8 Commercial Streaming Systems – An Overview

Literature:

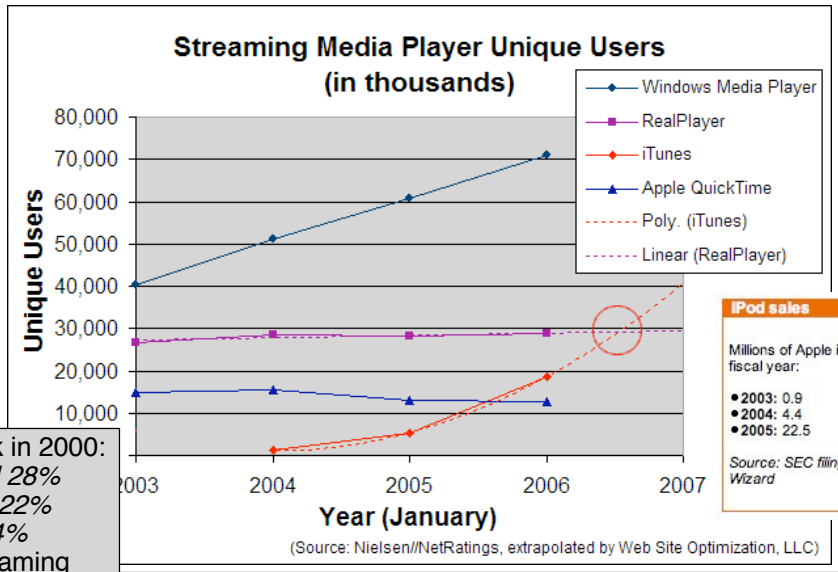
Tobias Künkel: Streaming Media – Technologien, Standards, Anwendungen, Addison-Wesley 2001

David Austerberry: The Technology of Video & Audio Streaming, Focal Press 2002

Actual Usage of Streaming

- 2000/2001 (Media Metrix, according to streamingmedia.com):
  - 99% of U.S. home computers (Windows & Mac) had media player installed
  - Only 47% of users used media player, only 40% used streaming
- 2004 (AccuStream iMedia research report):
  - Total number of video streams served/viewed rose 104% in 2003, following two years of consecutive growth
- 2005 (comScore Media Metrix):
  - In June 2005, more than 94 million people in the U.S., or 56 percent of the domestic Internet population, viewed a streaming video online. Over the three months ending June 2005, the average consumer viewed 73 minutes of streaming video content per month.
  - Possibly 9/11/2001 has caused boost of media streaming industry (D. Gardy)
- Collecting media usage data on streaming has become a profitable business
  - See e.g. www.comscore.com (ComScore took over “Media Metrix”)
  - Therefore recent numbers are difficult to obtain...

Market Shares of Streaming Players



iPod sales

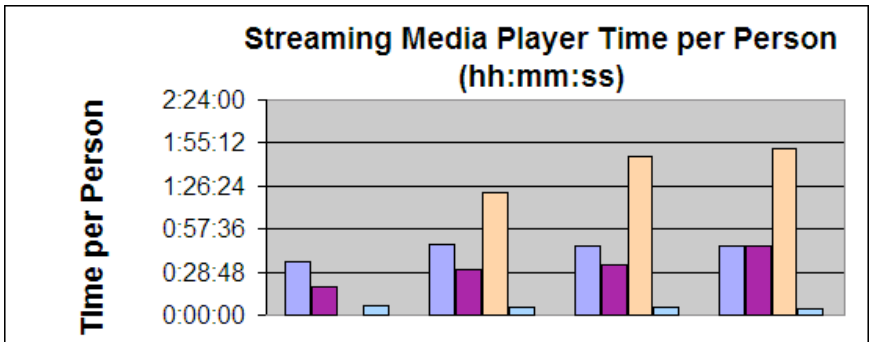
Millions of Apple iPods sold in each fiscal year:

- **2003:** 0.9
- **2004:** 4.4
- **2005:** 22.5

Source: SEC filings via 10(k) Wizard

Back in 2000:
Real 28%
Win 22%
QT 4%
(streaming media.com)

Streaming Media Player Time



	Jan-03	Jan-04	Jan-05	Jan-06
Windows Media Player	0:35:27	0:46:49	0:46:38	0:45:48
RealPlayer	0:18:54	0:30:30	0:33:26	0:46:24
iTunes		1:22:00	1:45:44	1:50:57
Apple QuickTime	0:06:09	0:05:07	0:05:05	0:04:25

