate set to use.

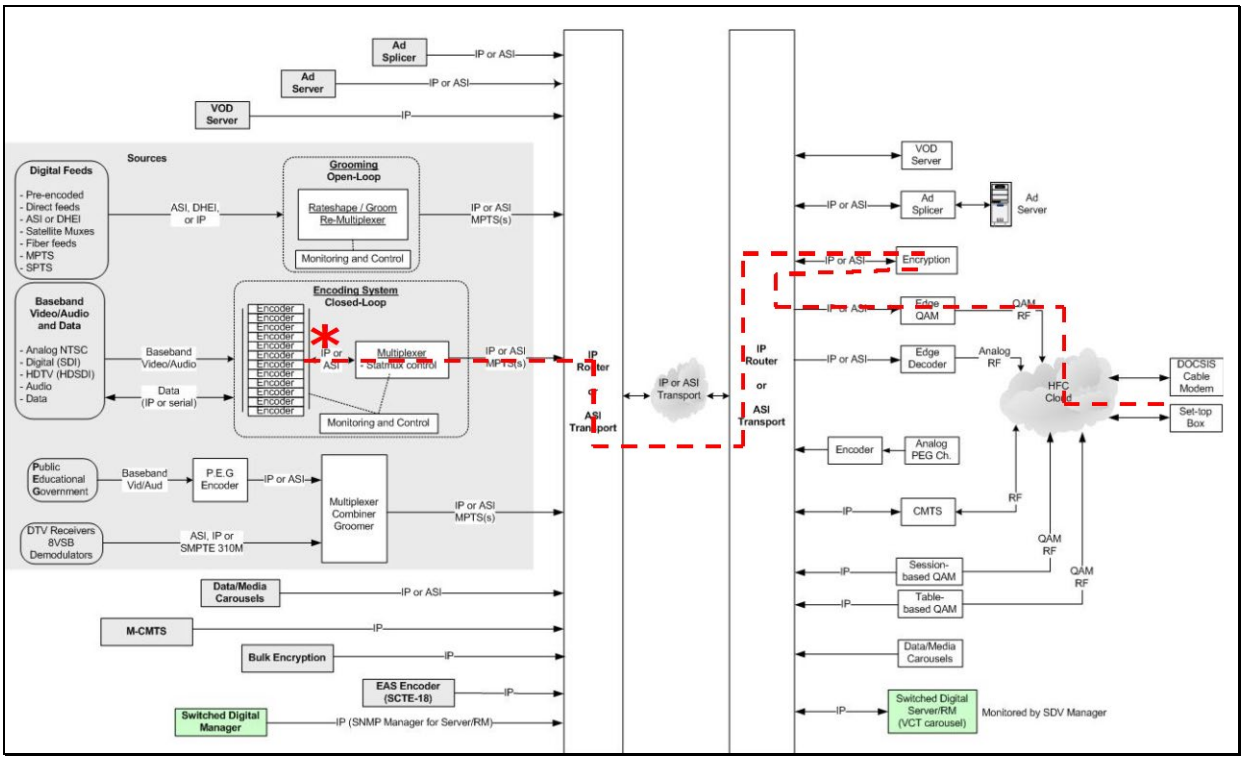

Figure 11-3 : Compressed content flow for TNC use case

A monitoring point after the encoder shows the following error condition (as do all subsequent monitoring points. However, the operator has set the monitoring system to log errors of a lower severity than QOS (Quality Of Service) – so this error is not immediately apparent. It only shows up during periodic inspection of the logs.

Table 11-2 : Example TNC error condition

Timing and Buffer Errors	Buffer errors	Presence	Boolean	Underflow of MPEG-2 Video buffer	TNC

This is quite appropriate behavior for errors of this severity. An error severity of TNC means that the strict requirements of the appropriate standard are not met – but the impact to the viewer is minimal, if at all noticeable. In order to prevent flooding the operator with "trivial" errors, it would be common practice to have TNC errors logged for future attention and not have them reflected on status panels.

In this particular case, when the TNC error was found in the log, noting that it persisted along the entire chain that the content took through the plant led to localization of the problem to the encoder – which was found to be set incorrectly.