



A How-To Guide to Video Backhauling

Summary

Preserving video quality in networks today is a very challenging requirement. Even as errors are kept to a minimum, it is almost impossible to understand the quality of a program before it is finally delivered to a customer. A new tool with the MTM400A (and its family of IPM/QAM/RFM monitors) allows network operators to better understand the video quality at any point in the network. Bringing the distant video program back to the operator allows for viewing the same program that the customer is watching. No matter the size of the network, it is possible for the MTM400A to redirect a copy of any MPEG program across the network and back to an

operator. With a network link of just a few feet, or several thousand miles, the MTM400A can deliver a copy of the remote program to an operator for review using VLC, Elecard, Elecard HD AVC, VQS1000 or any network-capable set top box. The programs native compression is kept as the MTM400A redirects the selected PIDs without altering them in any way (the MTM400A automatically converts an MPTS PAT into an SPTS PAT when using the Graphical User Interface). The resulting video and audio seen by the local operator would be the same as that seen at the distant location. Therefore, bringing video back to the operator allows a better understand of what the end user or customer is actually receiving.

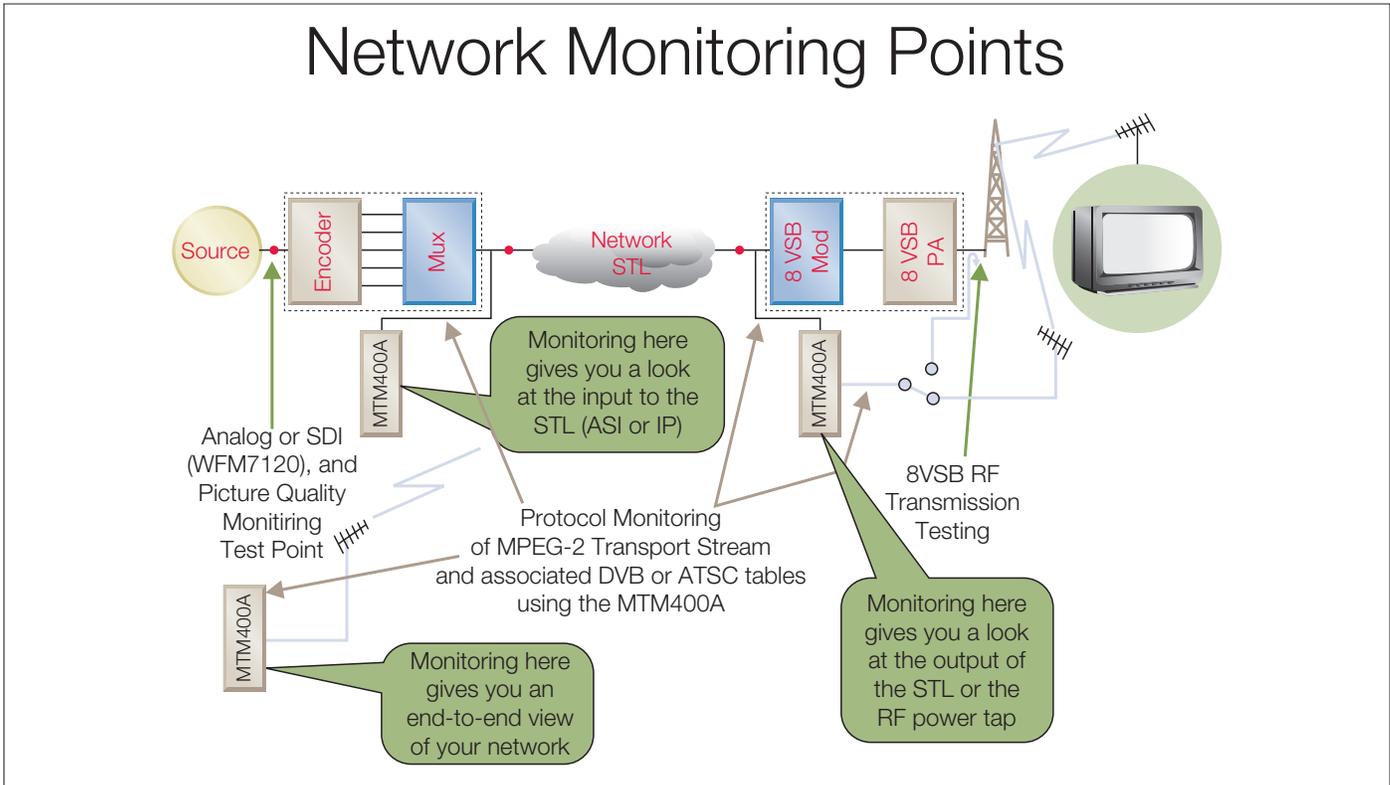


Figure 1. Multiple monitoring points throughout a broadcast network.

