MTS4EA Elementary Stream Analyzer Tutorials

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Getting Started

This set of eleven tutorials helps you learn more about operating the Tektronix MTS4EA Elementary Stream Analyzer. Perform tutorials 1 through 11 in the order they are presented, regardless of the video standard of interest. Tutorial 10 relates only to MPEG-2 and interlaced video.

The tutorials will help you answer the following questions:

- How do you know that your video compression complies with the standards
- If your codec doesn't work well with other vendors' codecs, where is the problem is it with your codec or theirs
- Are you optimizing your Codec
- Are you making the best use of available bandwidth
- Which frames and movement types use the most bits and why
- What changes to your codec software give the best reductions in bits used for the least reduction in visual quality
- What types of video content does your codec work poorly with and why

A description for each tutorial follows. (See Table 1.)

Tutorial	Name	Standard	Areas Covered
1	H.261	H.261	Syntax error; compression optimization; graph analysis
2	H.263 Compliance and Motion Vectors	H.263 Baseline	Errors and error log; motion vectors.
3	MPEG-4 Compliance	MPEG-4 Simple Profile	Common errors; searching for areas of codec optimization.
4	MPEG-4 Optimization	MPEG-4 Adv. Simple Profile	Common errors; HexView bitstream analysis; video navigator; synchronize views; project files
5	MP4 Compliance Basics	MP4/ Simple Profile/ L1(2)	Extract and examine container files; level conformance error.
6	MP4 Optimization	MP4/ Simple Profile/ L1(2)	Using MB type overlays and searching for areas of optimization.
7	3GPP/MPEG-4 Compliance	3GPP/MPEG-4 Simple Profile/ L1	Common errors; searching for areas for optimization
8	H.264/AVC Syntax Error	H.264/AVC Extended Profile/ L3	Syntax error in PPS; trace analysis of syntax
9	MPEG-4 and H.264/AVC Buffer Analysis	MPEG-4 ASP and H.264/AVC	Buffer analysis in MPEG-4 and H.264/AVC; fixing problems.

Table 1: Tutorial descriptions

Table 1: Tutorial descriptions (cont.)

Tutorial	Name	Standard	Areas Covered
10	MPEG-2 Compliance	MPEG-2 Main Profile / Main Level	Syntax errors; MPEG structure analysis; interlace.
11	Fidelity Analysis	MPEG-4, MPEG-2, and H.264	Fidelity analysis; visual difference.

Basic Functions

To complete the tutorial procedures, you must be familiar with the following basic functions. To perform the desired function, click the associated icon or type the appropriate keyboard shortcut. (See Table 2.)

Table 2: Basic functions

Function	Forward		Backware	d
	lcon	Keyboard shortcut	lcon	Keyboard shortcut
Play video		Ctrl + P	-	Ctrl + Shift + P
Stop video		Ctrl + S		Ctrl + S
Pause/step one frame		Ctrl + A	-	Ctrl + Shift + A
Fast forward/backward		Ctrl + F	4	Ctrl + Shift + F
Pause on frame	×		X	
Skip to next frame type/number/time	~	Ctrl + K	5	Ctrl + Shift + K

How to Begin a Tutorial

- 1. After starting MTS4EA, click anywhere to remove the splash screen. If you do nothing, the splash screen will disappear after 4 seconds.
- **2.** Load the desired tutorial stream. Note that the demo version of the MTS4EA will only play the provided example video files.

Tutorial 1: H.261

This tutorial shows non-compliance issues with the H.261 standard using temporal references and graphical analysis.

Procedure

 To load the H.261 tutorial, click File > Example files > H.261 stream > Conference Room. The window title changes to MTS4EA-H.261 Example
 Conference Room, and a warning message appears. (See Figure 1.)

🔯 MTS4EA - H.261 Example - (Conference Room	
🕑 🖉 🖬 📂 🖘 🛀	Warning 31501: Two consecutive temporal refs are zero Warning Picture Layer Two Consecutive Temporal Refs are Zero.	
	Summary Image size unknown Stream size (iBytes) 190 Address 0x000002 (dec. 2) bit 3 Time (secs) before 1 type no before 1 Image size Skip this Warning only in future Skip ALL Warning alets in future	
	Abort Pause Continue Goto	All Disabled: 0



NOTE. The H.261 standard states that the temporal reference (TR) value is the previous TR value + 1 + the number of skipped or non-reference pictures at the picture clock frequency (PCF). TR is 8 bits only, 0–255, at the standard PCF of 29.97 frames per second. However, if a custom PCF is used, then TR is 10 bits: 8 LSBs are denoted as TR and 2 MSBs are ETR, but they are taken together as a single 10-bit number.

- 2. View the warning message elements:
 - Warning Indicates that two consecutive temporal references are zero.
 - **Summary** Gives summary information about the stream.
 - Skip this Warning only in the future elects to skip this particular warning in the future (recommended).

- Skip ALL Warning alerts in the future elects to skip this alert and all other alerts in the future.
- 3. Select Skip this Warning only in the future, and then click Continue.
- 4. Click the toolbar icon or type **CTRL** + **P** to resume playing the video.
- 5. As you view the video, notice the following: (See Figure 2.)
 - Movement in the video is too quick (requires PC with processing speed of greater than or equal to 1 GHz)
 - Unwanted noise (visual artifacts) is visible when the man waves his arm (starting around frame 128, continuing into frame 161, with some artifacts remaining until frame 203)
 - Status bar notes that one alert is disabled

Although the video stream will play and will probably be decoded by other H.261 decoders, the H.261 sequence was incorrectly encoded, showing temporal issues.



Figure 2: Visual artifacts

6. Click Overlay on the menu and select MB Types, or click the Overlay icon

on the toolbar. MB (macroblock) Types are color coded and can be undocked, resized, or switched off. (See Figure 3.)

NOTE. The H.261 standard has 10 MB types. For more information on using these, see the user manual.

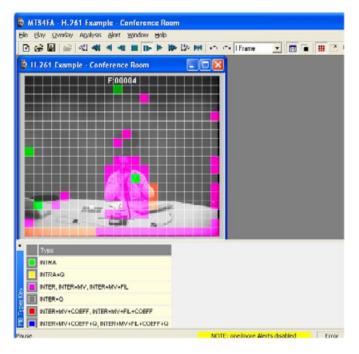


Figure 3: MB overlay

- 7. Check that the video is in either Play or Pause mode.
- 8. Click the MB Tooltip icon in the toolbar. The Tooltip typically docks at the left edge of the window, but you can undock it by pressing <CTRL> on your keyboard while dragging the Tooltip with your mouse.
- **9.** Move the mouse over the video. A white box will display around the MB from which data is being read. The Tooltip shows information about that MB. (See Figure 4.)

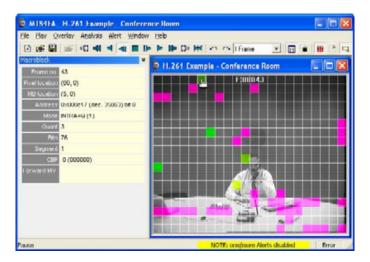


Figure 4: MB types and data

10. Advance through the video frame by frame, noting many green Intra MBs in the background wall. These block types use the most bits. (See Figure 5.)

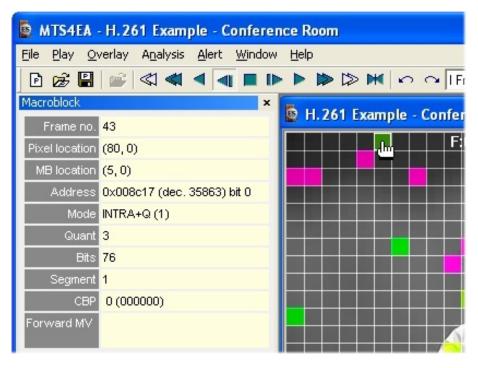


Figure 5: Intra MBs in the background wall and MB data

- 11. Stop the video sequence.
- **12.** To analyze the MB data, select **Analysis** from the menu and select **Video graph enable**. A dialog box will appear. (See Figure 6.)

Analysis options
Frame range Trace Graphs Visual difference/Fidelity
Options Spatial bits/MB Spatial bits/MB coded MV histogram Spatial average quant DCT frequency MB coded frequency Intra coded frequency
OK Cancel Apply

Figure 6: Analysis dialog box

- **13.** Check the **Enable**, **Spatial bits/MB**, and **Intra coded frequency** boxes in the Analysis dialog box.
- 14. Select the output filename: h261.xls.
- 15. Click OK and then play the video.
- **16.** When play ends, the data is exported to the .xls file and MS Excel will open. Click **Enable macros**. The screen will flash as the macros run.
- **17.** Click **Spatial Bits per MB** to view a graph of the spatial bits per MB. (See Figure 7.)

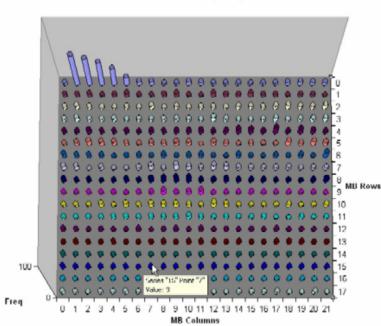
Walls 0 1 П П П 2 6 P 3 4 E 5 6 -£ 7 8 MB Rows 9 10 E 11 12 13 14 100 -Average bits 0 8 9 10 11 12 13 14 15 16 17 18 19 20 21 1 2 3 5 6 7 **MB** Columns

Spatial Bits per MB

Figure 7: Spatial bits per MB

NOTE. Notice that many bits are used in the center (by the man), top left (too many), and along the bottom edge (too many). These last two are errors.

18. Click the **Intra Coded Frequency** tab to view a graph of the Intra Coded Frequency. (See Figure 8.)



Intra Coded Frequency

MB C

Figure 8: Intra coded frequency

NOTE. Notice that there are many Intra-coded MBs at the top left of the graph. This indicates that there is an error with Intra-coding in the encoder.

Conclusion

This tutorial demonstrated that the H.261 bitstream is not standard compliant and that there were coding inefficiencies. These problems were discovered through TR errors and frequency of playing. Coding inefficiencies were discovered through graphical analysis.

Tutorial 2: H.263 Compliance and Motion Vectors

This tutorial covers the standards and compliance issues in H.263 and also demonstrates the proper functioning of the motion vectors.

Procedure

 To load the H.263 tutorial, click File > Example files > H.263 stream > Rally (250K). The window title changes to MTS4EA-H.263 Example -Rally (250k), and a warning message appears. (See Figure 9.)

	EA - Viden View: II.2	63 Exam	ple - Rally (250k)		
Elv Bas	Overlar Applysie Ed	L Aleit	Window Belo		
0 📽	🔛 😅 🕫 🖷	-11	le le De De HK 🚋 🏯 (frame	🗉 🚵 🚜 💈 🚥 🕴	0
8 🖩	🚾 🛃 🖽 🖉 🦷	h ha i t	1 🛤 🖷 📷 🐨 👘 👘		
		Decode	Warning 31751: PSUPP being ser	n 🗵	
8	Vlden Vlew: H. 263 E	⚠	Warning PSI IPP hoing anni (annos I.) ignorad at position 0x6 (dec. 6) bit 5	Pintum Layor	
			Gummery		
			Image ritro Image format Unream size (RUytes) Artifrans Time (secs) Iypo		
L			Shap this Waining only in Mare Shap ALL Waining alets in Mare About Proce	Lurdenae Liulu •	
Keedy					Ţ,

Figure 9: Initial warning message

- 2. View the warning message elements:
 - Warning Indicates that the PSUPP field is being sent and ignored.
 - **Summary** Gives summary information about the stream.
 - Skip this Warning only in the future elects to skip this particular warning in the future (recommended).

- Skip ALL Warning alerts in the future elects to skip this alert and all other alerts in the future.
- 3. Select Skip this Warning only in the future, and then click Continue.
- 4. Click the toolbar icon or type **CTRL** + **P** to resume playing the video. Another error message appears. (See Figure 10.)
- 5. View the error information provided, which indicates a more serious error that occurs at bitstream byte address 0x0c9cfa, bit 3, after frame 326.

Decode	Error 21761: Error in MCBPC_P VLC	×
8	Error Error in MBCPC_P VLC at position 0xc9/f6 (dec. 827382) bit 7	MB Layer
	Summary	
	Image size 352 x 288	~
	Image format YUV 4:2:0 8-bit	_
	Stream size (kBytes) 808	
	Address 0x0c9cfa (dec. 826618) bit 3	
	Time (secs) after 21.979	
	Frame type P Frame	
	Frame no. after 326	¥
	🔲 Skip this Error only in future	
	Skip ALL Error alerts in future	
	Abort Pause Continue	Goto 🔻

Figure 10: Initial error message

- 6. Click Continue. Another error message will appear. (See Figure 11.)
- 7. Note that it was an MBCPC error that resulted in the Out of Sync alert message. This often occurs when one syntax error triggers a series of alerts.

