

CODECS AND COMPRESSION

An overview of main concepts and standards

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Run through most common compression standards and formats

Images • Audio • Video

Pros and cons of each format

Clarification on some confusing terminologies

Codecs vs File Formats

Image

JPEG GIF

PNG BMP TIFF

File Formats

.3gp .mov .mp4

.avi .mp3 .mpg

Audio

WAV FLAC

MP3 AAC

AMR Vorbis MIDI

Video

H.264 MPEG4

MPEG2 DivX

VP8 WebM

Lossless | **Lossy**

Images



BMP, TIFF

Almost uncompressed formats

Not used on the web, large dimensions

Allow multiple edits

Hi-quality processing

.bmp, .tiff files

JPEG

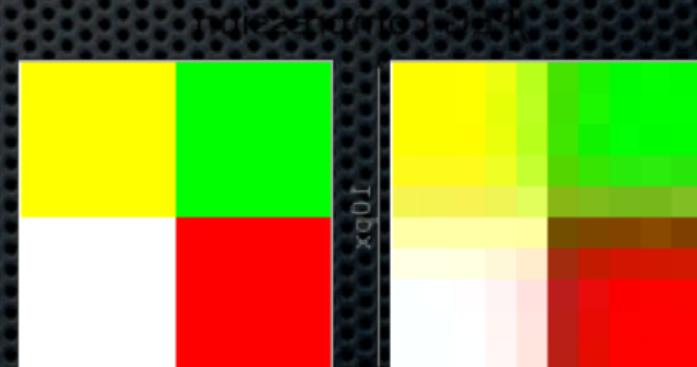
Most common lossy compression format for photography

10:1 compression with minimum degradation

Not suitable for file editing, vector shapes and text drawing (artifacts)

No transparency

File Format: JPEG/Exif , .jpeg files



GIF

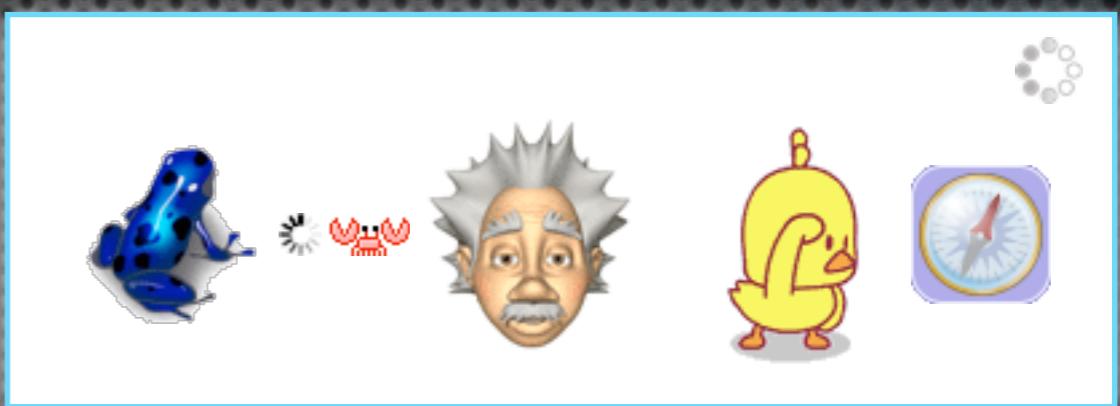
Popular file format, especially for little images, logos, animations

max 256 colors - dithering

Limited transparency (only 1 color)

