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ATSC Recommended Practice on Bitstream Verification

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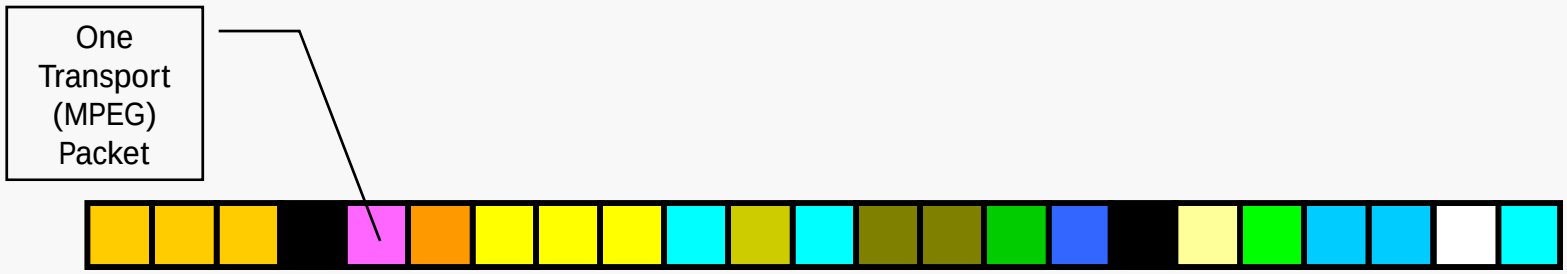
Agenda

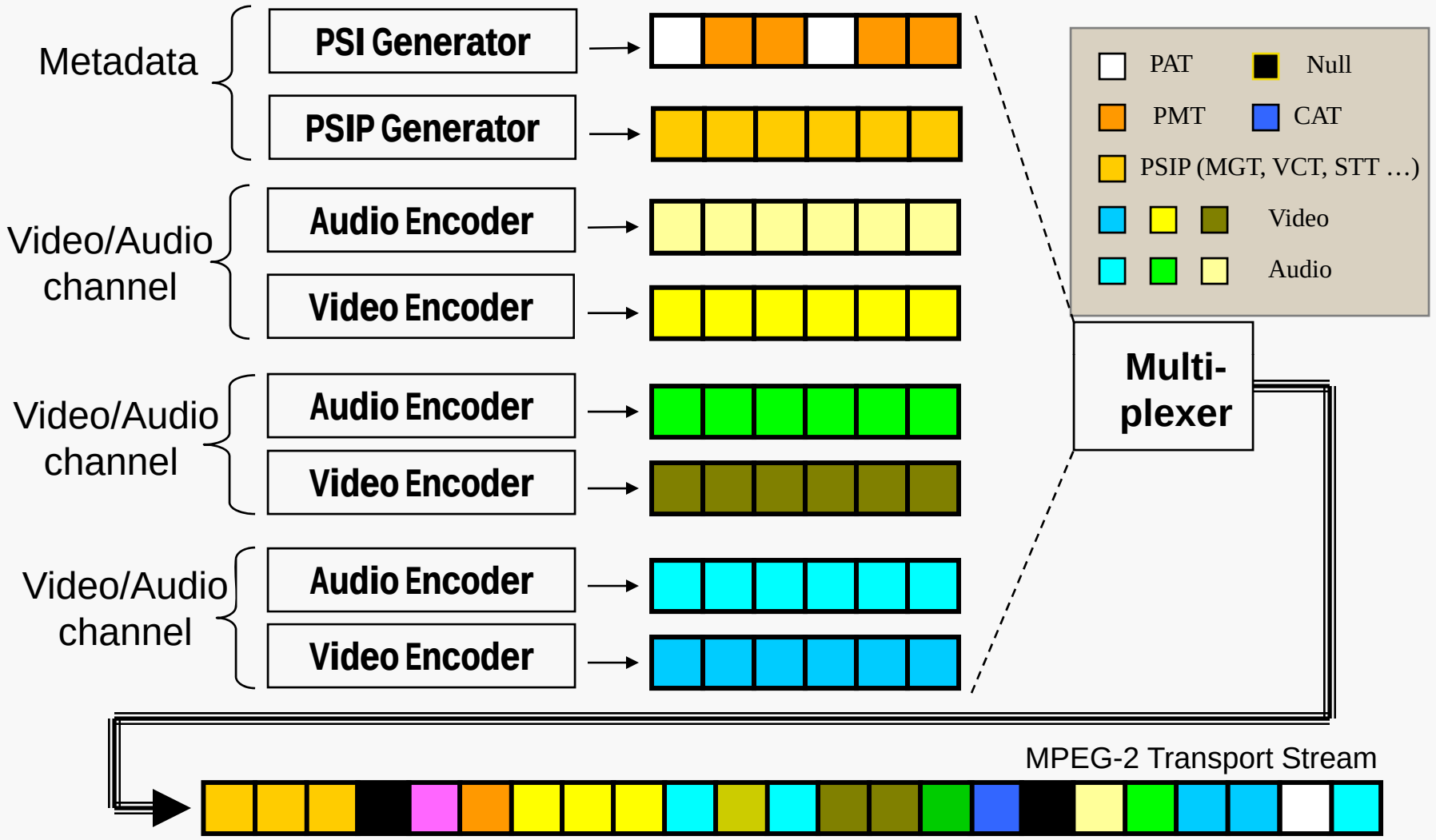
- DTV Stream Basics
- Why Monitor Transport Streams?
- Goals
- Background
- Emphasis
- ATSC Recommended Practice
- Example
- Summary