Decode	Error 21502: Out of sync	×
8	Error Out of sync at position 0xc9ff7 (dec. 827383) bit 2	General
) Summary	
	Image size 352 x 288	^
	Image format YUV 4:2:0 8-bit	
	Stream size (kBytes) 808	
	Address 0x0c9cfa (dec. 826618) bit 3	
	Time (secs) after 21.979	
	Frame type P Frame	_
	Frame no. after 326	4
	Skip this Error only in future	
	E Skip ALL Error alerts in future	
	Abort Pause Continue	Goto 🔻

Figure 11: Out of sync error message

- 8. Select the Skip ALL Error alerts in the future check box, and then click Continue.
- 9. To open the Alert Log, click the Alert Log icon 2. The Alert log window will appear. (See Figure 12.)
- Note the active filter button in the toolbar. Because Skip ALL error alerts in the future was selected, the alert log view is filtered and the filter button is active. The status bar indicates that 23 of 24 alerts are hidden.
- 11. Click the Filter icon to deactivate the filter and view all alerts. (See Figure 13.)

evel	ID	Source	Class	Title	Decode	Display	Address (bytes)	Details
Fatal	13024	Video	General	Unexpected	327	Video	0x0c9ffa	Unexpected .

Figure 12: Alert Log window, filtered

🗢 🗄 🗖 🛛	è 📕								
Level	ID	Source	Class	Title	Decode	Display	Address (bytes)	Details 🔥	
🔥 Warning	31751	Video	Picture Layer	PSUPP being	1	Video	0x000006	PSUPP being .	
A Warning	31751	Video	Picture Layer	PSUPP being	2	Video	0x00306c	PSUPP being .	
🔥 Warning	31751	Video	Picture Layer	PSUPP being	3	Video	0x002766	DELIDE boing	
A Warning	31751	Video	Picture Layer	PSUPP being	4	Decode Warning	31751: PSUPP E	peing sent	
🔥 Warning	31751	Video	Picture Layer	PSUPP being	5	Warning			Pictur
\rm Warning	31751	Video	Picture Layer	PSUPP being	6				Fictur
A Warning	31751	Video	Picture Layer	PSUPP being	7		eing sent (annex L): igr 0x306c (dec, 12396)		
🔥 Warning	31751	Video	Picture Layer	PSUPP being	8		0.0000 (000. 12000)	DK D	
\rm Warning	31751	Video	Picture Layer	PSUPP being	9				
🔥 Warning	31751	Video	Picture Layer	PSUPP being	10				
\rm Warning	31751	Video	Picture Layer	PSUPP being	11	Summary			
A Warning	31751	Video	Picture Layer	PSUPP being	12	Junnary			
A Warning	31751	Video	Picture Layer	PSUPP being	13		Image size 352 x 2	88	
A Warning	31751	Video	Picture Layer	PSUPP being	14		mage format YUV 4:2	2:0 8-bit	
A Warning	31751	Video	Picture Layer	PSUPP being	15		size (kBytes) 808		
A Warning	31751	Video	Picture Layer	PSUPP being	16	Greens			
A Warning	31751	Video	Picture Layer	PSUPP being	17			65 (dec. 12389) bit 1	
\rm Warning	31751	Video	Picture Layer	PSUPP being	18		Time (secs) 0.332		
\rm Warning	31751	Video	Picture Layer	PSUPP being	19		Frame type P Frame	•	
\rm Warning	31751	Video	Picture Layer	PSUPP being	20		Frame no. 2		
8 Error	21761	Video	MB Layer	Error in MCBP	327				
Ar	24502	to de la	C	A. 4 - 5	222	C Skip th	is Warning only in futu	10	

Figure 13: Alert Log and Alert Details

12. Double-click an alert to view the alert details and then click **Close**. View the columns that appear in the alert log and note the column descriptions that follow. (See Figure 14.)

- Level the severity level for the alert. Levels include Info, Warning, Error, and Fatal.
- = **ID** MTS4EA unique alert ID number.
- Class Syntax area where the alert occurs.
- **Title** Alert title.
- Decode and Display Frame numbers where the alert is decoded and displayed (can vary).
- Address The address of the alert in the bitstream.
- **Details** Alert details.

Level	ID	Source	Class	Title	Decode	Display	Address (bytes)	Details
🕂 Warning	31751	Video	Picture Layer	PSUPP being	1	Video	0x000006	PSUPP being
🕂 Warning	31751	Video	Picture Layer	PSUPP being	2	Video	0x00306c	PSUPP being
🔔 Warning	31751	Video	Picture Layer	PSUPP being	3	Video	0x0037e6	PSUPP being
🕂 Warning	31751	Video	Picture Layer	PSUPP being	4	Video	0x004074	PSUPP being
🔥 Warning	31751	Video	Picture Layer	PSUPP being	5	Video	0x004718	PSUPP being
🕂 Warning	31751	Video	Picture Layer	PSUPP being	6	Video	0x005024	PSUPP being
🔥 Warning	31751	Video	Picture Layer	PSUPP being	7	Video	0x005713	PSUPP being
🕂 Warning	31751	Video	Picture Layer	PSUPP being	8	Video	0x005d62	PSUPP being
🔥 Warning	31751	Video	Picture Layer	PSUPP being	9	Video	0x0063a8	PSUPP being
🕂 Warning	31751	Video	Picture Layer	PSUPP being	10	Video	0x0068d3	PSUPP being
🔔 Warning	31751	Video	Picture Layer	PSUPP being	11	Video	0x006d97	PSUPP being
🔥 Warning	31751	Video	Picture Layer	PSUPP being	12	Video	0x0072c3	PSUPP being
🔥 Warning	31751	Video	Picture Layer	PSUPP being	13	Video	0x007831	PSUPP being
🔥 Warning	31751	Video	Picture Layer	PSUPP being	14	Video	0x007d3d	PSUPP being
🔥 Warning	31751	Video	Picture Layer	PSUPP being	15	Video	0x0081e9	PSUPP being

Figure 14: Alert Log, unfiltered

- 13. Close the Alert log and return to the main page of the application.
- 14. Click the icon to play the video again with the Motion Vectors (MVs) visible. (See Figure 15.)
- **15.** Note the following about the image:
 - The white dots are at the center of each MacroBlock.
 - The white lines indicate motion vectors. The arrows for each MV point to the position in the previous frame that contains the data for the current MacroBlock.
- **16.** Click the color transfer icon **I** to change the overlay from white to black.
- 17. To play the video again, click the line icon or type CTRL + A. Note that the motion vectors are clear and accurate.



Figure 15: Video image

Conclusion

This tutorial demonstrated where there is a standards-compliance issue in the H.263 bitstream, but also showed that other aspects of the H.263 bitstream, such as the motion vectors, are implemented properly.

Tutorial 3: MPEG-4 Compliance

This tutorial covers the following:

- Basic functions
- Alerts for syntax errors
- Video summary tooltip
- MacroBlock overlay MB types
- Optimization
- Frequency of intra-coding

Procedure

- To load the H.263 tutorial, click File > Example files > MPEG-4 Elementary Streams > Space. An error message will appear. (See Figure 16.)
- 2. View the error details:
 - The error occurs at bitstream byte address 0x11, bit 3, before VOP 1.
 - The error is present in the header, and MTS4EA does an initial check of the file header when it loads the file.
 - The error indicates that method 1 quantization is in use, which is not allowed because the stream is Simple Profile.
- **3.** Click **Continue**. MTS4EA loads the stream, and the window title changes to **MTS4EA-MPEG4 Example-Space**.
- 4. Click the ▶ icon or type CTRL + P to resume playing the stream. The same error message will appear. (See Figure 16.)
- 5. Click Continue. A warning message will appear. (See Figure 17.)

Decode	Error 23042: Method 1 quantisation not allowed in SP
8	Error Video Object Layer Error: quant_type is '1' at position 0x11 (dec. 17), bit start 3. Not allowed in Simple Profile.
	Summary
	Image size unknown
	Stream size (kBytes) 976
	Address
	Time (secs) before 1
	type
	no. before 1 Decode no.
	Skip this Error only in future Skip ALL Error alerts in future
	Abort Pause Continue Goto V

Figure 16: Initial error message

Summ	ary		
	lmage size	352 x 268	^
Stre	am size (kBytes)	976	
	Address	0x006182 (dec. 24962) bit 7	=
	Time (secs)	after 0.880	
	VOP type		
		after 12	
	Decode VOP no.	14	v
	tip this Warning o tip ALL Warning a		
1 51	up ALL Waining a	alens in future	
	Ab	ort Pause Continue Gi	oto 🔻
		<u> </u>	Video
		53	Hex
			Alert log

Figure 17: Initial warning message

- 6. Click Goto, and then click Hex. (See Figure 17.) The Hex view appears with the error location highlighted. (See Figure 18.)
- 7. Close the Hex view and again view the initial error shown message. The error occurs because modulo_time_base was set to 1 after a whole second elapsed

since the modulo_time_base was last 1 (at which time vop_time_increment should be reset, although not necessarily to zero).

- 8. Click the icon or type CTRL + P to resume playing the stream. An alert appears again. (See Figure 17.)
- 9. In the alert dialog box, select **Skip this Warning only in the future**, and then click **Continue**.
- 10. Complete the video and observe whether it works properly.

Hex: MPEG4 Example - Space	ce -		
🔽 Bin 🔽 Hex 🔽 ASCII Auto	Bytes per line Prev Goto 0	Absolute address 💽 🍯 Hex 🔿 Dec	
0616E 01110011 01101101 06174 11100001 11001101	10111111 00001110 01101101	10110111 73 6D BF 0E 6D B7 sm m 10110110 E1 CD B6 FC 39 B6 9	^
0617A 11011111 10000111 06180 11011011 01111110	00110110 11011011 11110000 00000000 000000	11100110 DF 87 36 DB F0 E6 6 10110110 DB 7E 00 00 01 B6 ~	•
06186 0101000 10111000 0618C 10110110 11111100	00000100 10000111 00110000	01000111 50 B8 04 87 30 47 P 06 11100001 B6 FC 39 B6 DF E1 9	
06192 11001100 00010001	11101101 10111111 00001110	01101101 CC 11 ED BF 0E 6D m	
06198 10110111 11100001 0619E 11000001 00011110	11001101 10110110 11111110 11011011 11110000 11100110	00011100 B7 E1 CD B6 FE 1C 11011011 C1 1E DB F0 E6 DB	
061A4 01111110 00011100 061AA 01101101 11111000	11011011 01101111 11000011 01110011 01101101 10111111	10011011 7E 1C DB 6F C3 9B ~ 0 10000111 6D F8 73 6D BF 87 m sm	
061B0 00110000 01000111 061B6 11011111 10000111	10110110 11111100 00111001 00110110 11011011 11110000	10110110 30 47 B6 FC 39 B6 0G 9 11100110 DF 87 36 DB F0 E6 6	
061BC 11011011 01111110 061C2 10011011 01101101	00011100 11011011 01101111 11111000 01110011 01101101	11000011 DB 7E 1C DB 6F C3 ~ o 10111111 9B 6D F8 73 6D BF m sm	
061C8 10000111 00110110 061CE 00111101 10110111	11011011 11111100 00111001 11100001 11001101 10110110	10000010 87 36 DB FC 39 82 6 9 11111100 3D B7 E1 CD B6 FC =	
061D4 00111001 10110110 061DA 11110000 11100110	11011111 10000111 00110110 00001000 11110110 11011111	11011011 39 B6 DF 87 36 DB 9 6 11100001 F0 E6 08 F6 DF E1	
061E0 11001100 00010001 061E6 01000111 10110110	11101101 10111111 10000111 11111100 00111001 10000010	00110000 CC 11 ED BF 87 30 0 00111101 47 B6 FC 39 82 3D G 9 =	
061EC 10110111 11100001	11001101 10110110 11111100	00111001 B7 E1 CD B6 FC 39 9	~
Address: 0x6186 (24966) bit 3			11.

Figure 18: Hex view with error location

- **11.** From the **Overlay** menu, click **Video summary tooltip** to enable the Video Summary tooltip.
- **12.** View the **Final Video Summary Tooltip** and note these field descriptions. (See Figure 19.)
 - Image size: 352 pixels high x 288 pixels wide (CIF).
 - Stream size: 976 kBytes.
 - Total frames: 175.
 - Total play time of the sequence: 13.920 seconds.
 - **–** Total bits: 7,998,576.
 - Bandwidth required to transmit this: 574 kbits/second.
 - Frame play rate: 12.50 frames per second (Hz).
 - Clip is MPEG-4 Simple Profile with Resync markers & Method 1 quantification.

13. Observe how the sequence looks, and then close the **Final Video Summary** window.

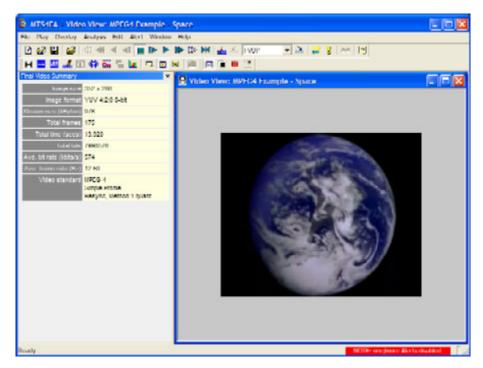


Figure 19: Final video summary tooltip

- 14. To see if the codec makes the best use of the MPEG-4 standard, open the Overlay menu, and then click MB Types (you can also type CTRL+ Y). The MB Types key appears.
- 15. Move forward 3 frames. The MB types are color-coded. (See Figure 20.)

