Encoding for HTML5

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Producing H.264

- PDF available on
  www.streaminglearningcenter.com now
- The HTML5 playback environment
- Producing H.264
- Producing WebM
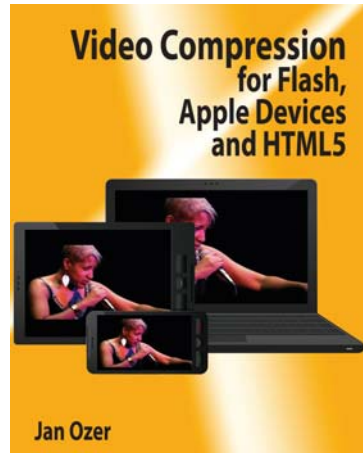
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For Additional Reference

The material in this presentation was derived from Jan Ozer's book, *Video Compression for Flash, Apple Devices and HTML5.*

For further explanation of the concepts presented in this presentation, check out the book at bit.ly/ozerbook1

Video Compression
for Flash,
Apple Devices
and HTML5

Jan Ozer

HTML5 Playback Environment

- HTML5 penetration – Desktop
- HTML5 codec support

Browser Marketshare

■	29.00% - Microsoft Internet Explorer 8.0
■	13.65% - Chrome 14.0
■	10.18% - Firefox 7.0
■	9.79% - Microsoft Internet Explorer 9.0
■	7.50% - Microsoft Internet Explorer 6.0
■	5.56% - Firefox 3.6
■	23.66% - Other

- http://www.netmarketshare.com/browser-market-share.aspx?qprid=2&qpcustomd=0

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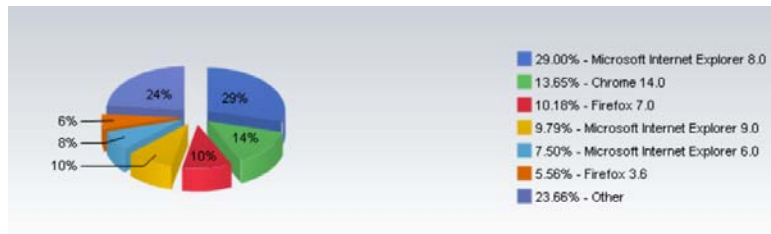
HTML5 Penetration

Browser	Share	HTML5 - Yes	HTML-No
Microsoft Internet Explorer 8.0	29%		29%
Chrome 14.0	13.65%	13.65%	
Firefox 7.0	10.18%	10.18%	
Microsoft Internet Explorer 9.0	9.79%	9.79%	
Microsoft Internet Explorer 6.0	7.5%		7.5%
Firefox 3.6	5.56%	5.56%	
Microsoft Internet Explorer 7.0	5.41%		5.41%
Firefox 6.0	3.12%	3.12%	
Safari 5.1	3.04%	3.04%	
Safari 5.0	1.59%	1.59%	
Chrome 15.0	1.42%	1.42%	
Opera 11.x	1.34%	1.34%	
Firefox 4.0	1.04%	1.04%	
Firefox 5.0	1.01%	1.01%	
Totals			
		51.74%	41.91%

- As of today, at least 42% of desktops NOT HTML5 compatible
- HTML5 usage MUST fall back to plug-in based technology

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HTML5 Codec Support

VIDEO CODEC SUPPORT IN UPCOMING BROWSERS

CODECS/CONTAINER	IE	FIREFOX	SAFARI	CHROME	OPERA
Theora+Vorbis+Ogg	·	3.5+	†	5.0+	10.5+
H.264+AAC+MP4	9.0+	·	3.0+	·	·
WebM	9.0+*	4.0+	†	6.0+	10.6+

* Internet Explorer 9 will only support WebM "when the user has installed a VP8 codec," which implies that Microsoft will not be s

† Safari will play anything that QuickTime can play, but QuickTime only comes with H.264/AAC/MP4 support pre-installed.

‡ Although Android 2.3 supports WebM, there are no hardware decoders yet, so battery life is a concern.

