Tektronix

MTS4CC Elementary Stream Compliance Checker Tutorials

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# **Getting Started**

This set of seven tutorials helps you learn more about operating the Tektronix MTS4CC Elementary Stream Compliance Checker. Perform tutorials 1–7 in the order they are presented, regardless of the video standard of interest. Tutorial 6 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?
- Codec optimization:
  - 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?

Table 1 includes a description for each tutorial.

Tutorial	Name	Standard	Areas Covered
1	H.263 Compliance and Motion Vectors	H.263 Baseline	Errors and error log; motion vectors.
2	MPEG-4 Compliance	MPEG-4 Simple Profile	Common errors; searching for areas of codec optimization.
3	MP4 Compliance Basics	MP4/ Simple Profile/ L1(2)	Extract and examine container files; level conformance error.
4	MP4 Optimization	MP4/ Simple Profile/ L1(2)	Using MB type overlays and searching for areas of optimization.
5	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.
6	MPEG-2 Compliance	MPEG-2 Main Profile / Main Level	Syntax errors; MPEG structure analysis; interlace.
7	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 basic functions shown in Table 2. To perform the desired function, click on the associated icon or type the appropriate keyboard shortcut.

Function	Forward		Backward	
	lcon	Keyboard shortcut	lcon	Keyboard shortcut
Play video		Ctrl + P	•	Ctrl + Shift + P
Stop video		Ctrl + S		Ctrl + S
Pause/step one frame	IÞ	Ctrl + A	-	Ctrl + Shift + A
Fast forward/backward	A	Ctrl + F	*	Ctrl + Shift + F
Pause on frame	X		X	
Skip to next frame type/number/time	2	Ctrl + K	5	Ctrl + Shift + K

#### **Table 2: Basic functions**

## How to Begin a Tutorial

- **1.** After starting MTS4CC, click anywhere to remove the splash screen. If you do nothing, the spash screen will disappear after 4 seconds.
- **2.** Load the desired tutorial stream. Note that the demo version of the MTS4CC will only play the provided example video files.

# **Tutorial 1: 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 MTS4CC-H.263 Example -Rally (250k), and a warning message appears, as shown in Figure 1.

MTS4CC - Video View: H.263	Example - Rally (250k)	
Eile Elay Qverlay Analysis Alert	<u>W</u> indow <u>H</u> elp	
🗃 🔍 🔍 🔳 🕨 🕨 📂	🝽 🚠 📶 Frame 💽 🚠 👫 💈 📼 🕅	
8 8 8 8 4 5 8	III III III II	
De	code Warning 31751: PSUPP being sent	X
	Warning	Picture Layer
4	PSUPP being sent (annex L): ignored at position 0x6 (dec. 6) bit 5	
📙 Video View: H		
	Summary	
	Image size unknown	<u>^</u>
	Image format unknown	
	Stream size (kBytes) 808	
	Address 0x000000 (dec. 0) bit 7	
	Time (secs) before 1	
	type	
	no. before 1	✓
	Skip this Warning only in future	
	🧮 Skip ALL Warning alerts in future	
	Abort Pause Continue	Goto 🔻

Figure 1: 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. The error message shown in Figure 2 appears.
- 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	×
Error Error in MBCPC_P VLC at position 0xc9ff6 (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	<b>*</b>
Skip this Error only in future           Skip ALL Error alerts in future	
Abort Pause Continue	Goto 🔻

Figure 2: Initial error message

- 6. Click Continue. An error message appears, as shown in Figure 3.
- 7. Note that it was an MBCPC error that resulted in the Out of Sync alert message shown in Figure 3. 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	
	Skip ALL Error alerts in future	
	Abort Pause Continue	Goto 🔻

#### Figure 3: 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 appears, as shown in Figure 4.
- **10.** 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, as shown in Figure 5.

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

### Figure 4: Alert Log window, filtered

▽ 📰 🗖									
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 Laver	PSUPP being	3	Video	0x002766	DELIDD being	
A Warning	31751	Video	Picture Layer	PSUPP being	4	Decode Warning	31751: PSUPP E	peing sent	
Narning	31751	Video	Picture Layer	PSUPP being	5	1.1		<u></u>	
🔥 Warning	31751	Video	Picture Layer	PSUPP being	6	Warning			Pictu
<b>Warning</b>	31751	Video	Picture Layer	PSUPP being	7		eing sent (annex L); igr 0x306c (dec. 12396)		
🔥 Warning	31751	Video	Picture Layer	PSUPP being	8		0x5000 (060, 12550)	DK S	
🔥 Warning	31751	Video	Picture Layer	PSUPP being	9				
🔥 Warning	31751	Video	Picture Layer	PSUPP being	10				
🔥 Warning	31751	Video	Picture Layer	PSUPP being	11	Summary			
\rm Warning	31751	Video	Picture Layer	PSUPP being	12	Summary			
\rm Warning	31751	Video	Picture Layer	PSUPP being	13		Image size 352 x 2	88	
🔥 Warning	31751	Video	Picture Layer	PSUPP being	14		mage format YUV 4:	2:0 8-bit	
\rm Warning	31751	Video	Picture Layer	PSUPP being	15		size (kBytes) 808		
🔥 Warning	31751	Video	Picture Layer	PSUPP being	16	ou cum a		65 (dec. 12389) bit 1	
🔥 Warning	31751	Video	Picture Layer	PSUPP being	17			65 (dec. 12369) bit 1	
🔥 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	9	
🔥 Warning	31751	Video	Picture Layer	PSUPP being	20		Frame no. 2		
😣 Error	21761	Video	MB Layer	Error in MCBP	327				
<b>O</b>	24502	sed a c	C	A.4.4	222	🗖 Skip th	is Warning only in futu	re	

### Figure 5: Alert Log and Alert Details

- **12.** Double-click an alert to view the alert details, as shown in Figure 5, and then click **Close**. View the columns that appear in the alert log, which are shown in Figure 6, and note the column descriptions that follow.
  - Level the severity level for the alert. Levels include Info, Warning, Error, and Fatal.
  - **ID** MTS4CC 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 6: 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. An image of the video is shown in Figure 7.
- **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.