Best replaced by PNG

Still the most used format for simple animations



PNG



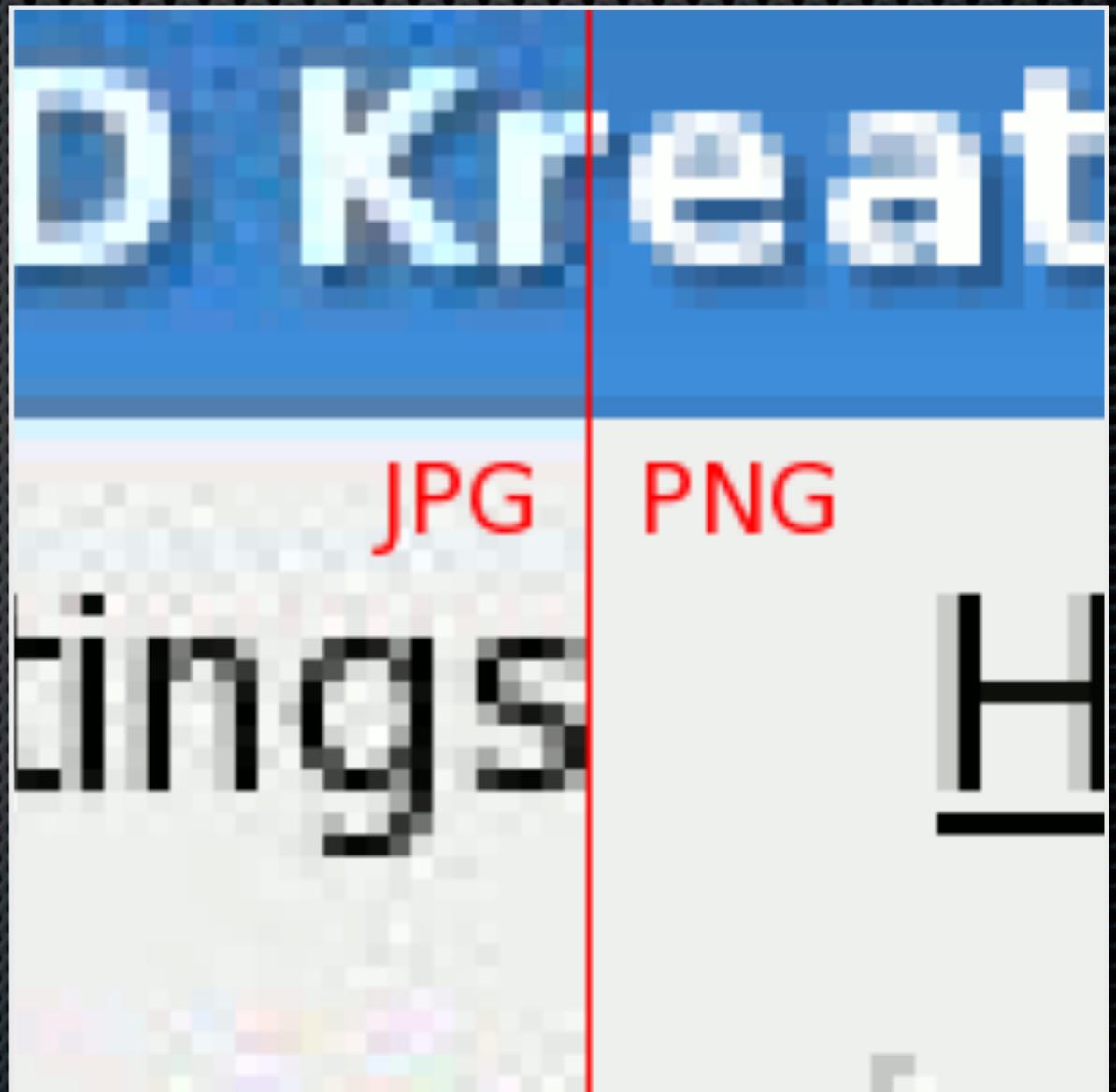
Born as improvement on GIF

Better compression for graphics
and vectors

Loseless format, 8-bit alpha
blending

Not fully supported by old
browsers

.png files





Original: "Untitled-1"
87,9K



no transparency

JPEG
1,987K
1 sec @ 1 Mbps

60 quality



full transparency

PNG-24
980 bytes
1 sec @ 1 Mbps



Just 1 bit transparency

GIF
1,835K
1 sec @ 1 Mbps

88% dither
Selective palette
64 colors

Pixel • Resolution • dpi • ppi

A lot of
confusion

PPI is the bridge between
digital and physical world

*Monitors display pixels, and
printers produce dots*

Screen 72 ppi,
Print 300 ppi
Fine Art 600 ppi

Pixel • Resolution • dpi • ppi

I want a 30x40 cm print
12"x16" inches at 300 ppi is 3600x4800

RECOMMENDED RESOLUTION SETTINGS			
Print Size	150ppi(Good) MegaPixels	300ppi(Best) MegaPixels	
4 x 6	600 x 900 < 1	1200 x 1800	2
5 x 7	750 x 1050 1	1500 x 2100	3
8 x 10	1200 x 1500 < 2	2400 x 3000	7
11 x 14	1650 x 2100 3	3300 x 4200	14

Audio



Loseless

Best Quality

Audiophile, Archive, Editing, Hi-Fi

FLAC, WMA Loseless, Dolby TrueHD

Lossy

Psycoacoustics

Some info not perceived by the auditory system

High frequencies, tones covered by a louder sound (masking)