● http://diveintohtml5.info/video.html

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HTML5 Codec Support

	Browser	Share	H.264	WebM	Ogg	NA
	Microsoft Internet Explorer 8.0	29%				29%
1	Chrome 14.0	13.65%	13.65%	13.65%		
2	Firefox 7.0	10.18%		10.18%		
	Microsoft Internet Explorer 9.0	9.79%	9.79%			
	Microsoft Internet Explorer 6.0	7.5%				7.5%
	Firefox 3.6	5.56%			5.56%	
	Microsoft Internet Explorer 7.0	5.41%				5.41%
2	Firefox 6.0	3.12%		3.12%		
	Safari 5.1	3.04%	3.04%			
	Safari 5.0	1.59%	1.59%			
	Chrome 15.0	1.42%	1.42%	1.42%		
2	Opera 11.x	1.34%		1.34%		
2	Firefox 4.0	1.04%		1.04%		
2	Firefox 5.0	1.01%		1.01%		
	Totals		**29.49%**	**31.76%**	**5.56%**	**41.91%**

1 - Google has announced they will remove H.264 from a future version of Chrome

2. Earlier versions of Firefox and Opera will play Ogg

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So:

- HTML5 lets you access about 60% of desktops today (maximum)
- To access those desktops, you'd have to produce three file versions
  - H.264 – Chrome, Safari, IE9 (Chrome going away)
  - Web M – Firefox post 3.6, Opera post 10.6, Chrome
  - Ogg – Firefox 3.6 and earlier, Opera 10.5 and earlier

Producing H.264

- What is H.264
- What does it cost?
- What are the key encoding parameters?
- How do I customize the file for HTML5?

What is H.264?

ITU – International Telecommunications Union Telephone, Radio, TV	ISO – International Standardization Organization Photography, Computer, Consumer Electronics
1984	H.120	
1990	H.261 – Video Conferencing	
1993		MPEG-1 – Video CD
1994	(H.262)	MPEG-2 – Digital Cable and Satellite TV
1995	H.263 – Improved Video Conferencing	
1997		ATSC – U.S. HDTV
1999		MPEG-4
2002	AVC (H.264)	AVC (MPEG-4 Part 10)

Streamcrest Associates
http://www.streamcrest.com/SDF%20Final1.pdf

- Adapted by ISO and ITU
  - Telephony/cellular
  - TV - consumer electronics
  - Computer electronics
- Only codec adopted by top three streaming providers (Apple, Adobe, Microsoft)

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What's MPEG-4/H.264 Cost?

- For free Internet video (e.g. no subscription or pay per view), free in perpetuity
  - Still technically a licensing obligation, but there are no teeth and no motivation to enforce
- For subscription or PPV, there may be a royalty obligation
- For browsers, encoders and players, there is a royalty (US$5 million max/company/year)
- Check www.mpeg-la.com

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What is an MP4 file (and what are the variants)?

- .MP4 - official MPEG-4 wrapper
- .M4V - Apple's variant for iTunes and devices
- .MOV - H.264 file for editing or QuickTime delivery
- .F4V - H.264 for Flash
- .3GP - (not shown) - phone
- .MPG - H.264 in MPEG-2 transport stream

File Format:	MPEG-4	
Extension:	mp4	☑ Allow Job Segmenting

File Format:	H.264 for Apple Devices	
Extension:	m4v	☑ Allow Job Segmenting

File Format:	H.264 for DVD Studio Pro	
Extension:	mov	☑ Allow Job Segmenting

Stream Type	F4V
Video-Basic	MPEG-2 Transport Stream
	MPEG-4 System
Width	F4V
Height	Raw H.264 Stream

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H.264 Encoding - Basics

- Profiles and Levels
- Entropy encoding
- I and B-frame settings

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What are H.264 Profiles?

- "Define a set of coding tools or algorithms that can be used in generating a bitstream"

	Baseline	Extended	Main	High
I and P Slices	Yes	Yes	Yes	Yes
B Slices	No	Yes	Yes	Yes
Multiple Reference Frames	Yes	Yes	Yes	Yes
In-Loop Deblocking Filter	Yes	Yes	Yes	Yes
CAVLC Entropy Coding	Yes	Yes	Yes	Yes
CABAC Entropy Coding	No	No	Yes	Yes
Interlaced Coding (PicAFF, MBAFF)	No	Yes	Yes	Yes
8x8 vs. 4x4 Transform Adaptivity	No	No	No	Yes
Quantization Scaling Matrices	No	No	No	Yes
Separate Cb and Cr QP control	No	No	No	Yes
Separate Color Plane Coding	No	No	No	No
Predictive Lossless Coding	No	No	No	No
	Baseline	Extended	Main	High

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What are H.264 Levels?