## 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 2: 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

- 1. To load the H.263 tutorial, click File > Example files > MPEG-4 Elementary Streams > Space. An error message appears, as shown in Figure 8.
- 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 MTS4CC 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**. MTS4CC loads the stream, and the window title changes to **MTS4CC-MPEG4 Example-Space**.
- 4. Click the icon or type CTRL + P to resume playing the stream. The error message shown in Figure 8 appears again.
- 5. Click Continue. A warning message appears, as shown in Figure 9.

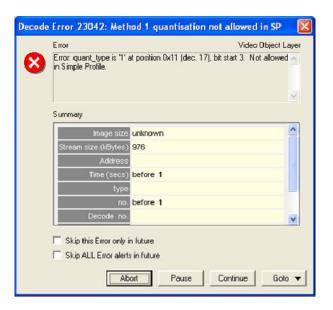


Figure 8: Initial error message

AN	/arning Video Objec VARNING: modulo_time_base is zero after vop_time_increment is re t position 0x6186 (dec. 24966), bit 3	set 📩
s	ummary	~
	Image size 352 x 288	^
	Stream size (kBytes) 976 Address 0x006182 (dec. 24962) bit 7	=
	Time (secs) after 0.880 VOP type P-VOP	
	VOP no. after 12 Decode VOP no. 14	~
	Skip this Warning only in future	
Γ	Skip ALL Warning alerts in future	
		ioto 🔻
		Video Hex
		Alert log
	•	Navigator
		Buffer Trace

Figure 9: Initial warning message

- 6. Click Goto, and then click Hex, as shown in Figure 9. The Hex view appears with the error location highlighted, as shown in Figure 10.
- 7. Close the Hex view, and again view the error shown in Figure 9. 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. The alert shown in Figure 9 appears again.
- **9.** In the alert dialog box, select **Skip this Warning only in the future**, and then click **Continue**.

<b>10.</b> Complete the video and observe whether it works properly.
--

1111	Hex	M	PEG	Exa	ample	e - Spa	ce																
	Bin	~	Hex	<b>v</b>	ASCII	Auto	•	Bytes p	er line	Prev	Goto	0		Absolu	ute ad	dress		• 6	• He	ex C	Dec		
			110		011	01101		1111		)1110			1011		73	6D	BF	0E		B7	sm	m	^
06		11	100	101	110	001101		0110		1011	0011		1011	~ ~ ~ ~	E1 DF	CD	B6 36	FC		B6	1	9	-
06		11	011		011	11110		00000	*****	00000			1011	0110	DB	87 7E	30	DB	F U	E6 B6	~6		
06		01	010	100	101	11000		0100		01111		0000	0100	vaav	50	BB	0.4	87	30	47	P	0G	
		V &	110		111	11100		1001		0110			1110	VAAA	B6	FC	39	B6		EI	9	00	
06		~~~	001			10001		11101	****	11111		11110	0110		CC	11	ED	BF		6D		m	
06	198	10	110	111	111	00001	1100	1101	1011	0110	1111	1110	0001	1100	B7	Ē1	CD	B6		10			
06	19E	11	000	001	000	11110	1101	1011	1111	0000	1110	0110	1101	1011	C1	1E	DB	FO	E6	DB			
06	144	01	111:	110	000	11100	1101	1011	0110	01111	1100	0011	1001	1011	7E	1C	DB	6F	C3	9B	~ (	D	
06	LAA	01	101	101	111	11000	0111	0011	0110	1101	1011	1111	1000	0111	6D	F8	73	6D	BF	87	m SI	n	
06			110		010	00111		0110		.1100			1011	0110	30	47	B6	FC	39	B6	0G	9	
06			011		100	00111		0110		1011		0000	1110		DF	87	36			E6	6		
			011		OTT	11110		1100		1011	0110		1100		DB	7E	10	DB	6F	<u>C3</u>	~	0	
06			011			01101		1000		0011	0110		1011	****	9B	6D	F8	73		BF	ma		
06		~ ~	000		001	10110		1011		1100	0011		1000		87	36	DB	FC	39	82	6	9	
	LCE	**	111		101	10111		0001		1101	1011		1111	****	3D	B7	E1	CD	B6	FC	-		
06			111		101	10110				0111		0110	1101		39 F0	B6	DF	87	35	DB	9	6	
06		_	110 001			00110		)1000		.0110	1000		1110		CC	E6 11	08 ED	F6 BF	DF 87	E1 30		0	
			0001			10110		1100		1001		00110	0011		47		FC	39	82		G	9 =	
	1EC					00001		01101		0110		1100	0011		B7	E1	CD		FC		G	9	~
-							1100		1011		1111	1100	0011	1001	21		~	20	10	55		,	
Add	ress:	0x6	186 ()	24966	5) bit 3																		1

Figure 10: 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**, shown in Figure 11, and note these field descriptions.
  - Picture size: 352 pixels high x 288 pixels wide (CIF).
  - File 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.

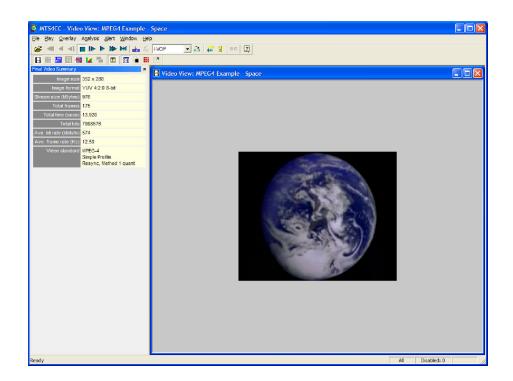
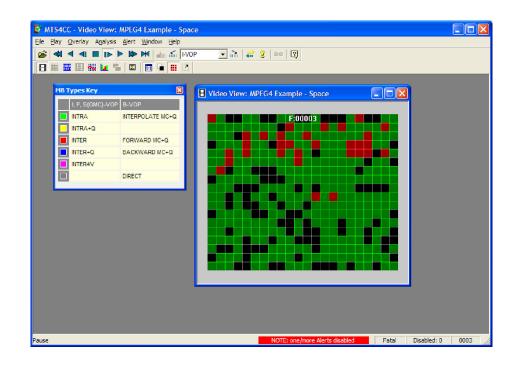


Figure 11: Final video summary tooltip

- 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 color key appears.
- **15.** Move forward 3 frames. The MB types are color-coded as shown in Figure 12.



