



triveni
DIGITAL.

INCOSPEC
COMMUNICATIONS INC.

Taking TV Delivery Digital - Lessons Learned

CCTA 2011 Annual Meeting

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CCTA
CARIBBEAN CABLE & TELECOMMUNICATIONS ASSOCIATION

Agenda

➤ Overview

- Strategic Stream Monitoring
- Tactical Stream Monitoring
- Service Based Monitoring
- Summary

Monitoring - 50,000 Foot View

- What matters most to a viewer?
- Being able to watch their preferred show/movie without glitches
 - Customers don't/shouldn't care about MPEG, 8-VSB, IP, RTP, QAM...
- To maintain customer satisfaction, the goal is to make this so
 - The ability to monitor the entire distribution system is crucial
 - End-to-end service assurance
 - How can this be done without information overload?

Service Concerns

- Common **issues** “visible” to consumers are:
 - Video tiling
 - Lip sync errors
 - Intermittent tuning
 - Missing components
- The **root cause** of these issues can be created by any of the MPEG affecting devices in the broadcast chain:
 - Dropped packets
 - Metadata errors and inconsistencies
 - PCR Jitter issues
 - Video/Audio buffer under/overflow
 - Under provisioning
- **Prevention** - examine the MPEG transport layer continuously and comprehensively

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

Common causes of defects

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

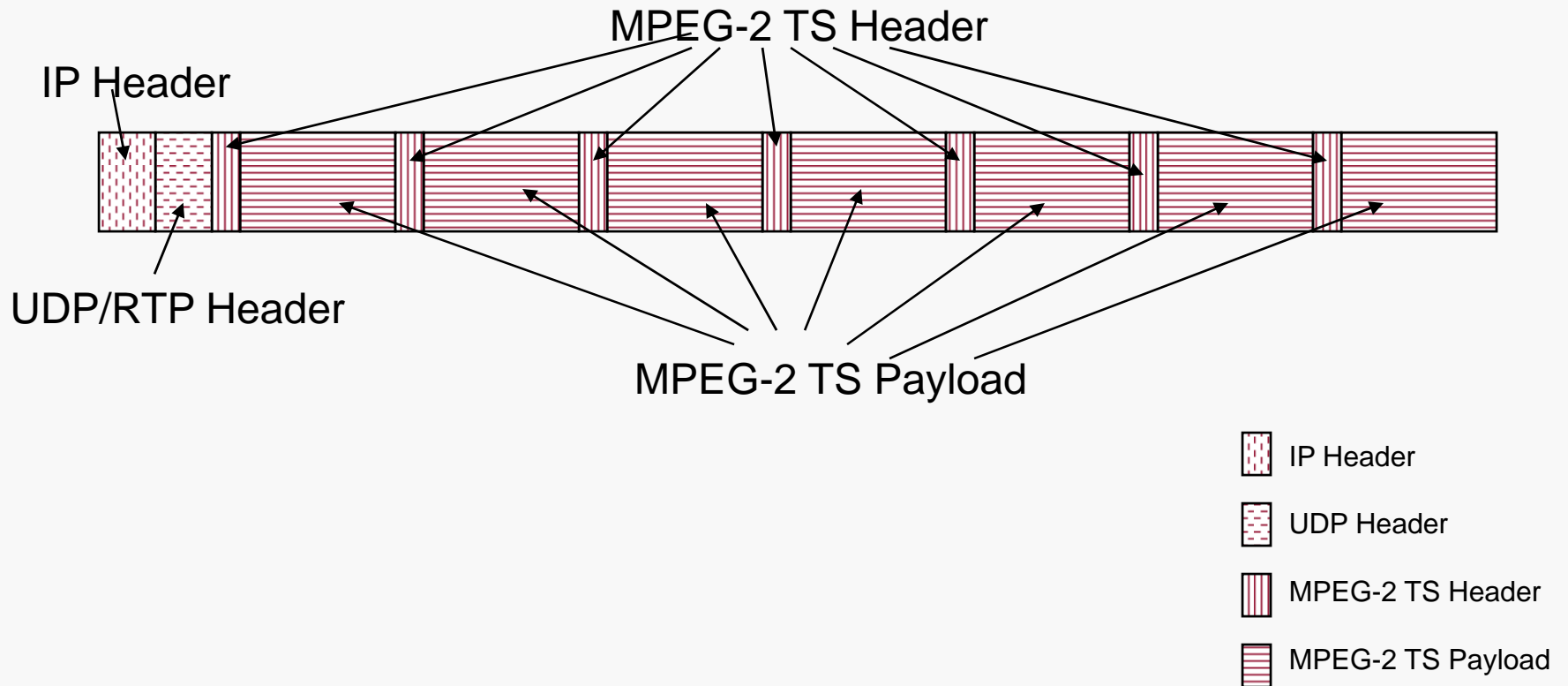
- "Oops"

Common DTV System Defects

- PSI/SI 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
 - Or effectively missing
- Incorrect audio/video synchronization

MPEG-2 TS Carriage over IP

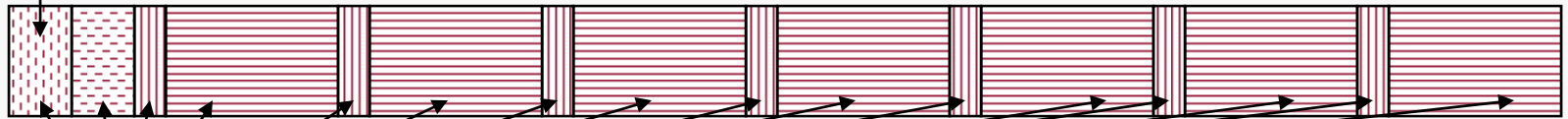
Each IP packet carries 7 MPEG-2 TS packets



MDI vs MPEG-2 TS monitoring

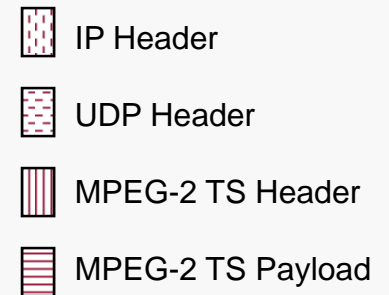
- MDI:

- Examine delays/loss for IP packets only
- No information about what is contained in MPEG-2 TS packets
- No information about “correctness” of contents of MPEG-2 TS

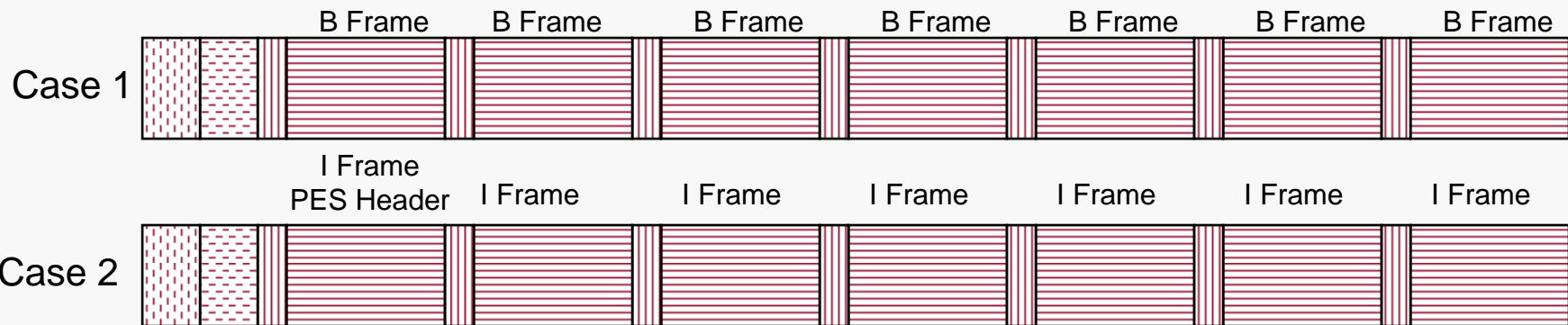


- Comprehensive:

- Examine delays/loss for IP packets
- Completely analyze contents of MPEG-2 TS packets
- Full information about stream quality



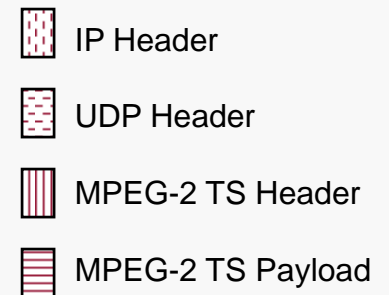
Not all IP packets are equal



Case 1: IP packet with MPEG-2 TS packets carrying B frame info
Loss of IP packet may result in momentary video glitch (may not be visible)

Case 2: IP packet with MPEG-2 TS packets carrying I frame info, including PES header
Loss if IP packet will probably result in .5 second (GOP size) visible video corruption

Effect of IP packet loss depends upon what is carried in packet



ATSC A/78

- Originally started with a charter to list all of the metrics that need to be observed to ensure a proper emission
- Involved participants from all aspects of the DTV industry:
 - Broadcasters
 - Equipment Manufacturers
 - Standards
- Evolved into a methodology that made monitoring effective & practical

Goals

- Create a set of recommendations for monitoring emission bitstreams
 - Which elements & parameters of MPEG and SCTE standards should be verified?
- Create a set of recommendations that provide valuable guidance for operators
- 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