- "Constrains key parameters in the bitstream," like video bit rate and resolution

Level number	Max video bit rate (VCL) for Baseline, Extended and Main Profiles	Max video bit rate (VCL) for High Profile	Examples for high resolution @ frame rate (max stored frames) in Level
1	64 kbit/s	80 kbit/s	128x96@30.9 (8) 176x144@15.0 (4)
1b	128 kbit/s	160 kbit/s	128x96@30.9 (8) 176x144@15.0 (4)
1.1	192 kbit/s	240 kbit/s	176x144@30.3 (9) 320x240@10.0 (3) 352x288@7.5 (2)
1.2	384 kbit/s	480 kbit/s	320x240@20.0 (7) 352x288@15.2 (6)

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Profiles and Levels

- Why do they exist?
  - Allow device manufacturers to build devices with varying power to support the various profiles
    - iPod – low power, Baseline profile
    - iPad – more powerful CPU, Main profile
    - iPhone 4S – more powerful still, High profile

Producing for HTML5

- All browsers have their own players, no specifications (that I could find)
  - Baseline, Main, High all supported up to 1080p
  - Ditto for AAC-LC, HE-AAC, HE-AAC v2
- Use MP4 file since F4V or MOV could trigger Flash or QuickTime players

Profiles and Levels

- General Rule - use highest supported profile and level on target
  - When producing H.264 for HTML5 deployment, this means High profile, any level
- When producing for multiple platforms, like HTML5 and iOS, have to use lowest common denominator format

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Encoding for iDevices

	Original iPod (to-5g)	iPod nano/classic	iPod touch/iPhone	iPhone 4/iPod touch 4	iPad 1	iPhone 4S	iPad 2
Device spec							
Screen resolution	320x240	320x240	480x320	960x640	1024x768	960x640	1024x768
Aspect ratio	4:3	4:3	16:9-ish	16:9-ish	4:3	16:9-ish	4:3
Codec spec							
Video codec	H.264	H.264	H.264	H.264	H.264	H.264	H.264
Max video data rate	768 kbps	2.5 Mbps	2.5 Mbps	14 Mbps	14 Mbps	50 Mbps	50 Mbps
Max video resolution	320x240	640x480	640x480	720p	720p	1080p	1080p
Frame rate	30 fps	30 fps	30 fps	30 fps	30 fps	30 fps	30 fps
Profile/level	Baseline to Level 1.3	Baseline to Level 3.0	Baseline to Level 3.0	Main to Level 3.1	Main to Level 3.1	High to Level 4.1	High to Level 4.1
Audio codec	AAC-LC	AAC-LC	AAC-LC	AAC-LC	AAC-LC	AAC-LC	AAC-LC
Max audio data rate	160 kbps	160 kbps	160 kbps	160 kbps	160 kbps	160 kbps	160 kbps
Audio params	48 kHz, stereo	48 kHz, stereo	48 kHz, stereo	48 kHz, stereo	48 kHz, stereo	48 kHz, stereo	48 kHz, stereo

- 1080p playback unproven: use 720p
- These are maximum settings; not recommended

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Entropy Encoding
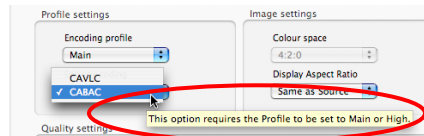
- Two options:
  - CABAC (Context-adaptive binary arithmetic coding)
    - More efficient (e.g. better quality), but harder to decode
  - CAVLC (Context-adaptive variable-length coding)
    - Less efficient, easier to decode
- General rule:
  - Use CABAC when available (Main, High profiles)

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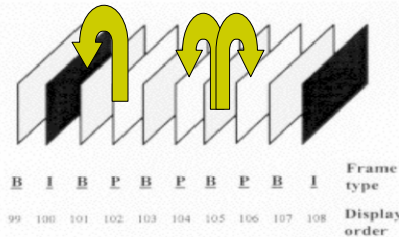

What Would YouTube Do?