#### Figure 12: MB Types color key

- **16.** Move forward to frame 34. As shown in Figure 13, note that there are several green (intra) coded MacroBlocks in the static black background (intra coded MBs generally use the most bits).
- **17.** View frames 35, 36 and 37, as shown in Figure 14. Observe that the MacroBlocks disappear.
- **18.** Go back to frame 34.
- **19.** From the **Overlay** menu, click **MB Statistics**, and then click **Bits**. In Figure 15, note that the black background uses a high number of bits.
- **20.** View frames 35, 36 and 37, as shown in Figure 16. Observe that the background uses progressively fewer bits.
- **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.

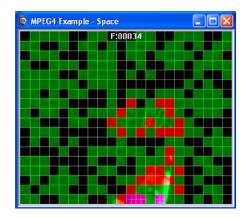


Figure 13: Frame 34, color key

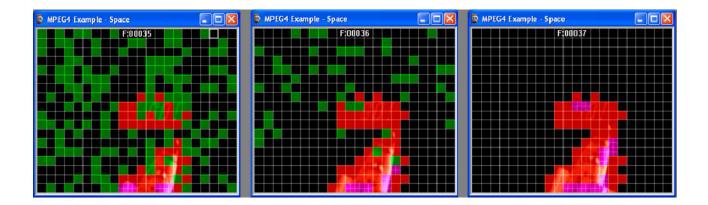


Figure 14: Frames 35, 36, and 37, color key



Figure 15: Frame 34

Βv	ide	o Vi	ew: I	MPEG4	Example -	Spac	e			8 Vi	deo V	'iew:	MPEG	4 Exam	ple -	Space	(		Video View: N	APEG4 Example - Sp	oace	
37	37	7	37 27		37 F:00035	5	37 27	37				37	37 27	F:0	0036			37		F:00037		
27	27	7 37		37	37 27		27 27	3	2							37						
27		37		27	37		37	37 2	7	37			37	37.2	7 27	27						
		27	37			37 27	27 27				37						37					
37	37	7 27	37		37	27 27	27	37 2	7		27 37		37	37 27				37 27				
	27	7 27	27	37 27		27	37 37 27		37			37				3	7 27 27					
		37	37	37 27		27	37	37 27	27	37	37			3	7			37				
	37		37	27	15	27105	37 27 37					37		37			37	37		25	32	
		37	37		37 384195209	41+++4	16+++ 33						37	2145	5353444	39731921	4			214033785163	73304 34	
37				37	354183374	43 +++3	26727 90	37	37	3				1410	828343	1407269 7	7 32			14 835174532	43269112 26	
27 3	37	37	37	27	213 922411	711111	11 84 37	37		2				4111	5 196 185	5 91 80 2	2	37		17 31 109 131	82286223	
	37	7	37	27	37		37	37 3	7	37	37			37		26231	7			1	50350318	
-37	27	7				37 2	25410 37	37 27		27						124 138 22				1953	54 535 342	
	27	7 37	27	37 :	27 37	272342	52380 27	37							21	1883 468 39	7			125 327 3	00543533	
37 2	27			37	6	81277+	++545 18	37							143350	540045182	6 35			303 396 7	368 201 37	
				27	37 1199	656315	40514 37							71 6	9250460	057857646	8			3333052632923	9375 23	
			37	27 37	199 187 223 3	526998	20928 20	37 3	2					37328	8 278 30	3 3 97 7/00 15	4 20			913603522693535	24 53261 20	
	37	37		37	376395855267	776011	275 37		37					17940948	0 463 673	3812 + 4	1			3814325103853507	32 11728	

Figure 16: Frames 35, 36 and 37

## Conclusions

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 It a Covered ME

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 3: 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, as shown in Figure 17.
- 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, as shown in Figure 18.
- 4. View the error message details as shown in Figure 18:
  - 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	
<u>-</u>	MPEG-4 part 2	001	Visual stream	690840	No	MPEG-4 part 2	
104							
	unknown streams empty streams	Video:	track:001				Go
Hide		Audio:	(No selection)				Go
	ed stream search						

### Figure 17: Track list

	Error Video Object I	Layer
8	[VDL] (MP4) Error: VOP ( height " width ) gives no. of MBs = 396 : too many MBs for Profile/Level (max = 99). (Error ignored: actual width & height used.)	<
		v
	Summary	
	Image size unknown	^
	Stream size (kBytes) 675	
	Address	122
	Time (secs) before 1	
	type	-
	no. before 1 Decode no.	
		1
	Skip this Error only in future	
	☐ Skip ALL Error alerts in future	
	Abort Pause Continue Got	

Figure 18: Initial error message

- 5. Select Skip this Error only in the future, and then click Continue. MTS4CC will continue, by using the actual size. A buffer conformance warning message appears, as shown in Figure 19.
- 6. View the warning message details as shown in Figure 19:
  - 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 I	Plane
4	Video Complexity Verifier model has overflowed by 237.0 MacroBs at time 0.000s. The overflow occurred during the decoding of frame 1, bistream position 0x0 (dec. 0). The total VCV buffer occupancy is 396.0 MacroBs and the maximum limit is 99.0 MacroBs. VCV parameters were derived from profile_and_level_indication in	
	Summary NOTE: display vs. decode ord	er
	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	
	Decode VOP no. 1	Y
	Skip this Warning only in future	
	Skip ALL Warning alerts in future	
	Abort Pause Continue Go	to 🔻

Figure 19: VCV overflow warning message

- 7. Select Skip this Warning only in the future, and then click Continue. Another buffer conformance warning message appears, as shown in Figure 20.
- 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, as shown in Figure 21.
- **11.** View the top-level atoms in the MP4 file. Click the **+** next to each atom to view the data for the atom.