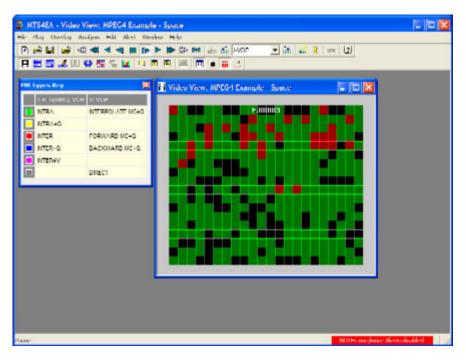


Figure 20: MB Types color key

- **16.** Move forward to frame 34. Note that there are several green (intra) coded MacroBlocks in the static black background (intra coded MBs generally use the most bits). (See Figure 21.)
- **17.** View frames 35, 36 and 37, and observe that the MacroBlocks disappear. (See Figure 22.)
- 18. Go back to frame 34.
- **19.** From the **Overlay** menu, click **MB Statistics**, and then click **Bits**. Note that the black background uses a high number of bits. (See Figure 23.)
- **20.** View frames 35, 36 and 37, and observe that the background uses progressively fewer bits. (See Figure 24.)
- **21.** Compare frame 34 with frame 37. Observe that the black background in frame 34 is coded and uses many bits, while the black background in frame 37 is not coded, and it uses no bits.

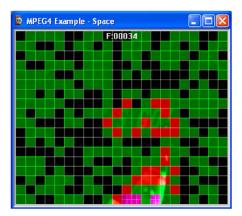


Figure 21: Frame 34, color key

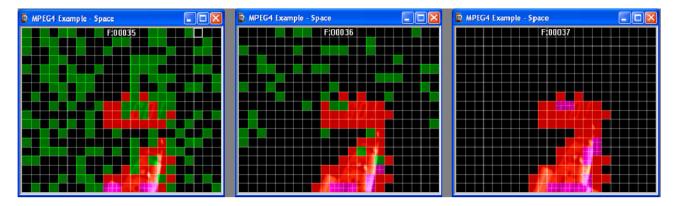


Figure 22: Frames 35, 36, and 37, color key

B	Vic	leo	Vi	iew	r: 1	NPE	EG	4 E	xa	mp	ole	- S	pa	ce			(-			×
	37	27	27	27			37	27	Б	00	03	47	27			37	27	27			37
37	27			37		37	27		37		37	27	27		37	27		37		37	27
	37	37	27				37	37	27		27	27		37	27	27	37		37	27	
37			37	37	27		27	27	27			37			37	27		37	27	27	37
27	37	27	27			37	27	27	27		37		37					27			37
27	27	27	27	37	27		37	27	27								37		37		
27	27		37		37	37			37		37	27		37	27	27		37	27	37	
27		37	27	37					27		32		146	21	79	37	37	27	27	27	37
27		37	27		37		37	27	334	399	948	483	***	••••	401	575		37	27	27	
27	37				27	37			172	849	714	672	460	•••	978	36	37				
	37	37	27						250	163	250	144	525	209	120	24	27	37		37	
	27		37		37					37					37	27			37	27	37
				37			37	27	27	27	37	27		60	119	37	37			37	27
37	27	27					27			37		37	37	27	345	27		37	27		
27	27	27		37				37	27			27	328	317	•••	68			37	37	
	37		37	27	37		37			37	27	247	361	361	795	37		37			
37		37	27	27			27	37			53	990	-	•••	-	20			37	27	
27	37			37	37	27			758	712	435	518	969	-	306	37		37		37	

Figure 23: Frame 34

8 v	ide	o Vie	ew: I	MPEG4	Example	- Spa	ace				B	Vide	o View	: MPE	G4 E	xample -	Space	(- 🗆 🖂	Video View: MPEG4 Example - Space	
37	37	7	37 27		37 F:0003	5	37 2	7	37				37	37 :	27	F:00036			37	F:00037	
27	25	7 37		37	37 27		27 2	7		37							37				
27		37		27	37			37	3	7 27	3	7		37		37 27 27	27				
		27	37			37 23	7 27 2	7				3	7					37			
37	37	7 27	37		37	27 23	7 27		3	7 27		2	7 37	37	37	27			37 27		
	27	7 27	27	37 27		27	37 3	7 27		37			37					37 27 27			
		37	37	37 27		27	3	7	37 2	7 27	3	7	37			37			37		
3	7		37	27	15	27105	5 37 2	7 37					37			37 17		37	37	25 32	
		37	37		37 38419520	941+++	+416++	+ 33							37	2145535344	43973192	14		21403378516373304 34	
37				37	35418337	443++-	+32672	7 90	3	7 37		37				14 108 283 43	1407269	77 32		14 83517453243269112 26	
27 3	7	37	37	27	213 92241	17111	1111 8	4 37	37			27				4111519618	5 91 80	22	37	17 31 109 131 82 286 223	
	37	7	37	27	37		37	3	7	37	3	7 3	7			37	2623	17		150350318	
37	27	7				37	22541	0 37	37 2	7	2	7					124 138 2	21		195354535342	
	27	7 37	27	37	27 37	27234	126238	0 27 3								21	48834683	97		125327300545533	
37 2	7			37		681273	7+++54	5 18	37							14335	64004518	26 35		303396743681 201 37	
				27	37 119	96563	154051	4 37								71 6925046	05785764	68		333 305 263 292 393 7 3 23	
			37	27 37	199187223	352699	982692	8 20	37	37						37328827830	33977601	54 20		91360352269353524 53261 20	
3	7	37		37	37639585526	77760	1 1 27	5 37		37					179	10948046367	3812	61		38143251038535073211+728	

Figure 24: Frames 35, 36 and 37

Conclusion

This tutorial demonstrated how to:

- Use and interpret the alert pop-up messages.
- Use the Video summary tooltip and understand the information provided.
- Use the MacroBlock overlays: MB types and motion vectors.
- Use the hexview bitstream viewer.

Additional Information Covered

It appears that the encoder chooses MB types less than optimally by using intra MBs for the background, which wastes many bits.

- Consider whether there are software bugs, such that the encoder is too sensitive to minor changes in the gray level.
- Check the encoder part of the codec that decides when to use Intra MBs and Inter MBs, and when to not code the MB.

Fixing this problem would save many wasted data bits.

NOTE. The MPEG-4 standard provides more data bits for intensity-gray level than for color information, so it is naturally more sensitive to changes in gray level (this mimics the human visual system). However, it appears that the sensitivity to gray in this example is too great.

Tutorial 4: MPEG-4 Optimization

This tutorial covers the following:

- Use of the video navigator view.
- Use of trace.
- Common error: stuffing bits; using HexView to examine bitstream data.
- Synchronizing views.
- Saving a setup in project files.

This tutorial requires that you have completed the previous tutorials and that you can perform the following tasks:

- Play, stop, step forward, and fast forward a video.
- Use and interpret the alert messages.
- Use the Video summary tooltip and understand the provided information.
- Use the MacroBlock overlays: MB types and motion vectors.
- Use the MacroBlock and Summary tooltips.
- Use the hexview bitstream viewer.
- View Trace files: Parse bitstream and interpret.

Procedure

- To load the MPEG-4 tutorial, click File > Example files > MPEG-4 Elementary streams> Window Car. A stuffing_bits error occurs at stream address 0x9, bit 1, when the file is loaded. (See Figure 25.)
- 2. Check the box next to Skip this, and then click Continue when the stuffing_bits alert appears.

	Warning	Video Object F	
7	WARNING: first bit of st 9): going on to next byte	uffing bits is not 10° at bit 1 at position 0x9 (dec.	2
			3
	Summary		
	Image size	unknown	^
	Stream size (kBytes)	355	
	Address		
	Time (secs)	before 1	
	type		-
	and the second s	before 1	
	Decode no.		×
	Skip this Warning on	lv in future	
	Skip ALL Warning al		

Figure 25: Stuffing_bits alert

3. Play the video to the end. Select **Skip this** and then click **Continue** when the **VCV overflow** alert appears. (See Figure 26.)

Video Complexity Verifier model has overflowed by 198.0 MacroBs at time 0.0005. The overflow occurred during the decoding of trane 2, bitterisam position 0.1 clo41 (dec. 7172). The total VCV buffer occupancy in 59.4 0 MacroBs. vtCV parameters were derived from profile, and jevel_indication in Summary NOTE: display vs. decode order Intege size 352 x 288 Stream size (189/661) 355 Address 0.001 c04 (dec. 7172) bit 7 Time (decs1) 0.133 VCP type 5 (CMC)-VCP VCP no 2 Decode VOP no 2	Warning		Video Object P	lan
Midge size \$52 x 288 Stream size (I6V/es) \$55 Address 0x001c04 (dec. 7172) bit 7 Time (aecc) 0.133 V/OP hype \$(SMC)_V/OP V/OP no \$	time 0.000s. The over bitstream position 0x is 594.0 MacroBs ar	aflow occurred 1c04 (dec. 717 ad the maximum	during the decoding of frame 2, 2). The total VCV buffer occupancy limit is 396.0 MacroBs. VCV	< >
Stream size (LB)462) 955 Address: 0x001c04 (dec, 7172) bit 7 Time (secs) 0.133 VOP type 5(SMC)-VOP VOP no 5	Summary		NOTE: display vs. decode orde	r
Address 0x001c04 (dec. 7172) b8 7 Trine (secs) 0.133 VCP type 5(GMC)-VCP VCP no 5	Image s	ze 352 x 288		^
Time (sec.s) 0.133 VCP type S(GMC)-VOP VOP no. 5	Stream size (kByte	(1) 355		
VOP type S(GMC)-VOP	Addre	ss 0x001c04	(dec. 7172) bit 7	
VOP no. 5	Time (see	e) 0.133		
	VOP by	pe S(GMC)-V	P	
Decode VOP no. 2		-		
	Decode VOP	no. 2		~
		-		
Skip this Warning only in future Skip ALL Warning alerts in future				

Figure 26: VCV overflow alert

4. Click the Video Navigator icon 😳. The Video Navigator window will appear in either Detail (See Figure 27.) or Thumbnail view. (See Figure 28.)

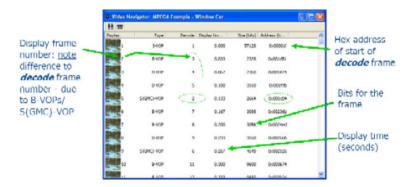


Figure 27: Video Navigator window, detail view

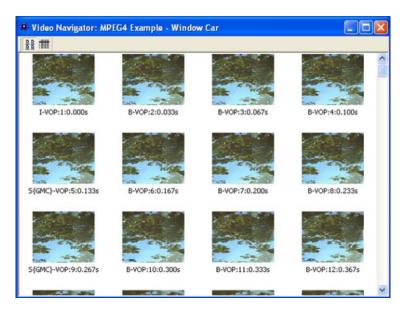


Figure 28: Video Navigator window, thumbnail view

- 5. To synchronize the video window and the video navigator, start by selecting **Tile Horizontally** on the **Window** menu to view the tiles horizontally. The following views can also be synchronized:
 - Buffer analysis
 - HexView
 - Alert log
 - Fidelity analysis
 - Trace/Parse bitstream and Trace/Interpret



Figure 29: Horizontal view

6. Click the synchronize views icon. (See Figure 30.)

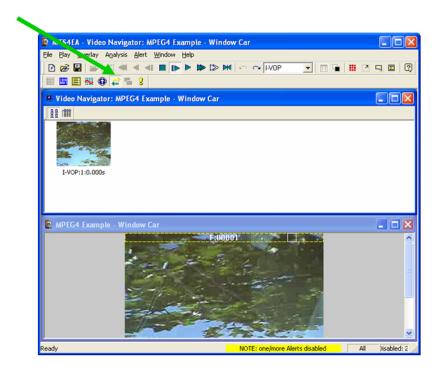


Figure 30: Synchronizing views

- 7. Play through the entire sequence again. This time, the video navigator and the video views are synchronized.
- **8.** Click the icon at the top left corner of the video navigator window to see the thumbnail view. Each thumbnail is labeled with the frame type, display frame number, and the display time (in seconds). (See Figure 31.)

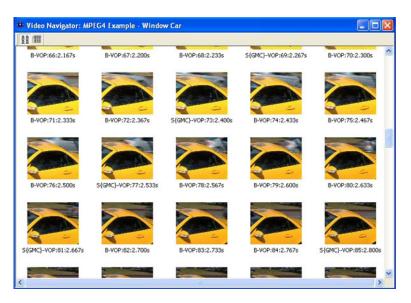


Figure 31: Video Navigator window, thumbnail view

NOTE. The last frame should now be displayed in the video window.

9. Double-click on frame 57. Decoding restarts from the beginning and stops at frame 57. (See Figure 32.)





10. Double-click on frame 51 and note that the view immediately changes and does not start from the beginning again. (See Figure 32.)

NOTE. *MTS4EA* has a cache of data, the size of which is selectable in the Play menu under Decoder Options and then the General tab. However, if the video is stopped (for example, played to the end), then the cache must be refilled.

11. Right-click on any view. Select **Goto view**, and then select **Trace/Interpret** from the drop-down menu. View the Trace files, frames 1–3. An alert will appear. (See Figure 33.)