AAC

AAC+

E-AAC+

WAV

MP3

Vorbis
WMA

AMR-NB

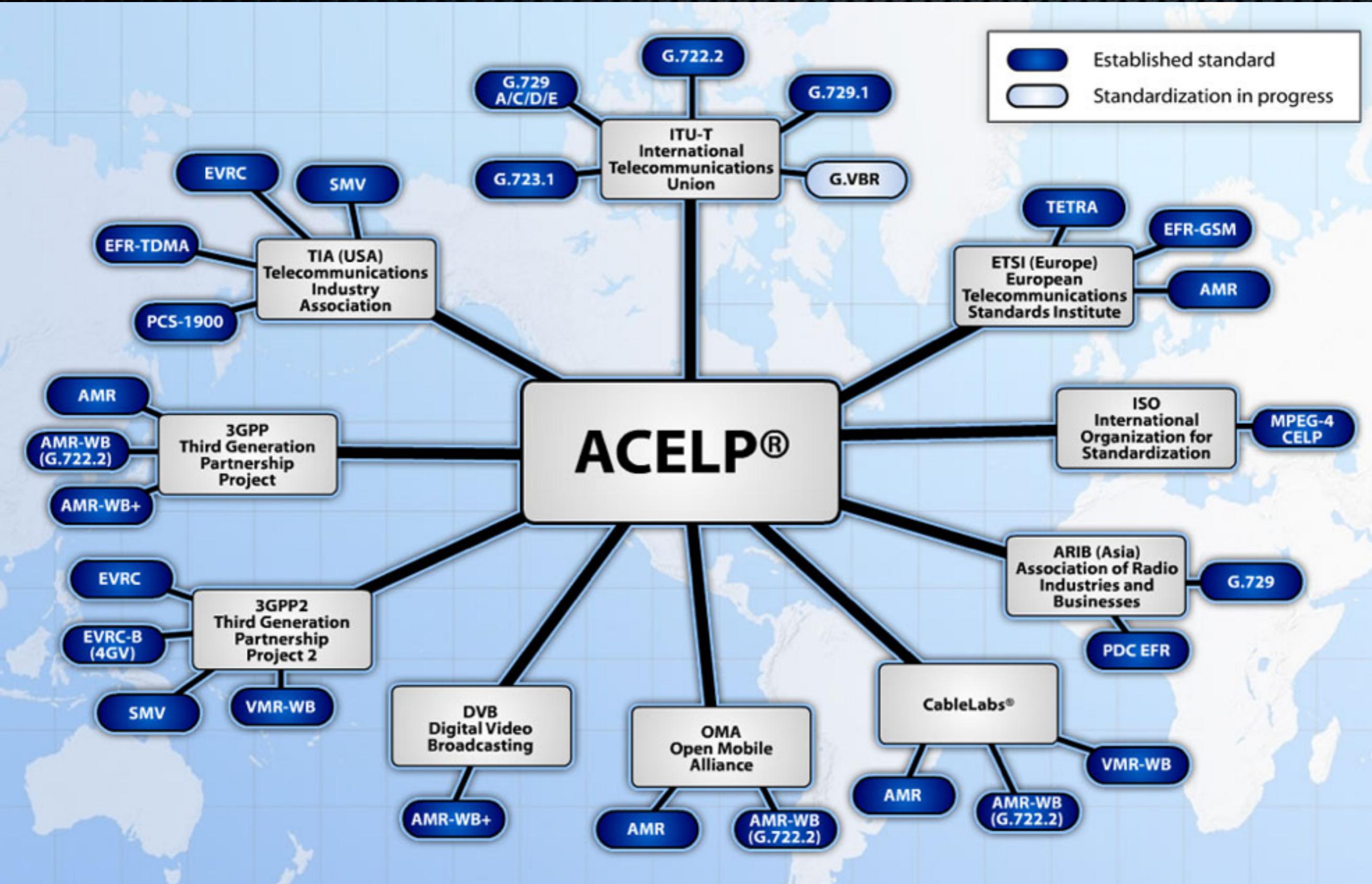
AMR-WB

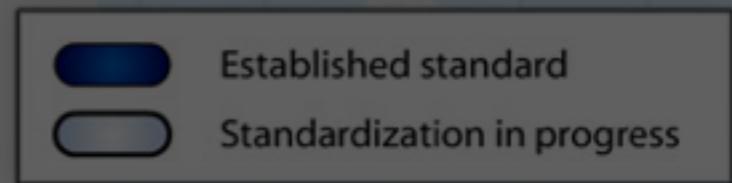