Figure 20: VBV underflow warning

Syntax	Value	Start bit	Size (bits)
- In file	* WINN	0x000000.7	5549184
E g ftyp		0x000000,7	192
123 size	24	0x000000,7	32
	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
ිම් 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	864
🖭 🕼 iods		0x0a8b3e,7	336
庄 🚱 trak		0x0a8b68,7	9696
🖭 🚯 trak		0x0a9024,7	3432
🗄 🚱 trak		0x0a91d1,7	3304
🗉 🕼 udta		0x0a936e,7	4368

Figure 21: Structure window

- 12. From the File menu, click Close stream, and then reopen the stream.
- **13.** When the track list appears, click **Extract**, as shown in Figure 22. The **Save stream file as** dialog box appears, as shown in Figure 23.

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

Figure 22: Track list

Save stream file as	? 🛛
Save in: 🛅 video	- 🖬 🏪 🛨
Customer H263 h264 mp4	Compeg2-conf Comple Simple Tutorial V1 Comps
<	
File name:     mp4fil_1-001.m4v       Save as type:     MPEG-4 Elementary S	tream (*.m4v) Cancel

Figure 23: 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 4: 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, as shown in Figure 24.
- 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 <sup>III</sup> icon or type **CTRL** + **M**.
- 6. Click the icon. A VCV buffer conformance warning message appears, as shown in Figure 25.

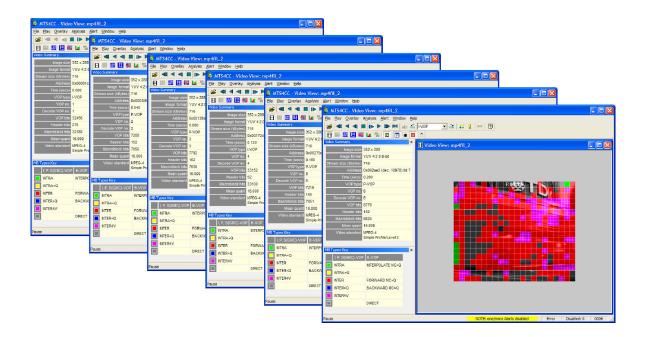
elect	Туре	ID	Description	Bytes	Scrambled	Decoder
2	🚴 MPEG-4 part 2	001	Visual stream	733169	No	MPEG-4 part
		002	Object descriptor stream	0	No	
		003	Scene description stream	0	No	
Hide	unknown streams empty streams	Video:	track:001			Got
Hide xtend		Audio:	(No selection)			Got

Figure 24: Track list

Decode	Warning 33015: VCV overflo	w	X
	Warning	Video Object Pl	ane
⚠	Video Complexity Verifier model has time 0.040s. The overflow occurred d bitstream position 0xfd9 (dec. 4057) 554.4 MacroBs and the maximum lim parameters were derived from profile	uring the decoding of frame 2, The total VCV buffer occupancy is t is 396.0 MacroBs. VCV	< >
	Summary	NOTE: display vs. decode order	-
	Image size 352 × 288		^
	Stream size (kBytes) 716		
	Address 0x000fd9 (d	ec. 4057) bit 7	Ξ
	Time (secs) 0.040		
	VOP type P-VOP		-
	VOP no. 2		
	Decode VOP no. 2		*
	<ul> <li>Skip this Warning only in future</li> <li>Skip ALL Warning alerts in future</li> </ul>	[ mmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmmm	
	Abort	Pause Continue Goto	<b>-</b>

Figure 25: 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), as shown in Figure 26. Another buffer conformance warning message appears, as shown in Figure 27.

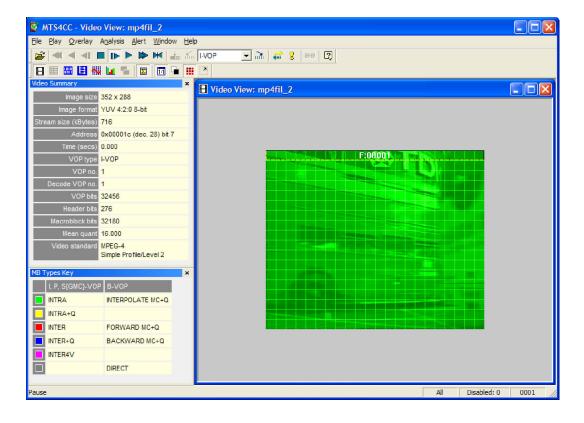


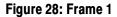
#### Figure 26: Progression of frames

7	1.320: The underflow o bitstream position 0x120	ccurred durin i39 (dec. 737 is and the mir	Video Objec flowed by -13961 bits at time g the decoding of Irame 34, 55). The total VBV buffer imum limit is 0 bits. VBV and_level_indication in	
	Summary		NOTE: display vs. decode or	der
	Image size	352 x 288		^
	Stream size (kBytes)	716		
	Address	0x012039 (d	lec. 73785) bit 7	
	Time (secs)	1.320		
	VOP type	I-VOP		
	VOP no.	34		
	Decode VOP no.	34		-

Figure 27: 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, as shown in Figure 28.





- 11. Click the red close button to remove the MB Types Key window.
- **12.** Click the *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, which is shown in Figure 29.
- **15.** For each frame, view the details, which are outlined in Table 3.

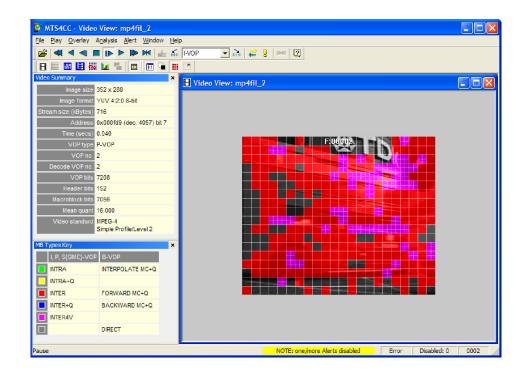


Figure 29: Frame 2

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

#### **Table 3: Frame details**

# 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 5: 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).

Table 4 provides the functions of each Buffer Analysis toolbar icon.

lcon	Function
- <b>-</b>	Zoom in (+) and zoom out (-) centered on the window; affected by the Lock X / Y icons.
D	Fit all data into window.
0	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.
+	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.
<b></b>	Scroll/pan (the cursor changes to show the scroll/pan direc- tion); this is affected by the Lock X-Y icons.
Q	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

## 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 View buffer analysis. The Buffer Analysis window appears, as shown in Figure 30.
- 3. View the graph example in Figure 30, as well as the descriptions in Table 5.

