

Video Headend Video Quality Monitoring Solution

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Abstract

Background: The convergence of traditional Broadcast Television Broadcasting (DVB) services is evolving towards all Internet Protocol (IP) delivery network. In addition, the response to this evolution is the standardization of Internet Protocol Television (IPTV) architectures, such as DVB-IPTV, focusing on the delivery of continuous high-quality video services and covering the natural evolution of services such as high definition television and stereoscopic video. Nevertheless, by using existing video monitoring solution, it cannot be possible to monitor more than one live stream simultaneously without delay and for that setup need many devices. Also it is not feasible to monitor real-time video for IP Headend without storing the content. By creating a centralized monitoring environment one can able to integrate all the headend devices where the operator can identify and rectify errors based on their priority that occurred throughout the network. **Methods:** The proposed work provides a solution to monitor video without delay and with fewer networks. This Video Quality Monitoring (VQM) Solution deals with real time monitoring of channels effectively and efficiently with the help of network management system. **Findings:** This project describes the design and functionality of VQM and all streamed channel will be displayed on the video wall with specific parameters of video for subjective monitoring purpose.

Keywords: DVB, Headend, IPTV, Monitoring, Quality, Video, VQM

1. Introduction

1.1 Headend Architecture and Components

IP Headend is a master facility for receiving Digital Video Broadcast (DVB)⁵ signals for processing and distribution over an IP network. Head-end encompasses solutions to acquire process, encode, and manage video content. Services of Headend are IPTV¹, Multiscreen. In IP headend it is difficult to maintain video quality because of packet transmission. Video Quality Monitoring (VQM) is to provide high quality of audio and video to the customer. VQM includes analyzing, monitoring, collecting reports, triggering corrective actions. VQM provides an end-to-end monitoring solution for Headend network from a centralized platform. This document gives the information about how to monitor video quality and what are the parameters that should be monitor. The

functions in headend are content acquisition, processing, encoding/transcoding, encryption, modulation, delivery, management. Headend Architecture is as shown in Figure 1.

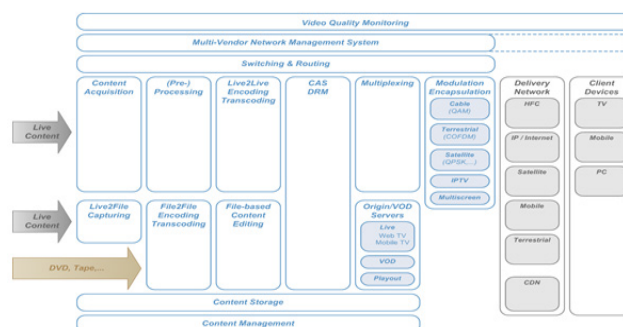


Figure 1. Headend architecture.

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Processing is done by IRD where preprocessing is done to send multicast IP network. Encoding/Transcoding of video is done before it sends as a parallel media streams to multiplexer. Digital Right Management (DRM) is the integral part of end-to-end content protection technology. It will take control of encryption, key management and user right provisioning. Modulation/Encapsulation takes place when data send from one source network to another delivery network. The delivery component providing the processed content in the proper way to the available delivery networks in the final step of multi-screen headend environment³. The components of headend are antennas, IRDs, encoders and switches. For receiving the DVB signals have two antennas (C band and Ku band). An IRD (Teleste Luminato and Harmonic) is an electronic device used to convert a RF signal to digital signal. An encoder (Envivio, Harmonic and Elemental) is a device that converts information from one format to another, for the purpose of standardization, speed, security, or saving space by shrinking size. The headend end-to-end network is shown in Figure 2.

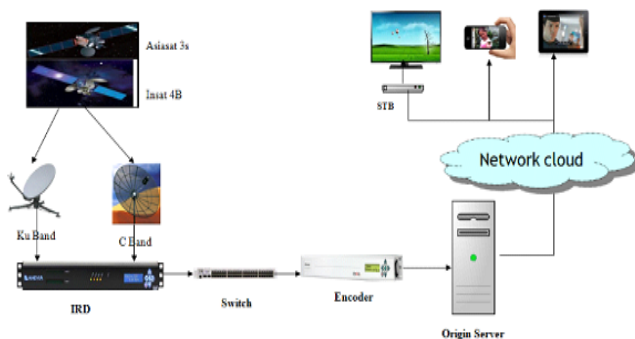


Figure 2. Headend end-to-end network.

1.2 Video Quality Monitoring

VQM is the most precise and the most flexible solution to measure and monitor audio, video quality perceived by end-users. Operators need complete visibility to quickly troubleshoot issues and ensure a great customer experience. To implement real time video quality monitoring at headend first need to analyze Transport Stream (TS). For analyzing TS continuously are using TAG (MCM 9000) probe⁷.

This probe creates a visual mosaic from the monitored services with rich data overlay, supplying the operator with a strong tool for error detection. After analyzing need to have operator environment where operator can monitor video, collect alarms, rectifying the raised alarms. The created mosaic is an HD video stream, encoded and transmitted as standard H.264 SPTS enabling remote

monitoring and very flexible installation topology⁶. The unit monitors for complete ETR-101-290 compliance and also for a variety of properties: video freeze, black video, audio silence, audio levels, color space, resolution change, service bitrate, Program Map Table (PMT) structure and more². For this purpose are using multi-vendor network management system. In this project will be integrating TAG (MCM 9000) with Network Management System (NMS) to implement real time video quality monitoring.

The central component of the entire VQM is the NMS (Skyline's DataMiner). The dataminer offers the ability to monitor video signal quality at each point in the network in an easy and effective way. Additionally it provides the ability to receive alarms from all headend elements.