Source: Nielsen//NetRatings / WebSiteOptimization.com

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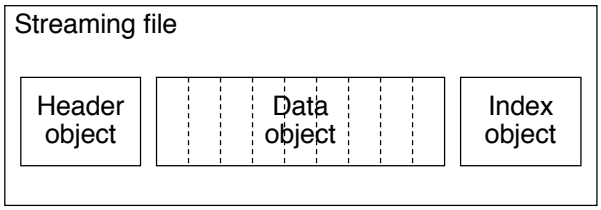
History of RealNetworks

- 1994: Rob Glaser, former Vice President for Multimedia and Consumer Systems at Microsoft, founds *Progressive Networks*
- April 1995: First RealPlayer, RealAudio 1.0 codec
- February 1997: RealVideo 1.0
- September 1997: *Progressive Networks* is renamed into *RealNetworks*
- 1998: RealNetworks buys *Vivo Software*
- 1998: RealSystem G2 (=6.0) (SureStream, RTSP, SMIL, support of various foreign formats)
- 1999: RealNetworks takes over *Xing Technologies* (MP3 developer)
- 2000: RealSystem 8, player becomes similar to a multimedia Web browser, narrowband audio streams up to TV quality video
- 2002: RealOne Player (version 9)
- 2002: “Helix” open source project provides client, encoder and server for Real compatible platform
- 2004: RealPlayer 10, plays also other file formats, integrated Web bowser, CD burning, media search, ...
  - » same quality at 30% lower bitrate than RealVideo 9
  - » same quality at 80% lower bitrate than MPEG-2

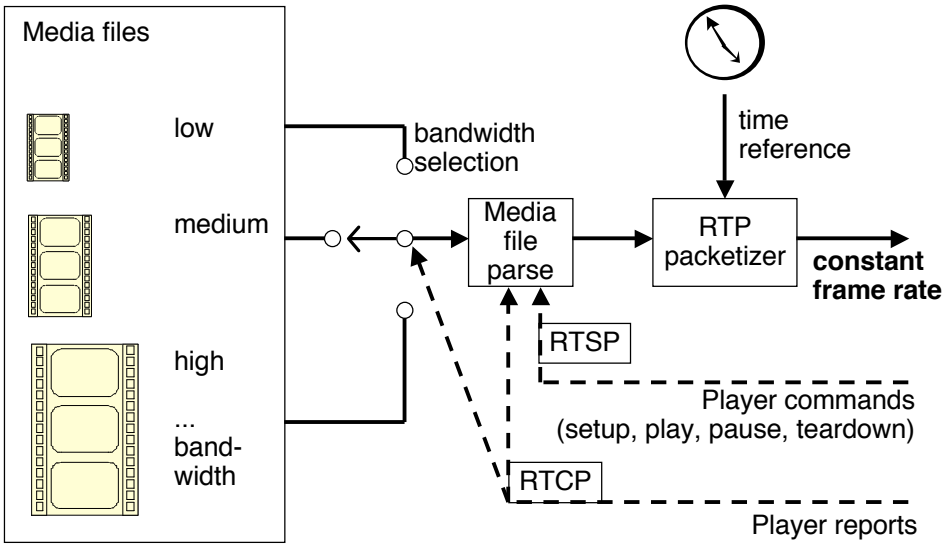
Streaming File Formats



(from ASF)

- Header, Data: As in other audio/video formats
  - Additional timing control information used to manage flow rate
- Index Object: Aid for client navigation
- Main streaming file formats:
  - Microsoft: Advanced Streaming Format (ASF), Windows Media Video (WMV), Windows Media Audio (WMA)
  - RealNetworks: RealMedia (RM), RealAudio (RA)
  - Apple: QuickTime Hinted Movie (MOV)

Adapting to Network Congestion



Realisations for Rate Adaptation

- Multiple bit rate files
  - RealNetworks “SureStream”, Windows Media “multiple bit rate”
  - Several bit rates in one file
  - Compatible only with streaming servers, not with Web servers
  - Adaptation by change of picture size not supported
- Alternate movies (QuickTime)
  - Player receives pointers to assemble the actual program
  - Usable for adapting bit rate and other parameters
  - Usable also for different language versions and other applications
- MPEG-4 Scalable Streams
  - Similar to “progressive” technique in picture compression
  - Basic low-resolution stream transmitted
  - Additional “helper” streams can add more detail and improve quality