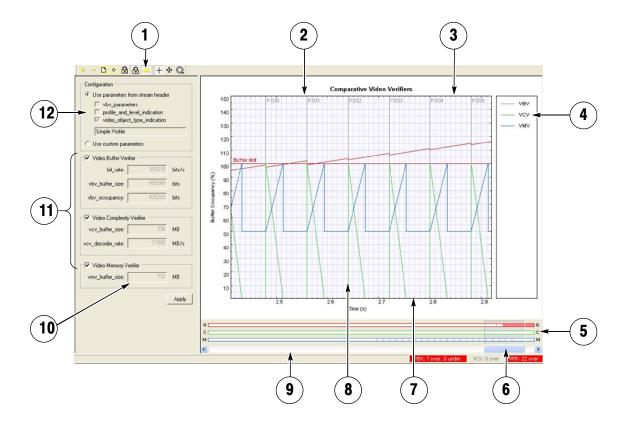


Figure 30: Buffer analysis window, example graph

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 and are shown in Figure 31. 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		
Use parameters from	n stream header	
Vbv_parameters	s	
F profile_and_lev	el_indication	
Video_object_ty	pe_indication	
Simple Profile		
1		
Use custom parame	ters	
<ul> <li>Video Buffer Verifier</li> </ul>	-	
bit_rate:	393216	bits/s
when huffer sizes	655360	hite

Figure 31: VBV, VCV and VMV values

- 5. Click the Pause/ Step Forward icon 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 lone more time. The graph appears.
- 7. Click the **Fit to Window** icon for a more detailed view of the graph, as shown in Figure 32.
- 8. Click the Fast forward icon 🕨 . A warning message occurs, as shown in Figure 33.
- **9.** Note that the VBV overflow occured while decoding frame 55 (the display frame number is 54).

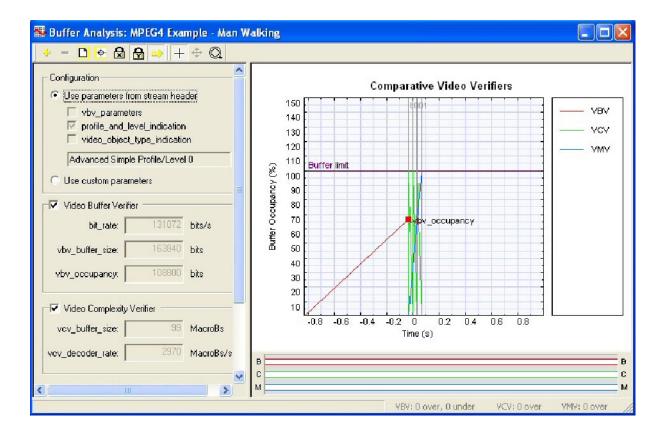


Figure 32: Buffer analysis graph, detailed view

2.167s. The overflow occurre bitstream position 0x71a8 (de occupancy is 164622 bits an	Video Object as overflowed by 782 bits at time ed during the decoding of frame 55, ec. 29096). The total VBV buffer ad the maximum limit is 163840 bits. VBV m profile_and_level_indication in	Plane
Summary	NOTE: display vs. decode or	der
Stream size (kBytes) 83	OP	
Skip this Warning only in Skip ALL Warning alerts i Abort	in future	oto 🔻

Figure 33: 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, as shown in Figure 34.
- **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.

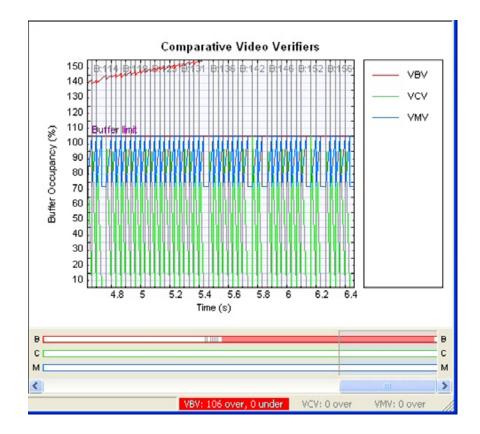
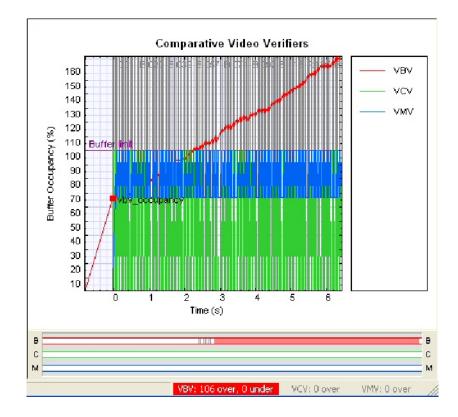


Figure 34: Buffer limit graph

**13.** To fit the graph to the window, click the icon on the **Buffer Analysis** toolbar. The red line displays the VBV overflow, as shown in Figure 35.



#### Figure 35: Comparitive 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 %, as shown in Figure 36.
- **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, as shown in Figure 37.

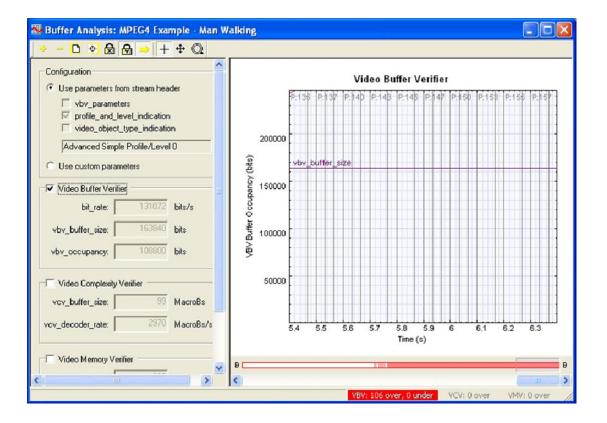


Figure 36: Frame 2

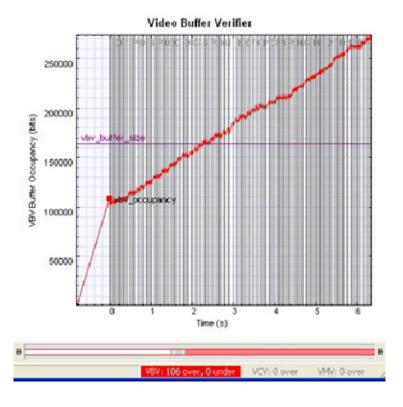


Figure 37: Graph details

**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 <u>icon to zoom out.</u>
- **20.** Select the **Use custom parameters** option button, as shown in Figure 38. The word **BUF** appears in a yellow box in the main MTS4CC status bar, indicating that custom buffer parameters are in use, as shown in Figure 39.