The main components for the VQM solution are:

- TAG MCM 9000 probe.
- Network Management System (DataMiner)
- Regular content VOC operators desktop.
- Television for Video wall display.

VQM provides an end-to-end monitoring solution for Headend network from a centralized platform that offer subjective monitoring of video quality measurement at different points of the headend network by means of the observation of internet protocol channels displayed on the video wall or in monitors located at the operator workstation⁴. VQM solution helps to narrow down to the exact point where error is introduced into the stream.

2. Video Parameters and Standards

A MPEG-2 Transport Stream (TS) is a special format for transmission as well as storage of audio, video and Program and System Information Protocol (PSIP) data. It's commonly used for digital television and streaming across networks, including the internet. The two major features of the TS are error checking/correction and stream synchronization. MPEG Transport Stream (MPEG-TS, MTS) is a standard format like MPEG-2 TS.

In IP headend the content information (i.e. video, audio, and data) in each layer will be TS. So there should be a standard that define parameters to analyze the transport layer information. The European Telecommunication Standards Institute (ETSI) is a standard for the TS analysis. For video quality measurement ETSI defined standard TR-101-290.

2.1 ETSI TR-101-290 Standard

ETSI TR-101-290 (ETR 290) defines measurement

guidelines for monitoring MPEG TS defined in three priorities:

2.1.1 Priority 1- Necessary for De-codability (Basic Monitoring)

- TS Sync loss
- Sync byte loss
- PAT error
- Continuity count error
- PMT error
- PID error

2.1.2 Priority 2 - Recommended for Continuous or Periodic Monitoring

- Transport error indicator check
- CRC error
- PCR repetition error
- PCR discontinuity
- PCR accuracy error
- PTS error
- CAT error

2.1.3 Priority 3 - Application Dependent Monitoring

- NIT actual/other error
- SDT actual/other error
- EIT actual/other error
- Buffer error
- RST error
- TDT error

In our project only focus on Priority 1 and 2 errors, because correction of those errors are more important for improvement of quality of a video. The following alarm severity levels are selected manually.

OK: color green.

Warning: color yellow

Critical: color orange

Major: color red

Minor: color black

If enable all severity levels in alarm template of probe, then the alarm will be present in the alarm list.

3. Implementation

3.1 End to End Network

The end to end network consist of headend, core, access and home network. Headend is where common or

national channel are required. The functions of headend acquiring the content, processing and send it to delivery network. The core network is a valuable target of crackers who wish to disrupt network operation for the purpose of demonstrating that they can do such a thing. It is also an attractive target for professionals who want to expropriate the network for their uses or disrupt the core network as a part of an extortion scheme. Disruption of the core network disrupts a national service. Access networks distribute the IP streams to the DSLAMs for local distribution. Home network is where the IP stream is terminated and viewed using a STB or computer. The end to end network architecture and where TAG can collect the streams is shown in below Figure 3.

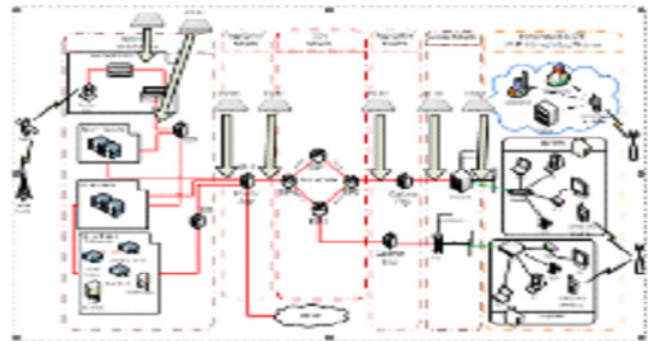


Figure 3. End-to-end network.

3.2 Existing System

The existing video quality monitoring network includes collecting information through Dektec, analyzing TS through TS reader and the integration of the new i-channel (NMS), and displaying through mosaic generator. So for subjective monitoring need additional devices which is shown in Figure 4.

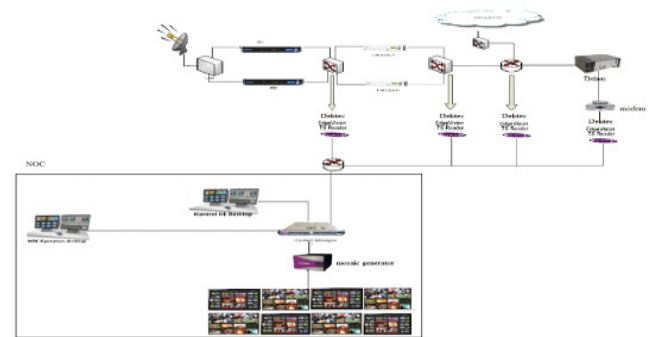


Figure 4. Existing video quality monitoring setup.

3.3 Proposed System Architecture

To avoid the disadvantage in existing solution are

proposing a solution which can monitor video quality effectively. In the existing video monitoring solution it need have multiple devices to collect information, to analyze TS, to manage the network. In proposed solution TAG (MCM 9000) probe will do subjective monitoring and it has the Intelligence to do quality test. No need to have multiple devices. TAG will collect all information and display multiple channel through mosaic through SPTS at all monitoring points. For management of the network are using DataMiner which is multivendor NMS where can integrate and manage all the headend components. The architecture of proposed solution is shown in the below Figure 5.

