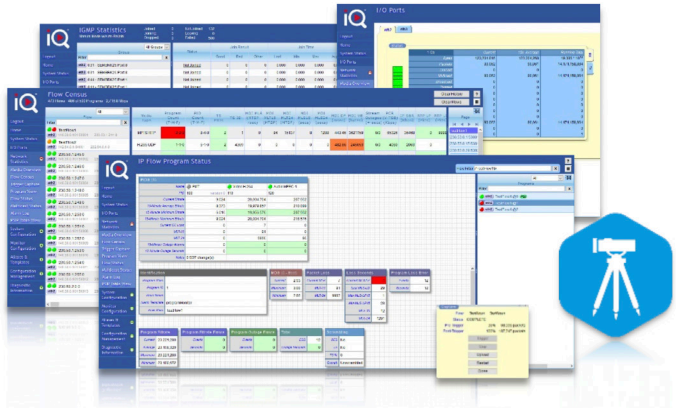


Ensuring Video Quality Across the Remote PHY Distributed Access Architecture with Telestream's Surveyor TS

Surveyor TS (Transport Stream) is a high capacity, scalable MPEG-2 Transport Stream monitor that provides comprehensive digital QoS monitoring with more capacity in a smaller network footprint than prior generation solutions. Surveyor TS continuously monitors up to 20 Gbps of video traffic at line rate and in real time, measuring, trending and alarming on the TR 101-290 and QoS metrics for each program.

Introduction

Cable operators are now deploying the Modular Head End Architecture (MHA) solution with Converged Cable Access Platform (CCAP) systems that integrate support for high-speed data and video services. Cable Labs has defined newer Distributed CCAP Architectures (DCA) that offer more flexibility, higher Physical Layer (PHY) performance for Data Over Cable Service Interface Specification (DOCSIS) 3.1 and reduced space and power requirements at the headend. See References [1, 2, 3] for details. The DCA moves some of the CCAP functionality–such as the PHY network layer or the Media Access Control and Physical (MAC-PHY) network layers–to edge locations. This paper focuses on monitoring the video quality carried on the Remote PHY (R-PHY) Distributed Access Architecture (DAA) networks.

In the R-PHY architecture, the CCAP Core at the headend includes the DOCSIS MAC and upper network layers for the DOCSIS protocols. The CCAP Core also includes all the video functions that would be performed in an Edge QAM (EQAM) for traditional non-CCAP implementations. In the Remote PHY architecture, the physical network layer functionality–such as downstream QAM modulators and upstream QAM demodulators–are removed from the CCAP Core and moved to an edge hub or fiber node location. The resulting simpler, compact, and low-power Remote PHY Device (RPD) communicates with the upstream CCAP Core via standard high-speed, typically 10 GB per second, Ethernet links using Layer 2 Tunneling Protocol Version 3 (L2TPv3). See Figure 1 and RFC 3931 Reference [4]. L2TPv3 provides for the transport of Layer 2 frames intended for the RPD over a Layer 3 IP network.

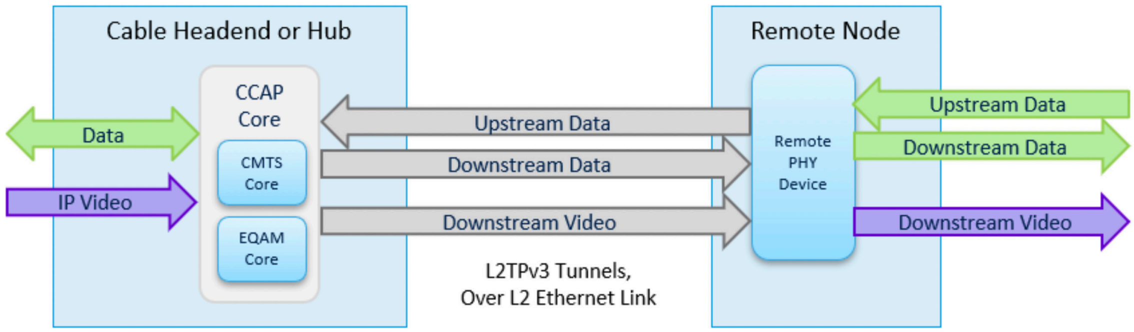


Figure 1 – CCAP Core to Remote PHY Communications Using L2TPv3 – See Reference [1]