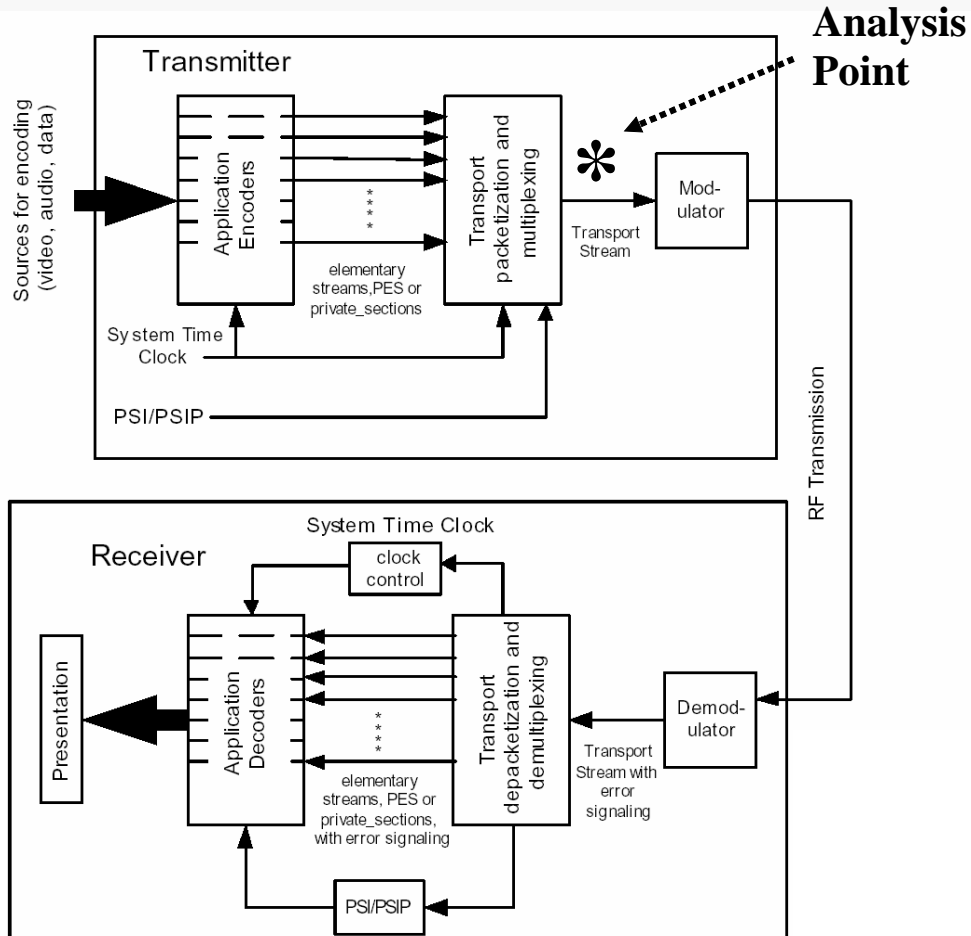
Background

- 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 SCTE systems
- Everything is black/white
 - Measurement is “in spec” / “out of spec”
 - No gradations in between
- ATSC A/78 recommended practice
 - Established notion of error severity
 - Basis for SCTE 142

SCTE-142 Recommended Practice

- Result of work by HMS subcommittee within SCTE
- Drew upon available resources
 - DVB
 - ATSC A/78
 - Test Equipment manufacturers
 - Encoding and receiver manufacturers
 - Cable Operators
- RP Approved by SCTE

Reference Analysis Point



Conceptual view

- Real systems may differ

Categories

- PSI Errors
 - PAT, PMT
- Out-Of-Band table errors
 - SCTE 65
- In-Band table errors
 - SCTE 35 & SCTE 18
- PSIP Errors
 - OTA turnaround & PSIP passthru: MGT, TVCT, CVCT, RRT, EIT & ETT, STT
- Timing & Buffer errors
 - PCR, PTS, Buffer
- Consistency Errors
 - Mismatches between tables, missing pointers...
- 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 PAT 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 PMT and the actual PID in the video TS packets
- Note: Some SCTE-65 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: PAT 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 PAT cycle time of 102ms

➤ “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	×	×	×	×	×

Real World Examples...

M40 Client UI

File Process

Networked Servers

- RM-40
- dev2650.lgercapj.lo...
- RM-40
- 10.10.10.25

Monitoring Node

Summary Messages monitor_3

204.192.50.250

Transport Stream Input

Interface: ASI_LS Bitrate (b/s): 19392577

Transport Stream ID: 0x9bb

Individual Programs

WX-PLUS 10-2.4

- VIDEO2 (0x2) 0x41 = 1,017,282,798
- AC3_AUDIO (0x81) 0x44 = 197,317,784

Auto-Rotate

WCAU-DT 10-1.3

Summarized Events

St.	Name	C.	Last Occuran...	Description
▲	TNC	22	Apr 17, 2006	ATSC Rule Violation
■	TOA	0	Apr 17, 2006	ATSC Rule Violation
■	CM	0	Apr 17, 2006	ATSC Rule Violation
■	QOS	0	Apr 17, 2006	ATSC Rule Violation
■	POA	0	Apr 17, 2006	ATSC Rule Violation

Overview Profiles Rules

Memory Usage: Used: Total: Message Queue: In: Out:

... Real World Examples

Channel 34 from input_0 on 192.168.20.28

Overview | Lineup | **Rules** | Guide | Streams | Pids | Physical | Logs

Rule Activation

- input_0
Quality: 94
 - US Bro...
 - Standards
 - TOA
0 / 12 Rules Fired
 - POA
1 / 7 Rules Fired
 - CM
6 / 15 Rules Fired
 - QOS
1 / 23 Rules Fired
 - PAT Repetition Interval Error (201 - 500ms)
 - PMT Repetition Interval Error (801 - 2000ms)
 - MGT Repetition Interval Error (301 - 750)
 - TVCT Repetition Interval Error (801 - 2000ms)
 - CVCT Repetition Interval Error (801 - 2000ms)
 - RRT Repetition Interval Error (120001 - 300000ms)
 - EIT-0 Repetition Interval Error (1001 - 2500ms)
 - EIT-1 Repetition Interval Error (6001 - 15000ms)
 - EIT-2 Repetition Interval Error (120001 - 300000m...
 - EIT-3 Repetition Interval Error (120001 - 300000m...
 - STT Repetition Interval Error (2001 - 5000ms)
 - PCR error

Applet com.triveni.client.applet.RemoteApplet started

start | [Taskbar icons] | 9:55 AM

Monitoring vs Troubleshooting

- Monitoring
 - Proactive
 - Continuously test emission / streams against rules and expectations
 - When rules are violated, take remedial action
 - Filter by severity of rule violation
 - Typically: problems solved before viewers become aware
- Troubleshooting
 - Reactive
 - When a problem is discovered, perform analysis to uncover root cause & repair
 - Typically, viewers aware of problems before you

Agenda

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- Tactical Stream Monitoring
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What is the advantage of Monitoring

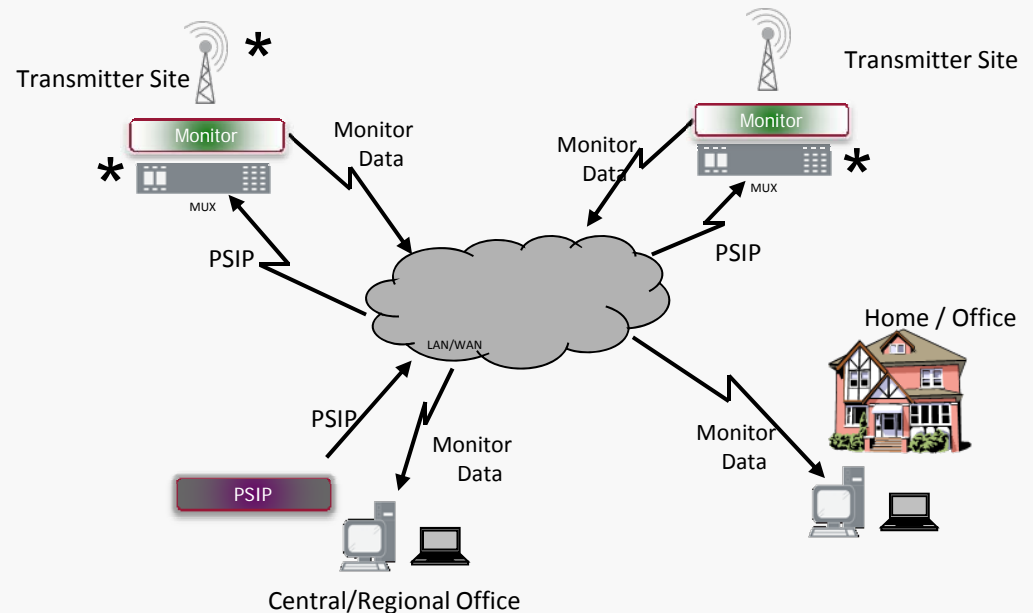
- Proactive fault detection
 - No reliance on trial and error
 - No dependencies on viewers uncovering system issues first
- Real-time alarming
 - Be informed when problems arise
- Problem localization
 - Be able to isolate faulty unit
- Tracing viewer problems to a specific deviation from the applicable standards
 - Understand causes of visible artifacts
- Monitoring allows access to multiple points in chain
 - 8VSB, SMTE310, ASI, GigE etc.

Tactical vs. Strategic Monitoring Points

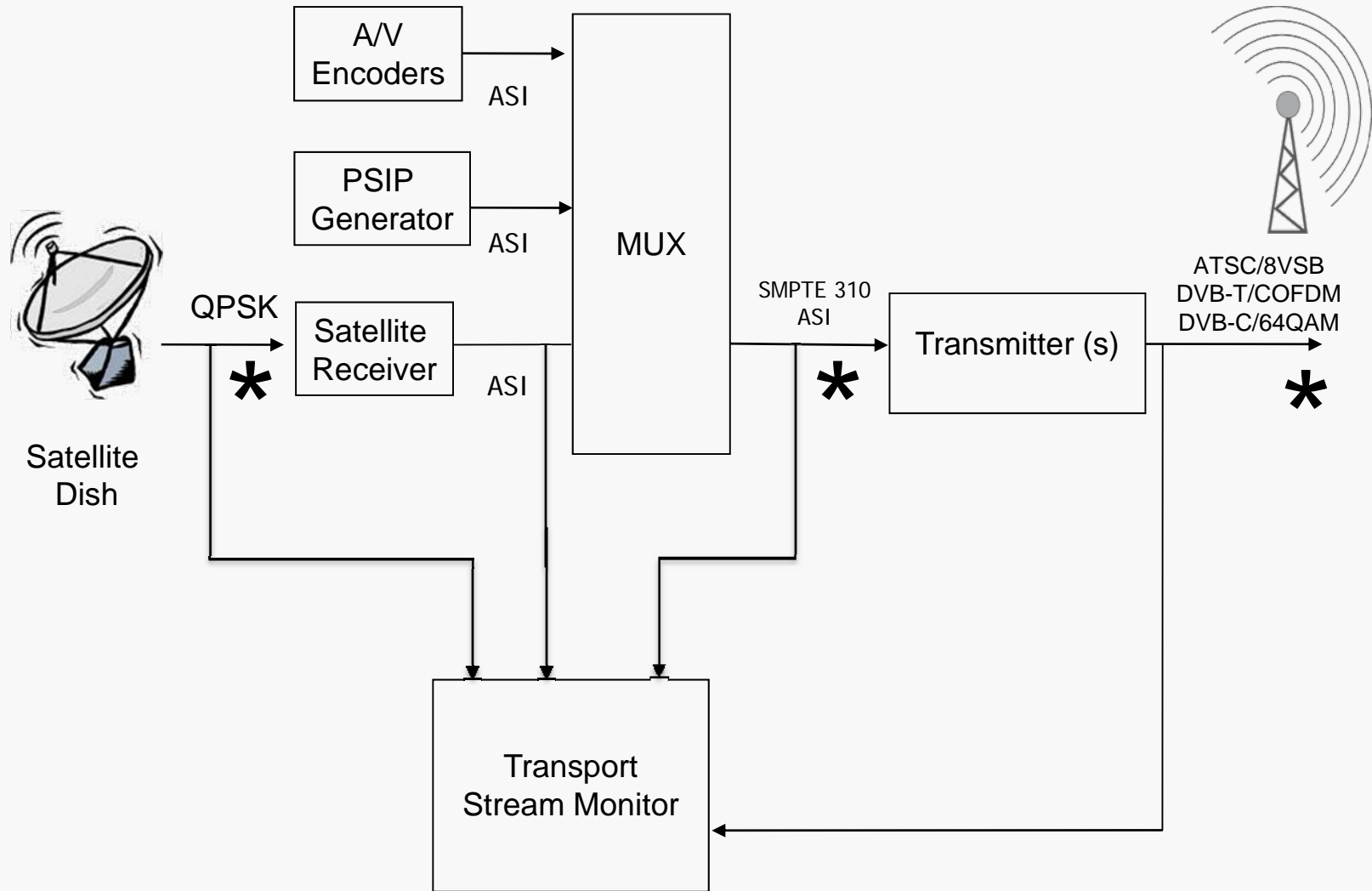
- Not every point in the broadcast chain can be monitored
 - The value proposition is too expensive
- Monitoring points can be defined by location and distance
- Strategic:
 - Satellite down/uplink, transmitter are strategic locations
- Tactical Monitoring:
 - Station, studio better served tactically
- Initially put monitors in strategic points
- If problems are detected - then portable analysis equipment can be put into place to further isolate the problem to a single component
- Imperative to bring these two models together
 - Unified and consistent point of view
 - Reporting
 - End-to-end services view