Trace: Window car pares bitstream f1-3	vpt :	
Euromanian First Prev [Neal] P Em	Wanny Whan That	
Standard: MPRG-4 Advanded Sing Hethod 1 quant, GHC Frame mize: 352x288 Filesize: 355 kDptes	sla Profile/Level 2	
	Trace: Window car interpret f1-3.vpt	
1111 0010 0000 0000 0000 0000 0001 1	Eneranters First New West P time "P Waring P have I	Teor
0001	Stendard. MPEG-4, Advanced Simple Profile/Level 2 Nathof 1 guant, GMC Frame size: 352x200 Filosize: 355 kBytes	4
(0x00000009.1) ULENHINE - WARNTI	(0x00000000,7) [VOS] (NP4) visual_object_sequence_sta	ert_code = 0x1b0 (should be 0x1b0)
0000 0000 0000 0000 0000 0001 0	(0x00000009.6) [WO] [HP4] visual object type = '0003	ar = 0 : no visual object version ID or priori)
25	Construction Construction	
	(0x00000009.1) WARNING: first bit of stuffing bits is (0x00000004.7) [V0] (MN4) video.object.start.code =	
	<u>c</u>	2

Figure 33: Trace files warning, frames 1–3

NOTE. Warnings, errors, and fatals are always shown in the Trace/Parse bitstream and Trace/Interpret files, whether or not the pop-up alerts are enabled.

12. In the Trace/Interpret window, select the address 0x00000009,1 and right-click. Select **Goto view** and then **Hex**. The HexView will open with the selected location highlighted. MTS4EA shows exactly where the problem is: bits 1 and 0 of byte 9 are both 1, but for stuffing bits, they should be 01. (See Figure 34.)

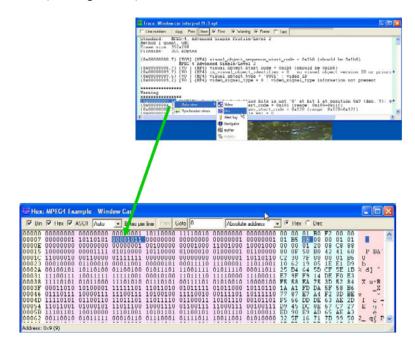


Figure 34: Selecting Hex from the Trace window

13. View the HewView window and its information. You can search for items using "." as a wildcard character. For example, you can enter the start code 0001b. to find 0001b1, 0001b5, and 0001b6. (See Figure 35.)

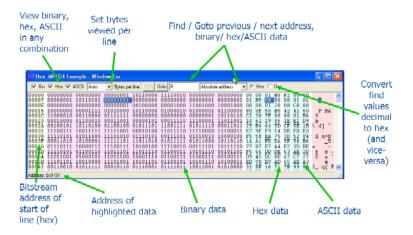


Figure 35: HexView window

14. Save your setup by clicking **File** and then selecting **Save project**. You can change the filename. (See Figure 36.)

Save project file	? 🛛
Save in: 🔁 MTS4EA	• 🖶 📸 📰 •
i default.vpp	
File name: MPEG4 Example - Window Car.vp	<u>S</u> ave
Save as type: MTS4EA projects (vpp)	Cancel

Figure 36: Saving a project file

- **15.** Close MTS4EA completely.
- 16. Restart MTS4EA.
- 17. Select the project file that you saved previously from the File drop-down menu. An alert will pop up when the video file is loaded. Dismiss it by selecting Skip this and Continue. (See Figure 37.)

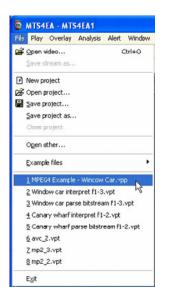


Figure 37: Opening the project file

Conclusion

This tutorial demonstrated how to:

- View different video data and navigate between different views.
- Store setups.
- Identify stuffed bit errors.

Tutorial 5: MP4 Compliance Basics

This tutorial covers the following:

- Opening an MP4 file and viewing the tracks.
- Syntax error: not obeying Profile/Level restrictions.
- Extracting and saving the video track.
- Viewing MP4 file structure.

This tutorial requires that you have completed the previous tutorials and that you can perform the following tasks:

- Play, stop, step forward, and fast forward a video.
- Use and interpret the alert messages.
- Use the Video summary tooltip and understand the provided information.
- Use the MacroBlock overlays: MB types and motion vectors.
- Use the hexview bitstream viewer.

Procedure

- To load the MP4 tutorial, click File > Example files > MP4 Files > Packet Woman. A list of tracks included in the MP4 appears in a dialog box. (See Figure 38.)
- 2. View the track information included in the dialog box. The video track ID, for example, is 001. Although there can be multiple tracks, the first video track is selected automatically.
- **3.** Click **OK**. The video track is analyzed, and an error message appears. (See Figure 39.)
- 4. View the error message details: (See Figure 39.)
 - The VOP has more MacroBlocks (396) than allowed in MPEG-4 / Simple Profile / Level 1: the maximum number allowed is 99.
 - This is likely an error with the level. It is stated as Level 1 in the encoded file, but it is actually the size of a Level 2.

elect	Туре	ID	Description	Bytes	Scrambled	Decoder
2	MPEG-4 part 2	001	Visual stream	690840	No	MPEG-4 part 2
	unknown streams empty streams tree		track:001 (No selection)			G
	led stream search					

Figure 38: Track list

Decode	Error 23021: Too many MBs for Profile/Level	X
	Error Video Object L	.ayer
8	[VOL] (MP4) Error: VOP (height * width) gives no. of MBs = 396 : too many MBs for Profile/Level (max = 99). (Error ignored: actual width & height used.)	~
		~
	Summary	
	Image size unknown	^
	Stream size (kBytes) 675	
	Address	
	Time (secs) before 1	
	type	
	no. before 1	
	Decode no.	*
	Skip this Error only in future	
	Skip ALL Error alerts in future	
	Abort Pause Continue Got	•

Figure 39: Initial error message

- **5.** Select **Skip this Error only in the future**, and then click **Continue**. MTS4EA will continue, by using the actual size. A buffer conformance warning message appears. (See Figure 40.)
- 6. View the warning message details: (See Figure 40.)
 - Overflow by 297 MB.
 - This error is to be expected, because the Level is incorrectly given as L1 (which has a limit of 99 MBs) whereas it should be L2 (which has a limit of 396 MBs).

Decode	Warning 33015: VCV overflow	
	Warning Video Object	Plane
⚠	Video Complexity Verifier model has overflowed by 297.0 MacroBs at time 0.000s. The overflow occurred during the decoding of frame 1, bitstream position 0x0 (dec. 0). The total VCV buffer occupancy is 396.0 MacroBs and the maximum limit is 39.0 MacroBs. VCV parameters were derived from profile_and_level_indication in	<
	Summary NOTE: display vs. decode ord	ier
	Image size 352 x 288	^
	Stream size (kBytes) 675	
	Address 0x00001c (dec. 28) bit 7	
	Time (secs) 0.000	
	VOP type I-VOP	
	VOP no. 1 Decade VOP no. 1	
	Decode VOP no. 1	×
	🔽 Skip this Warning only in future	
	Skip ALL Warning alerts in future	
	Abort Pause Continue Go	ito 🔻

Figure 40: VCV overflow warning message

- 7. Select Skip this Warning only in the future, and then click Continue. Another buffer conformance warning message appears. (See Figure 41.)
- 8. Select Skip this Warning only in the future, and then click Continue.
- 9. To ensure that the application window is active, click the Title bar.
- **10.** From the analysis menu, select **View video stream structure**. The **Structure** window appears. (See Figure 42.)
- **11.** View the top-level atoms in the MP4 file. Click the + next to each atom to view the data for the atom.

Warning	Video Object Pl	an
0.360s. The underflow o bitstream position 0x3f6 is -16015 bits and the m	del has underflowed by -16015 bits at time occurred during the decoding of frame 10, 3 (dec. 16227). The total VBV buffer occupancy inimum limit is 0 bits. VBV parameters were Llevel_indication in VisualObjectSequence	0 0
Summary	NOTE: display vs. decode order	•
lmage size	352 x 288	^
Stream size (kBytes)	675	
Address	0x003/63 (dec. 16227) bit 7	
Time (secs)	0.360	
VOP type	P-VOP	
VOP no.	10	
	10	200

Figure 41: VBV underflow warning

Syntax	Value	Start bit	Size (bits)
file		0x000000.7	5549184
⊟ 🚱 ftyp		0x000000.7	192
123 size	24	0x000000.7	32
-123 type	ftyp	0x000004,7	32
-123 major_brand	mp42	0x000008,7	32
-123 minor_version			
compatible_brands	0	0x000010,7	0
🖃 🚱 mdat		0x000018,7	5526560
-123 size	690820	0x000018,7	32
-123 type	mdat	0x00001c,7	32
10 data	[32, 690844]	0x000020,7	5526496
🖃 🚱 mdat		0x0a8a9c,7	368
123 size	46	0x0a8a9c,7	32
-123 type	mdat	0x0a8aa0,7	32
🛞 data	[690852, 690890]	0x0a8aa4,7	304
= 🚱 moov		0x0a8aca,7	22064
-123 size	2758	0x0a8aca,7	32
-123 type	moov	0x0a8ace,7	32
🖭 🕼 unknown		0x0a8ad2,7	86.4
💌 🕼 iods		0x0a8b3e,7	336
🗄 🚱 trak		0x0a8b68,7	9696
🗉 🚳 trak		0x0a9024,7	3432
😐 🚱 trak		0x0a91d1,7	3304
🗉 🕼 udta		0x0a936e,7	4368

Figure 42: Structure window

- 12. From the File menu, click Close stream, and then reopen the stream.
- **13.** When the track list appears, click **Extract**. (See Figure 43.) The **Save stream file as** dialog box appears. (See Figure 44.)

ID	Description	Bytes	Scrambled	Decoder
001	Visual stream	690840		MPEG-4 Video Decoder
	Object descriptor stream		No	
003	Scene description stream	19	No	
H	ide unknown streams			
	ide empty streams			
Stre	am search			
	Search			
	5 earch			

Figure 43: Track list

Save stream file as	2
Save in: 🛅 video	- 🔁 🖆 📰 -
 3gpp asp Customer H263 h264 mp4 	Conf Conf Simple Tutorial V1 Converses
<	>
File name: mp4fil_1-001.m4v	Save
Save as type: MPEG-4 Elementary Stream (*.m4)	() Cancel

Figure 44: Save stream file as dialog box

14. In the **Save stream file as** dialog box, type a different file name if required. The track ID and video file type has been automatically appended to the file name.

NOTE. To open this dialog box in the future for a video track that was not extracted at the time the MP4 file was first opened, open the File menu and then click Save stream file as.

Conclusion

This tutorial demonstrated how to:

- View the tracks in an MP4 file.
- Extract and play a video, while checking for errors.
- Identify and locate the Level conformance error.
- Identify two buffer conformance errors (see Tutorial 5 for details about buffer analysis).

Tutorial 6: MP4 Optimization

This tutorial covers the following:

- Opening an MP4 file and viewing the video track.
- Using the Video summary tooltip and the MB types overlay.
- Performing optimization checks that could reduce bit usage by 45% in this sequence.

This tutorial requires that you have completed the previous tutorials, and that you know how to:

- Play, stop, step forward, and fast forward the video.
- Use and interpret the pop-up alerts.
- Use the Video summary tooltip and understand the information provided.
- Use the MacroBlock overlays: MB types and motion vectors.
- Use the hexview bitstream viewer.
- Open MP4 files, view/extract the video, and view the MP4 file structure.

Procedure

- To load the MP4 tutorial, click File > Example files > MP4 Files > Picadilly Circus. A list of tracks included in the MP4 appears in a dialog box. (See Figure 45.)
- 2. View the track information included in the dialog box. The video track ID, for example, is 001. Although there can be multiple tracks, the first video track is selected automatically.
- 3. Click OK.
- 4. To view the Video Summary tooltip, click the \square icon or type CTRL + U.
- 5. To view the MB types overlay, click the \blacksquare icon or type CTRL + M.
- 6. Click the icon. A VCV buffer conformance warning message appears. (See Figure 46.)

Select	Туре	ID	Description	Bytes	Scrambled	Decoder
~	🚴 MPEG-4 part 2	001	Visual stream	733169	No	MPEG-4 part
		002	Object descriptor stream	0	No	
		003	Scene description stream	0	No	
¢						
	unknown streams empty streams	Video:	track:001			Got
Hide		Audio:	(No selection)			Gol
	ed stream search	r totalo.	,			

Figure 45: Track list

Decode	Warning 33015: VCV overflow	×
	Warning Video Object P	lane
⚠	Video Complexity Verifier model has overflowed by 158.4 MacroBs at time 0.040s. The overflow occurred during the decoding of frame 2, bitstream position 0xfd9 (dec. 4057). The total VCV buffer occupancy is 554.4 MacroBs and the maximum limit is 396.0 MacroBs. VCV parameters were derived from profile_and_level_indication in	<
	Summary NOTE: display vs. decode or de	r
	Image size 352 × 268	^
	Stream size (kBytes) 718	
	Address 0x000fd9 (dec. 4057) bit 7	
	Time (secs) 0.040	
	VOP type P-VOP	_
	VOP no. 2 Decode VOP no. 2	
		~
	🔽 Skip this Warning only in future	
	🔲 Skip ALL Warning alerts in future	
	Abort Pause Continue Goto	•

Figure 46: VCV buffer conformance warning message

- 7. Select Skip this Warning only in the future, and then click Continue.
- **8.** View the progression of frames, and note that the first frame is green, as is every third frame (Intra MBs). (See Figure 47.) Another buffer conformance warning message appears. (See Figure 48.)