- High Profile
- CABAC

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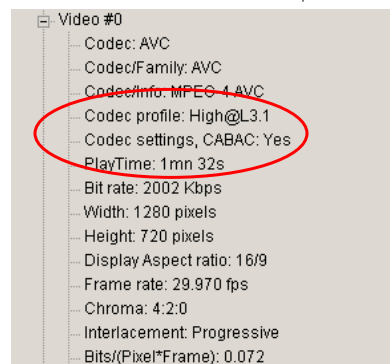
What are I, B and P Frames?

- I-Frame - encoded without reference to other frames (also called Key Frames)
- P - looks backward to I and P frames (predictive)

- B - looks forward and backward to previous I and P frames (Bi-directional interpolated)
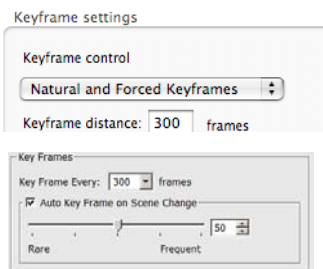 - No frames refer to B-Frame (most of the time)

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What do I Need to Know About Key Frames?

- Enable 1 key frame every ten seconds or so
  - Helps playback interactivity
- Enable key frames on scene changes
  - Optimizes quality

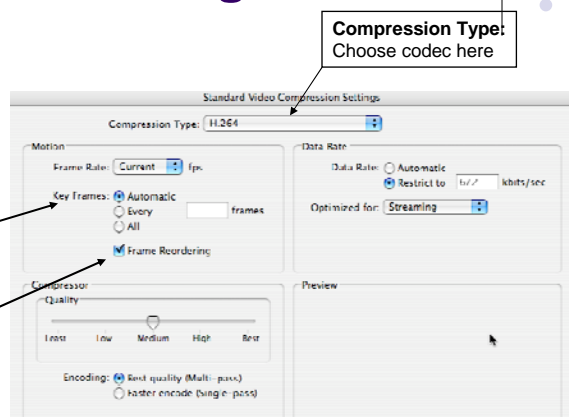**Streaming Learning Center**

What do I Need to Know About B Frames?

- Use B-frames when available
  - Main and High profiles
- Use an Interval of 3 (number of B frames between I and P-Frames; (IBBBPBBBPBBBPBBBP)
- Reference frames (both P and B-frames)
  - Number of frames searched for redundancies
  - Use 5

Number of B-Frames:
0 | | 3   3 Frames
Number of Reference Frames:
0 | | | | | | | | | | | | | | | | | 16   5 Frames

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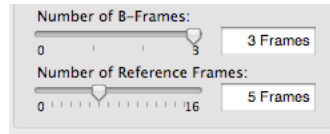
Apple Compressor - Compression Settings
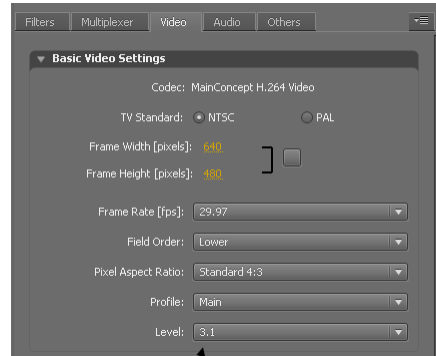
Compression Type: Choose codec here

- Available options and presentation varies by encoding tool
- Apple's is very simple
- Can set key frames
- Frame Reordering enables B-frames; can't control interval

Standard Video Compression Settings

Compression Type: H.264

Motion
Frame Rate: Current fps.
Key Frames: ◉ Automatic
○ Every [   ] frames
○ All
☑ Frame Reordering

Data Rate
Data Rate: ○ Automatic
◉ Restrict to [b/7] kbits/sec
Optimized for: Streaming

Compressor
Quality
Least Low Medium High Best

Encoding: ◉ Best quality (Multi-pass)
○ Faster encode (single-pass)