Importance of Monitoring for Centralized Architectures

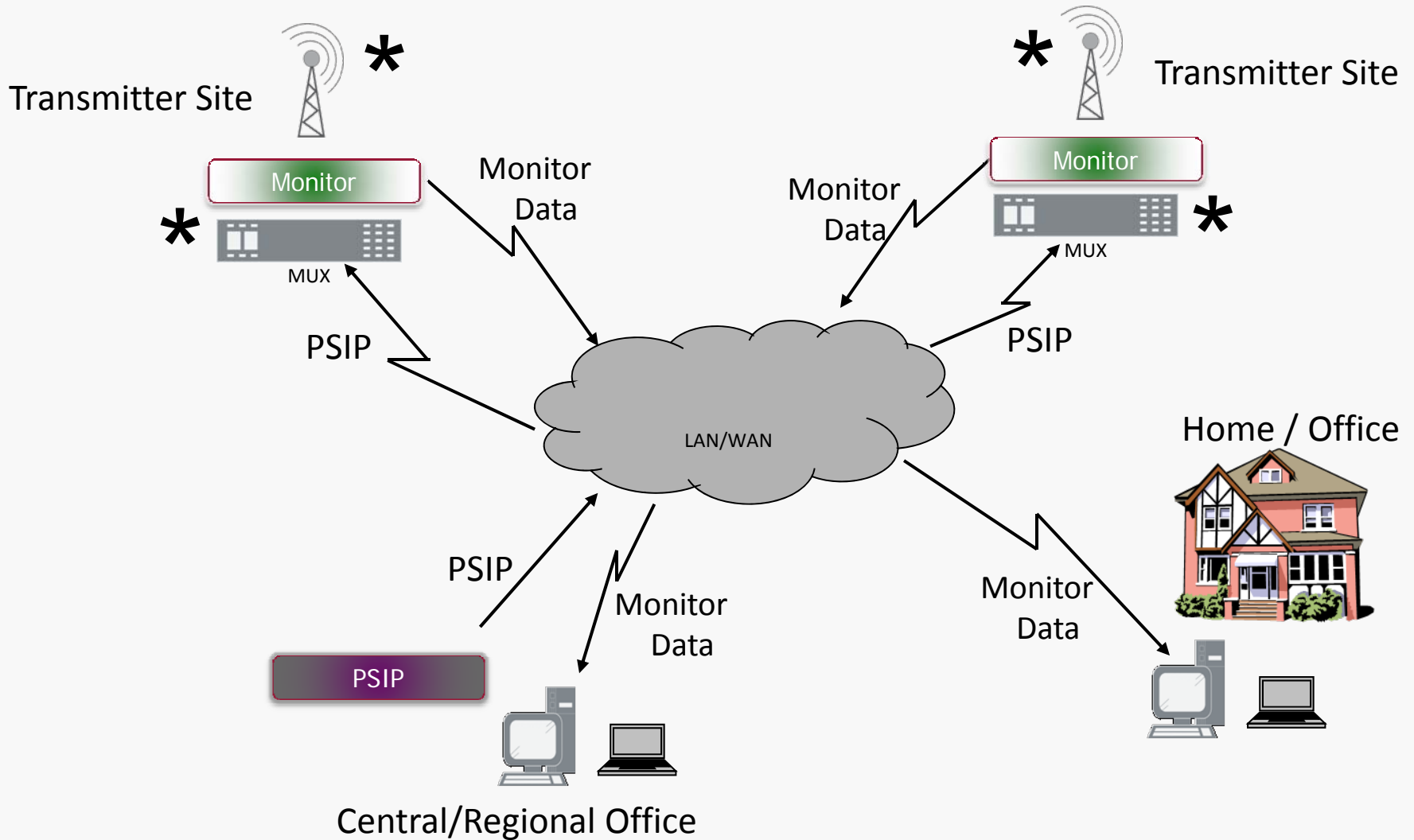
- Centralization has emerged for large station groups
 - Significant decreases in Opex/Capex
- Differing degrees of centralization
 - Station groups with centralized operations
 - Large station groups that have both centralized and regionalized operations
- Often have limited resources and expertise at edges
 - Centralizing the monitoring and analysis is advantageous



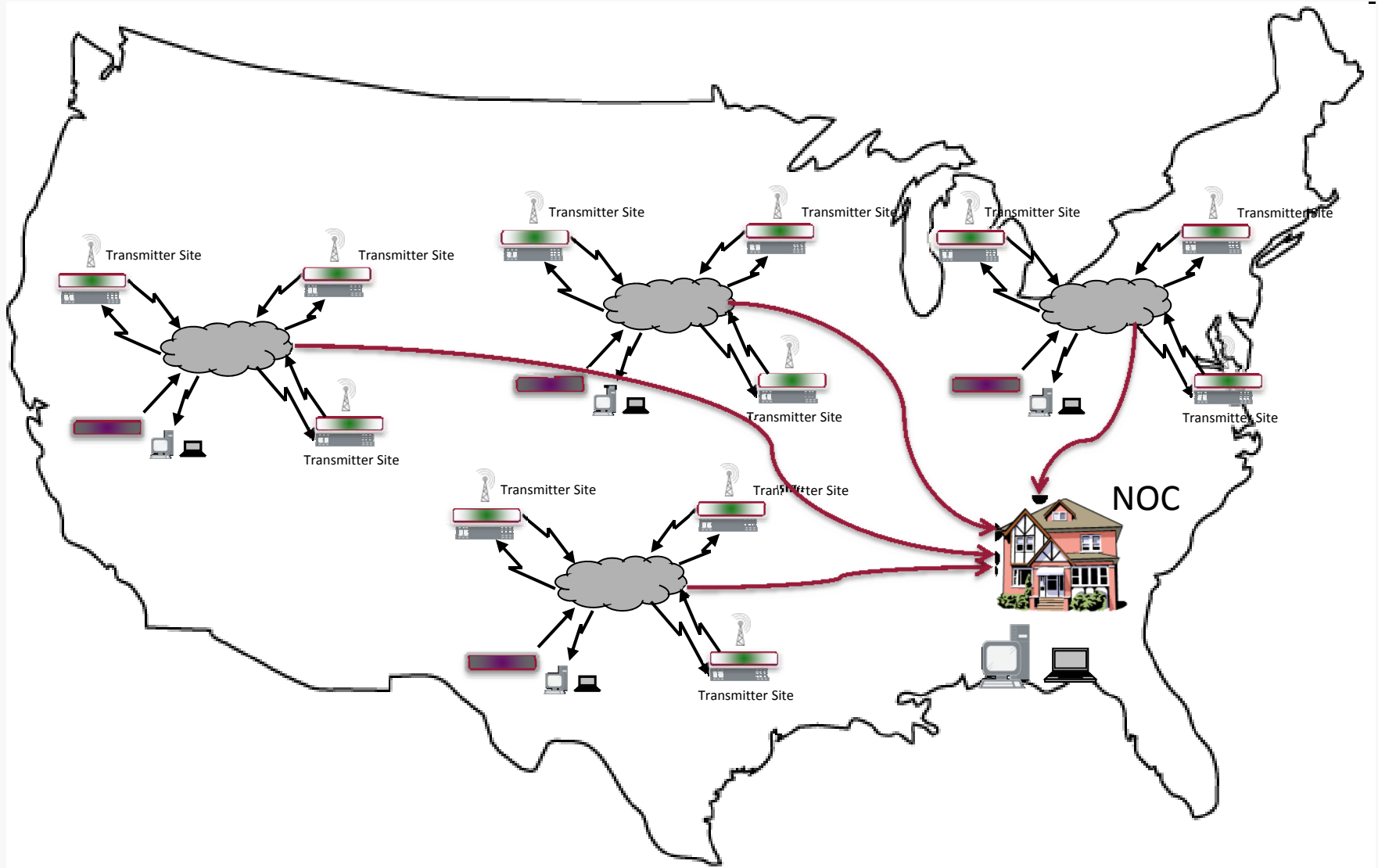
Single Station Strategic Monitoring Points