The downstream interface protocol from the CCAP Core to the RPD is the Remote Downstream External PHY Interface (R-DEPI). It uses an IP pseudowire protocol between the CCAP Core MAC and the downstream RPD for setting up, maintaining, and tearing down sessions. The Remote Upstream External PHY Interface (R-UEPI) is the similar pseudowire protocol for upstream communications from the RPD to CCAP Core.

The MPEG Transport (MPT) operation mode of R-DEPI is used to transport video MPEG Transport Stream packets. The Packet Streaming Protocol (PSP) mode transports DOCSIS frames in the L2TPv3 payload. Each MPT mode packet contains a 32-bit session ID associated with the target QAM channel.

The clock component in every CCAP and RPD device needs to be synced to allow for proper operation of the R-PHY DAA. The synchronization and timing require-ments are detailed in the DOCSIS Timing Interface (DTI) specification, which is part of the Remote PHY set of specifications.

Challenges in Deploying R-PHY DAA

The new Remote PHY Distributed Access Architecture provides many benefits, but it also poses challenges for cable operator teams. The complexities in migrating to and using this new architecture will require operators to investigate new areas of technology, update and change their processes, and make changes in their field measurement tools to maintain peak efficiency and ensure quality of service (QoS).

With a R-PHY DAA deployment, the once colocated network functions are now split. Some functions migrate out into the field, changing the demarcation points for technicians within a cable multiple-system operator. One of the outcomes is that technicians will have new responsibilities with new technology and tools to learn. The new tools will help to optimize the installation process and network management and resolve issues to ensure the success of the company. Along with the new architecture that separates the CCAP core and the physical layer–often by long distances and multiple network hops–comes the critical issue of timing in DOCSIS communications and delivery of services. The R-DEPI, as explained above, deals with the pseudowire connecting the CCAP to the RPD and specifies requirements for UDP and MPEG-TS, along with buffering and allowable deviation. Its requirements must be met to ensure a high-quality service.

Video Quality Assurance for R-PHY Architecture

With consumers' appetite for video entertainment, today's digital broadcast environments are becoming more complex, with a wide array of sources, compres-sion standards and formats, developing technologies, and a plethora of devices content is delivered to. Delivering video to your viewers across these evolving distribution networks has its challenges. There is no perfect environment, and errors will occur at various points throughout the distribution chain. The two primary contributors to playback excellence are content preparation and network performance.