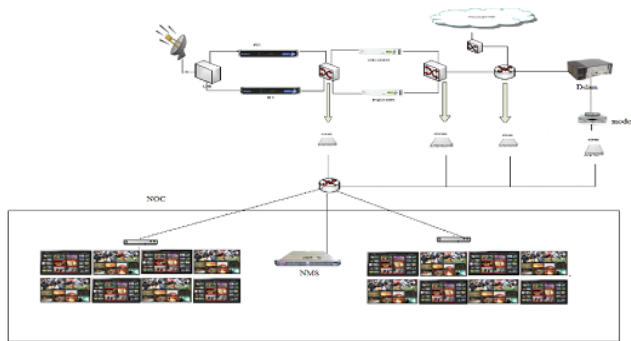


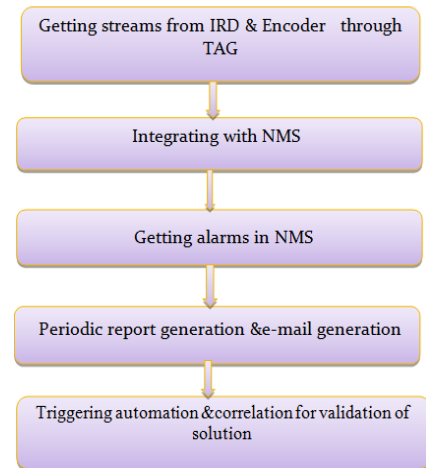
Figure 5. Proposed system architecture.

TAG is Multi channel monitoring, probing with mosaic solution using Off the Shelf hardware. Monitors both for errors on the transport layer and on the payload layer. TAG will do objective as well as subjective monitoring. It will take all IP streams and will display in mosaic as SPTS. No need to have separate network for doing streaming through HDMI to video wall. The same exact output can be duplicated many times with no limitation on the network (Multicast). The main differences between DEKTEC and TAG are mentioned in the below Table 1.

Table 1. TAG and Dektec comparison

TAG MCM 9000	Dektec
Mosaic and multi-vendor display	No mosaic display, for that need mosaic generator
Alerts generated in TAG	Cannot generate alerts
Supports TR-101-290, ATSC A/78A	Supports only TR-101-290
Round-Robin display layout	No Round-Robin
Reduce operating cost	Operating cost is more

3.4 Work Flow



3.5 Steps to Configure and Monitor Channels

3.5.1 Configure the Network

The first step is configuring the network shown. Network interfaces could be easily configured to match system's requirements. A group of network interfaces can be grouped together to create a logical network definition that could be approached anywhere. While configuring network need to give device name, IP address, interface ID, Management Multicast TTL.

3.5.2 Setting Mosaic Stream

Configure the mosaic SPTS – both the encoding parameters and the network multicast and bitrate. For sending all the channels through one SPTS need to select IP and layout which want to display. Mosaic setting is as shown in below Figure 6.

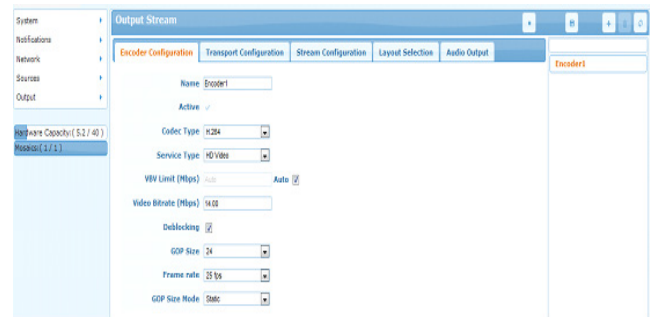
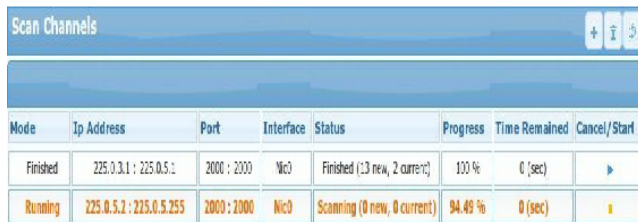


Figure 6. Encoder configuration for output stream.

3.5.3 Scan for Channel Source

For scanning of channels need to give range of multicast addresses, a range of port values and a possible source specific address, which will all be scanned for transport streams is shown in Figure 7.



Mode	Ip Address	Port	Interface	Status	Progress	Time Remained	Cancel/Start
Finished	225.0.0.1 : 225.0.5.1	2000 : 2000	Nic0	Finished (13 new, 2 current)	100 %	0 (sec)	[Start]
Running	225.0.5.2 : 225.0.5.255	2000 : 2000	Nic0	Scanning (0 new, 0 current)	94.49 %	0 (sec)	[Cancel]

Figure 7. Scanning of channel display.

3.5.4 Activate Channel Monitoring

A list of all detected services should be displayed. Need to select required channels persistent. Remove all scanned channels from the list. Only persistent channels will remain. Configuration of source channel display is as shown in below Figure 8.



Name	IP Address	Port	Program Number	Network	Service	Alert	Record	Thresholds	Notifications
225.0.0.1:2000:2000	225.0.0.1	2000	2	Nic0	MCM9000-SK-993	✓	x	Default	Default
225.0.0.2:2000:2000	225.0.0.2	2000	7	Nic0	MCM9000-SK-993	✓	x	Default	Default
225.0.0.3:2000:2000	225.0.0.3	2000	7	Nic0	MCM9000-SK-993	✓	x	Default	Default
225.0.0.4:2000:2000	225.0.0.4	2000	3	Nic0	MCM9000-SK-993	✓	x	Default	Default
225.0.0.5:2000:2000	225.0.0.5	2000	3	Nic0	MCM9000-SK-993	✓	x	Default	Default
225.0.0.6:2000:2000	225.0.0.6	2000	15	Nic0	MCM9000-SK-993	✓	x	Default	Default
225.0.0.7:2000:2000	225.0.0.7	2000	1	Nic0	MCM9000-SK-993	✓	x	Default	Default
225.0.0.8:2000:2000	225.0.0.8	2000	1	Nic0	MCM9000-SK-993	✓	x	Default	Default

Figure 8. Configuration of source channel display.

