Publishing Media for Silverlight
Windows Media Overview

- Windows Media 9 in 2003 defined platform
- Most mature, media platform available
- Only widely deployed interoperable DRM
- Scales from PocketPC to HD
- Preinstalled on all new Windows machines
- Auto-update for older players’ codecs
- High, growing installed base
- Silverlight as the future of WMV for web video
Extensions for WM

• **Media Files**
  - All “Advanced Streaming Format”
  - Old extension: .asf
  - New video extension: .wmv
  - New audio extension: .wma

• **Metafile**
  - Old extension: .asx
  - New video extension: .wvx
  - New audio extension: .wax
What does WMV give content creators?

- Improved compression efficiency
  - Fewer bits needed for same quality
  - Better quality
  - Faster decode performance (2x H.264)
- Faster encoding
  - 3x faster than other codecs on 4-core system
  - 15x faster yet with Tarari acceleration board
- Much better TCO for video hosting
  - Many more simultaneous streams than other servers
  - Scalability doubles in Server 2008
WMV Ecosystem

- Mature live streaming/encoding tools
  - Up to broadcast-grade rackmount systems
  - Already capable of HD streaming today
- Big ecosystem of encoding tools
  - WMV encoding out of the box in nearly all compression products
- Integration into major editing platforms
  - Can ingest and edit in variety of NLE tools
  - Lossless editing and insertion into files
Windows Server 2008

Media Services 2008

- 2x scalability vs. Windows Media Services 2003
- Proven reliability, extensibility
- Server Core installation, reduce footprint for dedicated streaming
- Built-in cache/proxy plug-in makes it easier to configure
- Supports live, on-demand

Internet Information Services + IIS 7 Media Pack

- Enhanced progressive download (on-demand) scalability
- Built-in “bit-rate” throttling, lowers download delivery costs
- Caching support for files >4GB, enables HD delivery
- SSL-based content delivery
- Simplified admin
Silverlight
What is Silverlight

- New Cross-platform, Cross-browser web plug-in
  - Window XP, Vista, and Mac OS X (PPC and Intel)
  - Internet Explorer, FireFox, and Safari
  - Linux coming in partnership with Novell
- Rich Interactive Applications and Rich
  - Think Flash, AJAX, Web 2.0 applications
  - With a better media experience
- Layout uses XAML (XML) and Expression tools
- JavaScript programming for 1.0
  - .NET CLR/DLR runtime in 1.1
- DRM support coming
Video and audio in Silverlight

• It's just Windows Media!
  • Huge library of existing content already compatible
  • Existing URLs from Windows Media Services work
  • Huge ecosystem of compatible products
  • Silverlight targeted WMV also plays in WMP, Flip4Mac, Xbox 360, Zune, VBrick, Kinoma Media Player…

• Media features baked into runtime
  • No dependency on OS codecs

• Video codecs
  • Windows Media Video 7/8/9 and 9 Advanced Profile

• Audio codec
  • Windows Media Audio in 1.0

• MP3 files also supported
Video Codecs
Windows Media Video 9 (WMV3)

- Most commonly used WMV codec today
- Available back to NT4 w/ download
- Used for 6.x or higher compatibility
- Simple Profile
  - Limited version for simple devices
  - Needs more bits for equivalent quality
- Main Profile
  - Mainstream version for more advanced devices
  - Zune and Windows Mobile devices do Main Profile
  - Always been the default in Windows Media Encoder
WMV9 Advanced Profile

- Automatic download in WMP9+ on Windows
- Preinstalled with Silverlight, WMP 11, and Flip4Mac
  - Should be default for all Silverlight content
- Much better interlaced support
  - Although Silverlight 1.0 doesn’t support interlaced
- Dquant: “Differential Quantization”
  - Apply less compression to smoother areas
  - Allows transparency at lower bitrates
- Two flavors
  - WMVA
    - Original Flavor, introduced in Format SDK 9.5 (deprecated)
  - WVC1
    - Fully VC-1 Compliant (used once WMP 11 installed)
Windows Media Video 9 and VC-1