RealVideo Codecs

- Mainly proprietary, compression algorithms kept secret
  - Since version 8.0 probably using wavelet or fractal compression
- Versions (mutually incompatible, identified by 4-char codes):
  - RV10+RV13: RealVideo version 5 and 6, based on H.263
  - RV20: RealVideo G2, version 7, used to be very popular
  - RealVideo G2 SVT *(Scalable Video Technology)*
    - » Dynamic control of transmission (frame) rate by client player
  - RV30: RealVideo 8, proprietary
  - RV40: RealVideo 9 and 10, proprietary
- Variable Bitrate Encoding
  - (See next slide)
- Two-Pass Encoding
  - First pass: Analyses video clip before encoding, collects statistical information
  - Second pass: Optimized encoding with parameter settings derived from information obtained in first pass
    - » Not applicable for live streams
- Loss Protection
  - Adds information for error correction and additional key frames

Constant and Variable Bit Rate

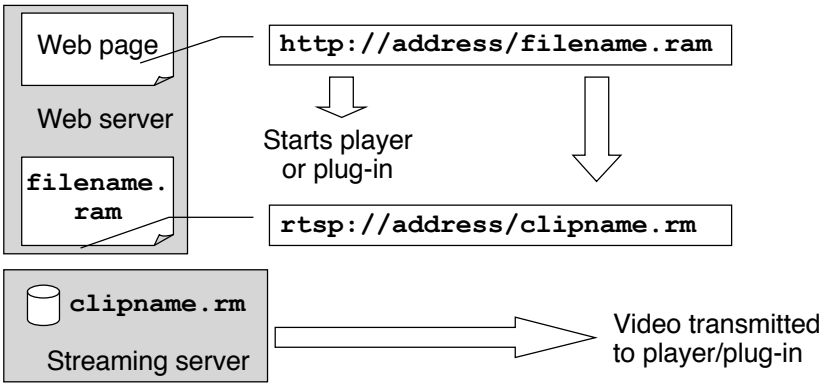
- Constant Bit Rate (CBR)
  - Fixed bit rate (of decoded data stream) independent of content
- Variable Bit Rate (VBR)
  - Low bit rate for simple scenes (e.g. no movements)
  - High bit rate for complex scenes (e.g. quick changes)
  - Average bit rate can be optimized: Scenes “borrow” bandwidth from others
    - » Still an average bit rate limit is obeyed
    - » “Instantaneous bit rate” can be limited
  - Leads to increase of buffer lengths and buffering times
  - Optimal effect in combination with two-pass encoding
- Quality-Based Encoding
  - Maintains steady visual quality of output
  - No limit to average bit rate
    - » “Instantaneous bit rate” can be limited

RealAudio Codecs

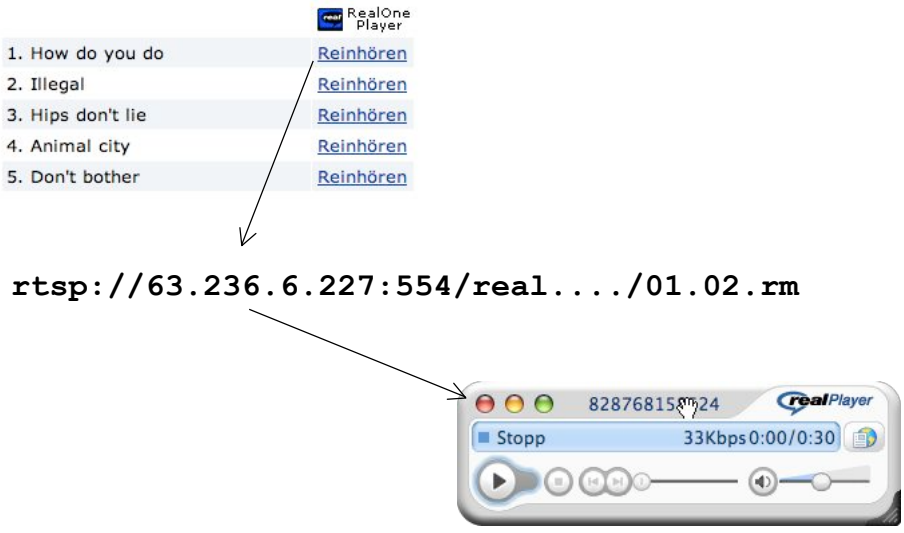
- **Voice**
  - Between 5 Kbps (4 kHz frequency range, 8 kHz sampling rate) and 64 Kbps (20 kHz frequency range, 44.1 kHz sampling rate)
- **Music**
  - Starting from 6 Kbps (3 kHz frequency range, 8 kHz sampling rate)
  - Sophisticated intermediate settings like “20 Kbps Music High Response” (10 kHz frequency range, 20.05 kHz sampling)
  - Up to 64 Kbps
- **Stereo Music**
  - From 16 Kbps to 96 Kbps (using differential stereo encoding)
  - “Broadband Codecs” with Sony ATRAC technology
    - » From 105 Kbps up to 352 Kbps (almost identical to CD quality)