MPEG-2 Transport Stream

- Made up of 188-byte ***transport packets***, each with 4 byte header & 184 byte payload
- Conveys multiple interleaved ***elementary streams*** -- audio, video, data, PSI, ...
- Elementary stream to which each packet belongs is identified by ***packet id*** (PID) in packet header.



ATSC Transport Stream Multiplex

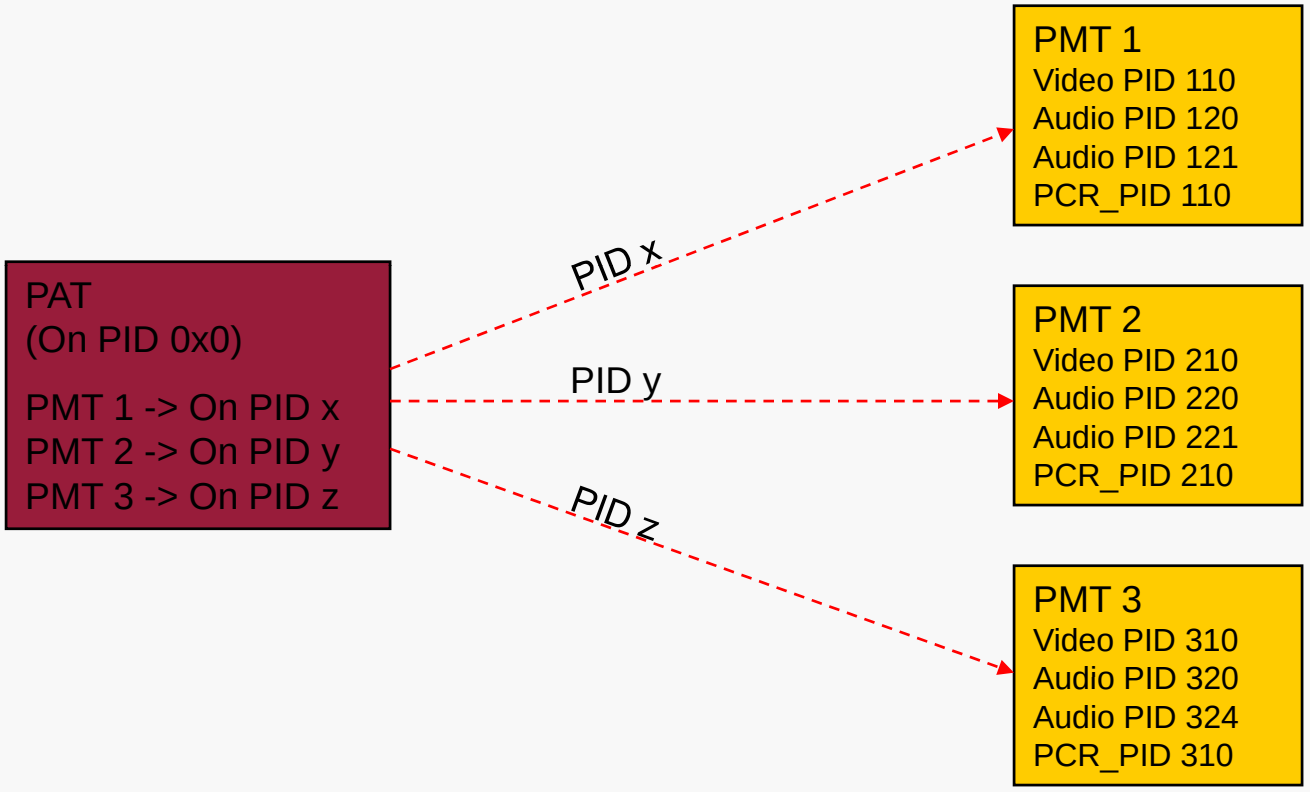


PSI tables - defined

PSI – **Program Specific Information**

- PAT - **Program Association Table**
  Appears in PID 0x0000.
  Identifies MPEG-2 ***programs*** in transport stream and gives PIDs for their PMTs.
- PMT - **Program Map Table**
  Identifies elementary streams in program (virtual channel), and gives their PIDs.