- Windows Media Video 9 came first
- Was standardized by SMPTE as “VC-1”
- SMPTE standard just covers video codec
  - Not file format or audio codecs
- Licensing handled by MPEG-LA
  - Like MPEG-2 and H.264, similar terms to H.264
- Profile/codec mapping:
  - WMV9 (Simple) = VC-1 Simple Profile
  - WMV9 (Main) = VC-1 Main Profile
  - WMV9 Advanced Profile = VC-1 Advanced Profile
Legacy Video Codecs

- **WMV 8**
  - Lower compression efficiency, but still good
  - Progressive, square pixel only
  - Very fast encoder

- **WMV7**
  - Oldest currently supported encoder
  - Oldest codec supported by Silverlight
  - Much less efficient than VC-1

- **WM Screen**
  - For screen recording
  - Not as efficient if natural images on screen
    - Vista, Mac OS X look a lot like “natural images”
    - VC-1 Advanced Profile better for today’s screens
  - Not supported in Silverlight 1.0
    - But a pretty easy transcode
Audio Codecs
Audio Codecs

• **WMA 9.2**
  - New enhanced encoder
    - 9.2 slightly faster and better sounding than 9.1
  - Backwards compatible to WMA 2 decoder
  - Supports 2-pass and VBR modes
  - Better than MP3 at moderate-low bitrates
Windows Media Audio Professional

- **WMA 9 Professional**
  - Stereo, 5.1, 7.1
  - 44.1, 48, 88, 96 KHz
  - 16-bit and 24-bit
  - Natively supported by some receivers
- **WMA Pro 10 added new low bitrate modes**
  - WMA 9/10 Pro @ 128+ Kbps unchanged
- **WMA 10 Pro 32-96 Kbps are new modes**
  - Use frequency synthesis
  - Compatible WMA 9 Pro core @ ½ sample rate
  - Full sound quality on WMP 11, new devices
- **First deployed by Verizon Vcast Service**
- **Not supported in Silverlight 1.0**
Other audio codecs (not in Silverlight 1.0)

- **WMA 9 Lossless**
  - Lossless encoding for archiving
  - Same modes as WMA Pro
- **WMA 9 Voice**
  - 5-16 Kbps
  - Better than WMA at low rates
  - Not supported in Silverlight, Kinoma, Flip4Mac, others
  - Actually supports musical “stings” pretty well
- **ACELP.net**
  - Low bitrate speech codec
  - Good at 16 Kbps and below
  - Not on Mac OS X, PocketPC
  - Deprecated in favor of superior WMA Voice
Other WM Features
Intelligent Streaming

- Windows Media Multiple Bit Rate (MBR) solution
- Massively enhanced with WM9
- Can vary most parameters
  - Any number of video, audio streams
  - Frame size
  - Data rates
  - Interlaced/progressive mode
- Fixed
  - Codec
- Requires WMS on Windows 2003 or 2008 Server
- Silverlight 1.0 supports initial stream selection
Windows Media Encoding Modes

• **CBR (1-pass and 2-pass)**
  • Set data rate, buffer duration, quality target
• **1-pass Quality VBR**
  • Quality limited encode
  • Good for capturing
• **2-pass VBR Unconstrained**
  • Specify average data rate
• **2-pass VBR Constrained**
  • Specify average data rate
  • Also specify peak rate and duration
Expression Suite

- Creative Tools for Silverlight, .Net, and Web experiences
- Expression Web
  - Web site/HTML designer
- Expression Design
  - Design and image processing
- Expression Blend
  - GUI designer and animator
  - Supports programming internally, and via
  - Free Beta version 2 needed for full Silverlight support
- Expression Media
  - Media management tool (formerly iView MediaPro)
- Expression Encoder
  - Why we’re here today
Expression Encoder 1.0 Overview

• Bundled with Expression Media for Windows
  • $299
• 180-day demo key available
• Uses same Format SDK as other WM tools
  • So same codec implementations
• Real value is around
  • Workflow
  • Silverlight Integration

• Expression Encoder is not required for Silverlight
  • Can add Silverlight to files encoded in other tools
Expression encoder VOD Workflow