Indirect Web Links

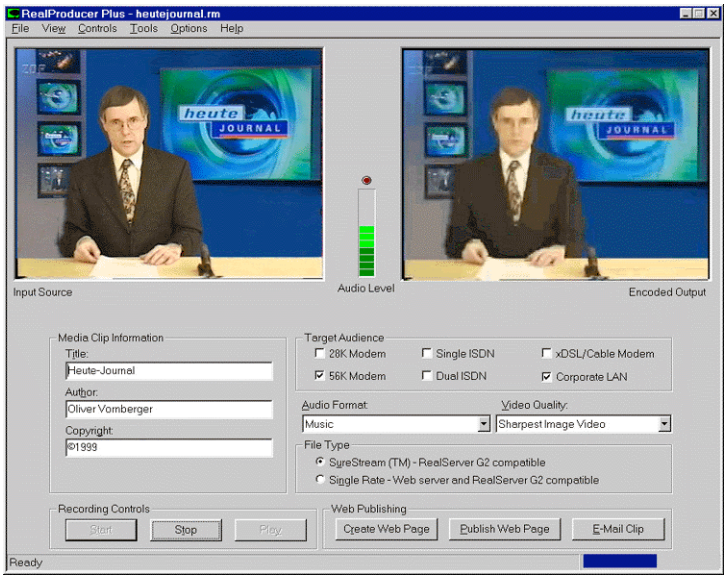
- Web link points to small file containing the actual media file link
  - Real: “Real Audio Metafile” (RAM)
  - Microsoft: “Stream redirector” (ASX)
- Metafile may contain list of files (playlist)



Example for Indirect Links to Stream Files



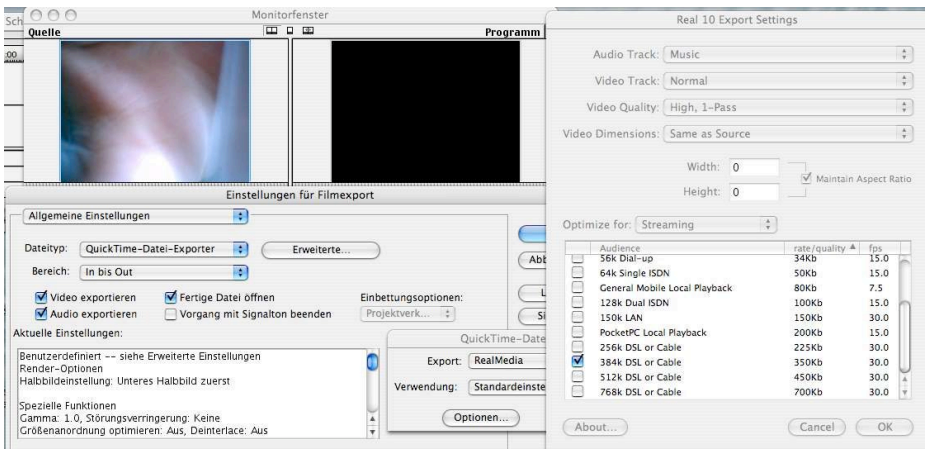
RealProducer



Open source variant: HelixProducer

Real Plugin

- Plugin solution to embed production into many video editing applications on MacOS
  - Example: With Adobe Premiere