Centralized Station Group



Centralized/Regionalized Station Group



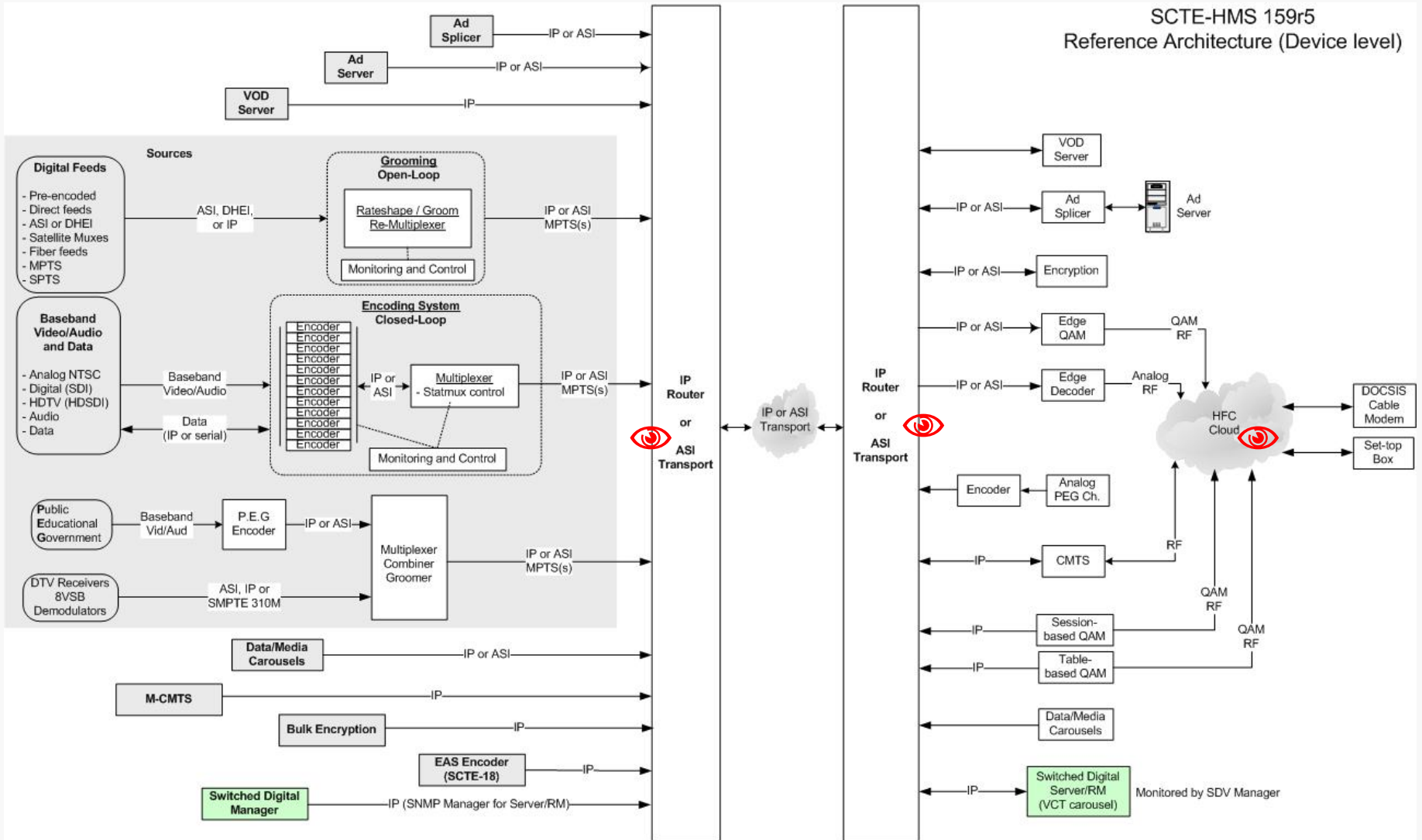
Monitoring Strategies

How does one leverage monitoring via SCTE 142?

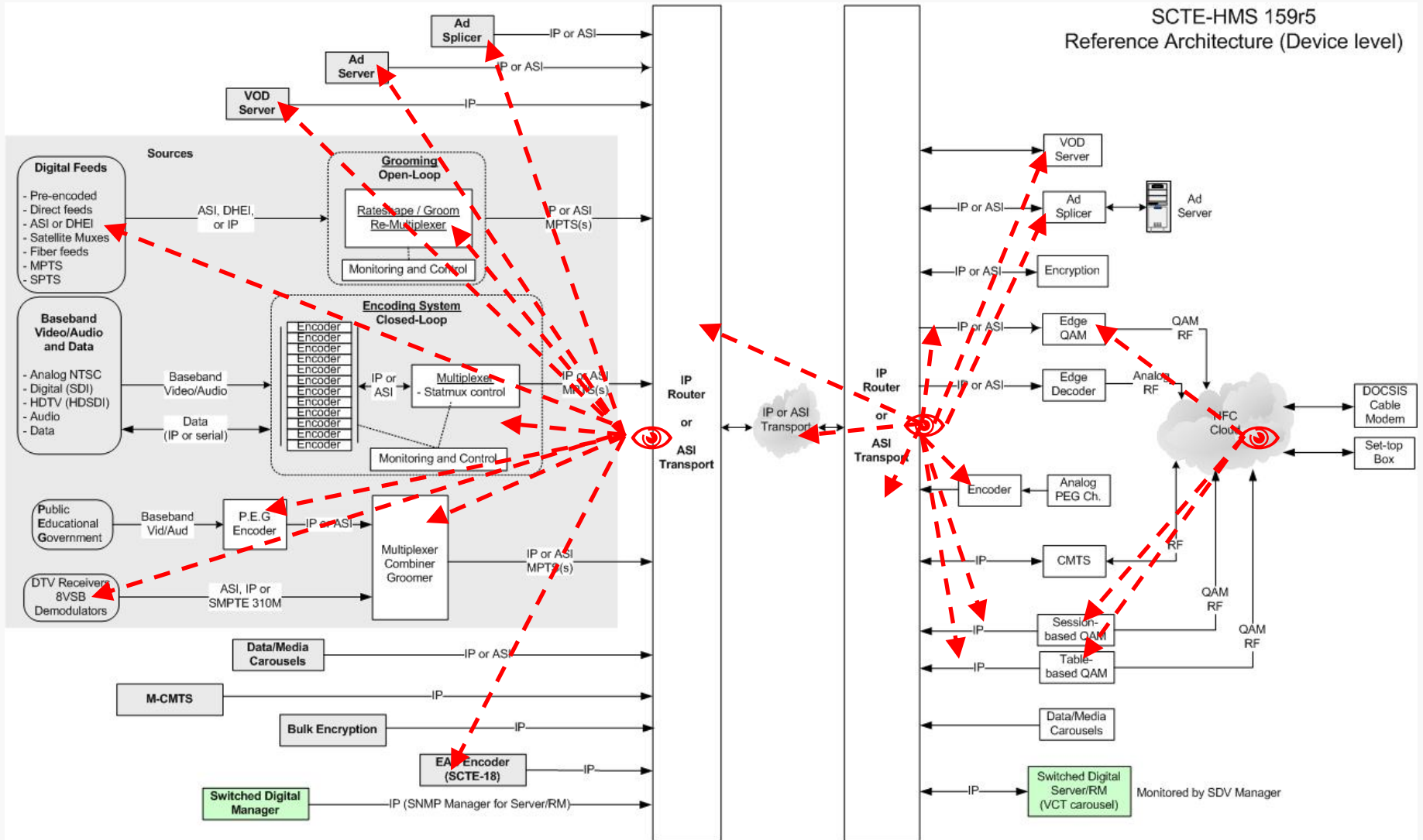
- Minimal Approach
 - Determine that problems exist
 - Avoid swarming
- Practical Approach
 - Isolate issues to functional areas
- Maximal Approach
 - Instrument everything