- CAT - **Conditional Access Table**
  Contains information about the encryption method used by your network

PSI Overview



PSIP

- Branding – Station call letters and Channel number
- Signaling – V-Chip data, information about audio and Video PID's
- Announcement – Program Guide

PSIP Base Tables

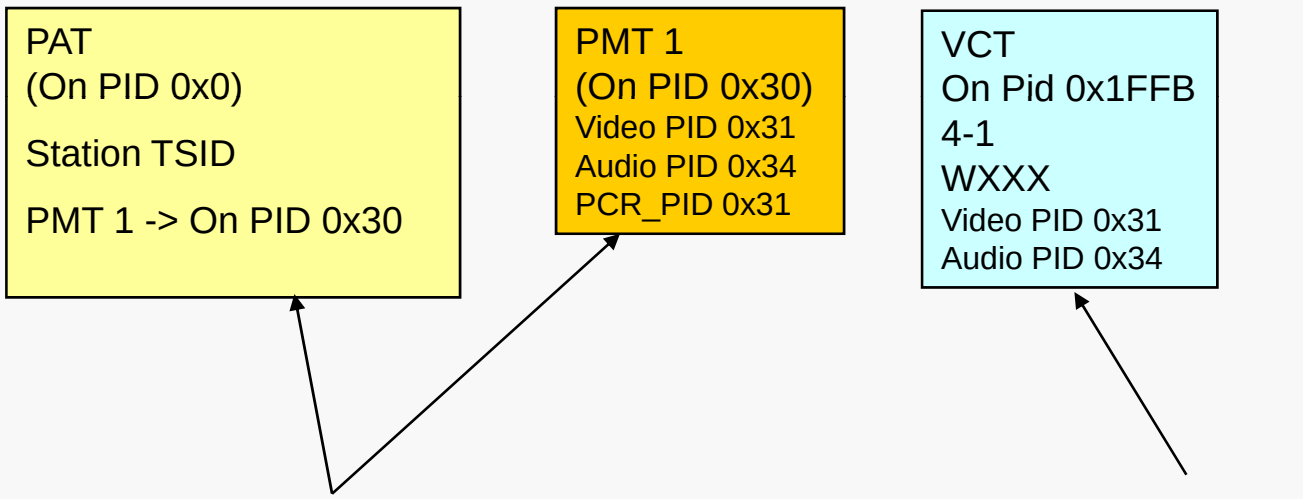
- MGT - Master Guide Table
  - Appears in PID 0x1FFB.
  - Gives PIDs, sizes, and version numbers of other PSIP tables (except STT).
- STT - System Time Table
  - Appears in PID 0x1FFB
  - Gives current UTC time.
- TVCT or CVCT - Virtual Channel Table
  - Identifies and describes virtual channels.
- RRT - Rating Region Table
  - Describes content advisory system(s) being used to rate events.