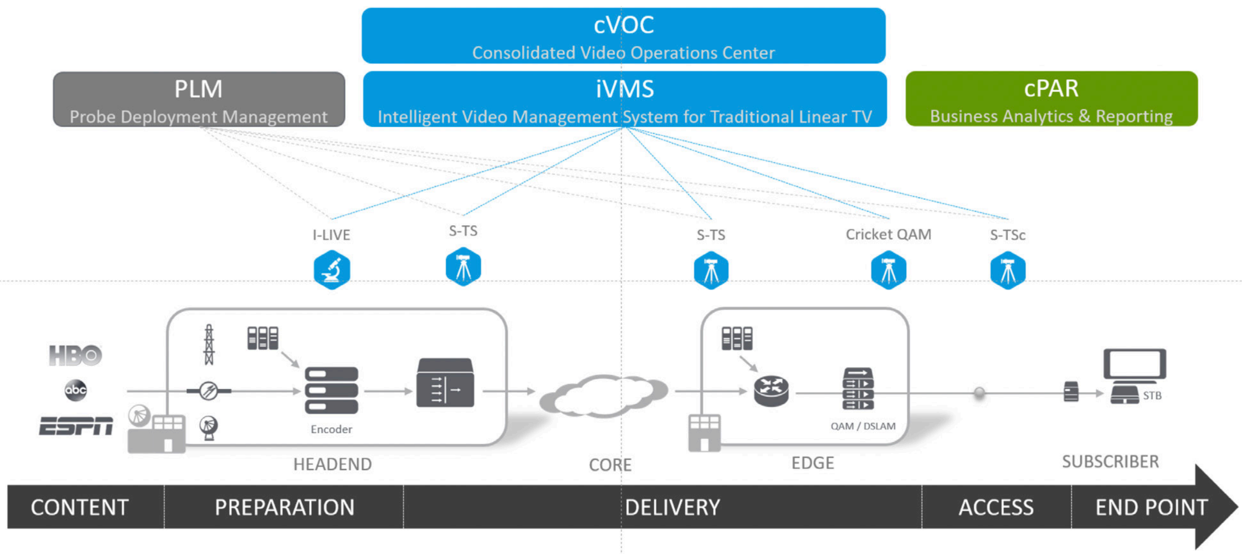


Figure 2. End-to-End Video Delivery System Monitoring for Quality of Service (QoS) and Quality of Experience (QoE)

Network performance issues can ruin the playback experience in spite of perfect content preparation. Packet-based video delivery is highly susceptible to packet loss and latency. It is critical to monitor both of these aspects to ensure a seamless viewing experience. The new R-PHY Distributed Access Architecture being deployed adds to the complexity of the network, creating more points where errors can happen. Telestream's Video Quality Assurance (VQA) solution gives you the information you need to manage the video quality challenge. Our platform goes beyond merely detecting and reporting problems. The VQA platform allows you to pinpoint where those problems originate, so you can quickly diagnose and fix them, often before your viewers even notice. The system easily pays for itself through reduced operating expenses, customer support costs, and higher viewer satisfaction, engagement, and retention.

This solution provides video network operators with a comprehensive view of both content and transport quality for delivery of programs from origin through network edge delivery, as shown in Figure 2. The Telestream VQA platform begins with the acquisition elements (probing technologies) that gather metrics from the critical points along your video distribution chain. Inspector LIVE monitors the content preparation. Surveyor TS (S-TS), Surveyor TS Compact (S-TSc), and Cricket QAM monitor the network performance in delivering the video.

Telestream's Surveyor TS monitoring probe is a high-capacity, scalable MPEG-2 Transport Stream and IP flow monitor that provides comprehensive QoS stream monitoring. The Surveyor TS can monitor up to 2,000 flows in a small 1U footprint. It can be used to monitor Remote PHY networks. Surveyor TS [6] continuously monitors up to 20 GB per second of video traffic at line rate and in real time, measuring, trending and alarming on the TR 101-290 metrics for each program and on a number of IP flow metrics, such as real-time bitrate, IP jitter, and loss *signatures for up to 2,000 programs simultaneously.

Surveyor TS is designed to locate transport impairments as they happen and produce actionable insights that enable you to address issues before they affect the customer viewing experience. Surveyor TSc [6] provides the same features as Surveyor TS at a lower cost point and smaller form factor, with reduced capacity for lower-bandwidth networks.

Surveyor TS and TSc deliver comprehensive video QoS monitoring, enabling diverse network applications, such as:

- Full-time, 24x7 line rate monitoring of video network performance at the headend, hub offices, and local serving offices.
- Flow-by-flow and program-by-program troubleshooting.
- Performance verification for new networks and updated network designs.

Both S-TS and S-TSc are can be used within our VQA platform, or they can be used stand-alone with an available API for configuration and data extraction. The Surveyor TS API has been integrated with several well-known operations support system/network management system solution providers' management systems.

Surveyor TS Deployment in R-PHY Networks

Since most traditional edge QAM networks will not be completely changed over to CCAP Core and Remote PHY Devices overnight, Surveyor TS simultaneously supports monitoring both types of network protocol stacks, beginning with version 1.04.01. Existing TS over IP links to Edge QAMs and R-PHY L2TPv3 tunnels can be monitored simultaneously.