- Following examples use tiling isolation

Minimal Monitoring

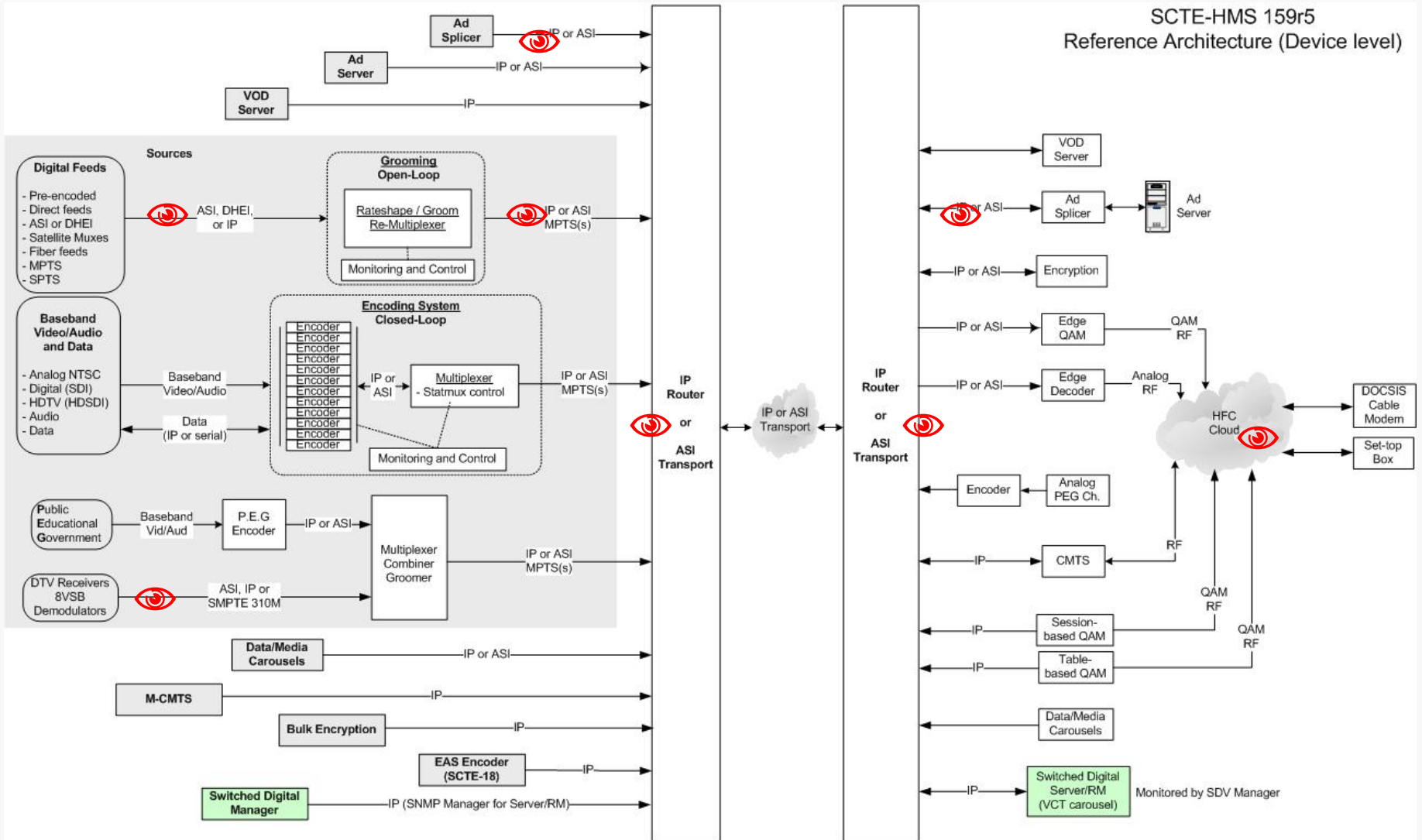


Minimal Monitoring – Tiling Localization

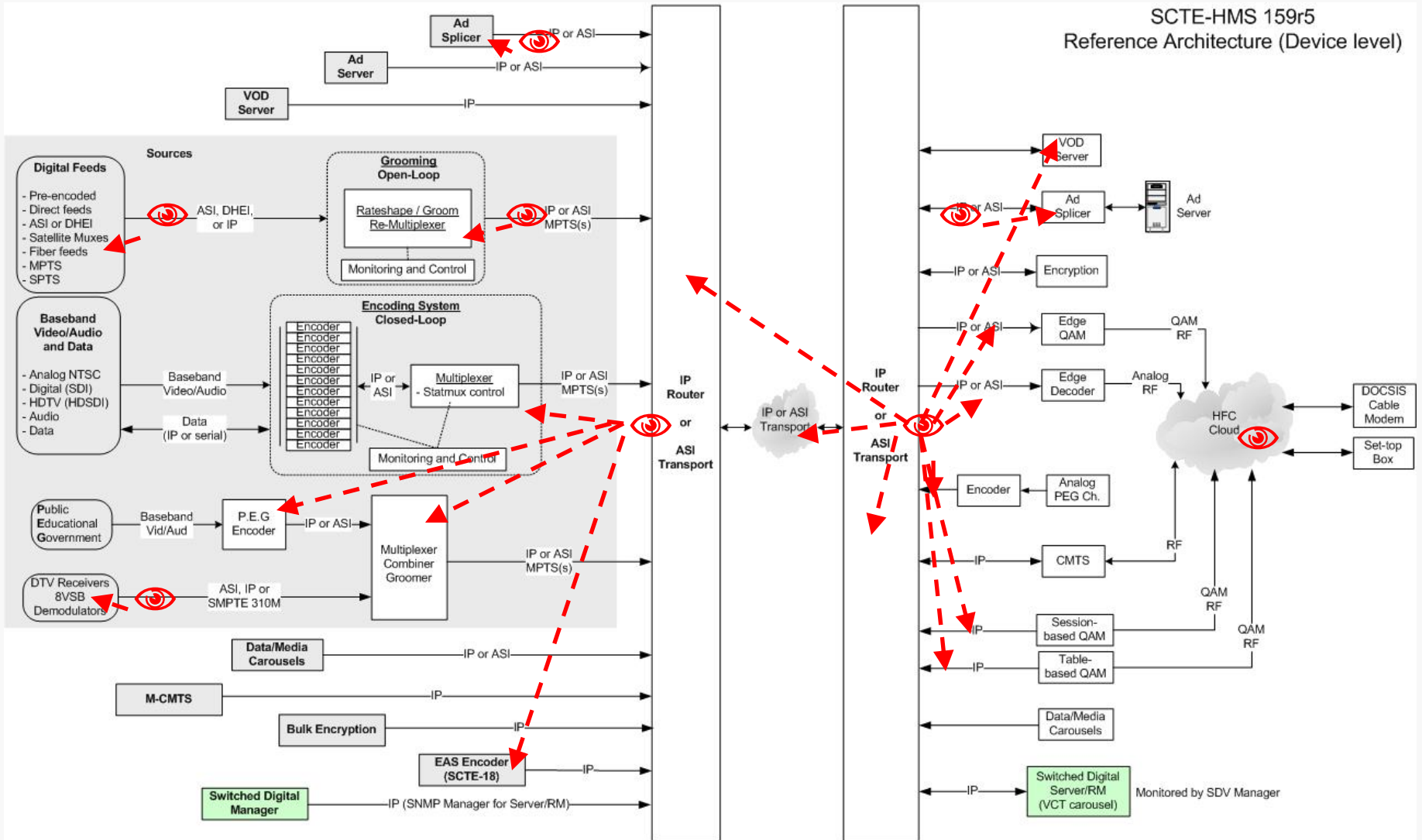


SCTE-HMS 159r5
Reference Architecture (Device level)

Practical Monitoring

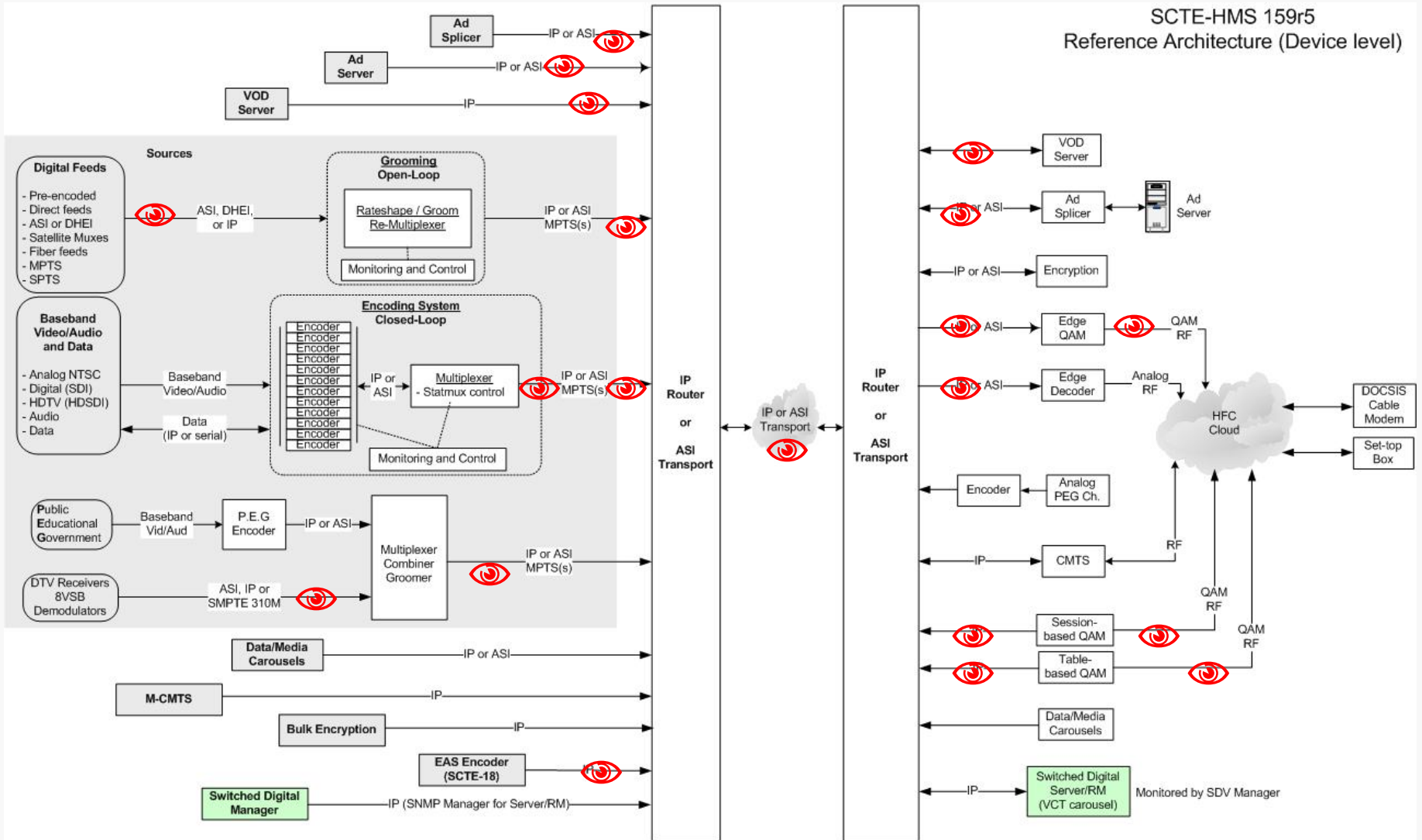


Practical Monitoring – Tiling Localization

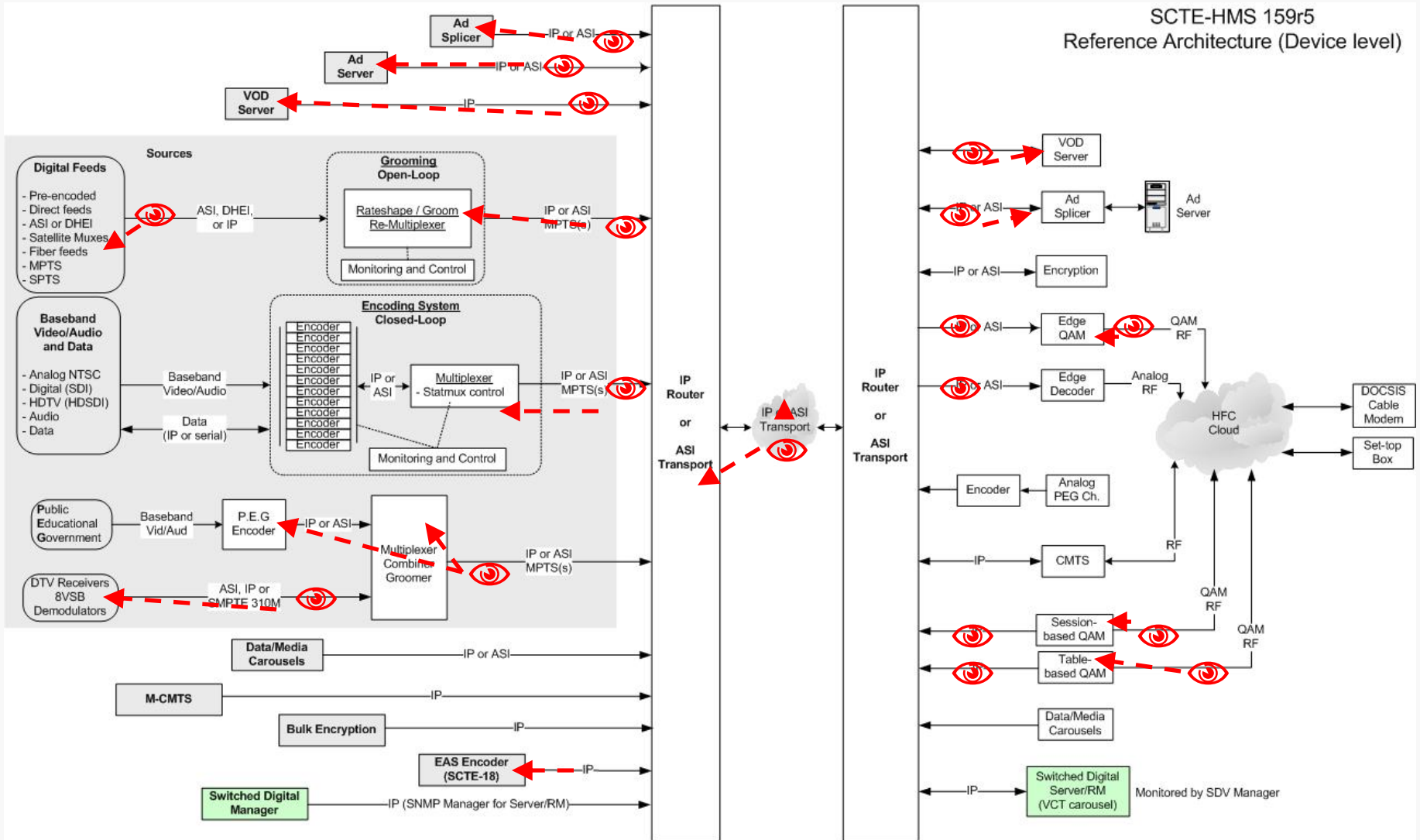


SCTE-HMS 159r5
Reference Architecture (Device level)