AMR-WB+

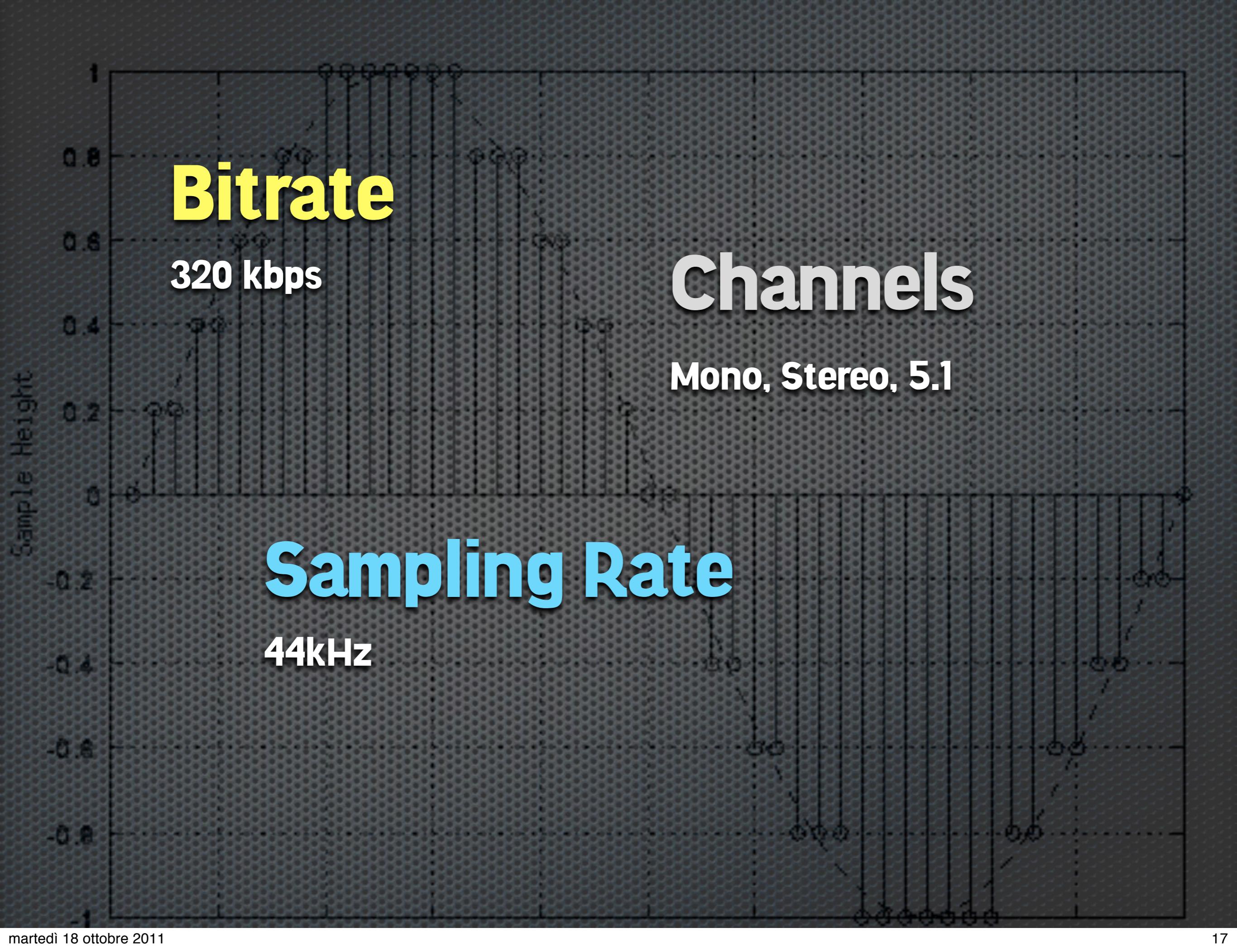
MIDI

File formats

.3gp, .mp4, .m4a, .3ga, .mp3, .aac, .amr, .ogg







MP3