Other PSIP PID's

- EIT - Event Information Table
  - Gives titles, start times, durations, content advisory ratings of ***events*** (TV programs).
- ETT - Extended Text Table
  - Gives extended textual descriptions of virtual channels and events.

PSIP and PSI Link

Table Information for a
Television Broadcast Stream



Why Monitor Transport Streams?

- From a viewer's point, DTV must "Just plain work."
- Broadcaster must be aware of any problems in emission transport
  - Awareness of problems before viewers is a "good thing"
  - STB/Receiver method simply doesn't work
- Monitoring the transport for conformance allows reduction in
  - Fault Detection Time
  - Fault Isolation Time
  - Total Service Impairment time
- Monitoring allows for higher quality product

Common DTV System Defects

- PSI/SI/PSIP tables missing, incorrectly formatted, incomplete and/or inconsistent
- Excessive jitter in PCR values
- Audio or video buffer underflow or overflow
- Audio or video program element(s) missing
- Incorrect audio/video synchronization

Common causes of defects

- Initial setup / configuration
- Equipment drift
- Equipment failures
- Communication link failures
- Loss of synchronization

- "Oops"

Consequences of Defects

- DTV receivers have trouble tuning
- No information in on-screen program guide
- Programs missing
- Picture or sound breaks up
- Picture or sound absent
- Noticeable “lip sync” errors

- Upset viewers
  - Phone calls

A/78 Goals

- Create a set of recommendations for monitoring emission bitstreams
  - Which elements & parameters of A/53 and A/65 should be verified?
- Create a set of recommendations that provide valuable guidance for broadcasters
- Create a set of recommendations that allow for freedoms of implementation

Emphasis

Create verification methodology that best benefits the users

- Graduated scale:
  - Most importance for errors that cause viewer problems
  - Least importance for errors that viewers are not aware of
- Categorization
  - Group errors into categories that will help uncover problem source
- Reduce false alarms
  - Alarms for “don’t-care” situations causes operator fatigue
  - → which increases probability that important alarms will be ignored