3.5.5 Configure the Current Layout

To view all channels in mosaic need to set layout which looks like a metrics where we will be selecting channels in each tile to display in mosaic. TAG provides different layouts where add 2 to 40 channels, depending on the number of channels and specifications over the information display will be selecting the layouts. TAG also provides user defined layouts, so operator can create new layout according to the requirement. Mosaic layout in TAG shown in Figure 9.

3.6 Integration with NMS

Dataminer (NMS) can be integrated with measurement devices or probes as referred in dataminer terminology.

To manage with NMS, TAG need to be integrated with the help of MIB information. To define all snmp traps and parameters in xml and this xml is uploaded in Dataminer. The Probe should be added as an 'Element' in Dataminer by giving the following information.

- Name: < Name of the Element>
- Protocol: Select the appropriate version of the Protocol for the probe which was given by Skyline.
- Select the Alarm and Trend Templates for the probe
- Select the Trend Template if any
- Enter the IP address of the Probe

The element is been displayed under Dataminer System Display>>Admin>> Element List as shown below. After successful uploading of protocol in Dataminer, Need to create element by defining alarm template.

After successful integration of element, NMS will show added element in the element list as shown in below Figure 10.

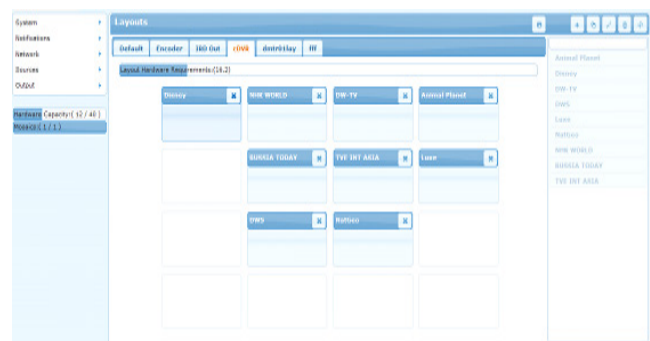


Figure 9. Mosaic layout in TAG.

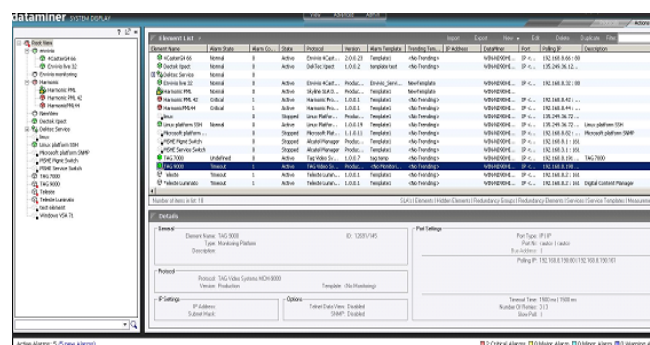


Figure 10. Dataminer system display after integrating TAG with NMS.

3.7 Adapting Microsoft Visio Drawing for use in DataMiner

Microsoft Visio Drawing in DataMiner. Save it in an XML format called "VDX". Use special shape data to link the shapes in the drawing to DataMiner items (views, elements,

services, parameters, properties, alarms, automation scripts) as well as to external files. In the drawings, insert images in a variety of formats: png, jpg, bmp and emf. Notice that, in case of multi-page VDX file, every page in the file is rendered as a tab in Visual Overview. In case of designing functional architecture of VQM, create a drawing in Microsoft Visio; add the necessary shape data to the shapes, and save the file in VDX format. After having created a Visio drawing, have to upload the VDX file to the DataMiner system and link it to a view, a service or a protocol. If want to edit the drawing, then can edit it in the DataMiner client interface (DataMiner Cube or System Display) if only have to make changes to shape data. There are different shape data fields that can be specified in Microsoft Visio files used in a DataMiner system. Also to use dynamic shape positioning based on coordinates stored in tables, the dynamically positioned shapes can automatically be connected by lines. Figure 11 is about configuration of different channels with TAG probe. First draw the network in visio (.VDX file) then integrate that .vdx file with DataMiner System Display page. There have to select proper protocol for probe and upload it in DataMiner.

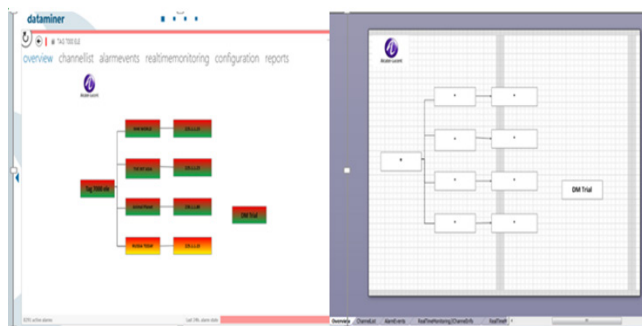


Figure 11. Overview of network in Dataminer and Visio file.

3.8 Design and Functional Architecture of VQM

The design of VQM consists of a dashboard with the following tabs.