Preview

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AME - Compression Settings

- Adobe lets you choose Profile and level directly
- No Entropy Encoding controls
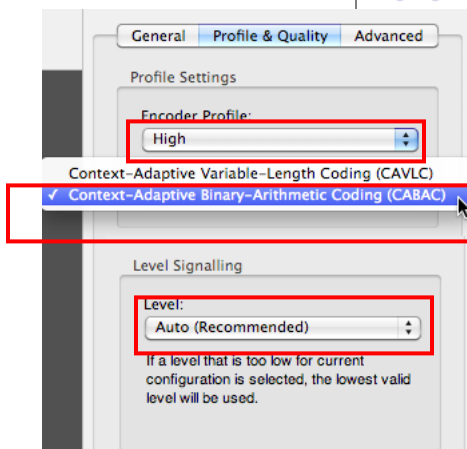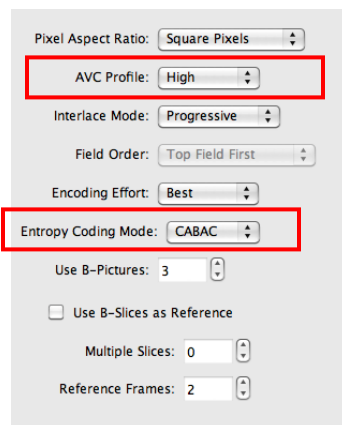- No controls over B-frame
- Can set key frame interval

Filters | **Multiplexer** | **Video** | **Audio** | **Others**

▼ **Basic Video Settings**

Codec: MainConcept H.264 Video

TV Standard: ● NTSC ○ PAL

Frame Width [pixels]: 640.

Frame Height [pixels]: 480.

Frame Rate [fps]: 29.97

Field Order: Lower

Pixel Aspect Ratio: Standard 4:3

Profile: Main

Level: 3.1

Profile/Level:

Profile/CABAC in Squeeze and Episode

Pixel Aspect Ratio: Square Pixels

AVC Profile: High

Interlace Mode: Progressive

Field Order: Top Field First

Encoding Effort: Best

Entropy Coding Mode: CABAC

Use B-Pictures: 3

☐ Use B-Slices as Reference

Multiple Slices: 0

Reference Frames: 2

General | **Profile & Quality** | **Advanced**

Profile Settings

Encoder Profile:

High

Context–Adaptive Variable–Length Coding (CAVLC)

✓ Context–Adaptive Binary–Arithmetic Coding (CABAC)

Level Signalling

Level:

Auto (Recommended)

If a level that is too low for current configuration is selected, the lowest valid level will be used.

Encoding Caveats

- Beyond these basics, configuration options will vary greatly
  - Get these right and you're 95% there
- Quality varies among encoding tools
  - Other than Apple Compressor they are generally pretty good
  - X264/MainConcept H.264 codecs are the "gold" standard

H.264 Reference Configurations

	Width	Height	Codec	Data Rate	Bits per Pixel	Profile	CABAC
Media							
CNN - video library	640	360	H.264	671	0.097	Main	Yes
ABC - Castle	768	432	H.264	614	0.077	Main	Yes
NFL.com	768	432	H.264	465	0.047	High	Yes
Corporate							
Deloitte	640	360	H.264	1072	0.194	Main	Yes
Apple	848	480	H.264	3174	0.325	Main	No
Starbucks	732	408	H.264	951	0.110	Main	Yes
Victoria's Secret	996	544	H.264	1300	0.100	High	Yes

Producing H.264 - Other Sessions I'm teaching

- Tuesday
  - 2:45 pm - 3:30 pm - How-To: Encoding Video for iDevices (HTML5 summit)

H.264 Specific Encoding Tutorials

- Understanding key H.264 encoding parameters
  - http://www.vimeo.com/5377029
- Apple Compressor
  - http://vimeo.com/5462108
- Adobe Media Encoder CS4
  - http://www.vimeo.com/5118579
- Sorenson Squeeze
  - http://www.vimeo.com/5279015
- Telestream Episode Pro
  - http://www.streaminglearningcenter.com/articles/producing-h264-files-for-flash-distribution-with-telestream-episode-pro.html