Introduction

Digital television programs today run through a long maze while traversing the globe and passing through many different devices until ultimately ending up inside your viewing device. Ensuring the integrity of these programs is an important task in order to maintain the highest level of quality. Transmission measurements run the gamut from RF signal power, to Bit Error Rate, to Jitter, just to name a few. Monitoring these digital video signals across the network ensures that the transmission link preserves the content. But what does the decoded picture actually look like when the link receives a minor fault? How is the video and audio affected as it passes through several remultiplexers and network switches? It would be helpful to see the decoded program at each point in the network, but that would be challenging given the breadth of most networks today given the availability of manpower and equipment. One possible solution would

be to stream a copy of the program from any point in the network back to the operator monitoring the transmission. The Slingbox provides something similar to this for the general public, but the quality of the program can be heavily affected given that the signal is decoded and then encoded to preserve bandwidth. The resulting quality can at times be lower than the quality originally delivered to the customer. This application note looks at methods available today within the Tektronix MTM400A to view a TV program from any point in the network without affecting its audio or video quality. Figure 1 shown below offers several test points in the network to monitor the transmission quality. The MTM400A is able to send a copy of the selected program back to a PC using the standard IP network already used by the MTM400A. Each MTM probe provides critical transmission and protocol measurements as well as the ability to stream programming back to the operator.

For each MTM400/MTM400A installed in a network, the capability exists to redirect an in-the-clear program back to a PC or network decoder. If the receiving device is capable of supporting conditional access, then the MTM can redirect the ECM and EMM PIDs also. This means that you can effectively watch TV from any point in the network by simply sending a copy of the live TV program back to a viewing station (e.g., any PC with VLC). The selected program is retransmitted using its existing compression scheme and bit rate. Therefore, it is important to ensure that the network is able to support this additional bandwidth. The additional bandwidth can be as low as 64 kbps for audio-only, and as high as 17 Mbps for MPEG-2 HD.

If the MTM is currently operating with V4.5 or later, and the PC already has VLC, Elecard, or VQS1000 installed on it, then redirecting a TV program is as simple as selecting the play-button on the MTM Remote User Interface (RUI). Figure 2 shows VLC being used to decode a live TV program.



Figure 2. Viewing a live TV program on a PC.

Configuring the MTM400, MTM400A, RFM300, QAM400A, or IPM400A

To take advantage of this new capability, simply upgrade any MTM400 or MTM400A to V4.5 or later. The www.tek.com web site contains all versions including the latest MTM release (free of charge). MTMs using firmware older than V3.0 will need to be upgraded to V3.0 before upgrading to the latest release. Once upgraded, a simple setup in the Configuration menu will allow the MTM to redirect incoming programs to the PC for decoding. Figure 3 shows the RUI configuration menu for a PC that does not have VLC, Elecard or VQS1000. install. In this case, go to <http://videoLAN.org> to download the latest s/w decoder. Version 1.05 has been evaluated to successfully inter-operate with the MTM400.

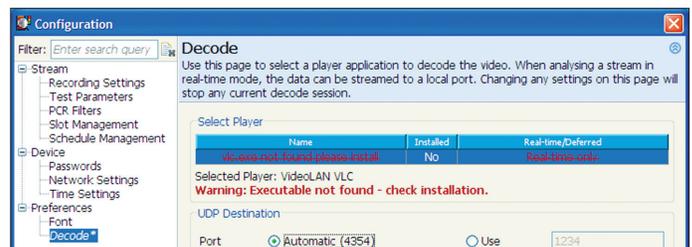


Figure 3. PC without VLC.

Once the VLC, Elecard Players, and VQS1000 has been installed, launch the RUI once again to take advantage of the new decoder.

For MTM operators who have already installed VLC on their PC, the MTM will display link to the location of VLC, as seen below.

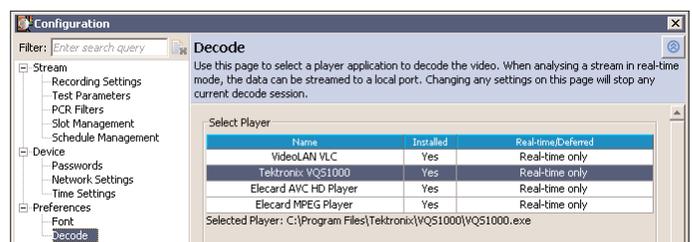


Figure 4. PC with VLC installed.