Typical Video Filters

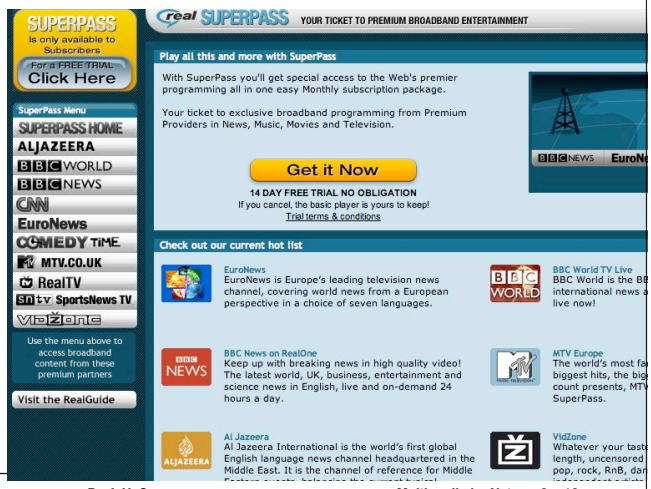
- Noise filter
  - Remove “snow” (often originating from antenna signals)
- Resizing filter
  - Quick or fast methods to compute a smaller version of the video
- De-Interlacing filter
  - Remove “jagged” contours resulting from overlaying two half-pictures
- Inverse-Telecine filter
  - In particular relevant for US standards (Movie 24 fps, NTSC 29,97 fps)
  - NTSC signal is converted by “3:2 pull-down”, adding additional half frames
  - Filter removes added frames
- General principle:
  - High picture quality leads to low encoding speed

Capturing in RealPlayer

- Recording of streamed content
  - Only in premium versions of player
- Restrictions during production
  - Streams have to be explicitly enabled for being recorded in the client
- Simple Model of Digital Rights Management

Content & Technology in One Business Model

- See website www.real.com and the *RealGuide*
  - Free player
  - Subscription to
    - » Live content, e.g. news
  - Downloads
    - » E.g. music
- Similar (and even more successful):
  - Apple iTunes + iTunes Music Store
  - 3 million songs sold per day....



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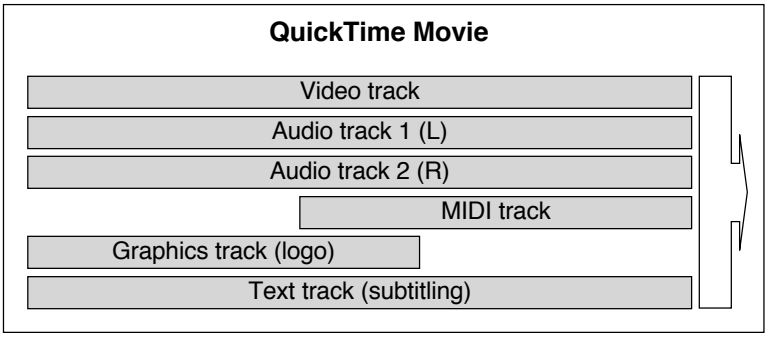
QuickTime

- Popularity (according to Apple)
  - QuickTime 6: 350 million downloads, 98% by Windows users
  - 25,000 Web sites refer to QT player download
- Platform independence
  - QuickTime player available for Windows and MacOS
  - (Streaming server available only for MacOS)
- Digital cameras
  - Many photo cameras use QuickTime for recording small video clips
- Records of live Internet streaming events
  - Live Webcast of Steve Jobs' keynote speech at MacWorld 2002 (QuickTime)
    - » 81,000 simultaneous viewers, 160,000 Web visitors
    - » Peak total serving bandwidth 16,5 Gbit/s
  - NASA Space Shuttle Return to Flight Launch July 2005 (Real/Windows)
    - » 430,000 simultaneous webcast streams (NASA/Yahoo/Akamai)
    - » Peak total serving bandwidth 50 Gbit/s

QuickTime Tracks

- Modular and flexible architecture
  - Multimedia files organized in tracks
  - Example:



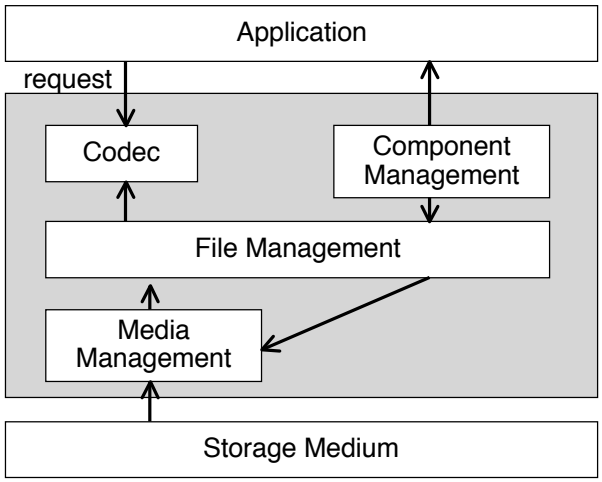
Types of QuickTime Tracks

- Movie track: Copyright info, annotations, ...
- Audio track(s)
- Text track: Titles, subtitles, credits, notes, ...
- Sprite track: Images with animatable, programmable behaviours
- Flash track: SWF animation
- QuickTime VR track: VR objects, panorama movies
- Video track: Digital video, 3D animation, ...
- Music track: MIDI
- Chapter track: Inserts addressable entry points
- 3D track: Contains QuickDraw 3D metafile objects
- Streaming track: References to streams from a server source
- Hint track: Additional information for streaming (see below)