Maximal Monitoring



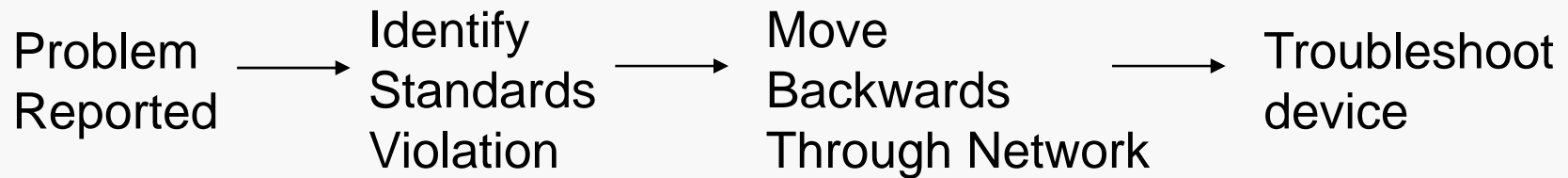
Maximal Monitoring – Tiling Localization



Agenda

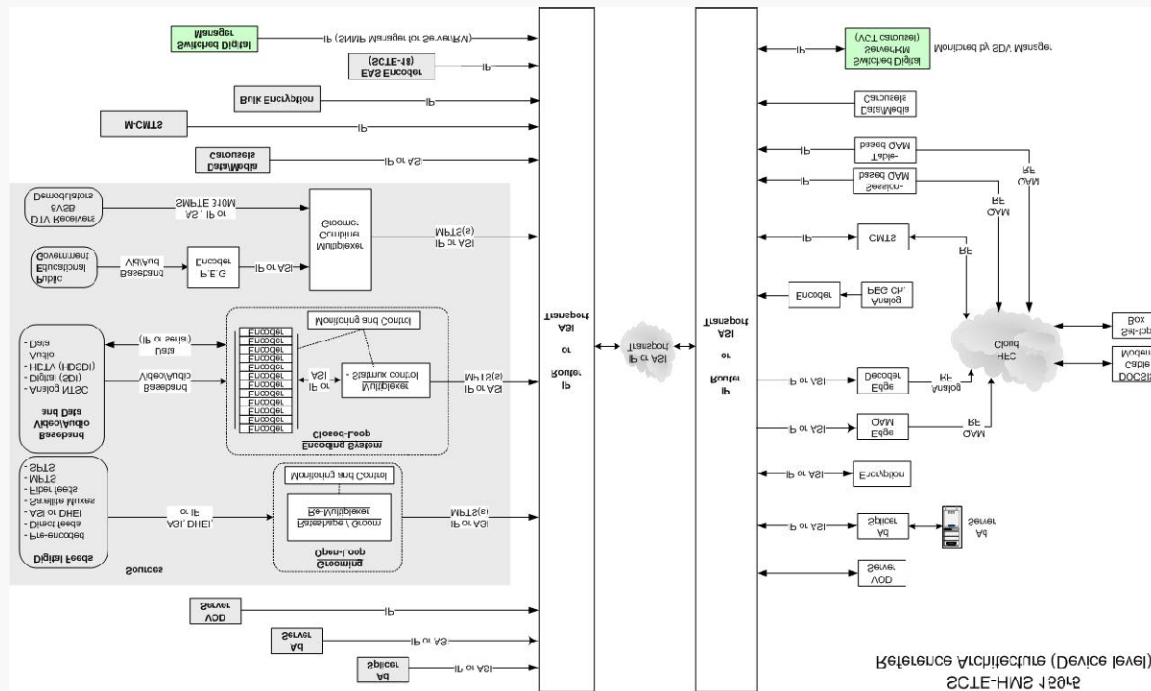
- ✓ Overview
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- **Tactical Stream Monitoring**
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Tactical Monitoring → Troubleshooting

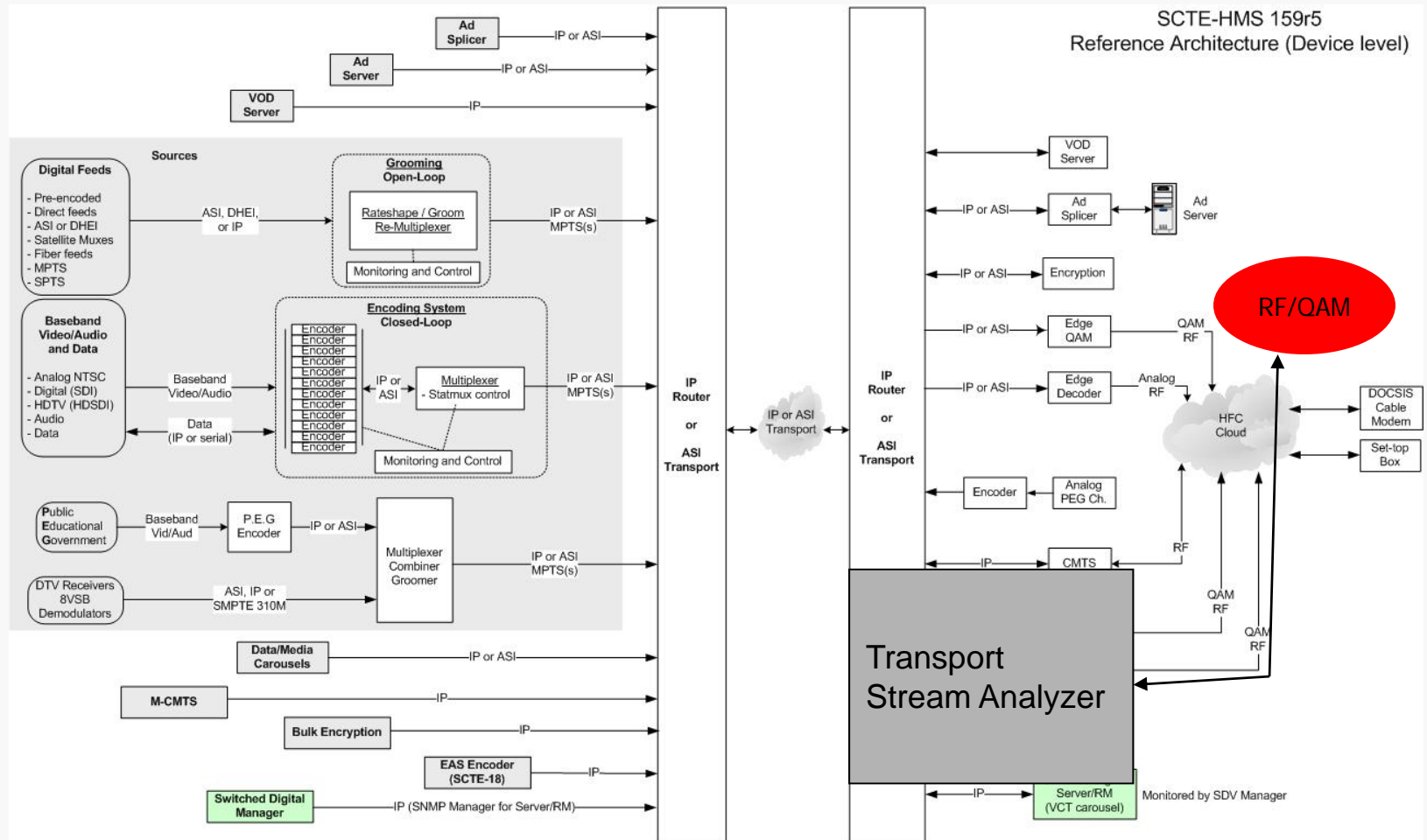


Troubleshooting Example – Audio Outage

- Customer calls into station – audio dropping out on their set
- In station set top boxes do not have any problems
- How serious is this problem? Are other Customers seeing it?



Troubleshooting Example (Contd.)



Troubleshooting Example

- Standards violation has occurred

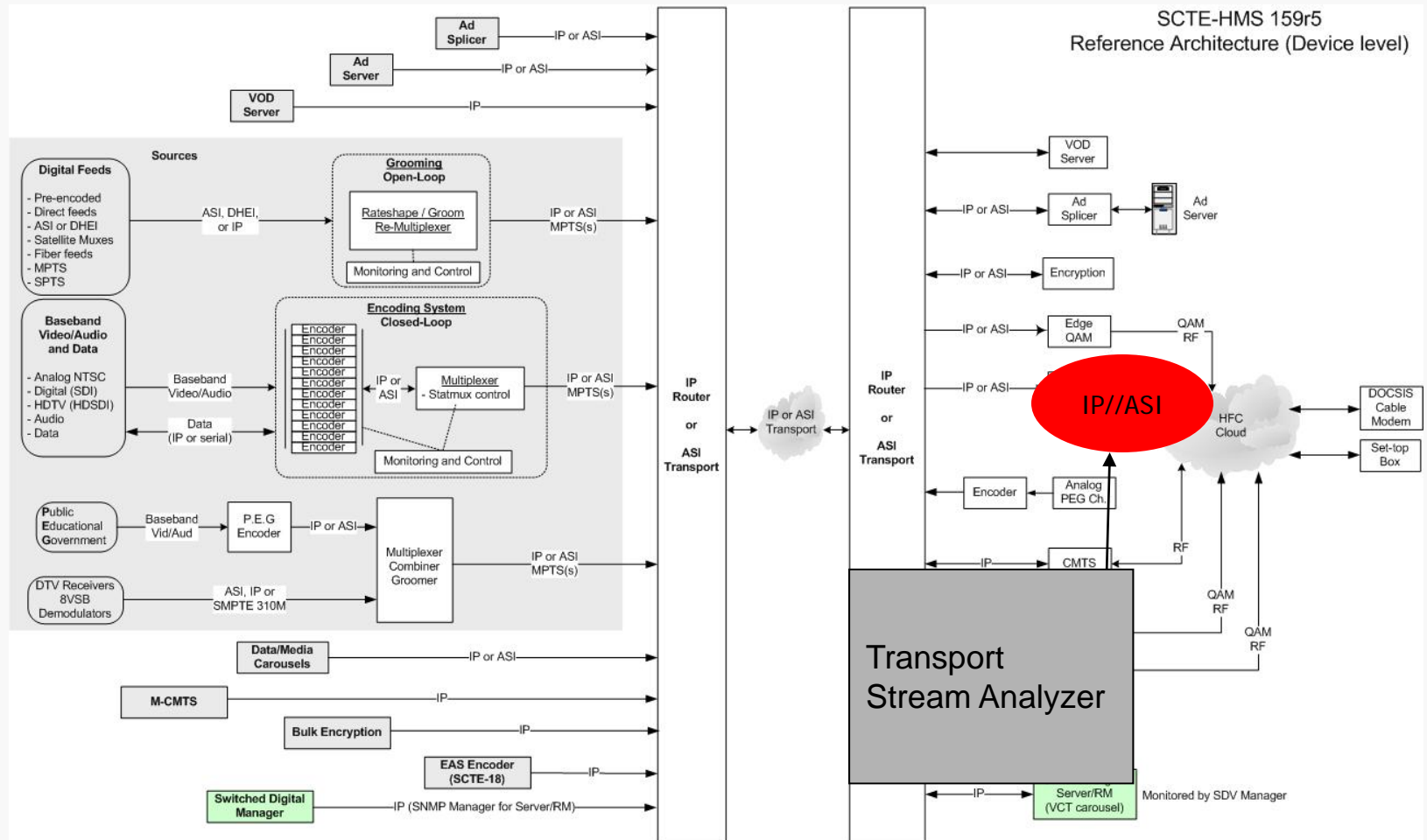
The screenshot shows the Triveni StreamScope interface. The 'Monitor' tab is active, displaying a table of monitoring metrics. The 'Audio Buffer Level' metric is highlighted with a red circle and a red 'X' icon, indicating a violation. The 'PCR Jitter Frequency' metric is also highlighted with a red circle. The 'Summary' and 'RF View' tabs are also visible.