- **Import formats**
  - Anything supported by DirectShow or QuickTime
- **Implicit preprocessing**
  - Define your output, EE figures out encoding settings
    - Automatic deinterlacing
    - Letterboxing/dynamic image size for source aspect ratio
- **Autostitch**
  - Add preroll/postroll video
- **A/B comparison for compression settings**
  - Compare
- **Batch encoding**
- **Supports command-line encoding**
Expression Encoder Silverlight Integration

• **Metadata**
  • Dozens of metadata fields
  • SAMI import for captioning
  • Event markers for programming

• **Thumbnails**
  • Make your chapter markers I-frames (keyframes)
  • Extract JPEG for visual navigation

• **Skinning**
  • Library of included skins
  • Easy to add new skins made or modified in Blend

• **Skinning/metadata don’t require reencoding**
  • Can skin and add metadata to existing WMV files
Hands-on demo
Expression Encoder Live
Expression Encoder Live Overview

- Live encoding module of Expression Encoder
- Multiple live sources
  - Webcam or DV
- File sources
  - Preroll/intermission/postroll video
- Live metadata
  - Insert tags and triggers during the stream
- Can post live event for VOD publishing
  - Including adjusting metadata
- Tip:
  - Custom encoder settings need to be defined in main GUI
Live Encoder Demo
Silverlight Streaming
Silverlight Streaming Overview

- Free Silverlight app hosting service
  - [streaming.live.com](http://streaming.live.com)
  - (it’s actually progressive download right now)
- Includes media apps
  - Up to 4 GB of storage
  - Maximum media file size in free version is 22 MB
- Expression Encoder plugin for automatic upload
- Existing CDNs also all support WMV
Advanced Codec Settings
Enhanced Video codecs

- Windows Media Player 11 installs new codecs
  - Improved WMV9 Main Profile
  - New WMV9 Advanced Profile
- Improved compression efficiency
- Registry Key settings to tune encoding
  - Registry key tool in WMV PowerToy
- 4-thread optimized (use all of dual-dual)
Complexity

- Speed/quality tradeoff control
- Six levels in V11
  - 0-5 or 0, 20, 40, 60, 80, 100
- Remapped some from older codecs
  - Complexity 1-3 slower than before, but do more
- Complexity 5
  - Uses modes otherwise only via registry keys
    - Chroma search and adaptive motion match
  - But with fixed values – Complexity 4 + reg keys typically better (and slower)
“Quality”

- **Controls “Quantization Parameter”**
  - Like JPEG Quality per frame
  - 1-31, with lower less compressed
  - Generally looks decent below 8
- **1-pass VBR**
  - Determined quality, and implicitly file size
- **CBR (1-pass or 2-pass)**
  - Determines minimum and maximum QP
  - As quality goes up
    - Frame quality can go up
    - But increased risk of dropped frames
  - Magic value: 90
    - Min QP of 1 (90-100), Max QP of 5
    - Will always look pretty good. Make sure frames don’t drop
CBR Quality effect

![Graph showing CBR Quality effect]

- **Quality Setting**
- **Quantization Parameter**

- **minQP**
- **maxQP**
Registry Key settings

- Registry keys to optimize encoding with v11 .dll
- WMV9 PowerToy can be used to set parameters
- Can script with parameters using WMCmd.vbs

- Lots more options than I’ll discuss today
  - Link to full documentation at end
WMV9 PowerToy

[Image of the WMV9 PowerToy software interface]
WMCmd.vbs

C:\Windows\system32\cmd.exe

D:\BenWagg.Old\Videos\Yahoo samples\Webcasting Samples>cscript "C:\Program Files\Windows Media Components\Encoder\WMcmd.vbs" -input "Basketball 400p30.avi" -output "Basketball aug 1200p.wmv" -a_codec WMVSTD -a_mode 0 -a_setting 40_44_1 -v_codec WMV1 -v_mode 0 -v_keydist 4 -v_bitrate 1152000 -v_buffer 8000 -v_quality 90 -v_performance 80 -v_bframedist 1 -v_dquantoption 2 -v_loopfilter 1 -v_overlap 1 -v_adz 1 -v_lrc 15 -v_msrangle 0 -v_mslevel 3

Microsoft (R) Windows Script Host Version 5.7
Copyright (C) Microsoft Corporation. All rights reserved.