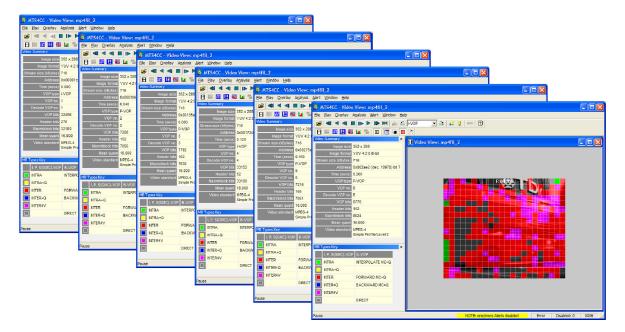


Figure 47: Progression of frames

<u>\</u>	Video Butfer Verifier model has underflowed by 19561 bits at time 1.320s. The underflow occurred during the decoding of trame 34, bitsteam position 0x12039 (dec. 73785). The total VBV butfer occupancy is 19561 bits and the minimum limit is 0 bits. VBV parameters were derived from profile_and_level_indication in	< >
	Summary NOTE: display vs. decode o	rder
	Image size 352 x 288	^
	Stream size (kBytes) 716	
	Address 0x012039 (dec. 73785) bit 7	
	Time (secs) 1.320	
	VOP type LVOP	
	VOP no. 34	
	Decode VOP no. 34	¥

Figure 48: VBV underflow warning

- 9. Select Skip this Warning only in the future, and then click Continue.
- **10.** To replay the video file, click **Pause, step forward**. Note that the first frame takes 32,456 bits. (See Figure 49.)

) 🐼 🖬 🥔 🖉 1 😑 🖬 🚜 🛄	이에 이에 비해 바람이 아이지 않는 것이 아이지 않는 것이 아이지 않는 것이 아이지 않는 것이 같이 않는 것이 같이 않는 것이 아이지 않는		
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Figure 49: Frame 1

- 11. Click the red close button to remove the MB Types Key window.
- **12.** Click the **III** icon twice to reopen the **MB Types Key** window.
- **13.** To undock the **MB Types Key** window, hold the **CTRL** key, while dragging it with the mouse pointer.
- 14. View the next six frames, including Frame 2. (See Figure 50.)
- **15.** For each frame, view the details, which are outlined in Table 3.

in ef 🖬 🗃 i	April 2011 (1997) (19977) (19977) (1	🕨 🕬 🔐 🖧 🕬 🐨 💌 🛣 🛃 👘 🕅	
Nov Serenery Image atte Image atte Stream cole (SC) Hel Address Term Jeccol VOT son Notifies Notifies Notifies Notifies Notifies Notifies Notifies Notifies Notifies Notifies Notifies	307 x 700 1VV 42.01246 10.000544 (dec. 45.0)547 0.000 2 3 7005 182 192 192 19.000 1947 4 19.000 1947 4 19.000		

Figure 50: Frame 2

Table 3: Frame details

Frame	Frame type	Bits used	
2	P-VOP	7,208	
3	P-VOP	7,792	
4	I-VOP	33,152	
5	P-VOP	7,216	
6	P-VOP	8,776	
7	I-VOP	34,344	

Conclusion

This tutorial demonstrated the following:

- The I-VOPs require about 4.5 times as many bits as the P-VOPs.
- There are I-VOPs every 3rd frame.
- There is no need to have I-VOPs so often. If the frequency of I-VOPs were reduced to 1 in 30, the bits used for the sequence would reduce by ~45%.
- You can reduce the number of bits used.

Tutorial 7: 3GPP/MPEG-4 Compliance

This tutorial covers the following:

- Opening a 3GPP file and viewing the tracks.
- Viewing syntax errors using reserved Profile/Level indication.
- Performing optimization checks that may or may not be applicable in a wireless environment.

This tutorial requires that you have completed the previous tutorials, and that you know how to:

- Play, stop, step forward, and fast forward the video.
- Use and interpret the pop-up alerts.
- Use the Video summary tooltip and understand the information provided.
- Use the MacroBlock overlays: MB types and motion vectors.
- Use the hexview bitstream viewer.
- Open MP4 files, view/extract the video, and view the MP4 file structure.

Procedure

 To load the 3GPP tutorial, click File > Example files > 3GPP File > Mobile Hands. A list of tracks included in the 3GPP appears in a dialog box. The first video track is automatically selected. (See Figure 51.)

Select	Туре	ID	Description	Bytes	Scrambled	Decoder
~	🐣 MPEG-4 part 2	001	Visual stream	273233	No	MPEG-4 part
		002	Object descriptor stream	0	No	
		003	Scene description stream	0	No	
	unknown streams empty streams	Video:	track:001			Go
Hide	tree	Audio:	(No selection)			Go
	ed stream search					

Figure 51: 3GPP track list

- 2. Click OK.
- **3.** An alert will appear for a syntax error. This error shows as a reserved value (0) for **profile_and_level_indication**. (See Figure 52.)
- 4. Click Continue and do not enable Skip.

Decode	Error 23001: Reserved Profile/Level	
	Error Visual	Object Sequence
8	Error: [VOS] {MP4} Profile/Level = 0x0 at position 0x4 (de 7, is RESERVED value or not supported in this version of value will be ignored	
	Summary	
	Image size unknown	^
	Stream size (kBytes) 267	
	Address	

Figure 52: Syntax error alert

5. Run Trace/Interpret (frame 1) and look at the error at address 4, bit 7. (See Figure 53.)

🛄 Trace: Mobile	sands interpret.vpt	
Line numbers	Find: Prev Next 🛛 Error 🖓 Warning 🖓 Frame 🥅 Text	
		-
(0x00000000),) [VOS] (MP4) visual_object_sequence_start_code = 0x1b0 (should be 0x1b0)	
Error (0x00000004,		·. •
(0x00000005, (0x00000009, (0x000000009)		

Figure 53: Trace/Interpret error at address 4, bit 7

6. Play the video again and at the error, click **Goto** and then select **Hex** from the drop-down menu. (See Figure 54.)

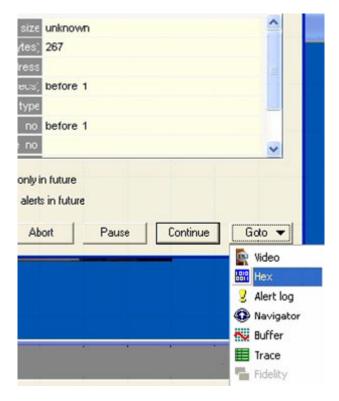


Figure 54: Selecting Hex from the Goto drop down menu

7. The HexView window will appear with the location of the error bits highlighted. (See Figure 55.)

I₩ Din	W Hex W	ASCII Auto	· Byles pe	time Prev	Goto 0		Absolut	e adde	- 22	@ Hex C	Dec
00000 000014 00012 00012 00022 00022 00022 00022 00022 00022 00022 00022 00022 00022 00022 00022 00022	00000000 01000000 10010000 00000001 1011001 00100010	000000000000000000000000000000000000000	00000001 00000001 00100000 10001010 10001010 10001000 1000000	10110000 10110101 00000000 00000000 0010100 000000	000001001 10000000 00100000 00010000 00010000 000000	00 00 40 90 01 88 30	00 01 00 01 00 01 01 20 06 60 A2 0F D6 10 3F D7 7F 00 04 10 AC 00 AC 00 AC 00 82 82 F5 80 00 83	01 0 00 0 2C 2 00 0 62 1 D6 0 00 0 B6 1 16 1 0C 1	19 14 14 10 10 10 10 10 11 10 10 10 10 10 10 10		
00046 0004B	10111000		10110110 10111001 00100010	10110000 00000000 11011111	000000001 000000000 00110101	D5 88 84	7Å B6 24 B9 82 22	00 0	1 2 0 9	5	

Figure 55: HexView window with error locations highlighted

- 8. To look at the VOP types, first stop the stream if it is playing.
- 9. Click the Summary tooltip icon 🗵 to turn on the tooltip.
- **10.** Click the MB Types Overlay icon **III** to turn on the overlay.
- **11. Play** or **Pause/Step** forward through the sequence to the end. Notice that the first frame and every second frame are Intra-MBs. (See Figure 56.)

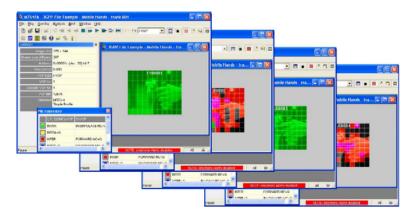


Figure 56: Viewing VOP types

- 12. Now examine the error resilience by clicking the Summary tooltip icon **D** to turn the tooltip on again, if it is not already on.
- **13.** Click the Pause/Step Forward icon by to move to frame 1.
- 14. Notice in the Summary window that **resync markers** and **data partitioning** are both on. This is vital for good error resilience in a mobile environment. (See Figure 57.)

Summary	3	×
Image size	176 × 144	
File size (kBytes)	267	
Address	0x000000 (dec. 0) bit 7	
Time (secs)	0.040	
VOP type	I-VOP	
VOP no.	1	
Decode VOP no.	1	
VOP bits	12800	
Standard	MPEG-4 Simple Profile Resync, Data Partitioning	

Figure 57: Summary window data

Conclusion

This tutorial demonstrated the following:

- Using the Summary tooltip allows you to look at VOP types.
- Reducing the frequency of I-VOPs can allow for better quality video in the same bit-rate.
- With error resilience tools in use, the frequency of I-VOPs can be reduced, reducing the bit-rate by approximately 15%.

Tutorial 8: H.264/AVC Syntax Error

This tutorial covers the following:

- Opening an H.264/AVC byte stream.
- Syntax error in PPS
- Finding the frame number of the error.
- Examining the byte stream syntax and finding the error using Trace/Parse bitstream and Trace/Interpret.

Procedure

- 1. To load the tutorial, click File > Example files > H.264/AVC Byte Streams> Canary Wharf.
- 2. An incorrect direct_8x8_inference_flag error will occur at address 0x0, bit 7, when the file is loaded. (See Figure 58.)

8	Error direct_8x8_inference_fl	RBSP. ag is 0. This is not permitted in Extended Profile.	SPS
	Summary		~
	Image size	176 x 144	^
	Stream size (kBytes)		
	Address	0x000000 (dec. 0) bit 7	=
	Time (secs)	before Frame 1	
	Frame type		
	Frame no.	before Frame 1	
	Decode Frame no.	1	~
	Skip this Error only in Skip ALL Error alerts	in future	

Figure 58: Direct_8x8_inference_flag error alert

3. Notice that the syntax error occurs before frame 1. This is the displayed frame number. Check the **Skip this** box and then click **Continue**. (See Figure 58.)

4. An invalid Picture Parameter Set ID error will occur during the decode of frame 1. Use the scroll bar to view all of the information in the error dialog box. (See Figure 59.)

Decode	Error 24304: Invalid Picture Parameter Set	×
	Error RI	BSP
8	Trying to use an invalid (uninitialised) Picture Parameter Set with ID 1, at position 0x1c (dec. 28), bit 7. Vprove will attempt to use value from previous slice header, ID 0.	
		~
	Summary	
	Image size 176 x 144	^
	Stream size (kBytes) 181	
	Address 0x000000 (dec. 0) bit 7	=
	Time (secs) before Frame 1	
	Frame type	
	Frame no. before Frame 1	
	Decode Frame no. 1	~
	Skip this Error only in future Skip ALL Error alerts in future Abort Pause Continue Goto	•

Figure 59: Invalid Picture Parameter Set ID error

- 5. Click on Analysis in the menu. Select Trace enable and then select Frame range from the drop-down menu.
- **6.** Set the frame range from 1 to 2. This will run the Trace/Interpret and Trace/Parse bitstream on frames 1 and 2.
- 7. View the Trace file and clear the **Frame** box. Click **Find Next** three times. An error alert will appear. (See Figure 60.)

E Trace: Cenary wherf parse bitstream #1 2.vpt	
Firementes Find New New Pitror Piller Toto	
0001 000	10
(AsAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA	eremeter Set with ID 1, at position (*
0000 0000 0 (0x00000001C,4) : PRAMK NUM (0x0000001D,3) : IDR PIC ID	
0000 0000 (0x0000001D.2) : PIC_ORDER_CNT_LCL 0	PICS PLAG
0 (0x0000001E 1) LOBC TERM REFEREN	
1 (0x0000001F,3) . HB TYPE	
1 (0x0000001F 2) . PREV_INTRAXX4_PRE 0 (0x0000001F 2) . PREV_INTRAXX4_PRE (0x00000001F 1) . PREV_INTRAXX4_PRE	D_BODE_FIAG
AAT IA AAAAAATE'AT REU TUTALIGI RAFE	

Figure 60: Trace/Parse bitstream error

8. View the Trace/Interpret for the same range. Clear the Frame box and click Find Next twice. An error alert will appear. (See Figure 61.)