After the MTM has been upgraded to V4.5 or later, the MTM Thumbnail views will provide a set of new icons for streaming video and audio. If VLC, Elecard, or VQS1000 is not installed, the selected TV program can still be streamed to the PC for use with another application, or to a different IP address for h/w or s/w decoding. Figure 5 below shows the MTM FlexVuPlus screen with the new icons under the Thumbnail panel.

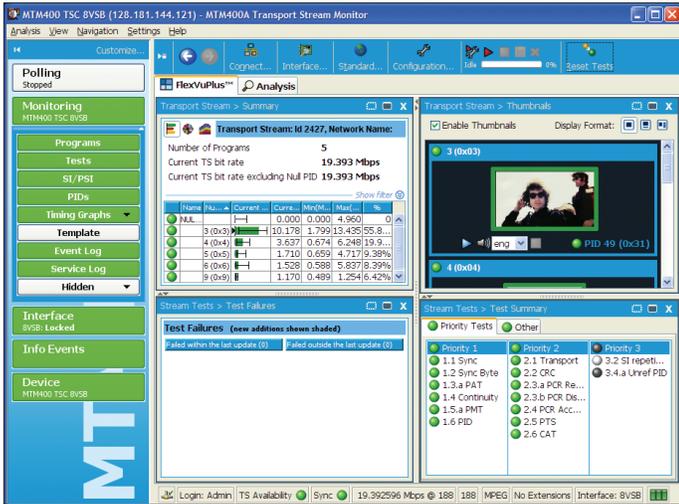


Figure 5. MTM RUI FlexVuPlus window.

Figure 6 shows the same new icons from the Analysis tab (Program tab, Thumbnail tab).

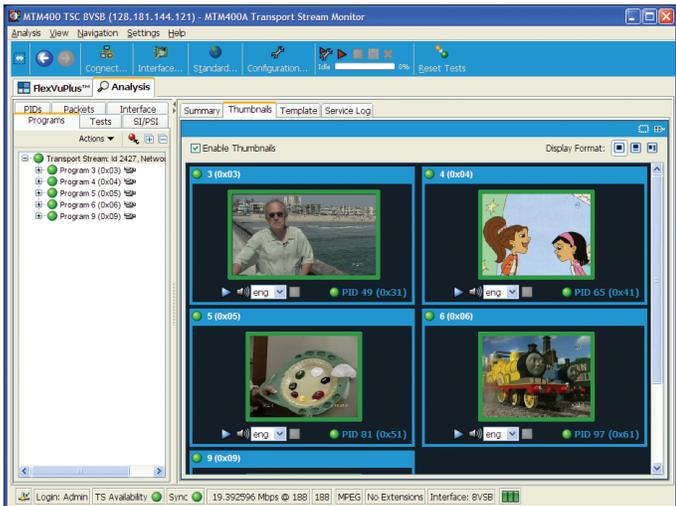


Figure 6. MTM RUI Analysis window.

Figure 7 shows the same window after selecting the Tear-off button from either the Analysis or FlexVuPlus tabs (dotted rectangle icon, upper right corner of Figure 6).

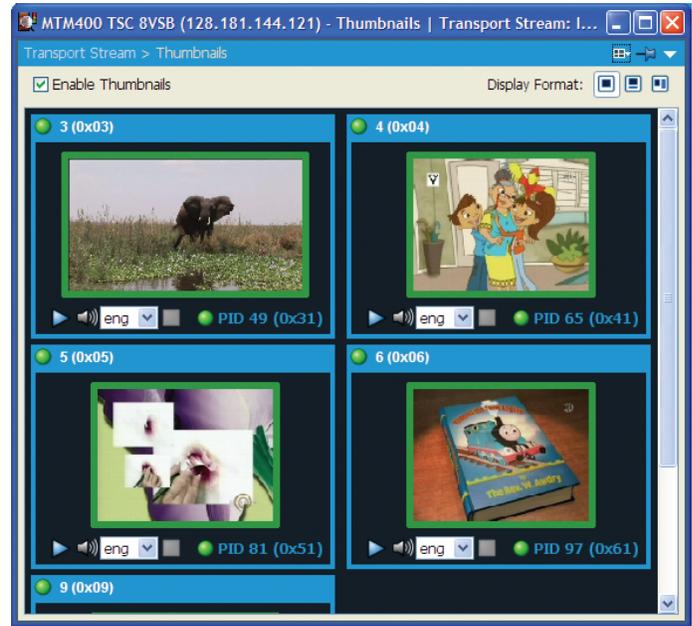


Figure 7. Thumbnail window after selecting the Tear-off icon.