3.8.1 Overview/Dashboard

• Network Status

Network status shows the status of video delivery in the IP video headend network. Video delivery status will be based on channel alarm events. The overview of the architecture and arrangement of monitoring points are as shown in below Figure 12.

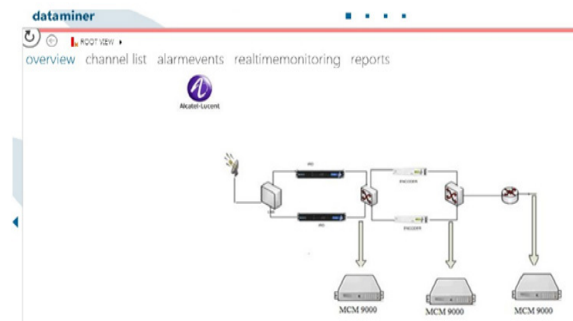


Figure 12. Network overview in VQM dashboard.

• Alarm Status

Figure 13 shows alarm status of video delivery in the video headend network. Video delivery status will be based on TR-101-290 ETR standards based on the alarm severity colors of alarm parameters highlighted.



Figure 13. Alarm status in dashboard.

3.8.2 Channel List

This section displays the list of all channels or services that are monitored in the system. This is achieved by developing a script which collects all the information of all the channels through exposed web APIs of DataMiner. Following is a sample screenshot with channel or services information are shown in Figure 14.

Status ID	Status Name	IP Address	Port	Program Number	Status Description
1	ENR-TV	205.2.8.33	5003	3751	2014-10-20 2:52
2	ENR-VIDEO	205.2.8.33	5003	3752	2014-10-20 2:52
3	RUSA TODAY	205.2.8.33	5003	3753	2014-10-20 2:52
4	ENR	205.2.8.33	5003	3754	2014-10-20 2:52
5	ENR	205.2.8.33	5003	3755	2014-10-20 2:52
6	ENR	205.2.8.33	5003	3756	2014-10-20 2:52
7	ENR	205.2.8.33	5003	3757	2014-10-20 2:52
8	ENR	205.2.8.33	5003	3758	2014-10-20 2:52
9	ENR	205.2.8.33	5003	3759	2014-10-20 2:52
10	ENR	205.2.8.33	5003	3760	2014-10-20 2:52
11	ENR	205.2.8.33	5003	3761	2014-10-20 2:52
12	ENR	205.2.8.33	5003	3762	2014-10-20 2:52
13	ENR	205.2.8.33	5003	3763	2014-10-20 2:52
14	ENR	205.2.8.33	5003	3764	2014-10-20 2:52
15	ENR	205.2.8.33	5003	3765	2014-10-20 2:52
16	ENR	205.2.8.33	5003	3766	2014-10-20 2:52
17	ENR	205.2.8.33	5003	3767	2014-10-20 2:52
18	ENR	205.2.8.33	5003	3768	2014-10-20 2:52
19	ENR	205.2.8.33	5003	3769	2014-10-20 2:52
20	ENR	205.2.8.33	5003	3770	2014-10-20 2:52

Figure 14. Channel list in dashboard.

3.8.3 Alarms Events

This section displays all the alarms which are raised by the probe on the status of the streams that are being monitored. These alarms displayed in this section are collected from DataMiner for that particular probe. Currently, priority 1 and 2 alarms of TR-101-290 are handled by the VQM.

3.8.4 Real Time Monitoring

Real time information with respect to the service monitored is shown in the Figure 16. This also contain subjective monitoring details. Subjective monitoring talks about video wall. The streamed channels will be displayed on the video wall with the error parameters. Layout will be changed based on the requirements after triggered an appropriate action.

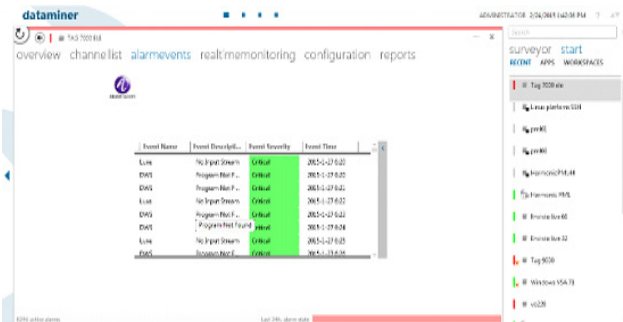


Figure 15. Alarm events in dashboard.

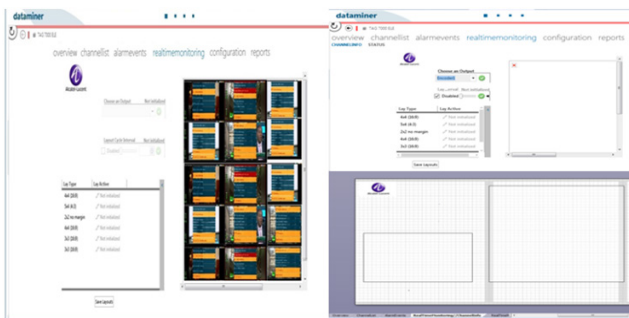


Figure 16. Subjective monitoring and Mosaic view.

3.9 Procedure to Display Streams from Different Probe

- Transport streams cannot be displayed directly in NMS because it is located somewhere in the network not near to the device.
- TS cannot be broadcasted to all the networks for need to do multicast routing.
- Instead of multicast routing are using small script in Linux machine which will receive multicast streams and it will send to the destination through http.

- For the playback are using VLC player because it will not change any parameters
- With the help of a script in html are calling VLC plugin and the multicast IP
- When there is a request it will display through VLC.
- NMS has CGI where can place html files. This CGI will get html file and display in NMS.