Microsoft (R) Windows Media Encoder Command Line Script Utility
Copyright (C) Microsoft Corporation. All rights reserved.

Encoded: 93.7s (99.7%)  Elapsed: 00:11:21  Left: 00:00:02  [10.14x]

======== Encoding Completed ========

Audio:
Codec: Windows Media Audio 9.2
Expected bit rate: 48024 bps
Average bit rate: 48024 bps
Expected sample rate: 5363
Average sample rate: 5363
Dropped byte count: 0 bytes
Dropped sample rate: 0
Total bytes: 567535 bytes

Video:
Codec: Windows Media Video 9 Advanced Profile
Expected bit rate: 1152000 bps
Average bit rate: 1146281 bps
Expected fps: 29.97
Dropped frame count: 0
Total coded frames: 2817
Average sample rate: 29.97
Dropped bytes: 0 bytes
Total bytes: 14232470 bytes

Overall:
Encoding time: 684 seconds
Average bit rate: 1194225 bps
File size: 14934022 bytes
File duration: 93.993 seconds
MV Range options

- Available Options:
  - Macroblock-adaptive
  - 64 pixels horizontally, 32 pixels vertically (default)
  - 128 pixels horizontally, 64 pixels vertically
  - 512 pixels horizontally, 128 pixels vertically
  - 1024 pixels horizontally, 256 pixels vertically
- Each progressive option slows encoding by ~2x
- Use Macroblock Adaptive for best quality
  - Performance only slows for high motion segments
MV Range – Reference Frame
MV Range – Search Frame
Chroma Search

• Finds where color changes but contrast doesn’t
• Quality improvements with colorful content
  • Crowd shots, motion graphics helped in particular
• Modes:
  • Luma only (default)
  • Luma with nearest-integer chroma
  • Luma with true chroma (best, slowest)
  • Adaptive modes coming in VC-1 SDK
    • Does chroma search where it’s useful
B-Frames

- Number of bi-directional (B-Frames) between I-Frames and P-Frames
- B-Frames based off previous and next I/P frame
- B-Frames need fewer bits for same quality
- No frames are based on B-frame
  - Dynamically insert B-frames for flash frames
  - So frame after flash references frame before
    - No more I-frame with every strobe!
  - Big win for gunfights and raves
- 1 B-frame optimal for most web encoding
Loop Filter

• Short for “In-Loop Deblocking Filter”
• Smoothes out blocking artifacts
  • “In-loop” - used as prediction for future frames
• Only softens where an artifact would appear
  • Much less noticeable at higher resolutions
  • Softness is better than artifacts
• Increases CPU decoder requirements somewhat
• But helps reduce bits needed to hit quality level
Overlap Filter

- Softens edges between blocks
  - Softens image somewhat
  - But reduces artifacts
- Smaller CPU hit than Loop Filter
  - Supported in Simple Profile
- Recommendation
  - On if you see artifacts
  - Otherwise Off
Median Filter

- Ignores noise when calculating motion vectors
  - Keeps grainy/noisy areas from “swirling”
    - Especially with low-bitrate encodes
  - But can leave “trails”
- Recommendation
  - Only use with grainy source, and QA carefully
Denoise filter

- Simple noise reduction preprocessing filter
- Helps when the source is noisy
- Not as good as offline noise reducers
- Recommendation
  - Good for realtime encoding in low light
  - But better to not have noisy source…
Noise Edge Removal

- Removes Line 21, noise around edge of frame
- Handy for real-time encoding of analog sources
- Only use if source has edge noise
Lookahead

- Specifies up to 16 frames forward for analysis
- Used to detect scene changes, flash frames
  - Big improvement for 1-pass CBR encodes
  - Can dynamically insert B-frames with flashes
- Default is Off (Does not look ahead)
- Adds to latency for live encoding
  - ~1/2 second for Lookahead=15 @ 29.97 fps
- Slightly slows encoding as Lookahead increases
- Only used in 1-pass CBR and Quality VBR
DQuant