If VLC, Elecard, or VQS1000 was previously installed, then you re ready to go. Just select the Play button (blue right arrow) from any video program and you re ready to begin streaming that program from the remote MTM back to your PC.

If you have an older version of VLC, then you may want to upgrade to something more recent. The MTM V4.5 RUI has been tested using VLC V1.0.5.

Configuring VLC

VLC is a free and Open Source software application with cross-platform support for both the PC and Mac (www.videolan.org). Several different versions exist and each with its own benefits and issues. A full list of versions is available at <http://download.videolan.org/pub/videolan/vlc/>. There are often subtle differences within each version of VLC.

Simply download the zip or exe file from videolan.org and install it on your local PC or Mac. Once installed, you are ready to begin streaming.

Some PCs may not be able to decode all forms of MPEG video retransmitted from the MTM because of older CPUs, graphics card, and audio processors. Most PCs available today provide sufficient CPU power to easily decode MPEG-2 SD and HD, as well as H.264 SD. H.264 HD is best decoded by h/w devices, but several s/w decoders exist today and come with a small price tag. Before streaming video from the MTM to the PC, it would be worthwhile to use the Windows Task Manager to get an idea of how much network bandwidth will be used while streaming.

Bandwidth usage on the PC and network

The MTM RUI only requires a small amount of network bandwidth to update the GUI in real-time. An additional amount of bandwidth is consumed whenever the Thumbnail screen is selected (sending I-frames back to the PC). Figure 8 below shows small bursts of bandwidth used to create all of the video thumbnail on the previous figures.

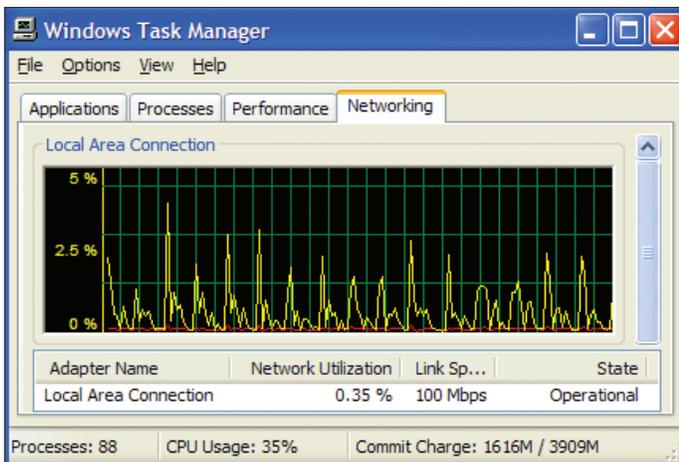


Figure 8. Thumbnails require a small burst of bandwidth.

Selecting an MPEG-2 SD program will cause the MTM to send a copy of the video and audio along with the required PAT and PMT sections. Figure 9 shows PC's network bandwidth to jump from almost nothing to about 3% of the PC's 100 Mbps LAN connection.

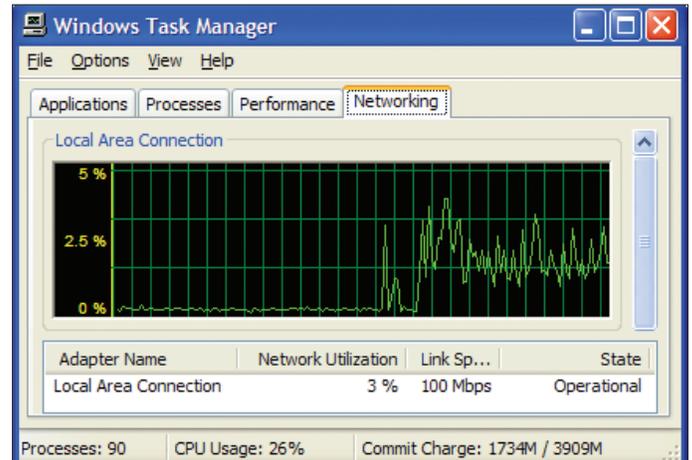


Figure 9. Network usage for SD.

If the selected program is HD as shown in Figure 10, then the bandwidth would range anywhere from 7 Mbps up to 19 Mbps depending upon the encoder format. Much of the HD content from broadcasters and is variable bit rate, and so will the bandwidth being sent across the network back to the PC. On the other hand, audio-only is constant bit rate and consumes very little bandwidth. More on Audio later in this document.