THEORY OF THE AND A THE COMPANY AND A COMPAN	E Les medeurs I m	of Fue Your Rans R Warey E Fairs T test
EXCOUNTED: () for any any first (numerical formation of the formation for with 10 1. at contrast provided (1)	(3+92698948-8)	[SIF SIR] slice type 7. All slices for this sloture. I slice (hitsiness values.) Sign SIR.
$ \begin{array}{l} \hline \begin{array}{l} \hline \begin{array}{l} \hline \\ \hline $		
defondatic,4) (512 5789) form sume = 0 Astronomin,3) (522 5789) ide pictuit = 0 (bitatrass values: hemathet bits, ide pictuit-fat) Hadmannin,2) (522 5789) pictuation and the = 0 Hadmannin (2) (522 5789) pictuation and the = 0 Hadmannin (2) (522 5789) idea (522 5785 pictuation and 578 578 Hadmannin (2) (522 5789) idea (522 5785 pictuation and 578 578 Hadmannin (2) (522 5787 578 578 578 578 578 578 578 578 57	INVERSOR .	
defondatic,4) (512 5789) form sume = 0 Astronomin,3) (522 5789) ide pictuit = 0 (bitatrass values: hemathet bits, ide pictuit-fat) Hadmannin,2) (522 5789) pictuation and the = 0 Hadmannin (2) (522 5789) pictuation and the = 0 Hadmannin (2) (522 5789) idea (522 5785 pictuation and 578 578 Hadmannin (2) (522 5789) idea (522 5785 pictuation and 578 578 Hadmannin (2) (522 5787 578 578 578 578 578 578 578 578 57	COMPODUDUDU, 73 7	- Inview to use an invalid (unimitialized) Ficture Parameter Set with 10 1. at position
desGADALD,2) [CLEFCH4] pic_order_cos_lab.= 0 HXHUHHH K 2) [CLEFCH4] pic_ordput_ot_prior_proc_ting = 0 HXHUHHH K 1) [CLEFCH4] inco_text_prioremos_lab.= 0	(4+00000010.4)	ISTN STRI (rom: num)
UNITOTICE (CINCUIL Interference fine = 0	(AwMAMAMIN, 2)	[122-111] pin order can leb = 0
ASIAAAATTII (CTA:CTH) 1000-1622-1636-1992 - A		<pre>[Bild] housespet_st_prior_prior_ting = 0</pre>
	(UNIDEDITE 2) (UNIDEDITE 1) ([AB+GUA] pin_ender_cos_idh = 0 [GB+GUA] nn_endput_ni_mine_pine_idag = 0 [GB+GUA] [GB=_cospine_pineidag = 0

Figure 61: Trace/Interpret error alert

- **9.** To determine if the **pic_parameter_set_id** number 1 has been set, search for it in the Trace/Interpret file that is already open (frames 1 and 2).
- 10. Select the Text box in the Trace/Interpret window and type pic_parameter_set_id= in the text box.
- 11. Click Find **Prev** to search for an occurrence of **pic_parameter_set_id** before the error. Note that it does not occur before the location of the PPS ID error (at 0x1c, 7). (See Figure 62.)

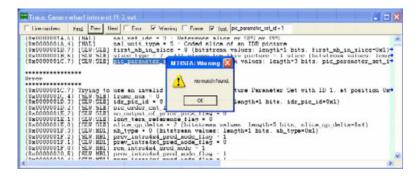


Figure 62: Pic_parameter_set_id error location search

Conclusion

This tutorial demonstrated the following:

- The pic_parameter_set_id=1 did not occur before the slice header tried to use this in frame 1, and therefore caused an error.
- It is an error to set the PPS ID to 1 at stream address 0x1c, bit 7.
- With this error, the MTS4EA decoder uses the data from the last known good pic_parameter_Set_id (ID 0) and continues decoding.

NOTE. This may not always be possible and could generate other consequential errors.

THE MTS4EA showed what the error was and where it occurred.

Tutorial 9: MPEG-4 and H.264/AVC Buffer Analysis

This tutorial covers the following:

- Buffer analysis in real-time (VBV, VCV, VMV of MPEG-4 ES).
 - Information provided values, overflow/underflow indications.
 - Icon controls for navigation through the graphs.
- Buffer conformance errors/alerts.
 - Graphs.
 - Error dialog boxes.
- Achieving conformance.
 - Altering the buffer parameters and seeing the effect in the graph.
 - Adjusting values to prevent overflow.
- HRD buffer analysis in H.264/AVC.

This tutorial requires that you have completed the previous tutorials, and that you know how to:

- Play, stop, step forward, and fast forward a video.
- Use and interpret the alert messages.

This tutorial also requires that you already understand the principles of buffer analysis/conformance (VBV, VCV, VMV) in MPEG-4 and H.264/AVC (HRD).

The following table provides the functions of each Buffer Analysis toolbar icon. (See Table 4.)

Table 4: Buffer analysis icons

lcon	Function
	Zoom in (+) and zoom out (-) centered on the window; affected by the Lock X / Y icons.
	Fit all data into window.
Φ	Go to origin (zero), which is the start of the video sequence.
	Lock X/Y zoom in/out and scrolling/panning. When the Lock Y button is pressed, zoom in and zoom out and scroll/pan only affect the X-direction. This allows you to keep a useful vertical scale, while still viewing the length of the video sequence.
	Autoscroll; fill the analysis data in real time as the video is being decoded and scroll the window to the right.

Function
Measure the data at the cursor. The data values are reported on the status line at the bottom of the analysis window. Offsets and angles/slopes of lines can also be measured by holding the mouse and dragging.
Scroll/pan (the cursor changes to show the scroll/pan direction); this is affected by the Lock X-Y icons.
Zoom in/zoom out centered on the location of this cursor; this is affected by the Lock X-Y icons. Press the <shift> key to zoom out.</shift>

Table 4: Buffer analysis icons (cont.)

Procedure

- 1. To load the tutorial, click File > Example files > MPEG-4 Elementary Streams> Man Walking. Ensure that the video is not playing.
- 2. From the Analysis menu, click View buffer analysis. The Buffer Analysis window appears. (See Figure 63.)
- **3.** View the buffer analysis graph example, as well as the descriptions in the table. (See Table 5.)

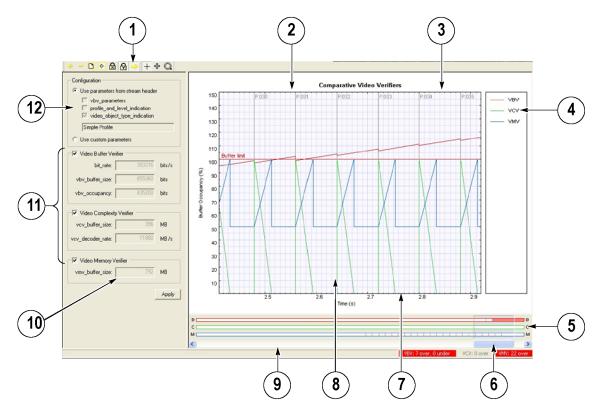


Figure 63: Buffer analysis window, example graph

Area	Description
1	Graph window control toolbar.
2	Frame type, number.
3	Graph window.
4	List of analyses for VBV, VCV, and VMV.
5	Location of overflows and underflows in stream.
6	Scroll bar for sequence.
7	Time through sequence.
8	Vertical blue line at time=0; vertical gray lines at each VOP decode time.
9	Status lines.
10	Custom values.
11	Switch on/off VBV, VCV, VMV graphs.
12	Source of buffer analysis values.

Table 5: Buffer analysis descriptions

4. Observe the VBV, VCV and VMV values that appear beside the graph. (See Figure 64.) These parameters are specified in the stream, or from the implied values from the Profile/Level, as given in the standard, or the implied values from the Object Type (Simple or Advanced Simple), at the highest level for each. You can enter them manually by selecting **Use custom parameters**.

Configuration		
O Use parameters from	n stream header	
vbv_parameter: profile_and_lev video_object_ty	el_indication	
Simple Profile		
Use custom parame	ters	
Video Buffer Verifier		
bit_rate:	393216	bits/s
ubu buffer size	655360	bite

Figure 64: VBV, VCV and VMV values

- 5. Click the Pause/ Step Forward icon IP three times. Nothing appears in the window because the Man Walking sequence contains B-VOPs, and the buffer analysis cannot start until there is sufficient data for the calculations (this will not occur until frame 4).
- 6. Click the Pause/ Step Forward icon be one more time. The graph appears.

- 7. Click the **Fit to Window** icon for a more detailed view of the graph. (See Figure 65.)
- 8. Click the Fast forward icon 📂 . A warning message occurs. (See Figure 66.)
- **9.** Note that the VBV overflow occured while decoding frame 55 (the display frame number is 54).

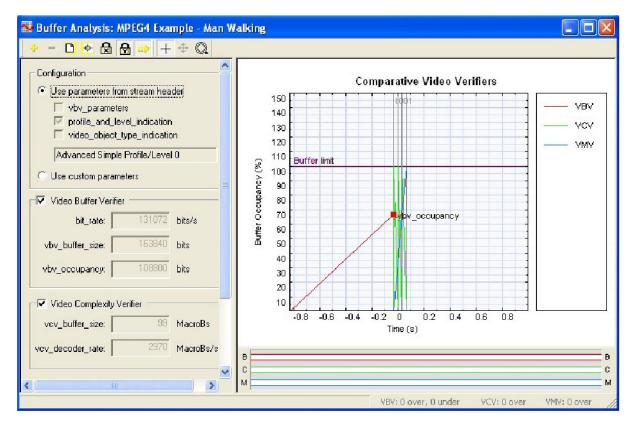


Figure 65: Buffer analysis graph, detailed view

2.167s. The overflow o bitstream position 0x71 occupancy is 164622	Video Object I odel has overflowed by 782 bits at time courred during the decoding of frame 55, a8 (dec. 29096). The total VBV buffer bits and the maximum limit is 163840 bits. VBV ed from profile_and_level_indication in	Plar
Summary	NOTE: display vs. decode ord	er
Image size	176 x 144	^
Stream size (kBytes)	83	
Address	0x0071a8 (dec. 29096) bit 7	
Time (secs)	2.167	
VOP type	B-VOP	-
VOP no	. 54	

Figure 66: VBV overflow warning

- 10. Select Skip this Warning only in the future, and then click Continue.
- **11.** Observe that the red VBV line goes above the **Buffer limit** line. (See Figure 67.)
- **12.** Observe that when the decoding stops, the graph looks like the section that appears between 75% and 105% buffer occupancy. Note also that the number of frames with VBV overflow appears at the bottom of the screen. In this case, the number of frames with VBV overflow is 106.

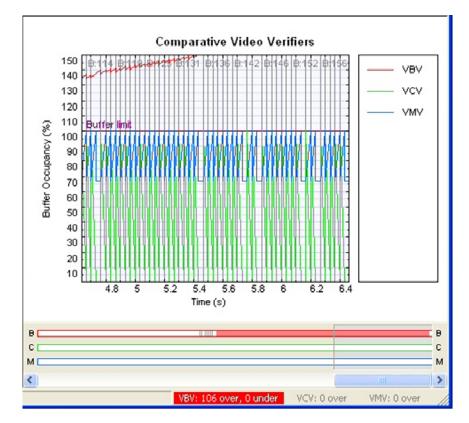


Figure 67: Buffer limit graph

13. To fit the graph to the window, click the D icon on the **Buffer Analysis** toolbar. The red line displays the VBV overflow. (See Figure 68.)

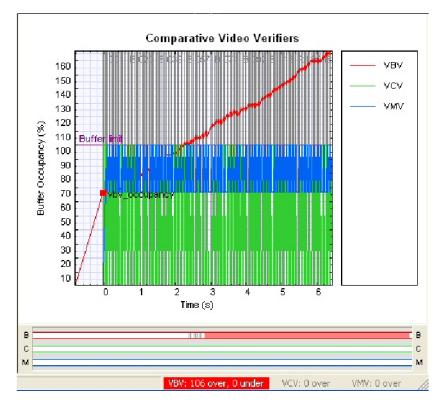


Figure 68: Comparative video verifier graph

14. Consider the information presented by the graph. The standard values used for a frame result in a VBV overflow, which means that the decoding rate cannot keep up with the input data rate, and frames will drop, beginning with frame 54.

Solutions include:

- Increase the vbv_buffer_size so that it does not overflow.
- Decrease the bit-rate, which is the rate at which the encoder sends the data to the decoder.
- Increase the displayed frame rate, so that the decoder removes bits more quickly.
- Increase the number of bits per frame by changing the quantizer or increasing the frame size.
- Change the Profile/Level indication, so that it stays within the set limits (for example, change to ASP at Level 2).
- Use custom values in the vbv_parameters in the sequence header.
- **15.** Clear the check boxes for VCV and VMV so that only the VBV check box is selected. Note that the vertical scale is now measured in bits, not %. (See Figure 69.)

- **16.** Observe that the VBV line has disappeared because it is beyond the scale set for the VBV.
- 17. Click the icon on the **Buffer Analysis** toolbar, and then click the icon three times for a detailed view of the graph. (See Figure 70.)