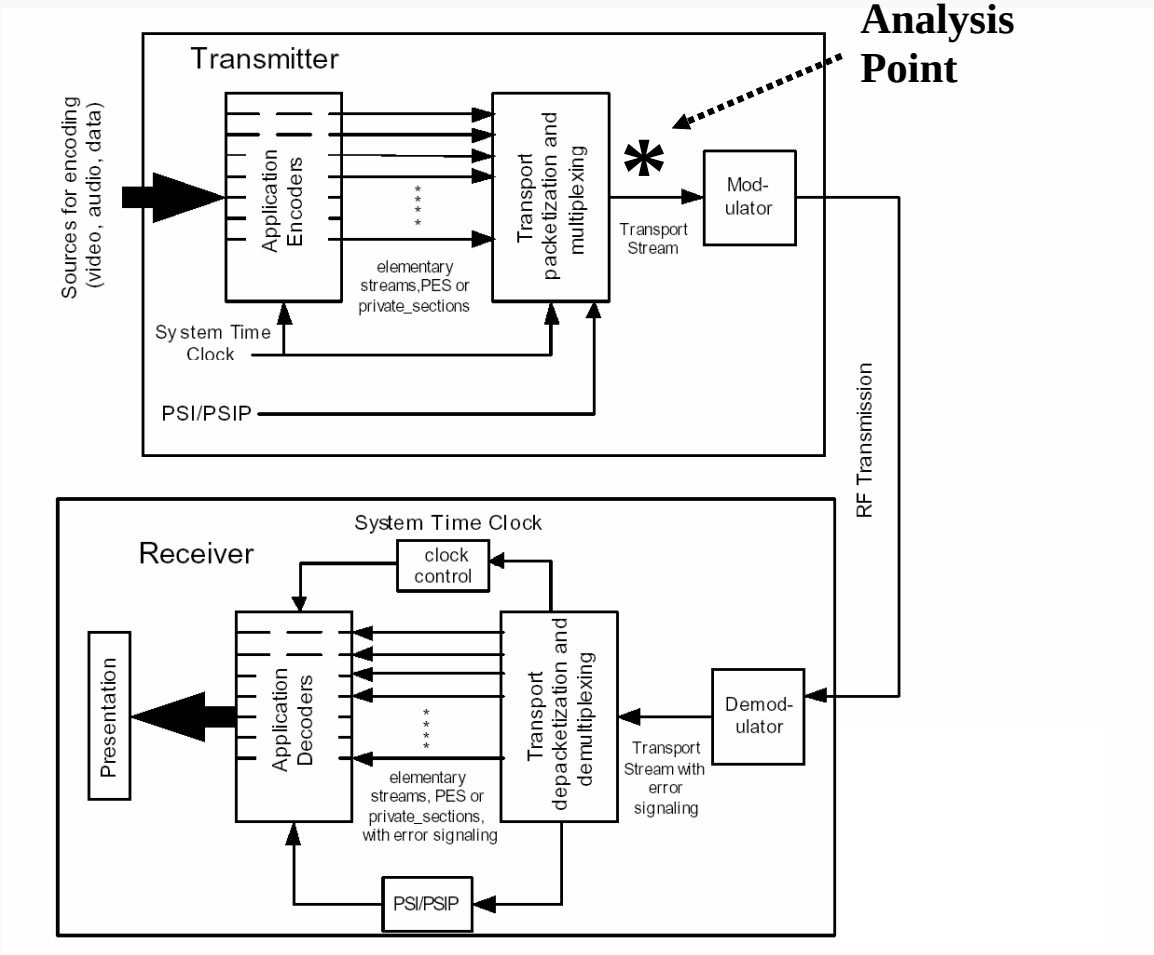
Background

- ETSI TR 101 290
  - Measurement Guide Lines for DVB Systems
  - Three severity levels
    - Priority 1: Errors that affect integrity and decodability of transport stream
    - Priority 2: Errors that affect individual programs
    - Priority 3: Application level errors – program elements / SI tables
  - Written around DVB standards – not directly applicable to ATSC broadcasts
- Everything is black/white
  - Measurement is “in spec” / “out of spec”
  - No gradations in between

ATSC Recommended Practice

- Result of work by TSG-1 AdHoc within TSG committee
- Drew upon available resources
  - DVB
  - Test Equipment manufacturers
  - Encoding and receiver manufacturers
  - Broadcasters
- Approved by ATSC as A/78
  - Equivalent RP approved by SCTE as SCTE-142

Reference Analysis Point



Conceptual view

- Real systems may differ

RF not addressed

Enhanced VSB not addressed

Categories

- PSI Errors
  - PAT, PMT
- PSIP Errors
  - MGT, TVCT, CVCT, RRT, EIT & ETT, STT
- Timing & Buffer errors
  - PCR, PTS, Buffer
- Consistency Errors
  - Mismatches between tables, missing pointers, DST problems...
- General Errors
  - Sync byte, continuity count, multiple MRDs, PID value ranges, missing descriptors

Error Severity

- 5 Levels of severity
  - TS Off Air (TOA)
  - Program Off Air (POA)
  - Component Missing (CM)
  - Quality Of Service (QOS)
  - Technically Non-Conformant (TNC)