HTML5 and H.264 Summary

- Use MP4 container format
- If computer only
  - High profile
  - CABAC
  - B-frames on, interval of 3
  - 5 reference frames
- If computer and iDevice
  - Conform to max settings compatible with iDevice

Producing WebM

- Overview
- Survey of encoding tools
- Live WebM encoding options

WebM Overview

- What is WebM
  - VP8 video codec (purchased from On2)
  - Open source Vorbis audio codec
  - WebM container format based on Matroska container
- Open source and royalty free
- Browser support:
  - Native - current versions of Chrome, Opera, FireFox
  - Via plug-in - Internet Explorer 9, Safari

Producing WebM

- Many tools, few are worthwhile
- *Streamingmedia* review - bit.ly/webmencoderreview
  - Performed 12/2010
  - Updated 4/2011 for book
- Basic workflow
  - Google encoded files for a presentation at StreamingMedia West (11/2010)
  - I encoded and compared results to Google output

Miro Video Converter

- Verdict
  - Good for experimentation but not production
- Issues
  - Can't configure presets
  - Presets use 160 kbps/audio, which is too high
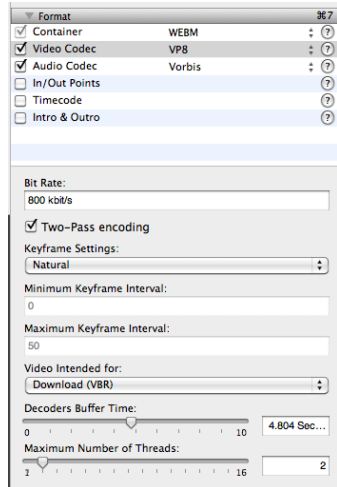 - Serious dropped frames during encoding

Firefogg

- Issues
  - Output didn't match configuration input
  - No data rate config for audio
- Verdict
  - Best free alternative, but has issues
  - OK for experimentation, not for production

Telestream Episode

- Verdict
  - Easy to use, fast, very good quality, but few VP8 config options
  - Who cares about config options if quality is very good?

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Sorenson Squeeze 7
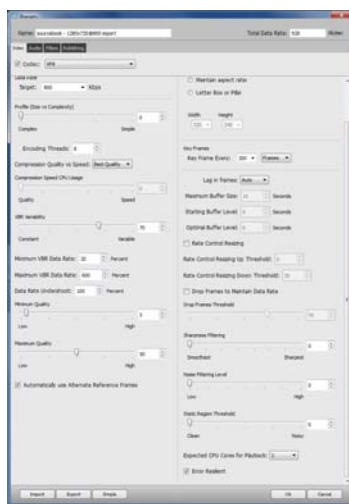
- Verdict
  - Fast,
  - Very good quality,
  - Highly configurable
- Issues
  - About 18% slower than Episode on same system for single file encoding

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Producing WebM

- Bottom line:
  - Free tools are all unsuitable for production
  - Episode; high quality, fast encoding, no encoding options
  - Squeeze, high quality, slightly slower encoding (may be faster in 8, haven't tested), extensive WebM encoding options.
- Complete list available at:
- http://www.webmproject.org/tools/encoder-parameters/

Other WebM Encoding

- Command line options - multiple are available
  - Check www.webmproject.org for links and command line arguments
- Live Options
  - Broadcast International - Head End
  - Entropy Wave E1000
  - Flumotion WebTV
  - AFAIK, none of the major hardware encoding vendors (Digital Rapids, ViewCast, Envivio, Cisco) have live WebM encoding yet
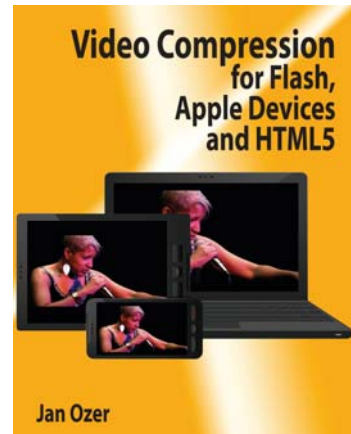
Questions?

- Most of the information for this presentation was taken from this book. For more information, check out the book
  - Available on Amazon
  - Bit.ly/ozerbook1

Video Compression
for Flash,
Apple Devices
and **HTML5**

Jan Ozer

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