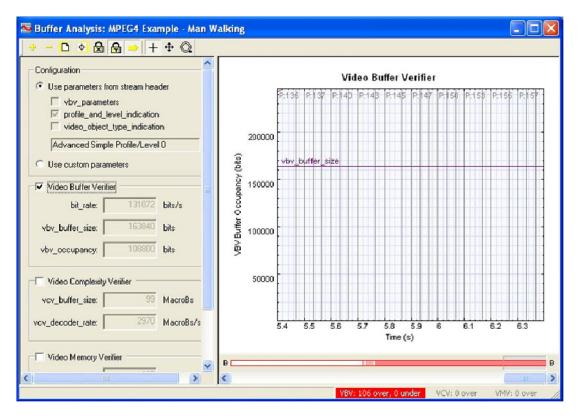


Figure 69: Frame 2

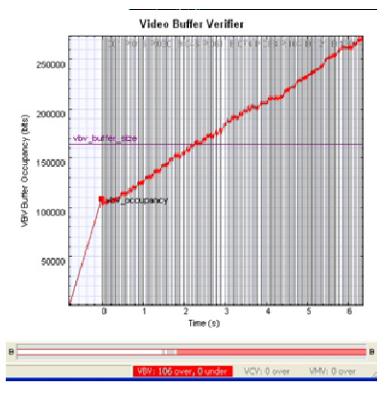


Figure 70: Graph details

18. Note the following details about the graph:

- The Y scale of the graph is locked, which keeps the graph at a useful zoom level.
- The VBV graph is higher at the end of every frame than at the start, which shows that the VBV buffer is filling faster than the decoder can empty it.
- **19.** Click the icon to zoom out.
- **20.** Select the **Use custom parameters** option button. (See Figure 71.) The word **BUF** appears in a yellow box in the main MTS4EA status bar, indicating that custom buffer parameters are in use. (See Figure 72.)

Configuration								
 Use parameters from stream header vbv_parameters profile_and_level_indication video_object_type_indication 								
Advanced Simple Profile/Level 0								
Video Buffer Verifier								
bit_rate: 131072 bits/s								
vbv_buffer_size:	163840 bits							
vbv_occupancy:	bits							
☐ Video Complexity Ve	rifier							
vcv_buffer_size:	99	MacroBs						
vcv_decoder_rate:	2970	MacroBs/s						
Video Memory Verifia	er							
vmv_buffer_size:	297	MacroBs						
		Apply						

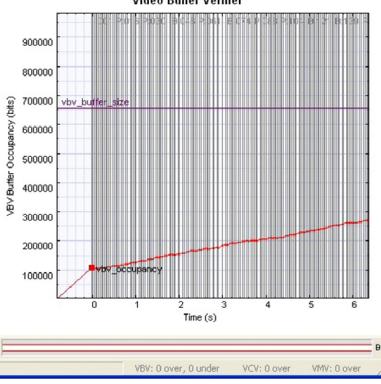
Figure 71: Buffer analysis configurations

				B
VBV: 25	З over, Оц	under	VCV: 0 over	VMV: 0 over
re Alerts disabled	BUF	All	Disabled:	1

Figure 72: Buffer parameter indicator

- **21.** View the video buffer verifier. (See Figure 73.) The default vbv_buffer_size for ASP L0 is 163,840 bits = 20,480 bytes, which is not very large.
- 22. Enter 655,360 bits = 80 kbytes, click Apply, and then click the Fit to window icon . Observe that the graph stays below the limit and there are no overflows or underflows.

- **23.** Consider the following:
 - What if your mobile device cannot spare 80 KBs of memory, and can only spare 20 KBs, as specified by the standard?
 - = By how much does the input data rate need to be reduced?
 - Does this comply with the specifications of the network on which your device will operate?



Video Buffer Verifier

Figure 73: Video buffer verifier graph

- 24. Reset the parameters by clicking Use parameters from stream header, and then reselect the Use custom parameters check box. The VBV graph shows that the decoder is being supplied with data faster than it can decode.
- **25.** Reduce the bit rate to 121072 bits, and then click **Apply**. (See Figure 74.) The graph goes up slightly and there are fewer frames with overflow. (See Figure 75.)

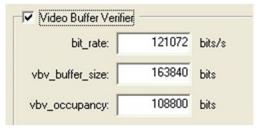
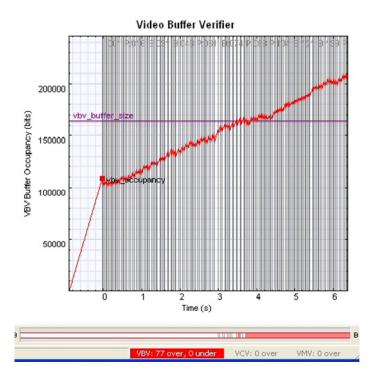


Figure 74: Bit rate configurations





- **26.** Reduce the bit rate to 111072 bits and then click **Apply**. (See Figure 76.)
- 27. Observe that the graph line now stays below the buffer limit. (See Figure 77.)
- **28.** Consider whether the maximum rate of 111,072 bits meets your network's specifications.

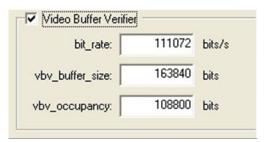


Figure 76: Video buffer verifier configurations

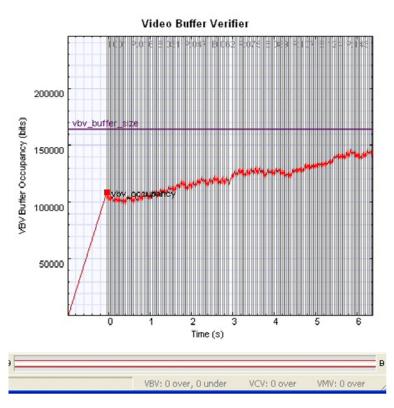


Figure 77: Video buffer verifier graph

Conclusion

This tutorial demonstrated that the buffer analysis of the MPEG-4 example, Man Walking, showed that the stream does not comply with the buffer constraints. The tutorial recommended ways to resolve this issue.

The tutorial also brought up the following considerations:

- How much memory needs to be allocated? Can your hardware allow this much memory usage?
- Is the input data rate limit appropriate for your network?

Tutorial 10: MPEG-2 Compliance

This tutorial covers the following:

- Opening an MPEG-2 program stream.
- Interpreting syntax errors:
 - Person track: invalid VLC for dct_differential.
 - Grenadier guards: frame_rate_extension denominator and numerator equal but not zero.
- Using the HexView:
 - Going from the alert pop-up to the HexView.
 - Examining the bitstream in the HexView.
- Looking at the MPEG-2 program stream structure.
- Looking at MacroBlock types in an interlaced video.

Procedure

- To load this tutorial, click File > Example files > MPEG-2 Program Streams> Person Track. A list of tracks included in the MPEG-2 program stream appears in a dialog box. (See Figure 78.)
- 2. View the track information included in the dialog box. The video track ID, for example, is 0xe0. Although there can be multiple tracks, the first video track is selected automatically.

elect	Туре	stream_id	Description	Bytes	Scrambled	Decoder
		0xbe	padding_stream	3840		
2	🚴 Video ES	0xe0	MPEG-1, MPEG-2, MPEG-4	950305	No	MPEG-2 part
)						
	unknown streams emply streams	Video:	stream:0xe0			Go
Hide		Audio:	(No selection)			Go
xtend	ed stream search		,			
Se	earch					

Figure 78: Track list

- 3. Click OK. The video track is analyzed and an error appears. (See Figure 79.)
- **4.** View the error message details, which provide a summary of the stream up to the point of the error.
- 5. Click Continue. Ensure that the Skip this Error only in the future check box is not selected. Another buffer conformance error message appears. (See Figure 80.)

	Error	Picture
8	Slices must be contained within a single row of macroblocks. The current macroblock (x=0, y=4) belongs to a slice from a previous row. Stream position: 0xfe6 (dec. 4070), bit 1 Bitstream context: [VSQIPCDISLI]	
		Y
	Summary	
	Image size 352 x 288	^
	Stream size (kBytes) 6+ (partially extracted)	
	Address	-
	Time (secs) before Frame 1	
	Frame type	
	Frame no. before Frame 1	

Figure 79: Initial error message

Decode	Error 22112: Bad VLC for dct_differential					
8	Error Invalid VLC for dct_differential: encountered bit pattern '00000000000000000'. This does not match any valid code value. Stream position: 0x1000 (dec. 4096), start bit 5 Bitstream context: [VSQ PCD SLI MBK BLK]					
	Summary					
	Image size 352 x 288	^				
	Stream size (kBytes) 8+ (partially extracted)					
	Address	_ =				
	Time (secs) before Frame 1					
	Frame type I Frame no. before Frame 1	_ =				
	Decode Frame no. 1	~				
	Skip this Error only in future					
		àoto 👻				

Figure 80: Invalid VLC error message

- 6. View the error message details. An invalid VLC has been used for the dct_differential field at bitstream byte address 0x1000, bit 5.
- 7. Click **Continue**. Ensure that the **Skip this Error only in the future** check box is not selected. Repeat this step for an additional error message that appears.
- **8.** Resume playing the video. Observe that the error is visible in frame 1. (See Figure 81.)



Figure 81: Error in image

- 9. Click the Pause, Step forward icon **b**. An error message appears.
- 10. Click Continue. An Invalid VLC error message appears. (See Figure 82.)
- 11. From the Goto menu, click Hex.
- **12.** Click **Continue**, and then view the **HexView window**. Note that the error is highlighted automatically. (See Figure 83.)
- **13.** Observe the bits surrounding the error and consider whether it is a start code emulation.

Error	Bloc
Invalid VLC for dot_differential: encountered bit patiern '000000000000000000. This does not match any valid code value. Stream position: 0x1000 (dec. 4036), starl bit 5 Bistream context: IVS0IPCDISUMBKIBUK]	-
europeane and entries fa and to need to reach and allowing	v
Summary	
mage size 352 x 288	^
Stream size (kBytes) 8+ (partially extracted)	
Address	
Time (secs) before Frame 1	
Frame type 1	_
Frame nc. before Frame 1	
Decode Frame nc. 1	v
Skip this Error only in future	
Skip ALL Error alerts in future	
	Goto ,
	Video
	Hex
	Alert
	Buffe
10	Trace



iiii Hex	: mp2_2 - st	tream 0xe0	(video)										
🔽 Bin	Hex 🔽 /	ASCII Auto	• Bytes p	er line Prev	Goto 0	Absolu	te addr	ess	• (• He	x C	Dec	
00FE4 00FE0 00FF0 00FFC 01002 01008 0100E 01014 01020 01026 0102C 01032 01038 01038 01044	01101111 10100111 00010011 01110001 000000	10110101 00000101 11001110 11101111 00001110 111111	10001111 10100001 01101001 00100100 001001	11101110 01100111 1001100 11000011 11000011 01111011 1110110	11011100 11101100 01000011 01011101 01010000 11010111 01110110 10010000 11001011 01000000 10010101 01010101	10110010 01100110 0110111 01000101 100100	6F E A7 0 71 E 00 00 1E F 6 D F 6 D F F 6 C C 6 C F F 6 C C C 6 C C C C C C C C C C C C C C C	85 8F 15 A1 1E 69 1F B6 1E 66 11 05	EF7C63BC1FBA45F4366F3	DC 43 5D 00 76 90 CB 80 80 F5	B2 66 77 45 00 93 52 36 01 23 4 60 66 59 C5	○ g f i Cw q f]E { v vR ≥_ # V\$* = @ a = T c[f I c[f X & 6 }h	
Address:	0x1000 (4096)	bit 5											- //.

Figure 83: HexView window

14. To open the Grenadier Guards program stream, Click File > Example files
 > MPEG-2 Program Streams> Grenadier Guards. An error message appears. (See Figure 84.)

15. View the details of the error message: the value of the denominator of frame_rate_extension is 1, but it must be 0 in Main Profile.

8	Error Vid Invalid value, frame_rate_extension_n = '01' frame_rate_extension_n must be 0 in Main profile. Stream position: 0x15 (dec. 21), start bit 6 Bitstream context: [VSQISQX]	eo Sequenc
	Summary	
	Image size unknown	^
	Stream size (kBytes) 14+ (partially extracted)	
	Address	
	Time (secs) before 1	
	type	
	no. before 1	
	Decode no.	~
	Skip this Error only in future Skip ALL Error alerts in future	

Figure 84: Error message

16. Select **Skip this Error only in the future**, and then click **Continue**. The status bar indicates one disabled alert. (See Figure 85.) An error message (See Figure 86.) and a warning message (See Figure 87.) appear.



Figure 85: Disabled alert indicator

17. For both error messages, select **Skip this Error** or **Warning in the future**, and then click **Continue**. Do not resume playing the video.

_	Error		equence
8			<u>^</u>
			~
	Summary		
	Image size	unknown	^
	Stream size (kBytes)	14+ (partially extracted)	
	Address		-
	Time (secs)	before 1	
	type		
	no.	before 1	
	Decode no.		V

Figure 86: Error message

	Warning Video Sequ Where the numerator and denominator of frame_rate_extension are	uenc
2	equal, they must be set to 0 (found: num=1, denom=1) Stream position: 0x15 (dec. 21), bit 6	
	Bitstream context: [VSQISQX]	3
	Summary	
	Image size unknown	^
	Stream size (kBytes) 14+ (partially extracted)	
	Address	
	Time (secs) before 1	
	type	
	no. before 1	
	Decode no.	Y

Figure 87: Warning message

- **18.** From the **Analysis** menu, select **View video stream structure**. The **Structure** window appears. (See Figure 88.)
- **19.** View the top-level atoms in the MPEG-2 program stream. Click the + next to each atom to view the data for the atom.