Typical QuickTime Codecs

- Video
  - Animation: Specially for large coloured areas
  - BMP: High-quality import/export
  - Cinepak: Exchange format for other platforms and old versions
  - Component video (3:2 compression, YUV colour model)
    - » High quality capturing with low CPU load
  - DV Stream (10:1 compression)
    - » Specially for capturing from DV devices (over FireWire)
  - H.261, H.263, H.264
  - Sorenson Video: Excellent compression/quality rate
  - ...
- Audio
  - IMA 4:1 (CD music quality with 80 kbps)
  - QDesign Music (comparable to MP3)
  - QualComm PureVoice

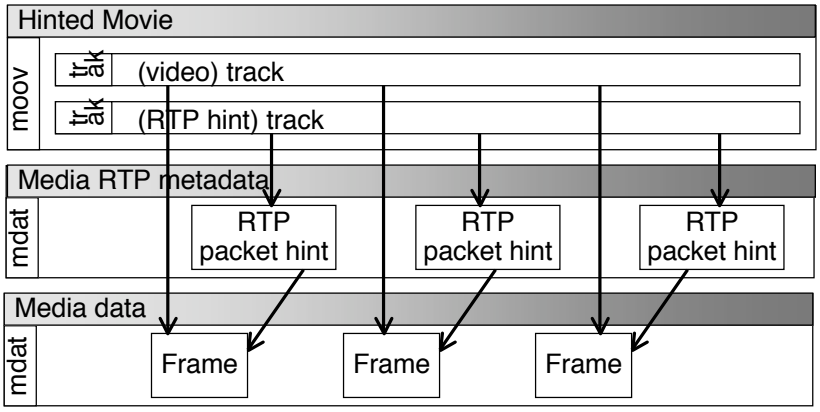
QuickTime Media Abstraction Layer



Interactivity in QuickTime

- Movies or video tracks as clickable links
  - "HREF tracks" allow dynamic change of target during runtime
- Sprites can react to system events (like mouse movement)
- Flash animations can be fully integrated
  - e.g. movie controllers developed in Flash
  - more efficient animations (vector-based)
- JavaScript support
- Full QuickTime API
  - Available also for Java (QuickTime for Java)

Hint Tracks in QuickTime and MPEG-4



- Hint track gives server software pointers to the RTP information to serve the relevant media chunks
- Concept from QuickTime, integrated in MPEG-4 (streaming)

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History of Windows Media

- 1991-1992: Multimedia extensions of Windows 3.0
  - Playback of AVI
- 1992-1996: Netshow 1.0
  - First experiments with OnDemand Streaming
- 1997-1999: Windows Media Technologies in Windows 98
  - Completely reworked version of NetShow
- Since 2000:
  - Strong emphasis on compression/quality ratios comparable to competitors Real and Apple
- Current version 2006:
  - Windows Media Services 9
  - Windows Media Player 11
- General impression: Duplication of many concepts from Real
  - Few special features: E.g. screen capturing
- Digital Rights Management is intrinsic part of Windows Media

Windows Media and MPEG-4

- Windows Media MPEG-4 Video V3
  - MPEG-4 based Microsoft implementation
  - Probably used as a quick-start to catch up with competitors
- Windows media Video V7 and higher
  - No longer compatible with standard MPEG-4
- ISO MPEG-4 Video
  - Special, additional codec for MPEG-4 standard

Market Trends for the Future

- Generally, integrating platforms become more important than individual players/formats
  - QuickTime player can play WMA/WMV using Microsoft plugin
  - iTunes comprises QuickTime player (and more)
  - Windows media player 11 as control device for digital media receiver in the home
- New competitors enter the market all the time
  - E.g. playing video through Abobe Flash
  - E.g. using game consoles as video streaming platform (Xbox 360)
- High definition content is coming up
  - Major players are already “HD ready”