Configuration		
C Use parameters from		der
profile_and_lev     ideo_object_ty	-	
Advanced Simple I	Profile/Level	10
Use custom parame	ters	
Video Buffer Verifier	-	
bit_rate:	131072	bits/s
vbv_buffer_size:	163840	bits
vbv_occupancy:	108800	bits
Video Complexity Ve	erifier	
vcv_buffer_size:	99	MacroBs
vcv_decoder_rate:	2970	MacroBs/s
Video Memory Verifie	er —	
vmv_buffer_size:	297	MacroBs
		Apply

Figure 38: Buffer analysis configurations

				B
VBV: 25	3 over, Οι	under	VCV: 0 over	VMV: 0 over
re Alerts disabled	BUF	All	Disabled:	1

Figure 39: Buffer parameter indicator

- **21.** View the video buffer verifier, as shown in Figure 40. 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 **D**. 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?

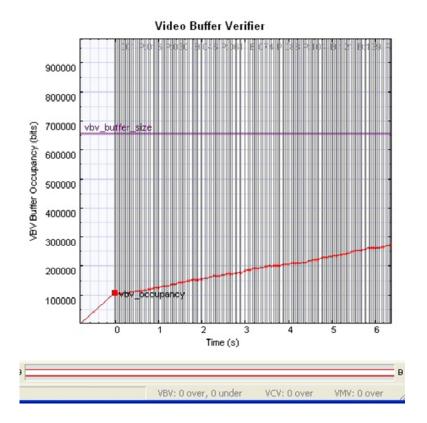
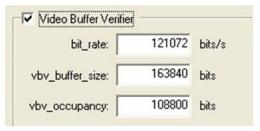
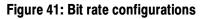


Figure 40: Video buffer verifier graph

- 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, as shown in Figure 41, and then click **Apply**. The graph goes up slightly and there are fewer frames with overflow, as shown in Figure 42.





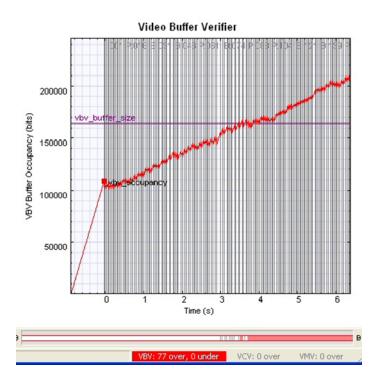
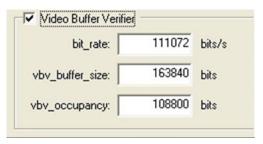
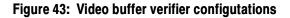


Figure 42: Video buffer verifier graph

- **26.** Reduce the bit rate to 111072 bits, as shown in Figure 43, and then click **Apply**.
- **27.** Observe that the graph line now stays below the buffer limit, as shown in Figure 44.
- **28.** Consider whether the maximum rate of 111,072 bits meets your network's specifications.





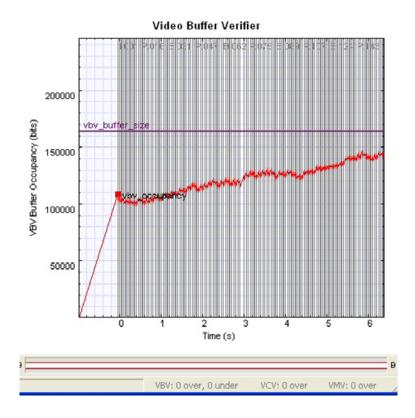


Figure 44: Video buffer verifier graph

## 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 6: 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

- 1. 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, as shown in Figure 45.
- 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	No	
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
	ed stream search					

#### Figure 45: Track list

- **3.** Click **OK**. The video track is analyzed and an error appears, as shown in Figure 46.
- 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, as shown in Figure 47.

	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]	~
		<u>~</u>
	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	
	Decode Frame no. 1	*
	Skip this Error only in future	
	Skip ALL Error alerts in future	
	Abort Pause Continue G	ioto 🔻

Figure 46: Initial error message

Decode	Error 22112: Bad VLC for dct_differential	
	Error	Block
8	Invalid VLC for dct_differential: encountered bit pattern '000000000000000000'. This does not match any valid code value. Stream position: 0x1000 (dec. 4096), start bit 5 Bitstream context: [VSQIPCDISLIMBK/BLK]	<
	Summary	
	Image size 352 x 288	^
	Stream size (kBytes) 8+ (partially extracted)	
	Address	=
	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 47: 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, as shown in Figure 48.



#### Figure 48: Error in image

- 9. Click the the Pause, Step forward icon **I**. An error message appears.
- **10.** Click **Continue**. An Invalid VLC error message appears, as shown in Figure 49.
- 11. From the Goto menu, click Hex.
- **12.** Click **Continue**, and then view the **HexView window**, as shown in Figure 50. Note that the error is highlighted automatically.
- **13.** Observe the bits surrounding the error and consider whether it is a start code emulation.