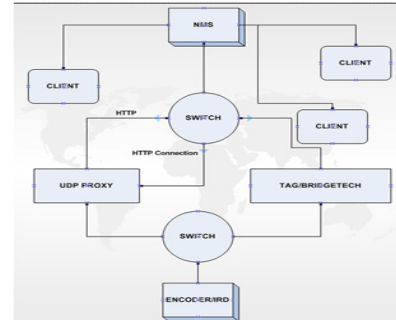


Figure 17. Flow of streams.

Sample HTML code which will be called in Dashboard of NMS is

```

<html>
<body>
<h2>Click the Link to Play the Object</h2>
<embedid = "vlc" name = "vlcplayer1" type = "application/
x-vlc-plugin" pluginpage = "http://www.videolan.org"
width = "400" height = "300" target = "http://udp proxy IP/
udp/channel IP" autoplay = "yes" loop = "no"/>
<link rel = "stylesheet" type = "text/css" href = "/css/styles.
css" />
</object>
</body>
</html>

```

When the client opens the dashboard which is in NMS, it will send request to the UDP proxy with will receive multicast streams join IP and multicast stream and will send as http to NMS. The output is as shown in the Figure 18.



Figure 18. Display mosaic layout in Dataminer.

3.10 Implementation of C# Code

3.10.1 Prerequisites

- **Common AlarmClass.cs:** This code is running continuously as a service for checking if there is any new alarm in DataMiner. For example each time interval (Major = 1minutes, Minor = 3minutes, Critical = 30 seconds and Warning = 7minutes), which is set manually by the operator, this code will check for new alarms and populate our table in DataMiner database.
- **ConnectDB.cs:** This class is necessary for connection purpose. Code will directly connect our MySQL database with the database of DataMiner. Further it will select Alarm ID from new alarm list and update it in Dataminer database as well in MySQL database.
- **Communication.cs:** Communication. cs basically authenticating the user with a license files for expose the code using SoupUI API. It is mainly required for security and authentication purpose, so that DataMiner can access the code. This class is mainly for communication between DataMiner and rest of the operation for our solution purpose.

Other classes are Program.cs, MajorAlarm.cs, MinorAlarm.cs, WarningAlarm.cs, CriticalAlarm.cs, and SendMail.cs. Those classes are Windows services, which are continuously running in the background. All the classes are successfully written in C# code under a namespace NewAlarmSendMail. Before that need to create one proper database in MySQL Database with authenticated credentials. Not supposed to touch DataMiner database, only populate our table in MySQL database. Whenever there is an occurrence of new error in headend part, it will automatically send that information to DataMiner. Now DataMiner compares those newly generated error with its own database, if the error is new in the database list, it will take appropriate action on it and send an automatic mail to tester. Email consists of sender ID, address to be sent the mail, subject and body. Body has proper information about error which contains channel name, error type and severity of error. Generic working flow of coding is shown in below Figure 19.

4. Results and Discussions

4.1 Testbed Preparation

A test bed is a platform for experimentation of large development projects. In this project the test bed set up is as shown in below Figure 20.

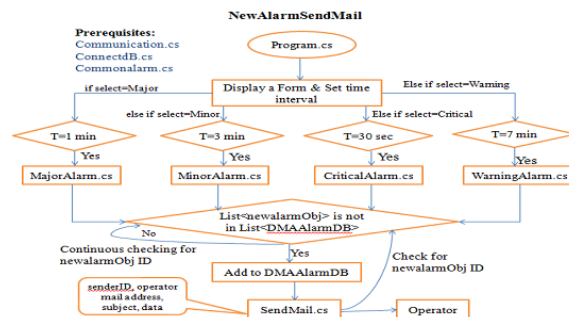


Figure 19. Flow of code execution.

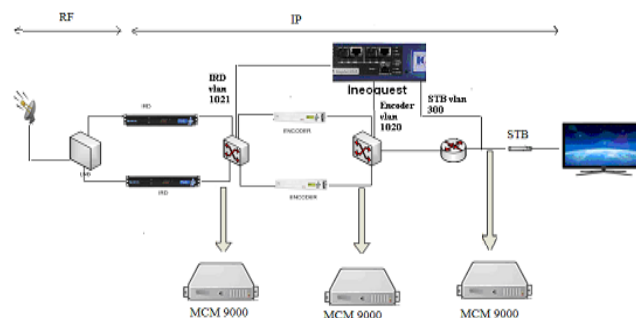


Figure 20. Testbed diagram.

4.2 Monitoring Points

4.2.1 IP Switch (Post IRD)

At this location, TAG (MCM 9000) is used to monitor the IP signals post IRD. TAG probes are used to perform the analysis of analysis at the transport stream level as defined in the ETR 101 290 (P1, P2, P3) standard for both the main and the redundant signal chain. Each TAG (MCM 9000) probe supports the analysis multiple multicast streams simultaneously. No need of TS reader for analysis TAG (MCM 9000) has the intelligence to read transport streams. It will do both subjective and objective monitoring. All collected information is viewed in TAG in mosaic and it will check quality and display error over each channel based on severity level.

4.2.2 IP Switch (Post Encoder)

At this location, the TAG (MCM 9000) is used to perform the objective and subjective monitoring of IP signal post-encoder. TAG probes are used to perform the analysis of analysis at the transport stream level as defined in the ETR 101 290 (P1, P2, P3) standard. All collected information is viewed in TAG in mosaic and it will check quality and display error over each channel based on severity level.