Monitor Name	Last Occurrence	Count	Reset
Carrier Detection	Never	0	Reset
Transport Sync Byte	Never	0	Reset
Continuity Counter	Never	0	Reset
PCR Interval	Never	0	Reset
PCR Jitter Frequency	Jul 31 09:19	212	Reset
Audio Buffer Level	Never	0	Reset
Video Buffer Level	Never	0	Reset
PID Statistics Range	Never	0	Reset
PSI Error	Never	0	Reset
PSI Interval	Jul 31 09:19	1	Reset
PSIP Table Error	Never	0	Reset
PSIP Table Interval	Never	0	Reset
Cross Table Analysis	NA	NA	Reset



Troubleshooting Example (Contd.)

- Move backwards in your set up



Troubleshooting Example (Contd.)

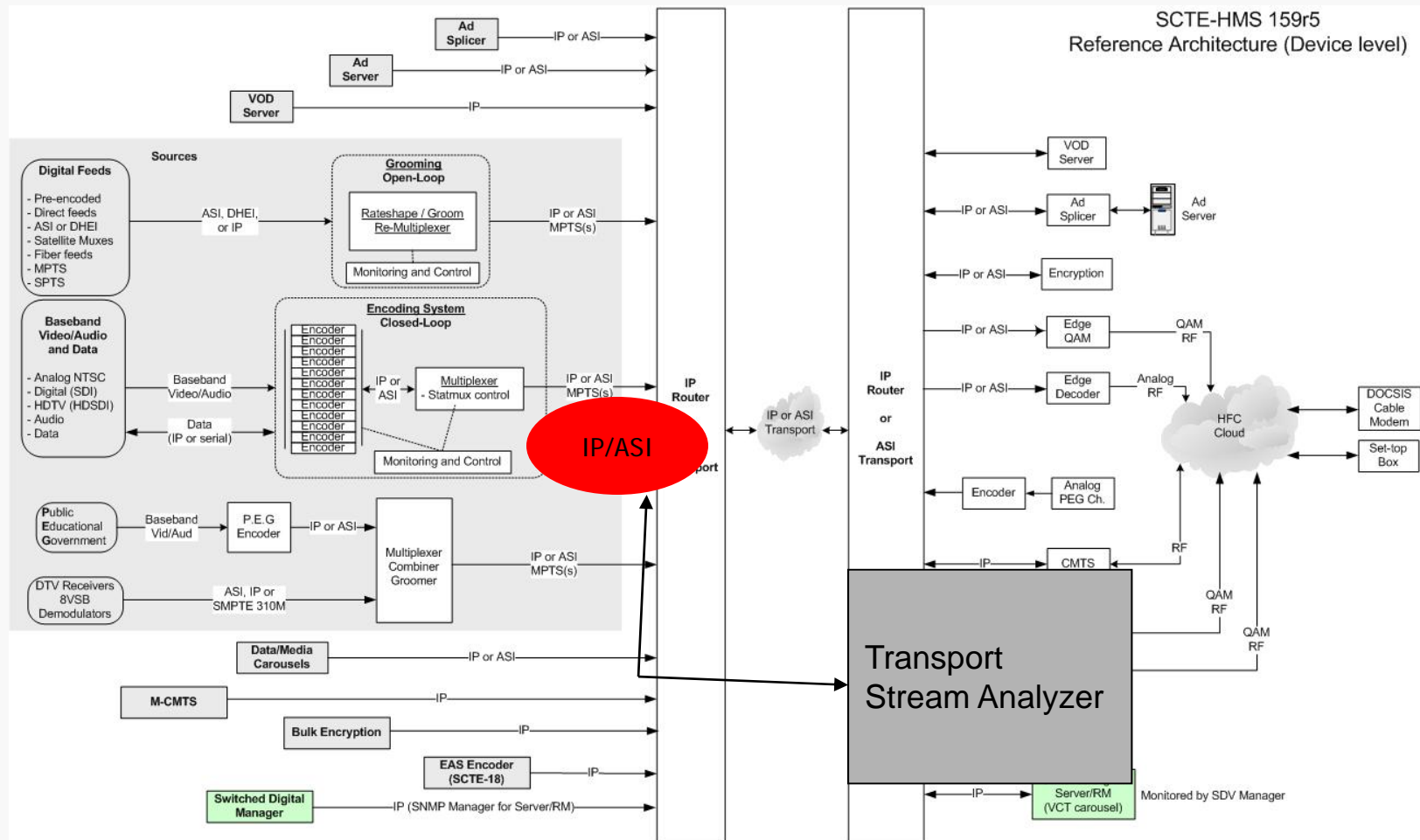
- Standards violation is still present

The screenshot shows the Triveni StreamScope software interface. The 'Monitor' tab is selected, displaying a table of monitoring items. The 'Audio Buffer Level' item is circled in red, indicating a violation. The table lists the following items:

Monitor Name	Last Occurrence	Count	Action
Carrier Detection	Never	0	Reset
Transport Sync Byte	Never	0	Reset
Continuity Counter	Never	0	Reset
PCR Interval	Never	0	Reset
PCR Jitter Frequency	Jul 31 09:19	212	Reset
Audio Buffer Level	Never	0	Reset
Video Buffer Level	Never	0	Reset
PID Statistics Range	Never	0	Reset
PSI Error	Never	0	Reset
PSI Interval	Jul 31 09:19	1	Reset
PSIP Table Error	Never	0	Reset
PSIP Table Interval	Never	0	Reset
Cross Table Analysis	NA	NA	Reset

Troubleshooting Example (Contd.)

- Move backwards further in your set up



Troubleshooting Example (Contd.)

- Standards violation is still present

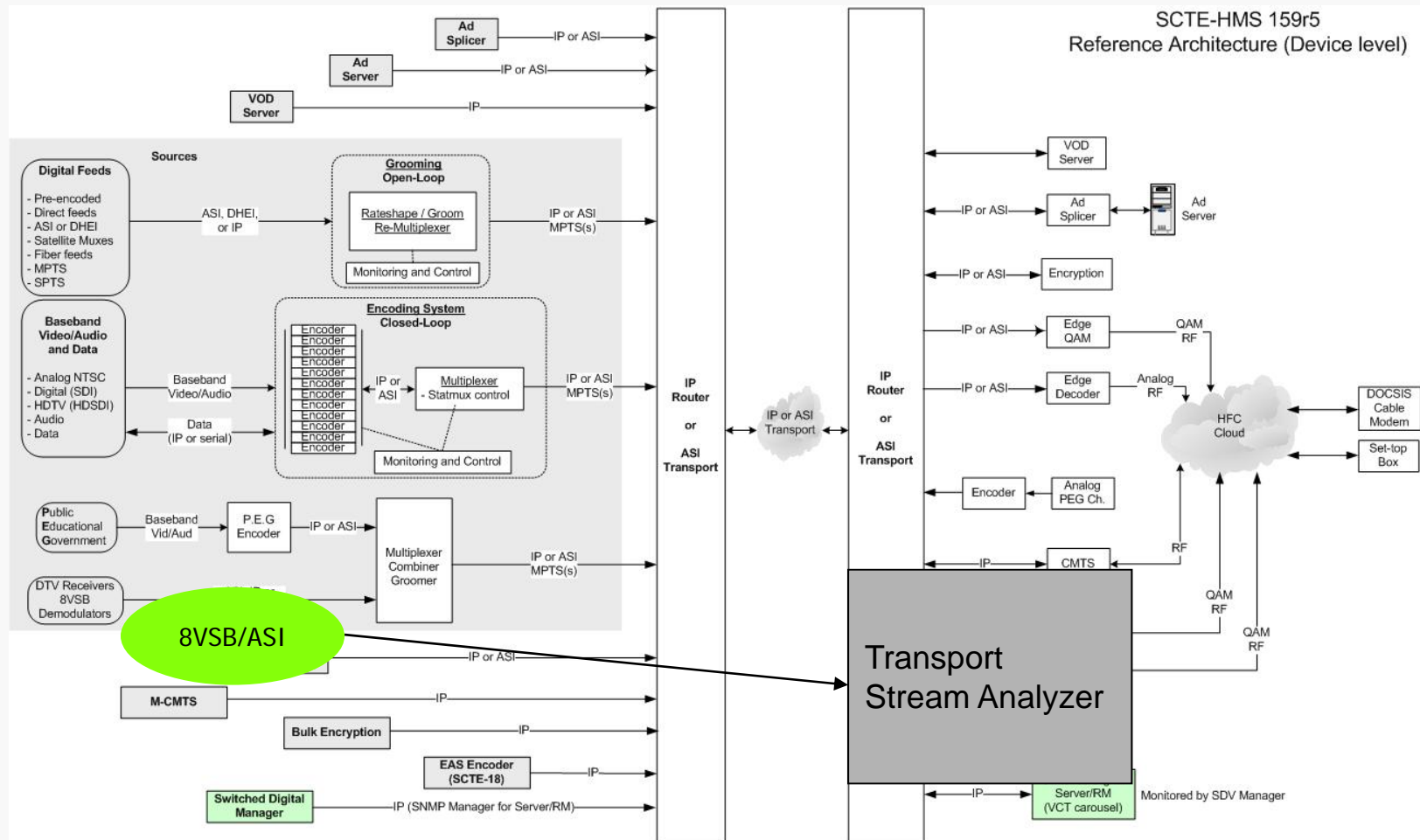
The screenshot shows the Triveni StreamScope software interface. The 'Monitor' tab is selected, displaying a table of monitoring items. The table has columns for 'Monitor Name', 'Last Occurrence', and 'Count'. The 'Audio Buffer Level' item is highlighted with a red circle and a red 'X' icon, indicating a violation. Other items show green checkmarks and 'Never' occurrence.