With the Remote PHY license installed, all the monitoring features and metrics of the existing Surveyor TS are available for video programs carried in the L2TPv3 tunnels used by the R-PHY network. A new session ID parameter associated with the L2TPv3 streams is used to identify an alias flows, source and destination IP addresses, and port numbers. The parameters can be configured as part of the Surveyor TS alias configuration shown in Figure 3 as well as via the Program Lineup Manager (PLM) software [9] (if used) and via the REST API [7] (if used).

1. On the Alias & Templates ➞ Alias page, click the flow name that has the Remote PHY link. In this version, the L2TPv3 section replaces the UDP section.

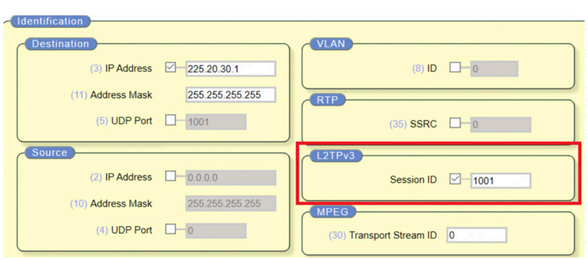


Figure 3 - L2TPv3 Section of Alias Page

2. On the Monitor Configuration ➞ Global Parameters page, the L2TPv3 Session ID check box is included in this version.

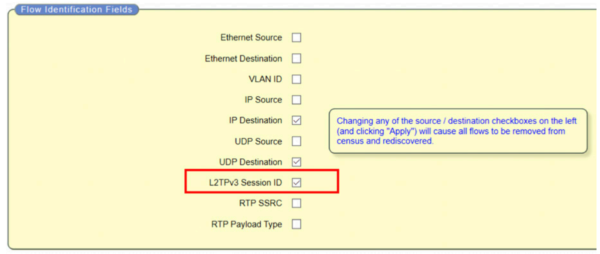


Figure 4 - L2TPv3 Session ID Check Box

When using the Surveyor TS to monitor Remote PHY streams, the following information is displayed:

1. On the Network Statistics ➞ Flow Census page, unaliased L2TPv3 flows are identified by their IP destination address plus the L2TPv3 session ID. In the Media Type column, the term "L2TPv3" replaces "UDP."

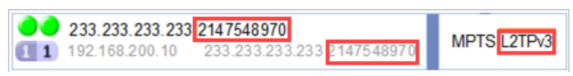


Figure 5 - Census Page

2. On the Network Statistics ➞ Flow Status page, the L2TPv3 session ID is displayed in the Encapsulation section.

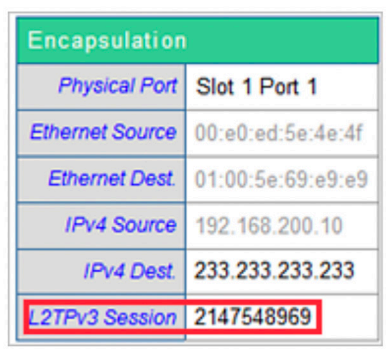


Figure 6 - Flow Status Page

3. Reporting Loss Period and Loss Distance using L2TPv3 Sequence Numbers: The lower 16 bits of each packet's L2TPv3 sequence number is copied into that packet's IPv4 datagram ID field. This behavior allows the use of existing mechanisms that

treat datagram IDs as Real-Time Transport Protocol (RTP) sequence numbers. This can then be used to report loss period and loss distance based on those numbers.

4. To enable datagram IDs to be treated as RTP sequence numbers, go to the Aliases & Templates ➞ Transport Alarm Template page and then click the Transport Stream tab. In the Video Source list, select IP Datagram ID.