Error		Bloc
Invalid VLC for dot_differentiat a '00000000000000000. This dox Stream position: 0x1000 (dec. 4 Bitstream context: [VSQIPCD]SL	es not maich any valid code val 096), starl bit 5	ue.
		3
Summary		
mage size 352 x 2	88	^
Stream size (kBytes) 8+ (par	tially extracted)	
Address		
Time (secs) before	Frame 1	
Frame type	Course d	
Frame nr. before	Frame 1	
Ceconerrane rk.		~
Skip this Error only in future		
Skip ALL Error alerts in futur	8	
Abort	Pause Continue	Goto
	- sole	Video
		Hex
		Z Alert
		( Navi
		Ny Buff
		III Trac



🔡 Hex: r	mp2_2 - st	tream 0xe0	(video)									X
🔽 Bin 🖪	🕶 Hex 🔽 🗚	ASCII Auto	💌 Bytes p	er line Prev	Goto 0	Absolu	te addres	s 🔽	] € н	ex C	Dec	
00FEA 1 00FF0 0 00FF6 0 01008 0 01008 0 0100E 1 01014 1 01014 1 01020 1 01020 1 0102C 0 0102C 0 01032 0 01032 0 01032 1 01044 0	1101111 0100111 0010011 1110001 0000000 0011100 1110110	10110101 00000101 11001110 11101111 00000110 000000	10001111 10100001 01101001 00100100 00000101 0011011	11101110 01100111 10011100 01100110 11000011 01111011 01000001 010010	11011100 11101100 01000011 01011101 0000000 11010111 0110110 10010000 11001000 10010000 1011011 01000000 10111010 01011011 10000000 1110101 01011011 01011011	01110111 01000101 00000000 10010011 001001	6F B5 A7 05 13 CE 71 EF 91 0E 00 01 1E FC F6 DA 9C DC FF C7 E1 56 65 00 0E 7F 26 CA 20 CA	A1696076556077655560776555560776555556077655555555	E DCC 7 EC 3 00 3 00 3 D7 6 5D 7 6 3 D7 7 6 3 D7 7 6 3 B 7 6 5 D7 7 5 D7 7 6 5 D7 7 5	667 400 95 301 24 08 06 66 95 02 25 00 25 00 25 00 25 00 25 00 25 00 25 00 25 20 20 20 20 20 20 20 20 20 20 20 20 20	g f i Cw f f]E f v vR A 6 >_ # V\$* e @ a _ V\$* T c[f f & & 6 }h	
Address: 0x	(1000 (4096)	bit 5										11

### Figure 50: HexView window

- 14. To open the Grenadier Guards program stream, Click File > Example files > MPEG-2 Program Streams> Grenadier Guards. An error message appears, as shown in Figure 51.
- **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.

_	-	deo Sequence
⊗	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: [VSQ[SQX]	<
	Summary	
	Image size unknown	^
	Stream size (kBytes) 14+ (partially extracted)	
	Address	1
	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 🗸

#### Figure 51: Error message

**16.** Select **Skip this Error only in the future**, and then click **Continue**. The status bar indicates one disabled alert, as shown in Figure 52. An error message and a warning message appear, as shown in Figure 53 and Figure 54.

the second se	 
NOTE: one/more Alerts disabled	 Disabled

#### Figure 52: 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.

_		Sequence
8	Invalid value: frame_rate_extension_d = '00001' frame_rate_extension_d must be 0 in Main profile. Stream position: 0x15 (dec. 21), start bit 4 Bitstream context: [VSQ[SQX]	<u>^</u>
	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	
	Abort Pause Continue	Goto 🔻

Figure 53: Error message

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

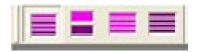
Figure 54: Warning message

- **18.** From the **Analysis** menu, select **View video** stream structure. The **Structure** window appears, as shown in Figure 55.
- **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	
	program_stream	0x000020,7	192	
E-E, PES_packet	MPEG-1, MPEG	0x000038,7	16560	
101 packet_start_code_p	0x1	0x000038,7	24	
	0xe0 MPEG-1, M	0x00003b,7	8	
123 PES_packet_length	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	
	0	0x00003f,3	1	
	0	0x00003f,2	1	
123 PES_CRC_flag	0	0x00003f,1	1	
	1	0x00003f,0	1	
	13	0x000040,7	8	
123 0011	3	0x000041,7	4	
	49157	0x000041,3	36	
123 0001	1	0x000046,7	4	
-Q DTS	47357	0x000046,3	36	*

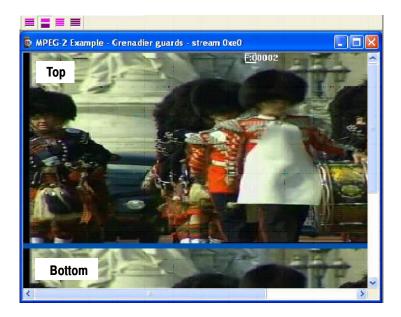
#### Figure 55: Structure window

**20.** Resume playing the video. The **Interlace** toolbar appears, as shown in Figure 56.



#### Figure 56: Interlace toolbar

- **21.** Click the **Pause**, **Step Forward** icon **b** to view frame 2.
- 22. On the Interlace toolbar, click the Split fields view icon = . The top and bottom fields are displayed separately, as shown in Figure 57.



### Figure 57: Frame 2

- **23.** Maximize the video window.
- 24. Click the icon. Different MB types appear in the top and bottom fields, as shown in Figure 58.

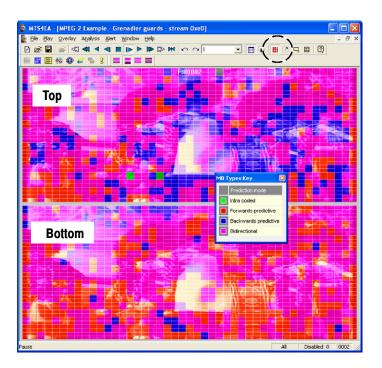


Figure 58: Varied MB types

## Conclusion

This tutorial demonstrated the following:

- There is one error in the Person Track stream:
  - The error is 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 7: 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 (MTS4CC does not cover this; however, the user manual contains descriptions of the fidelity metrics).

### 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 Enable fidelity analysis. The Video analysis options dialog box appears (see Figure 59) for the YUV 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, shown in Figure 59.
- 3. Set the Frame rate to 30, as shown in Figure 59.

Video analysis options	X
Frame range   Trace Visual difference/Fidelity	
Encoding: One byte	
Header skip: 0 Bytes	
Use <u>frame</u> rate for synchronisation	
Frame rate: 30000/1001 Frames per second	
Metric: PSNR (full signal range)	
OK Cancel App	ly

#### Figure 59: 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, as shown in Figure 60.
- On the Frame range tab, select the All frames check box, as shown in Figure 61, and then click OK. The video window appears with the fidelity analysis icon senabled in the Views toolbar.