• “Differential Quantization”
• Different macroblocks compressed different amounts
  • Compress smooth areas less
    • Reducing visible banding and blocking
• Recommendation
  • I and P frames
    • Using on B-frames wastes bits that will be discarded
  • No an “always use” feature
    • Can reduce quality of textured areas of frame
• Lots of levels available
  • “Regular” best choice for web video
• Only available in Advanced Profile
Adaptive Deadzone

- Like DQuant, optimizes bits based on image
- Has a bigger effect, and isn’t always better
- Tends to soften areas of detail
  - But better softer than blocky
  - Emphasizes quality in smooth areas
- Great for preserving film texture at decent bitrate
- Can slightly hurt quality with clean source
  - i.e. 3D rendered animation, motion graphics
- Recommendation: Use 1.0
Optimum Settings: On demand

- Highest quality with reasonable performance
- Encoder complexity = 4/80 (second slowest)
- Motion Search Level = True chroma
- Motion Search Range = Adaptive
- Motion Match Method = Adaptive
- LoopFilter = On
- Overlap = On if artifacts
- Num B Frames = 1
- Buffer Size (streaming) = 8 seconds
  - Assuming Advanced Fast Start and Server 2003
Optimum Settings: Webcasting

• Optimized for reliable real-time encoding
  • Dual-duals almost 4x faster than single core
• Motion Search Range: Adaptive
• Motion Search Level = Luma + integer chroma
• NumBFrames = 1
• LoopFilter = On
• Overlap = On
• Dquant Option = 2 (I and P frames)
• Lookahead = 16 (single most important option)
VC-1 SDK licensing

• What?
  • Commercially licensed VC-1 encoding library
  • Higher quality and faster than current v11
  • Advanced controls and features (via API!)  
  • More frequent updates

• Why?
  • Historically, Format SDK updated every few years
  • But we develop improvements much more often
  • And advanced features most appropriate for high-end professional use
Technical Overview

- Quality/Efficiency improvements
  - Better rate control for more consistent quality
  - Dynamic B-frame placement and bitrate
  - Fade detection and compensation
- Performance improvements
  - SSE4 optimization
  - Skip processing in letterboxing
  - Estimate 2x speed improvement in last year
- Hardware acceleration API
  - Tarari already supporting (5-15x speedup)
VC-1 Live SDK

• New features
  • Lookahead Rate Control
    • No more keyframe popping
  • Real-time stream ad insertion
  • Dynamic Complexity Balancing
    • Adjusts parameters to best use available CPU
  • Simultaneous encode for streaming and IPTV

• Performance
  • Great quality 480i/p in software on 4-core system
  • 720p and 1080i with Tarari
VC-1 Enterprise SDK

• For 2-pass on-demand authoring
  • HD DVD as well as WMV applications

• Features
  • Grid encoding
    • Faster than real-time HD encoding via multiple nodes
  • Segment reencoding/insertion
    • Tweak a single shot and reinsert in encoded video
    • Insert/replace a clip (ad, credits, etcetera)
  • Elementary Stream Analyzer for stream checking
Announced Licensees

- Anystream Agility
- Envivio 4Caster C4
- Harmonic Rhozet Carbon Coder and Carbon Server
- Inlet Technologies Fathom and Spinnaker
- Memory-Tech Digital Movie Factory Pro HD
- Tarari Encoder Accelerator for Windows Media
- ViewCast Niagara SCX Pro and Niagara Streaming Systems

...and a lot more coming
Making Windows Media on Mac
Making Silverlight on the Mac

• Silverlight is:
  • JScript/ECMAScript for coding
  • XML (XAML) for markup
  • Windows Media for Mac
  • No proprietary binary anything!
• All can be authored on the Mac
WMV Authoring on Mac

- **Telestream**
  - **Flip4Mac**
    - QuickTime Export Component for Windows Media
    - Support for Silverlight skinning in latest beta!
  - **Episode**
    - Complete compression tool
  - **Sorenson Squeeze**
    - Also uses Flip4Mac for Mac encoding
- **Main Concept**
  - Long-time codec licensing company
  - Just announced WMV+VC-1 support in new SDK
  - I haven’t been able to test the results yet
To find out more...

- **Me:**
  - ben.waggoner@microsoft.com
  - www.on10.net/blogs/benwagg/
- **Silverlight:**
  - http://www.silverlight.net