4.2.3 Before Set Top Box (STB)

At this location, the TAG (MCM 9000) is used to perform the objective and subjective monitoring of IP based on TR 101 290 standard. All collected information is viewed in TAG in mosaic and it will check quality and display error over each channel based on severity level.

For monitoring of different errors are using one special tool IQMediastimulus. IQMediastimulus is used for validation of this project. The IQMediastimulus software and the Singulus system is a complete solution for benchmark testing IP networks and their components. With the help of this software will be introducing errors by taking transport streams from Integrated receiver decoder (IRD), encoder. It is important to monitor priority 1 and priority 2 parameters which will define decoding capability and for contiguous monitoring. Concentrating on priority 1 and priority 2 parameters because these parameters will have more impact on the video quality.

4.2.4 E-mail

There is also a GUI page for IQMediastimulus. When drop video PID in the transport stream then the errors that rose in TAG are one of the three (No video, Zero BR PID, SPS missing). Cause for the loss of video is PID error; because of the loss of PID do not get any video content, Zero BR PID errors in TAG. These parameters point to PID error in the TR 101 290 standard. When there is no error the output of IRD, encoder and STB are as shown in the below Figure 21.

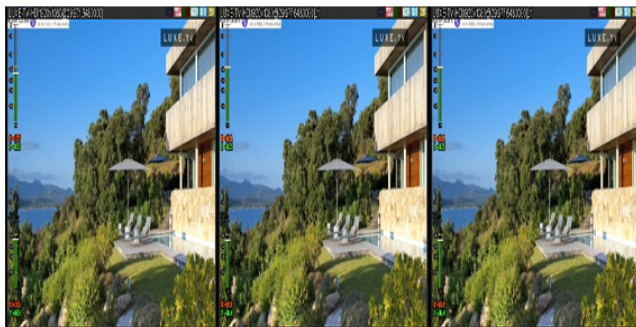


Figure 21. Output at 3 monitoring points when there is no error.

After dropping the PID at post encoder and before STB, the effected output are shown over the channel. The output when video PID dropped is as shown in the below Figure 22.

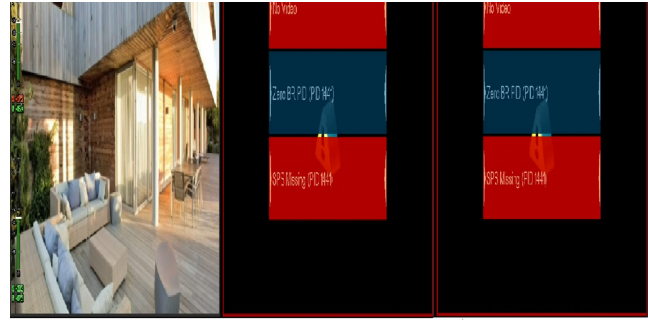


Figure 22. Output when video PID dropped.

Whenever alarm rises in TAG/BridgeTech the information passed to Dataminer. Dataminer (NMS) will send an automatic e-mail to the operator, which is having information about which channel is having errors and what error raised immediately. The sample mail that is received when there is error in the channel is as shown in below Figure 23.

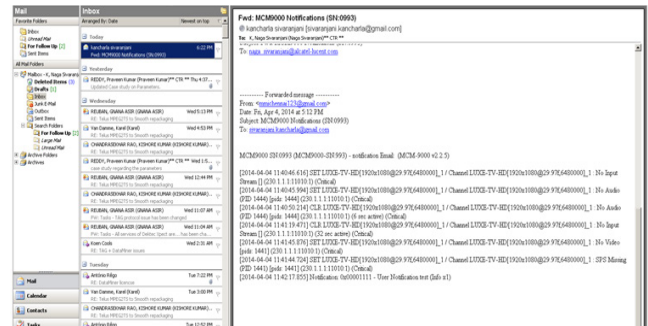


Figure 23. Email report when error occurs.

For most common alarms can trigger actions automatically in DataMiner. For example loss of video in any content in the IRD, then need to start that particular channel. To restart the channel when there is any loss of video content using sample script. In case of physical layer, need to restart the devices (IRD, encoders and probes) based on location of errors. Usually we maintain a replicate model for whole headend system.

4.3 Sample Script

```
// * Description:
// - Activate content occupation
// * Input Dummy:
// - Harmonic
// * Input Param:
// - Service ID: Id to use
```

```

using System;
using Skyline.DataMiner.Automation;
public class Script
{
    public void Run (Engine engine)
    {
        // Id of the service
        Script Param serviceId = engine. Get Script Param
        ("Service Id");
        // 4Caster
        Script Dummy dummy Element = engine.GetDummy
        ("Harmonic");
        if (!String.IsNullOrEmpty(serviceId. Value))
        {
            // execute action
            dummy Element. SetParameter("Content Occultation
            status", "activate");
        }
    }
}

```

After restarting the channel error will be rectified and video will be restored. After running the script the output is as shown in the below Figure 24. Similarly the errors will raise when audio drop, IP packet drop, duplicate packet arrived, out of sequence packet occurs in channel are mentioned in the below Figure 24, 25, 26 and 27 respectively.

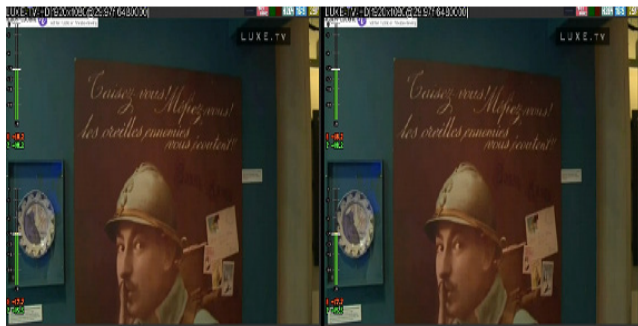


Figure 24. Output after video PID error rectified.