Syntax	Value	Start bit	Size (bits)	
- MPEG-2 Program Stream		0x000000,7	unknown	^
🗈 🖏 pack_header		0x000000,7	256	
E PES_packet	program_stream	0x000020,7	192	
E C3. PES_packet	MPEG-1, MPEG		16560	
101 packet_start_code_p	0x1	0x000038,7	24	
	0xe0 MPEG-1, M	0x00003b,7	8	
	2064	0x00003c,7	16	
123 10	2	0x00003e,7	2	
123 PES_scrambling_control	0	0x00003e,5	2	
123 PES_priority	0	0x00003e,3	1	
123 data_alignment_indic	0	0x00003e,2	1	
123 copyright	0	0x00003e,1	1	
-123 original_or_copy	0	0x00003e,0	1	
-123 PTS_DTS_flags	3	0x00003f,7	2	
-123 ESCR_flag	0	0x00003f,5	1	
123 ES_rate_flag	0	0x00003f,4	1	
123 DSM_trick_mode_flag	0	0x00003f,3	1	
123 additional_copy_info	0	0x00003f,2	1	
123 PES_CRC_flag	0	0x00003f,1	1	
	1	0x00003f,0	1	
123 PES_header_data_le	13	0x000040,7	8	
	3	0x000041,7	4	
	49157	0x000041,3	36	
123 0001	1	0x000046,7	4	
	47357	0x000046,3	36	1

Figure 88: Structure window

20. Resume playing the video. The Interlace toolbar appears. (See Figure 89.)



Figure 89: Interlace toolbar

- **21.** Click the **Pause**, **Step Forward** icon **b** to view frame 2.



Figure 90: Frame 2

- **23.** Maximize the video window.
- 24. Click the icon. Different MB types appear in the top and bottom fields. (See Figure 91.)

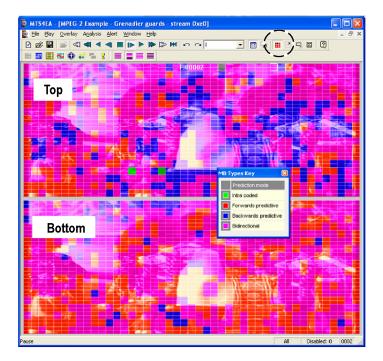


Figure 91: Varied MB types

Conclusion

This tutorial demonstrated the following:

- There is one error in the Person Track stream:
 - The error is in frame 1, at bitstream location 0x1000, bit start 5.
 - This error affects the visual quality.
- There are two errors and one warning message in the Grenadier Guards stream:
 - The errors are in the header (before frame 1), at bitstream location 0x15, bit start 6.
 - The warning message highlights the same error.
 - This does not appear to affect the visual quality.
- You can see the different MacroBlock types in the top and bottom fields.

Tutorial 11: Fidelity Analysis

This tutorial covers the following:

- Fidelity analysis in real-time (PSNR).
 - Using a YUV source reference file.
 - = Fidelity metrics.
 - Graph navigation.
- Comparing the fidelity of the same bitstream compressed with either MPEG-2 or H.264/AVC.
- Viewing the visual difference between the compressed bitstream and the YUV source reference video.

This tutorial requires that you have completed the previous tutorials and that you can:

- Open example streams.
- Play, stop, step forward, and rewind a video.
- Use and interpret alert pop-up messages.
- Use the icons and controls on the buffer analysis graphical display.

This tutorial also requires that you already understand the principles of fidelity analysis (this topic is not covered in this tutorial; however, the user manual contains descriptions of the fidelity metrics).

Procedure

- To load the tutorial, click File > Example files > MPEG-4 Elementary Streams> Man Walking. Ensure that the video is not playing.
- 2. From the Analysis menu, click Enable fidelity analysis. The Video analysis options dialog box appears for theYUV reference file. This file will later be used for comparison with the compressed video file. The YUV reference file is provided as an example, as indicated by the text under the **Reference filename** field. (See Figure 92.)
- 3. Set the Frame rate to 30. (See Figure 92.)

Video analysis options
Frame range Trace Visual difference/Fidelity
Enable visual difference
Enable fidelity analysis
Reference filename
man_walking_yuv
This is an un bedded Y <u>U</u> V file for use with tutorials.
Encoding: One byte
Header skip: 0 Bytes
Use frame rate for synchronisation
Frame rate: 30000/1001 Frames per second
<u>+</u>
Metric: PSNR (full signal range)
OK Cancel Apply

Figure 92: Video analysis options

- 4. From the **Metric** drop-down menu, select **PSNR (full signal range)**, and then click **OK**. (A detailed description of each fidelity metric is available in the user manual).
- 5. From the Analysis menu, click Enable fidelity trace.
- On the Trace tab, select the Enable check box, choose the filename mp4asp_1_video and then, under Options, select VOP Fidelity. (See Figure 93.)
- On the Frame range tab, select the All frames check box and then click OK. The video window appears with the fidelity analysis icon senabled in the Views toolbar. (See Figure 94.)

Video analysis options
Frame range Trace Visual difference/Fidelity
Filename
mp4asp_1_video.vpt
Available disk space: 68179 MBytes File size limit: 50 MBytes
Options VOP fidelity
☐ MB fidelity
1
OK Canc

Figure 93: Video analysis options

١	Video analysis options					
	Frame range Trace Visual difference/Fidelity					
	Frame range					
	First frame	Last frame				
	1 to	1 Al frames				
	1) v v nanca,				

Figure 94: Frame range tab

- 8. Click the Fidelity analysis icon <a>> . The Fidelity analysis graph view appears. Observe that the graph is empty because a video has not been played. (See Figure 95.)
- 9. Click the ▶ icon four times. A graph appears. (See Figure 96.)
- 10. Observe the following about the graph:
 - The graph area is not filled with each click because the bitstream includes B-VOPS, and a certain number of frames must be decoded before each frame can be displayed.
 - Some of the YUV PSNR values are not visible. This is because the graph auto-scales with the first few values. You can click the icon to rescale the graph.

- The thumbnail bar view shows that the fidelity data has been collected.
- **11.** View the descriptions of the **Fidelity analysis** window in the figure and the table. (See Figure 97.) (See Table 6.)

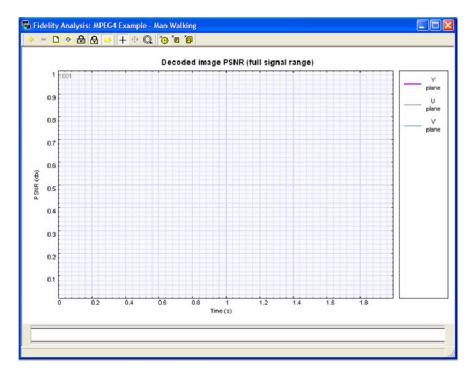


Figure 95: Fidelity analysis graph

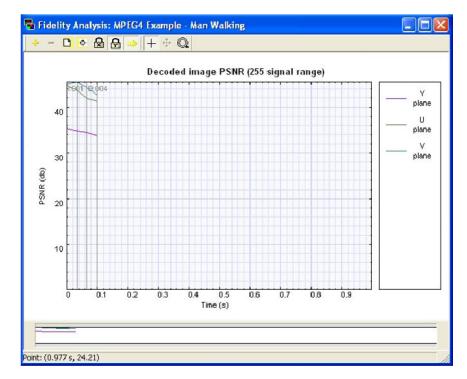


Figure 96: Fidelity analysis graph

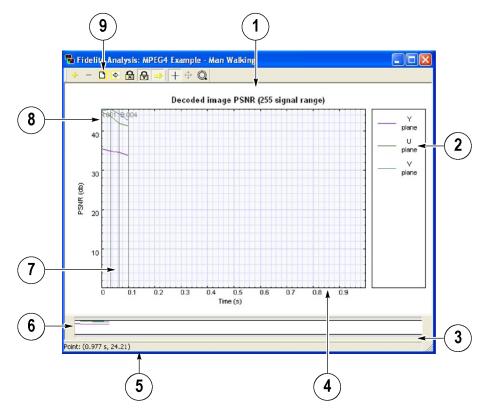


Figure 97: Fidelity analysis window descriptions

Description	
Scroll bar; appears and disappears according to zoom scale	
Status line; display measurements	
ime	

Table 6: Fidelity analysis window descriptions

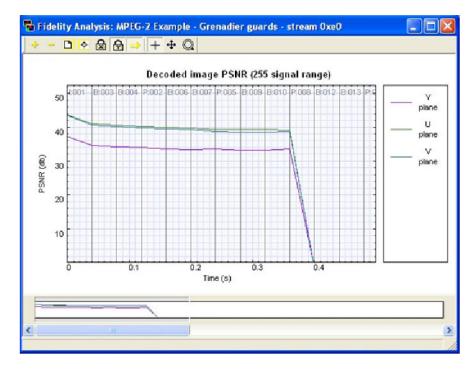
12. To open the Grenadier Guards program stream, Click File > Example files
 > MPEG-2 Program Streams> Grenadier Guards. An error message appears.

- 13. Select Skip this Error only in the future, and then click Continue.
- 14. From the Analysis menu, select View analysis options.

- **15.** On the **Visual difference**/**Fidelity** tab, set the **YUV frame rate** to 25, and then click **OK**.
- **16.** An error message appears because there are only 10 frames of YUV data. Click **OK**, and then view the graph result. (See Figure 98.)
- **17.** Load the MPEG-2 program stream example, Grenadier Guards. (See Figure 99.)
- **18.** Compare the first MPEG-2 program stream with the H.264/AVC PSNR example. (See Figure 99.) (See Figure 100.) Note that the PSNR is higher for H.264/AVC in Y, U, and V.



Figure 98: Graph result, YUV frame rate 25









19. Click the View trace icon. (See Figure 101.)



Figure 101: View trace icon

- **20.** The trace view gives the numerical values for the pictures' PSNR. (See Figure 102.)
- **21.** Consider the following:
 - What encoder parameters, such as frame type, were used for H.264/AVC and MPEG-2?
 - Could the H.264/AVC or the MPEG-2 encoding parameters be changed to improve the areas of lower PSNR?
 - Compare other fidelity analyses; do the same kinds of differences occur?
 - Although the PSNR is better for the H.264/AVC sequence, it does not necessarily look better. Consider the visual differences.

Trace: mp2_3_video.vpt	
🖹 🖹 🛛 Line numbers 🛛 Find: 🔤 Next 🔽 Error	r 🔽 Warning 🔽 Frame 🥅 Text:
Frame, Field, PSNR(Y), PSNR(U), PSNR(V) 1, 0, 38.1551205054, 44.1527441439, 1, 1, 36.2410429823, 43.1333866825, 2, 0, 34.2408434076, 41.0828362775, 2, 1, 34.8244399239, 40.8747086796, 3, 0, 34.1695327233, 40.5571772657, 3, 1, 34.1792323830, 40.5634068211, 4, 0, 34.1895275709, 40.0744906012, 4, 1, 33.7246588453, 40.1144933741, 5, 0, 33.4360061215, 40.0695929584, 5, 1, 33.6821124513, 39.7911766114, 6, 0, 33.5875051373, 39.8044087588, 6, 1, 33.7616637922, 39.4076668535, 8, 0, 33.090594850, 39.5244317504, 8, 1, 33.0525714220, 38.9345453769, 9, 0, 33.413761027, 39.2114152344, 9, 1, 33.0349589228, 39.1469252959, 10, 0, 33.4844855563, 39.1007939444, 10, 1, 33.7436073016, 39.0919941194, 11, 0, error	<pre>42.6906976668 40.5498890441 40.3956140428 40.1094564965 39.9926959618 39.765667373 39.7156833394 39.6645788375 39.4529675380 39.4529675380 39.4529675380 38.6190367668 38.8532040654 38.4532040654 38.492606341</pre>

Figure 102: H.264/AVC sequence

- **22.** Load the MPEG-2 stream, Grenadier Guards.
- **23.** From the **Overlay** menu, click **Visual difference**, and then select the **Enable** check box.
- **24.** Set the **Frame rate** to 25, and then click **OK**. The **Visual difference** toolbar appears.
- **25.** Use the following icons to view the visual difference.

lcon	Function
1	View encoded
111	View YUV reference
.	View difference
	View luma only (not U or V)

Table 7: Visual difference icons

26. Load the H.264/AVC stream, Grenadier Guards. Consider whether there is a difference in visual quality between the two streams.

Conclusion

This tutorial demonstrated the following:

- A method for assessing visual quality through:
 - The use of metrics such as PSNR.
 - Identifying the visual difference between the encoded video and the reference (source) video that is used for the encoding.
- Visual quality analysis and visual quality improvement require that you consider encoding parameters (such as frame types and motion vectors) and bit-rates of encoding.

This tutorial provided the tools to help you begin your visual analysis in a quantifiable and logical fashion.