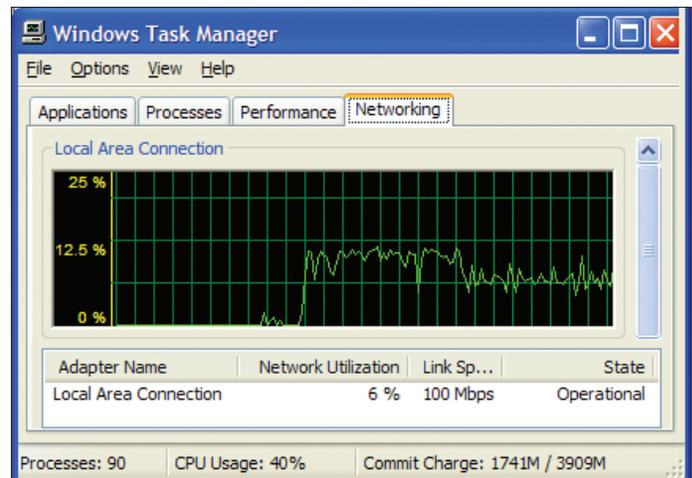


Figure 10. Network usage for HD.

Starting VLC/Elecard/VQS1000

VLC, Elecard, VQS1000 is started within the RUI by selecting the blue arrow or Play icon as shown below in Figure 11a. The default audio associated with the audio is shown in the same window (if more than one exists).



Figure 11a. New streaming icons.

Selecting the play button causes the remote MTM to redirect its video and audio PIDs to the PC. At the same time, the associated PMT is sent as well. A modified PAT section is sent with any additional PMT references removed to better conform to a single program transport stream. The VLC, Elecard or VQS1000 is then launched using several inline parameters to help direct the decoder.

The new MTM will launch the selected application highlighted as shown in figure 11b. To select a different application, highlight the application in the "Config-Decode" menu and select apply. Figure 11b. Selecting a different decoder application.

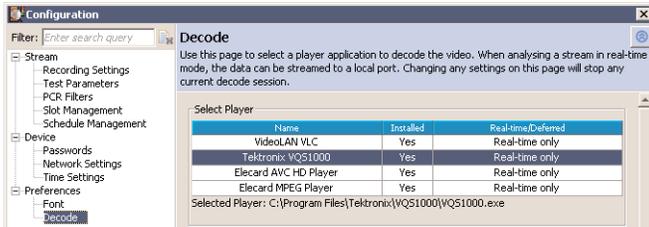


Figure 11b. Selecting a different decoder application.

Stopping the stream

There are several different ways to stop the MTM from streaming its PIDs to the PC. The first method is to simply close the VLC, Elecard or VQS1000 application. Selecting the square blue Stop button shown in Figure 12 will stop the streaming. Exiting the MTM RUI will also cause the streaming PIDs to stop.

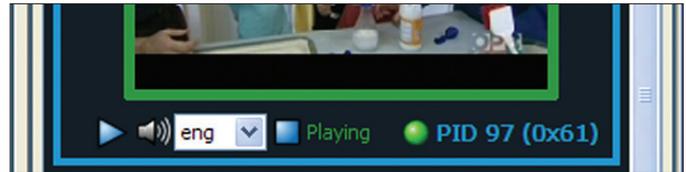


Figure 12. Stop playing button.

One final method to stop the remote MTM from streaming is to select the Stop button from the Configuration menu. The MTM will only stream one program to one PC (unless multi-cast addressing is used), therefore it is possible to use the Stop streaming button shown in Figure 13 to stop the MTM from streaming to another active user. By default, starting a streaming backhaul will stop any previous streams from being transmitted.



Figure 13. Stop streaming button. Start with VLC/Elecard/VQS1000

Audio Only

The MTM supports audio-only for those who do not want to create additional bandwidth associated with video. For programs that provide more than one audio element per program, the MTM displays the a selection to choose from. Figure 14 below shows the user selecting the third audio element which happens to be Spanish. This application is valid for both VLC and Elecard and should not be used with the VQS1000.