Video analysis options Frame range Trace Visual difference/Fidelity	
Implasp_1_video.vpt          Available disk space: 68179 MBytes          File size limit:       50       MBytes	
Options VOP fidelity MB fidelity	_
ок	Car

Figure 60: Video analysis options

Video analysis options		
Frame range Trace Visual difference/Fidelity		
- Frame range		
First frame Last frame		
1 to 1	All frames	
, , ,	<b>`````</b>	

Figure 61: Frame range tab

- 8. Click the Fidelity analysis icon <a>Image Provide P
- 9. Click the licon four times. A graph appears, as shown in Figure 63.
- **10.** Observe the following about the graph shown in Figure 63:
  - 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, as shown in Figure 64 and Table 6.

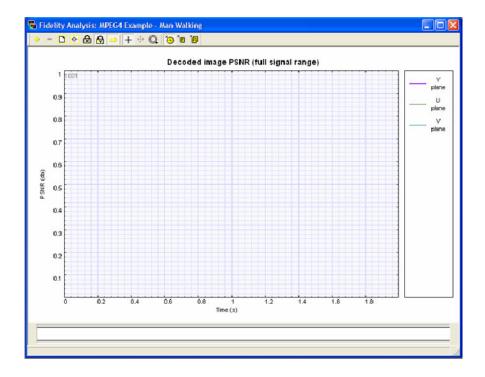


Figure 62: Fidelity analysis graph

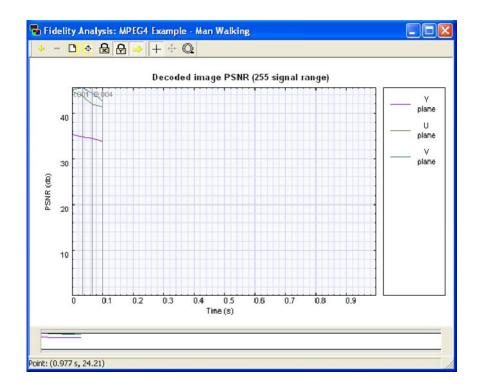


Figure 63: Fidelity analysis graph

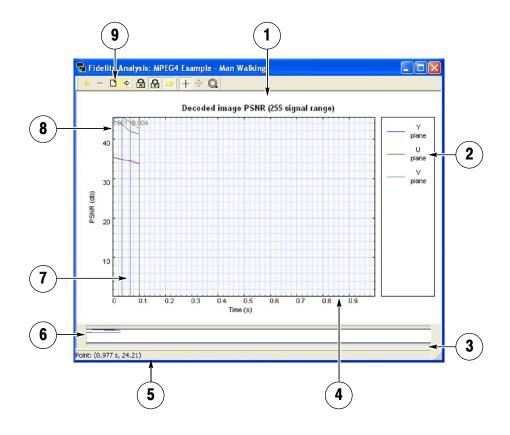


Figure 64: Fidelity analysis window descriptions

Table 6: Fidelity analysis window descriptions

Area	Description
1	Graph window
2	YUV color key
3	Scroll bar; appears and disappears according to zoom scale
4	Time through sequence
5	Status line; display measurements
6	Thumbnail bar line; displays overview
7	Vertical blue line at time=0; vertical gray lines at each VOP decode time
8	Frame type, number
9	Graph window control toolbar

- 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, as shown in Figure 65.
- **17.** Load the MPEG-2 program stream example, Grenadier Guards, as shown in Figure 66.
- **18.** Compare the MPEG-2 program stream in Figure 66 with the H.264/AVC PSNR example shown in Figure 67. Note that the PSNR is higher for H.264/AVC in Y, U, and V.

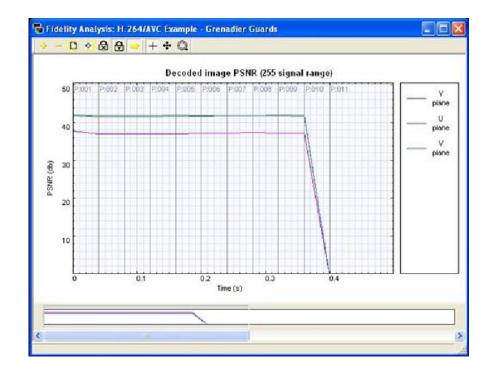


Figure 65: Graph result, YUV frame rate 25

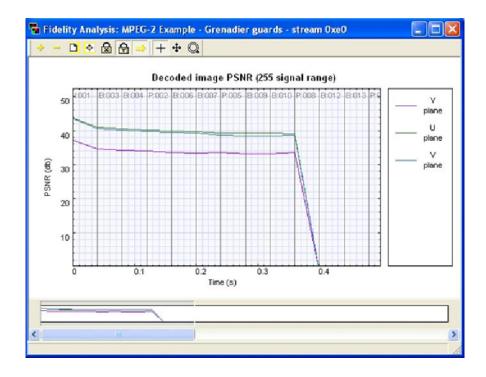


Figure 66: MPEG-2 program stream, Grenadier Guards

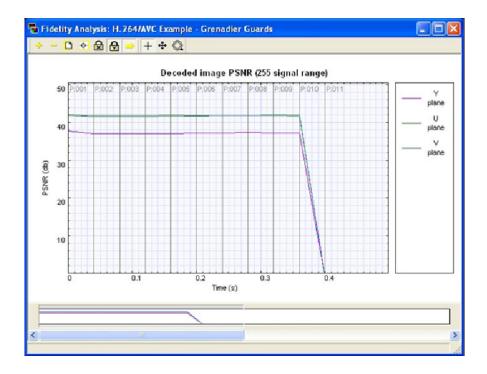


Figure 67: H.264/AVC stream, Grenadier Guards

19. Click the View trace icon as shown in Figure 68.



#### Figure 68: View trace icon

- **20.** The trace view gives the numerical values for the pictures' PSNR, as shown in Figure 69.
- **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.

#### Figure 69: 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.

Table 7: Visual difference icons

lcon	Function
	View encoded
<b>نور</b>	View YUV reference
2	View difference
	View luma only (not U or V)

**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.

**End of document**