TOA

- Transport stream Off Air
- Errors are severe enough that the transport stream is damaged beyond utility
- Receivers can't tune and decode broadcast
- Example – absence of sync bytes

➢ "Get up & run"

POA

- Program Off Air
- A virtual channel is flawed to the point where the service is off air
- Receivers can't tune to or decode the contents of the virtual channel
- Example: Missing entry in VCT for the virtual channel

➢ "Get up & run"

CM

- Component Missing
- An element of a virtual channel is flawed
- Receiver can't find/decode the program element
- Example: Mismatch between the video PID signaled in the SLD and the actual PID in the video TS packets
- Note: Some PSIP elements are included

➢ "Get up & run"

QOS

- Quality Of Service
- Parameters out of spec by amount where significant number of receivers can be expected to produce flawed outputs
- Broadcast may still be viewable, but exhibits degradation
- Example: VCT cycle time somewhat larger than spec resulting in slower than normal tuning

➢ “Walk slowly”

TNC

- Technically Non-Conformant
- Violates the letter of the standards, but has little effect on viewing experience
- Example: A single instance of an MGT cycle time of 152ms

➢ “When you get a chance”

Example: PAT

Error Condition	Error Qualifier	TOA	POA	CM	QOS	TNC
PAT repetition error	PAT repetition interval error (found between the last 101 and 200 ms)					✕
PAT repetition error	PAT repetition interval error (found between the last 201 to 500 ms)				✕	✕
PAT absence error	PAT not found for 501 ms (or longer)	✕	✕	✕	✕	✕
PAT syntax error	Packet with PID 0x0000 doesn't have table_id 0x00	✕	✕	✕	✕	✕