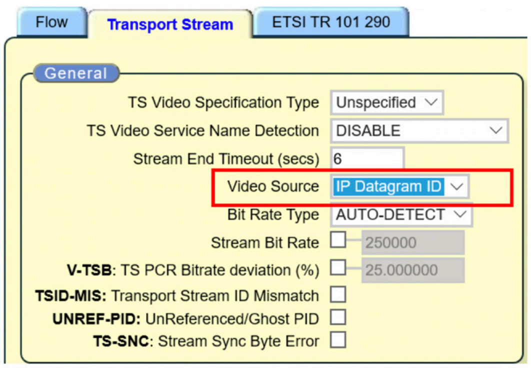


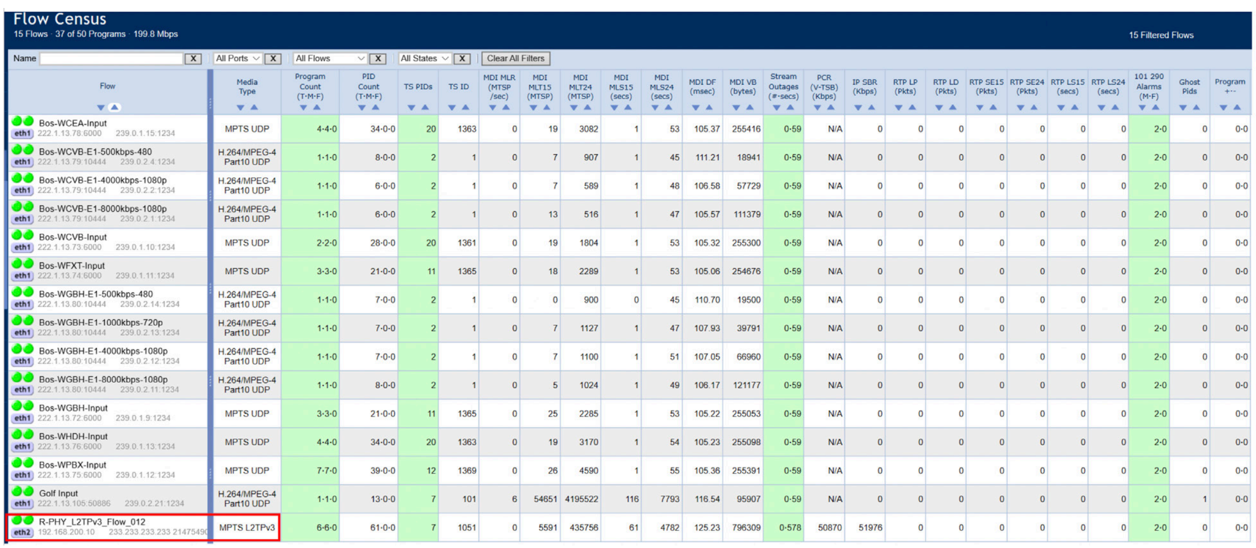
Figure 7 – Reporting L2TPv3 Sequence Numbers

5. On the Network Statistics ➞ Flow Census page, mixed L2TPv3 and UDP flows are supported. (See Figure 8)

Summary

As cable operators move to DAA and Remote PHY deployments, the need to monitor the quality of the R-PHY links becomes increasingly important. The Surveyor TS and Surveyor TSc provide valuable insight into the quality of the R-PHY link.

S-TS and S-TSc provides comprehensive, managed monitoring capabilities for current UDP distribution protocol stacks used with edge QAM devices as well as the emerging Distributed CCAP Architectures with R-PHY Devices simultaneously. The S-TS and S-TSc includes the full per-flow and per-program monitoring capabilities with both protocol stacks as networks are gradually updated. The accompanying Program Lineup Manager release [9] enables device configuration automation for all new management features, as does the updated REST API [7].