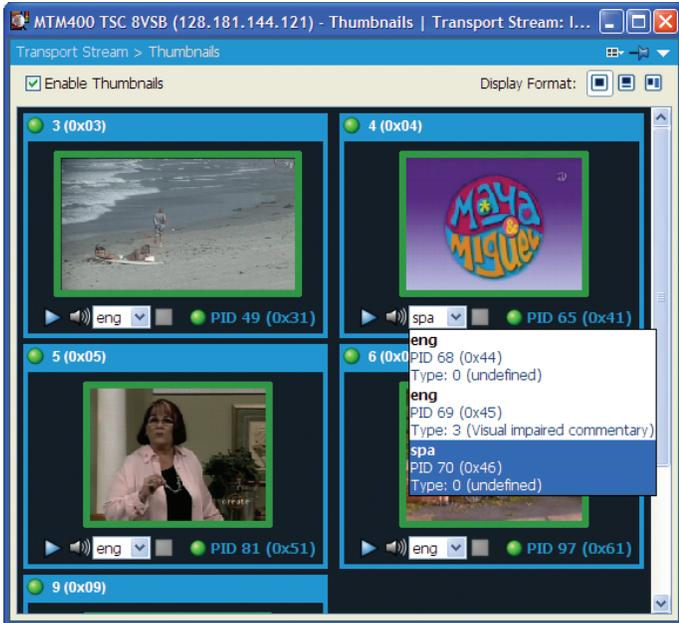


Figure 14. Selecting the Spanish audio-PID for backhauling with the video.

To begin streaming the audio PID along with its associated PMT and PAT, select the speaker icon from the MTM RUI. The VLC application will be launched as shown below in Figure 15.

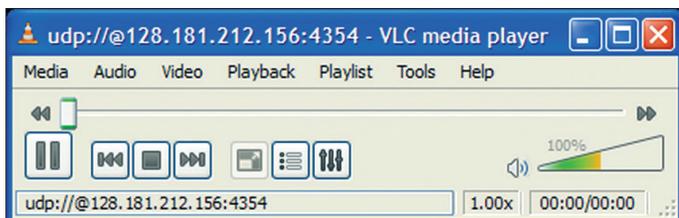


Figure 15. VLC with audio-only.

In the audio-only case, as well as with video, the VLC application provides useful windows to show the relative amplitude of the left and right channels (menu: Audio-Visualization-Scope or Vu meter). Audio elements using multi-channel (e.g., AC-3) will be converted to stereo by VLC as shown in Figures 16 and 17. The Scope and Vu meter windows allow one to determine several things. Left or right channel only will be evident from the graph (one channel will be flat). Clipping and distorted audio can be seen when the channels exceed the vertical limits. Audio channels with a flat line show low amplitude audio and lack of audio.

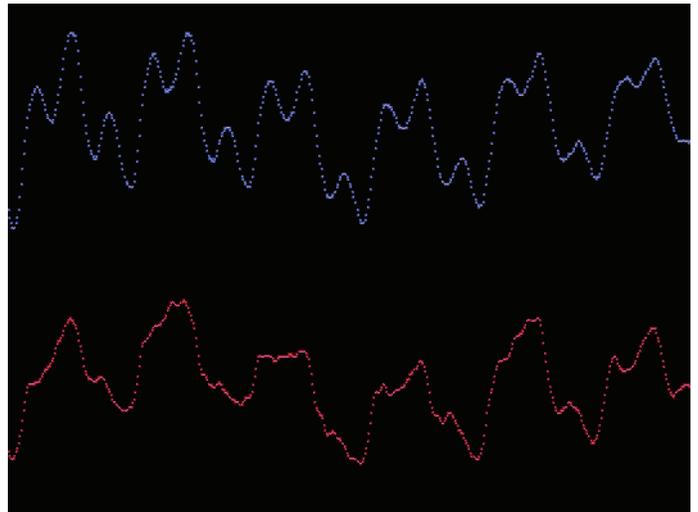


Figure 16. VLC Audio Scope display - Stereo.

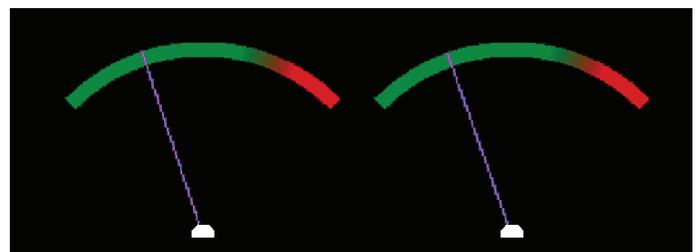


Figure 17. VLC Audio Vu meter display.

Important VLC note- if you do not have an audio decoder, disable the audio track in the VLC interface. Failure to do this will cause a memory overflow after some amount time.

Figure 16 was created using VLC version 0.9.6 and version 0.9.9. Versions released after 0.9.9 cause the waveform to be offset.