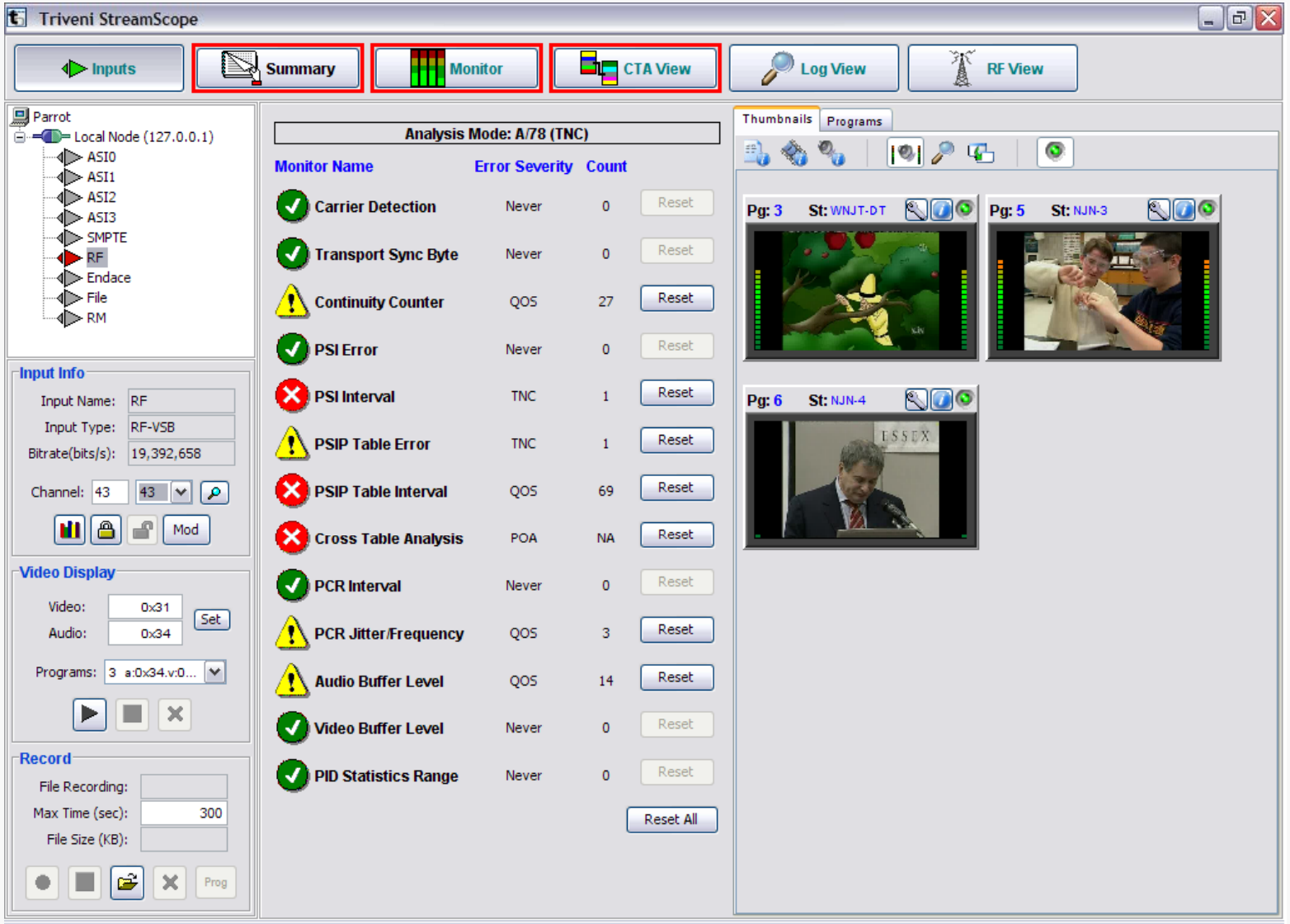
Example: PCR

Error Conditions	Error Qualifier	TOA	POA	CM	QOS	TNC
PCR Error	Un-signaled PCR discontinuity				X	X
PCR repetition	PCR repetition interval error (101 - 200 ms)					X
PCR repetition	PCR repetition interval error (201 - 500 ms)				X	X
PCR absence	PCR not found for than 501 ms (or longer)		X	X	X	X
PCR error	PCR inaccuracy (greater than +/– 500 ns and less than or equal to +/- 2500 ns)					X
PCR error	PCR inaccuracy (greater than +/– 2500 ns)				X	X
PCR parameters	PCR frequency offset (greater than 810 Hz and less than or equal to 4050 Hz)					X
PCR parameters	PCR frequency offset (greater than 4050 Hz)				X	X
PCR parameters	PCR frequency drift (greater than 75 mHz/s and less than or equal to 375 mHz/s)					X
PCR parameters	PCR frequency drift (greater than 375 mHz/s)				X	X
PCR parameters	PCR overall jitter (greater than 25 μs and less than or equal to 125 μs)					X
PCR parameters	PCR overall jitter (greater than 125 μs)				X	X

Example: Consistency Error

Error Conditions	TOA	POA	CM	QOS	TNC
TSID values in PAT and VCT do not match	X	X	X	X	X
PAT/VCT mismatch (Different number of programs found in VCT than signaled in PAT)		X		X	X
VCT/PMT mismatch (SLD/PMT mismatch)			X	X	X
PMT/EIT-0 descriptor mismatch		X	X	X	X
ETT syntax errors (ETT has invalid ETM_ID or ETM_ID does not match existing event_id in EIT)			X	X	X
Multiple sources of PSI	X	X	X	X	X
Daylight Savings time settings					X
Service Location Descriptor missing from VCT		X	X	X	X
Dangling source_id		X	X	X	X
MGT mismatch (Version number and/or size of tables signaled in MGT does not match with actual table; PSIP table found in stream, but not signaled in MGT)				X	X

Real World Example



Summary

- ATSC Recommended Practices provides a common methodology for describing bitstream non-conformance
- Methodology has been designed to be the most useful for real-world conditions and considerations
- Use of this methodology can significantly reduce the time required to address system faults

Thanks for your attention,

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