Flow Census
15 Flows · 37 of 50 Programs · 199.8 Mbps
15 Filtered Flows

Flow	Media Type	Program Count (T·M·F)	PID Count (T·M·F)	TS PIDs	TS ID	MDI MLR (MTSP /sec)	MDI MLT15 (MTSP)	MDI MLT24 (MTSP)	MDI MLS15 (secs)	MDI MLS24 (secs)	MDI DF (msec)	MDI VB (bytes)	Stream Outages (#·secs)	PCR (V-TSB) (Kbps)	IP SBR (Kbps)	RTP LP (Pkts)	RTP LD (Pkts)	RTP SE15 (Pkts)	RTP SE24 (Pkts)	RTP LS15 (secs)	RTP LS24 (secs)	101 290 Alarms (M·F)	Ghost Pids	Program +·-
Bos-WCEA-Input eth1 222.1.13.78:6000 239.0.1.15:1234	MPTS UDP	4·4·0	34·0·0	20	1363	0	19	3082	1	53	105.37	255416	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WCVB-E1-500kbps-480 eth1 222.1.13.79:10444 239.0.2.4:1234	H.264/MPEG-4 Part10 UDP	1·1·0	8·0·0	2	1	0	7	907	1	45	111.21	18941	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WCVB-E1-4000kbps-1080p eth1 222.1.13.79:10444 239.0.2.2:1234	H.264/MPEG-4 Part10 UDP	1·1·0	6·0·0	2	1	0	7	589	1	48	106.58	57729	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WCVB-E1-8000kbps-1080p eth1 222.1.13.79:10444 239.0.2.1:1234	H.264/MPEG-4 Part10 UDP	1·1·0	6·0·0	2	1	0	13	516	1	47	105.57	111379	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WCVB-Input eth1 222.1.13.73:6000 239.0.1.10:1234	MPTS UDP	2·2·0	28·0·0	20	1361	0	19	1804	1	53	105.32	255300	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WFXT-Input eth1 222.1.13.74:6000 239.0.1.11:1234	MPTS UDP	3·3·0	21·0·0	11	1365	0	18	2289	1	53	105.06	254676	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WGBH-E1-500kbps-480 eth1 222.1.13.80:10444 239.0.2.14:1234	H.264/MPEG-4 Part10 UDP	1·1·0	7·0·0	2	1	0	0	900	0	45	110.70	19500	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WGBH-E1-1000kbps-720p eth1 222.1.13.80:10444 239.0.2.13:1234	H.264/MPEG-4 Part10 UDP	1·1·0	7·0·0	2	1	0	7	1127	1	47	107.93	39791	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WGBH-E1-4000kbps-1080p eth1 222.1.13.80:10444 239.0.2.12:1234	H.264/MPEG-4 Part10 UDP	1·1·0	7·0·0	2	1	0	7	1100	1	51	107.05	66960	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WGBH-E1-8000kbps-1080p eth1 222.1.13.80:10444 239.0.2.11:1234	H.264/MPEG-4 Part10 UDP	1·1·0	8·0·0	2	1	0	5	1024	1	49	106.17	121177	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WGBH-Input eth1 222.1.13.72:6000 239.0.1.9:1234	MPTS UDP	3·3·0	21·0·0	11	1365	0	25	2285	1	53	105.22	255053	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WHDH-Input eth1 222.1.13.76:6000 239.0.1.13:1234	MPTS UDP	4·4·0	34·0·0	20	1363	0	19	3170	1	54	105.23	255098	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Bos-WPBX-Input eth1 222.1.13.75:6000 239.0.1.12:1234	MPTS UDP	7·7·0	39·0·0	12	1369	0	26	4590	1	55	105.36	255391	0·59	N/A	0	0	0	0	0	0	0	2·0	0	0·0
Golf Input eth1 222.1.13.105:50886 239.0.2.21:1234	H.264/MPEG-4 Part10 UDP	1·1·0	13·0·0	7	101	6	54651	4195522	116	7793	116.54	95907	0·59	N/A	0	0	0	0	0	0	0	2·0	1	0·0
R-PHY_L2TPv3_Flow_012 eth2 192.168.200.10 233.233.233.233 21475490	MPTS L2TPv3	6·6·0	61·0·0	7	1051	0	5591	435756	61	4782	125.23	796309	0·578	50870	51976	0	0	0	0	0	0	2·0	0	0·0

Figure 8 – Flow Census for L2TPv3 and Traditional UDP Streams

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