Advanced Features

It is possible to backhaul from more than one MTM at a time. This allows for more than one program to be delivered back to the PC. To keep the programs separate for each decoder, ensure that each MTM uses a unique UDP Destination Port. The default is 4354, but it is possible to use any port value. The RUI will use this value as the remote MTM backhauls the program to the local PC. This value will also be passed along to VLC, Elecard and VQS1000. Figure 18 below shows different port and address values being used by the MTM. This example will cause the MTM to send its backhaul stream using Port 1234. This example uses an IP address different



Figure 18. Custom IP address and port.

than the PC address.

It is possible to use a multicast addresses such as 239.1.1.1, so be extremely careful when using the multicast address range as many network routers and switches can be programmed to terminate a port upon seeing a high burst of multicast bandwidth.

Another powerful feature of the MTM is to continuously stream content even after the VLC and MTM applications have been closed. This is setup in the MTM Configuration menu (see Figure 19), and invoked with the Play button from the RUI. Make sure to manually stop the stream at a later time as the MTM will continue to stream until interrupted.



Figure 19. Check-box for continuous streaming.

Manually launching VLC

VLC can be launched manually through the DOS prompt or through its user interface. If the MTM is configured to stream indefinitely, then either V0.8 or V0.9 can be used to manually start decoding a video program. Figure 20 below shows the Open-Network menu allowing the user to select the protocol, address, and port.

The example below captured from the MTM with the Java

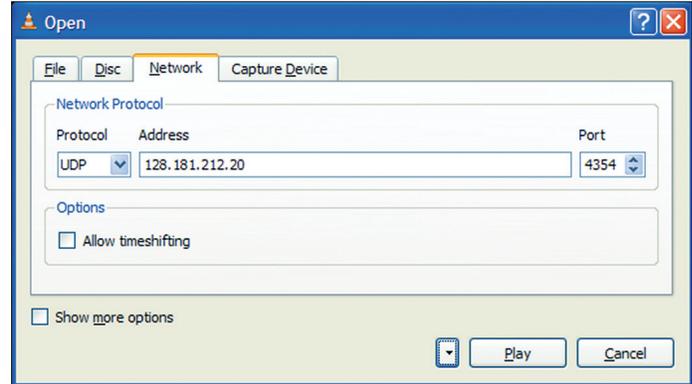


Figure 20. Manually starting VLC.

console or log shows how VLC is launched:

```
vlc --udp-caching="5000", --program="5",
udp://@128.181.212.156:4354
```

Remotely controlling the MTM using a browser

The MTM provides a simple graphical user interface, but it also allows for remote control using a browser. A simple method to view the list of possible commands is invoked using its address with the /stream/retransmit command:

`http://128.181.144.121/stream/retransmit`

The example shown above generates the following reply:

Retransmit mode - Copy up to 9 PIDs to a UDP streams

=====

START=anything - start flow

TIME=Secs - time to flow for, you must start again within this time to continue sending. (default 300)

STOP=anything - stop flow

PID[1..9]=number - define PID to copy (not 0x1FFF)

DESTADDR=address - destination address

DESTPORT=port - destination port (def 1307)

SVC=service - used with PMT=pmt_pid to create an SPTS PAT if required

TTS=anything - to enable TTS format output

RTP=anything - to use RTP format output

TTL=hops - set network time-to-live (def 12)

MODE=[0..4] - Debug modes, 0 is normal! (def 0)

PRI=[4..10] - Priority/burst size, SD ~ 6 HD ~ 9 (def 6)

PCR=number - to copy over PCR/PTS/DTS TS packets of a given PID (to support decode of audio) (use :no-video option in VLC)

The commands listed above are used by the MTM RUI, and can be used manually with a browser, but sending the right PID numbers is extremely important. Miss just one number, and VLC may not know what to do with the stream. Below are just a few examples of commands sent from a browser to the MTM to start streaming to a PC:

`http://128.181.144.121/stream/retransmit?start=true&destaddr=128.181.212.156&destport=4354&pid1=0&pid2=48&pid3=1984&pid4=1985&time=60&mode=0`

`http://128.181.144.121/stream/retransmit?start=true&destaddr=128.181.212.156&destport=1234&pid1=0&pid2=96&pid3=97&pid4=100&PID5=101&time=30`

`http://128.181.144.121/stream/retransmit?start=true&destaddr=128.181.212.156&destport=1234&time=0&RTP=true&SVC=6&PMT=96`

Keep in mind that the previous command using Time=0 means that the MTM will send content indefinitely, or until the unit is powered down, or "Stop sending" is selected from the Configuration menu. The MTM user interface actually uses Time=30 repeatedly and stops sending content when the application is closed, or Stop is selected from the menu. The following example will tell the MTM to stop streaming:

`http://128.181.144.121/stream/retransmit?stop=true`

To get a better idea of who last logged into the MTM, and which PC was receiving backhaul, the Debug command may help. The following URL:

`http://128.181.144.121/debug` responds with:

Login [Admin]: 128.181.212.20

Backhaul master 0.0.0.0 -> 128.181.212.20

ReTX PIDs:0,32,33,50,8191,8191,8191,8191,8191 to UDP://128.181.212.20:4354 (PRI=9 TTS=0 PCR=8191 SVC=1 PMT=50 TTL=12 MODE=0)

Which shows the last Admin was 128.181.212.20, and the same PC requested video backhauling from Program#1.