Most common lossy compression
format

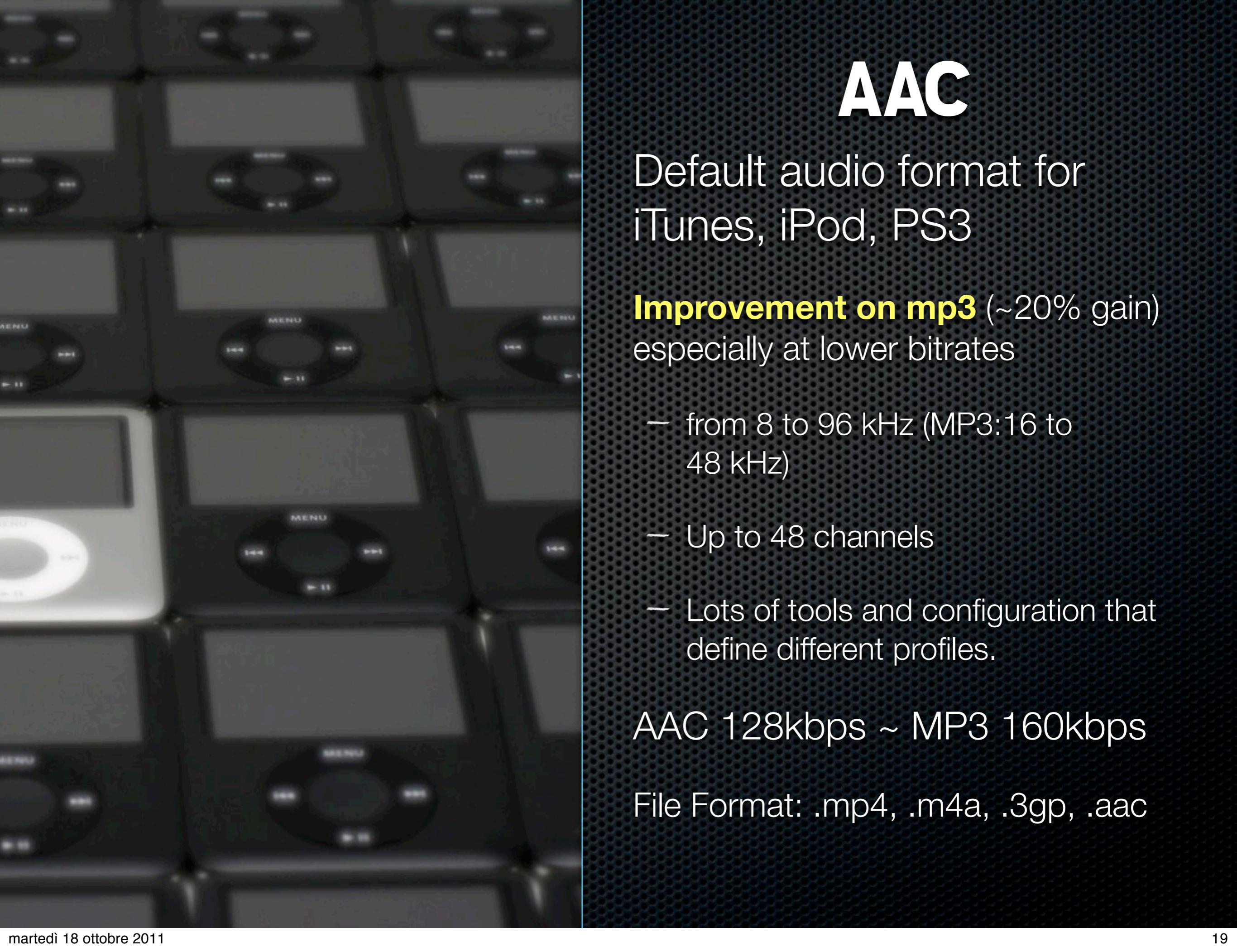
128kbps(Radio Quality)

192kbps(CD)

320kbps(Hi-Quality)