Monitor Name	Last Occurrence	Count	Action
Carrier Detection	Never	0	Reset
Transport Sync Byte	Never	0	Reset
Continuity Counter	Never	0	Reset
PCR Interval	Never	0	Reset
PCR Jitter Frequency	Jul 31 09:19	212	Reset
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PSI Error	Never	0	Reset
PSI Interval	Jul 31 09:19	1	Reset
PSIP Table Error	Never	0	Reset
PSIP Table Interval	Never	0	Reset
Cross Table Analysis	NA	NA	Reset



Troubleshooting Example (Contd.)

- And further...



Troubleshooting Example (Contd.)

The screenshot displays the Triveni StreamScope software interface. The top navigation bar includes tabs for Inputs, Summary, Monitor, CTA View, Log View, and RF View. The Monitor tab is active, showing an Analysis Monitor for ATSC. The interface is divided into several sections:

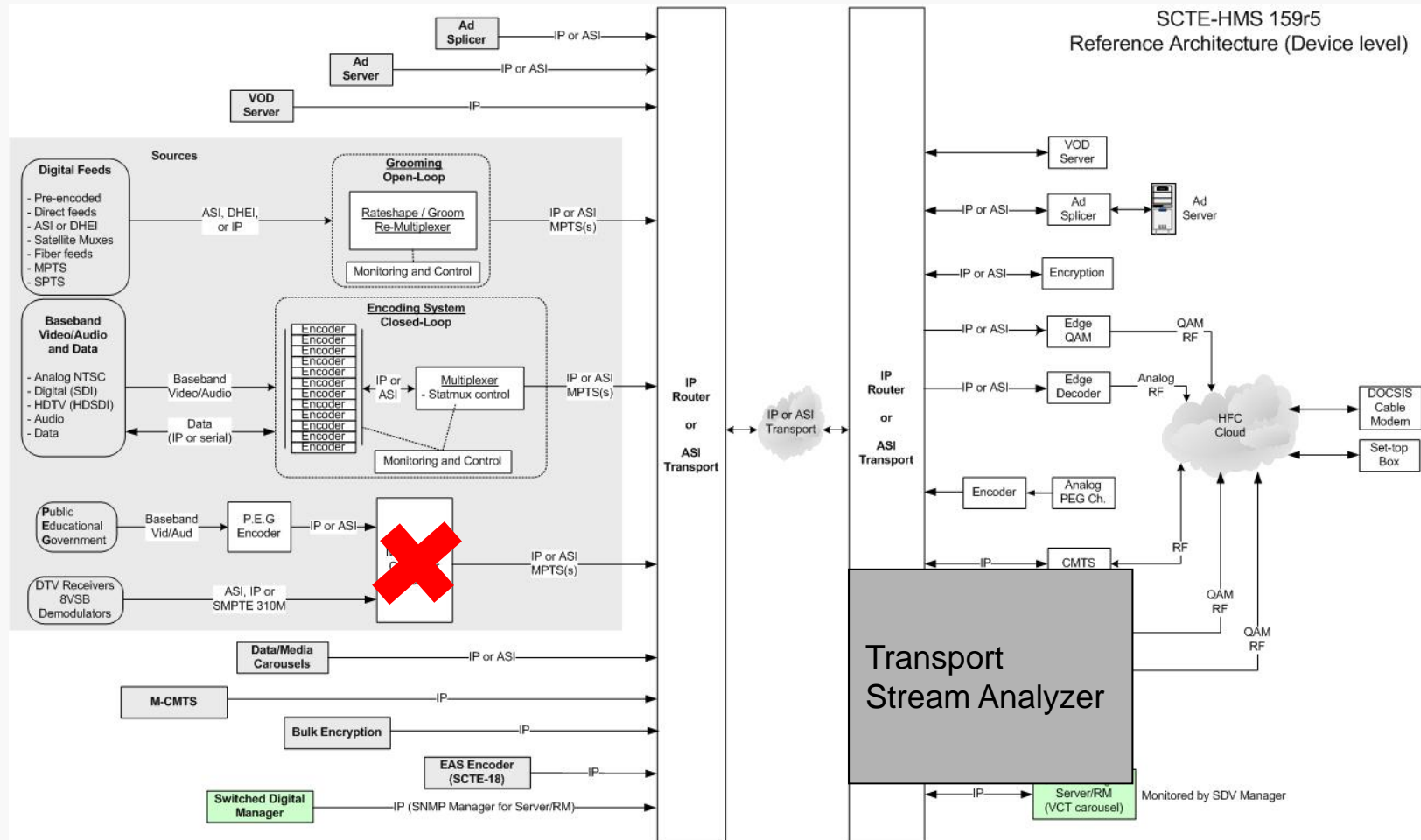
- Inputs:** A tree view on the left shows the signal path from Local Node (127.0.0.1) through ASI0-3, SMPTE, GIGE-CU, and FILE.
- Input Info:** Shows input name (RF), type (RF-USB), bitrate (18,392,658), and channel (3).
- Video Display:** Shows video (0x31) and audio (0x34) PID settings, and a program list.
- Record:** Shows recording settings for file name, max time (300 sec), and file size.
- Analysis Monitor: ATSC:** A table of monitoring metrics with 'Reset' buttons for each.
- Thumbnail/Programs:** A grid of video thumbnails for different programs.

Monitor Name	Last Occurrence	Count	Action
Carrier Detection	Never	0	Reset
Transport Sync Byte	Never	0	Reset
Continuity Counter	Never	0	Reset
PCR Interval	Never	0	Reset
PCR Jitter/Frequency	Jul 31 09:19	212	Reset
Audio Buffer Level	Never	0	Reset
Video Buffer Level	Never	0	Reset
PID Statistics Range	Never	0	Reset
PSI Error	Never	0	Reset
PSI Interval	Jul 31 09:19	1	Reset
PSIP Table Error	Never	0	Reset
PSIP Table Interval	Never	0	Reset
Cross Table Analysis	NA	NA	Reset



Troubleshooting Example (Contd.)

- Problem was groomer...



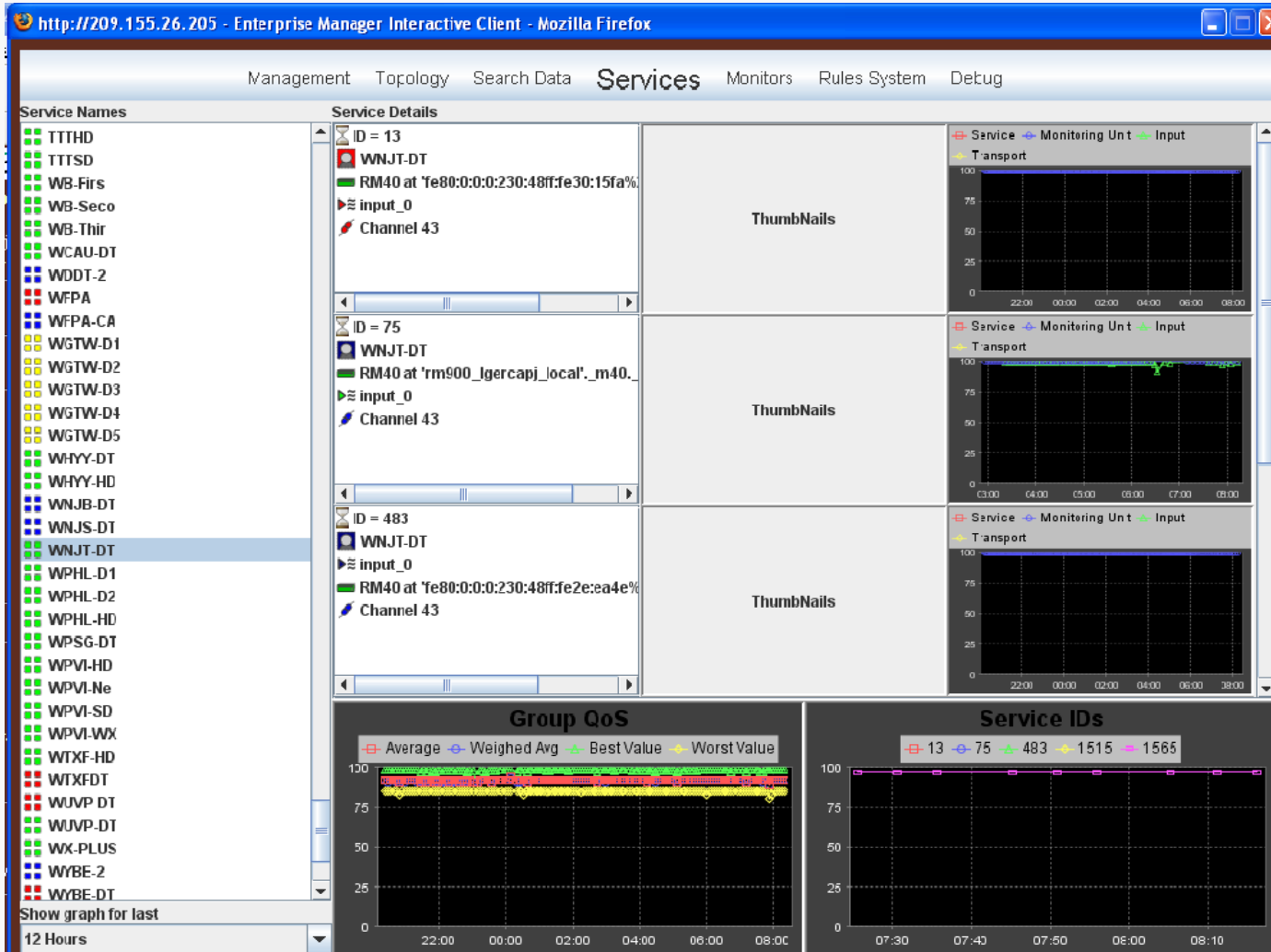
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Service based configuration

- At least two ways to view quality in a delivery network
 - Location
 - Which device might be causing issues?
 - Service
 - What is the health of a particular service across the entire system?
- Different network feeds
- View the health of a particular service across all of the different broadcast locations

Service View Example



Consolidated troubleshooting reports

- Information Overload
 - There can be many monitoring devices in the broadcast chain
 - Strictly monitoring against standard compliance could – while correct – generate a lot of alarms
 - ATSC A/78 allows prioritizing these alarms by assigning severities
- Consolidation
 - Allows pinpointing the actual location of the problem
 - Provides filtering mechanisms to allow focus on the issues that matter

Trend Analysis

- Problems can occur over time
 - Degradation in performance in one or more components
- Observing the monitoring results over a period of time, this degradation can be discovered – often before the parameters drift out of compliance
- Historical replay - recreate stream conditions at a time in the past
 - Why did we get so many calls yesterday evening?
 - Local storage required at the monitoring level

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Summary

- Digital is more complex than analog
- Identify issues before the consumer calls
 - Locate, Identify, Fix, Verify
- Monitoring strategy should be part of normal operations
- Service based assurance yields a different, useful viewpoint
- Collaborative postmortem & real-time troubleshooting
 - Reduce time to repair
 - Efficient utilization of the technical staff
- Everybody can be an expert

Thanks

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