Using WiFi

It is not recommended to use WiFi while streaming video, although there may be enough bandwidth to maintain a clear VLC, Elecard and VQS1000 display. The MTM delivers the stream using UDP, and unlike most TCP/IP, dropped packets are not retransmitted to the PC over WiFi. Therefore, WiFi users will notice a large amount of macroblocks while using VLC, Elecard and VQS1000.

Beyond VLC

Other network decoder applications beyond VLC are available, but usually for a small fee. These additional decoders can be used in conjunction with the MTM, but each must be controlled manually. The MTM can still be used to start the video backhauling, but the operator must manually launch the decoder and provide the streams address and port numbers.

Another decoder available to perform the same task is a networked set top box. Amino provides several choices including the AmiNET130 shown below with IP input and HDMI and analog outputs. Figure 21 shows an Amino set top box connected to a switch and HD TV.



Figure 21. Amino AmiNET130 HD H.264/MPEG-2 decoder.

This device works similar to the VLC decoder, but requires the MTM to redirect the program to a separate IP address on the network. As shown in Figure 22.

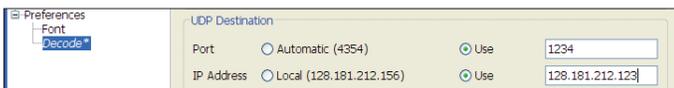


Figure 22. Redirecting the program to the Amino set top box.

Keep in mind that Amino does not support RTP, so do not use the MTM advanced features to send RTP instead of the default UDP.

Closed Captioning, Subtitles, and Teletext

The MTM will automatically forward Closed Captioning as it is embedded within the video PID, but some s/w decoders do not provide Closed Captioning support. The same applies to Amino.

Subtitling and Teletext is carried as an individual element (PID), and will be redirected just as audio and video are redirected. VLC supports DVB Subtitling and closed captioning, so this feature can be viewed as long as it is enabled within VLC.

Scrambled and encrypted video

VLC and other similar video decoders do not support scrambled video, and therefore it is not recommended to redirect scramble programming to VLC. Elecard provides more accurate closed captioning support when compared to them.

Mac Support

The MTM started supporting Sun Java with the introduction of MTM400A V3.0. This enables the MTM remote user interface to be run from any Mac with Sun Java support. The video thumbnails may not be visible due to the requirement of thumbnail driver, but the video programs should be displayed live based upon VLC support (VLC support on the Mac was not tested at the time of this printing).

Conclusions

Troubleshooting video and audio quality problems in a large network has been always been a difficult task. Monitoring signal transmission and protocol helps to identify the source of the problems, but the level of impact upon the video program is not easy to determine. To better understand the quality of the video and audio at any point in a network, an MTM can be used to backhaul the video and audio back to the local PC being used to monitor the transport stream. The MTM allows the operator to literally watch a video program as if he or she was physically at the remote test point. Network engineers can more easily and efficiently see the quality of video and audio with having to physically drive to the location. The distance between the MTM and PC can be as little as a few feet, or as far as several thousand miles.

References

1. <http://www.videoLAN.org> provides network decoders for both the PC and Mac. Revision history at: <http://download.videolan.org/pub/videolan/vlc/>
Several versions are available and V1.0.5 is being used today.
2. www.tek.com for current up to date s/w releases for the IPM400A, MTM400, MTM400A, QAM400A and RFM300. Use V4.5 or later to enable video backhauling.
3. <http://www.elecard.com> provides two decoders for the MTM (for a small fee). The MTM currently supports: Elecard MPEG Player and the Elecard AVC HD Player.

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Central Europe & Greece	+41 52 675 3777
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Germany	00800 2255 4835*
Hong Kong	400-820-5835
India	000-800-650-1835
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Middle East and Africa	+41 52 675 3777
The Netherlands	00800 2255 4835*
Norway	800 16098
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United Kingdom & Ireland	00800 2255 4835*
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* European toll-free number. If not accessible, call: +41 52 675 3777

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