Figure 25. Output when audio dropped.

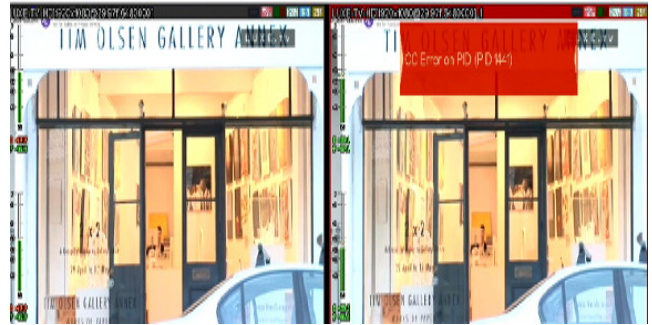


Figure 26. Output when IP packet dropped.

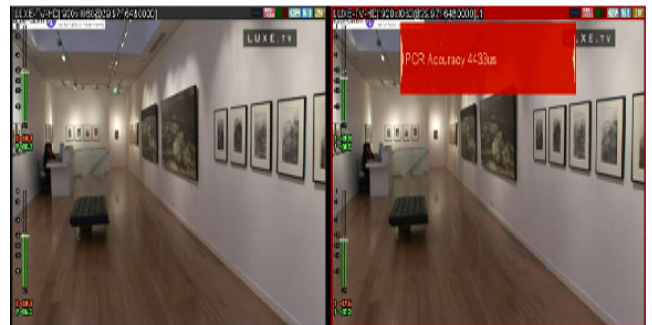


Figure 27. Output when duplicate packet occurs.

These are the most frequent errors that arise in transmission of video. The most errors and the solution are mentioned in the below Table 2.

Table 2. List of errors and their solution

Problem	Solution
Video PID loss	Check the video parameter source i.e. antenna, IRD, then reconfiguring and restarting the stream
Audio PID loss	Check the audio parameter at each point, identify and rectifying.
Packet drop	This is due to network disturbance and cabling problem.
Duplicate Packet	This is due to configuration problem.
TS Sync loss	Due to network need restart the channel.
PCR	Due to loss of sync this occurs need to set the PCR value.
CC error	Due to audio or video loss if reset the video/audio, rectify this error.
PAT,PMT	Need to check at antenna and IRD from the channel parameters.
Loss of I, P, B Frame	Due to IRD and encoder problem, the sequence may loss.

4.4 Applying the Mosaic Layout on Television Wall

Figure 28 shows the television wall view (Mosaic) of different channels. Here all other channels inside a single layout which is designed in VQM architecture at the time of real-time subjective monitoring. First have done the mosaic designing inside a probe and displayed it as a Virtual Remote Video Wall inside a probe or in NMS (subjective monitoring). After that we need to configure that display with a television channel just giving a proper IP address of a layout. Finally just need to configure the IP address of that particular layout inside a STB. Mosaic layout are operator dependent, actually design a layout in any shape in between (1x1) to (4x4) matrix size.



Figure 28. Output when out of sequence packet occurs.



Figure 29. Television wall display.

Earlier VQM solutions were proposed with 3 devices for single monitoring point to integrate at NOC. Also for subjective monitoring need to have HDMI hub connecting to Multi-viewer device (Mosaic View) for Video wall. There are tool for monitoring live streams but they can monitor only one stream. For the IP headend don't have real time video monitoring system. With our VQM solution just with one probe device is required at single monitoring point. need to monitor multiple

streams (Subjective) without storing the content. From same probe multicast/unicast SPTS can be streamed as output and same stream can be given as input to low cost HD STBs for Video Wall.

VOC has to be close to Monitoring probes and multiple VOC at different regions. With our VQM solution VOC can be placed at NOC with the help of unicast SPTS from probe. Correlation engine in NMS will provide an efficient solution to the operators by triggering corrective actions or notification. These corrective actions are triggered with help of automation C# scripts. VQM solution also provides operators to define list of actions for channels alarm events raised by probe. Operators can also change Mosaic layouts from NMS without connecting to any probes at NOC. This video quality monitoring solution is beneficial for IPTV, which deliver a secure, high quality multichannel Live TV, Time shifted TV, VoD (Video-on-Demand), Web data and software to a consumer electronics device (STB, Mobile or Portable), via a managed, dedicated, broadband IP network. Based on customers RFC this solution was developed and same solution has been provided to customers as POC.

5. Conclusion and Future Scopes

Video Quality Monitoring provides more efficient and effective solution with real time subjective and objective monitoring at VOC without any delay. Subjective monitoring and event notification of streams are done with different types of probe device at each monitoring point but separately. Event notifications are captured by multivendor NMS at customer's NOC for managing and monitoring of different probes. Corrective actions wherever possible and alert notifications are triggered from VQM solution to operator by E-Mail. In this solution operators provide a complete visibility to quickly troubleshoot the issues and ensure a great customer experience

Future expansion: Same Video Quality Monitoring Solution can be extended from Headend network to End-to-End video Network (ex. End-to-End IPTV solution). Also same solution can be implemented to Multiscreen Headend (for HAS like Microsoft smooth streaming, Apple-HLS, etc.) using unicast probes. In future integrate different probe devices with multivendor NMS at a time and proceed with monitoring the quality of video parameters from different probes simultaneously.

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