Lots of songs in your
pocket

File Format: only .mp3 files



AAC

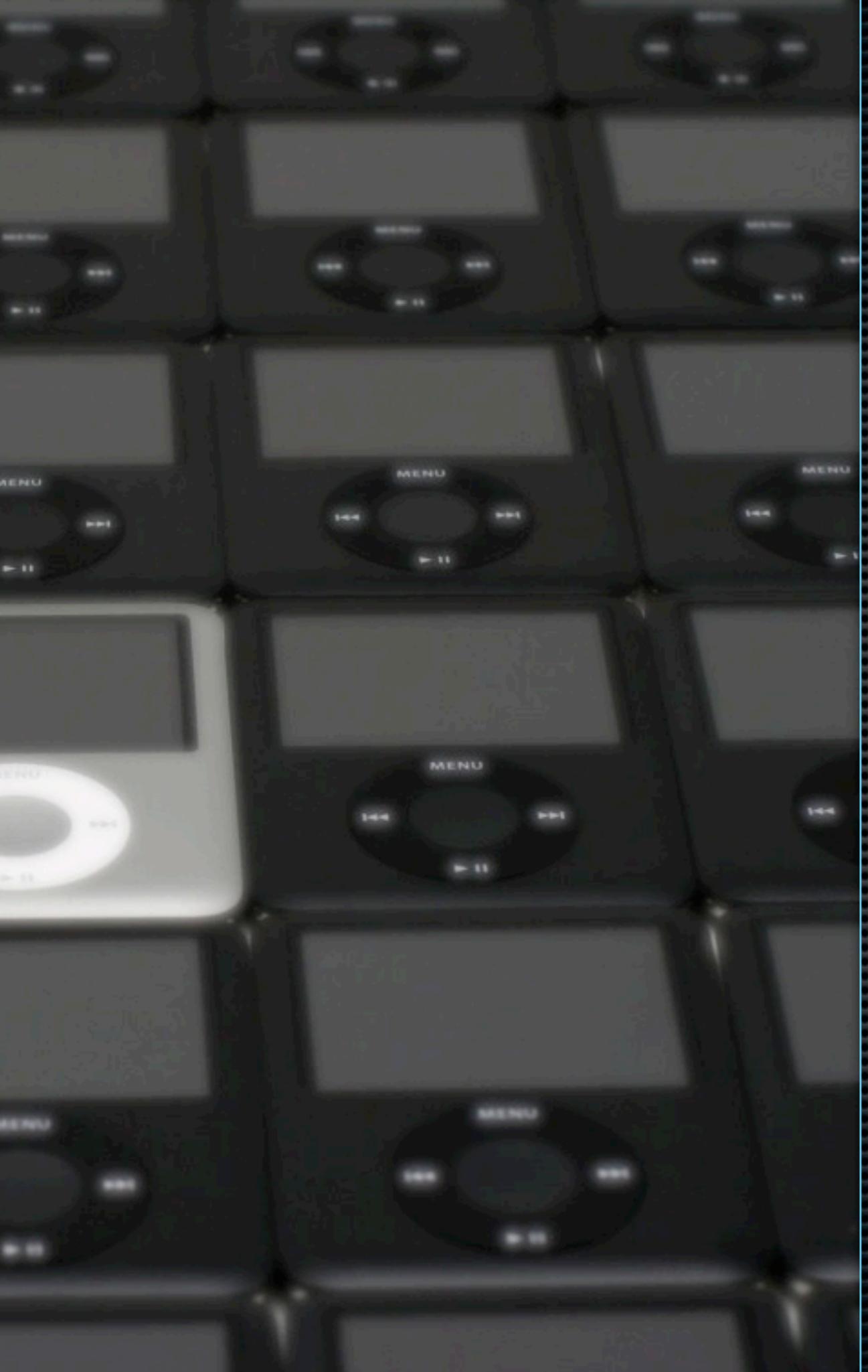
Default audio format for
iTunes, iPod, PS3

Improvement on mp3 (~20% gain)
especially at lower bitrates

- from 8 to 96 kHz (MP3:16 to 48 kHz)
- Up to 48 channels
- Lots of tools and configuration that define different profiles.

AAC 128kbps ~ MP3 160kbps

File Format: .mp4, .m4a, .3gp, .aac



AAC+

Enhanced AAC+

Version	Common trade names	Codec feature	Standards
HE-AAC v1	aacPlus v1, eAAC, AAC+, CT-aacPlus	AAC LC + SBR	ISO/IEC 14496-3:2001/Amd 1:2003
HE-AAC v2	aacPlus v2, eAAC+, AAC++, Enhanced AAC+	AAC LC + SBR + PS	ISO/IEC 14496-3:2005/Amd 2:2006

Spectral Band Replication

creation of higher frequencies by an approx. of lower harmonies (psycoacoustics)

AAC 60kbps = AAC+ 48kbps
AAC+ 32kbps >> AAC 48kbps

Parametric Stereo

Downmix of 2 stereo channels into a mono channel along with PS info

Works at low bitrates (~24kbps)
> 48kbps is transparent
Backward compatible

AMR–NB

Low quality for speech - Based on ACELP®

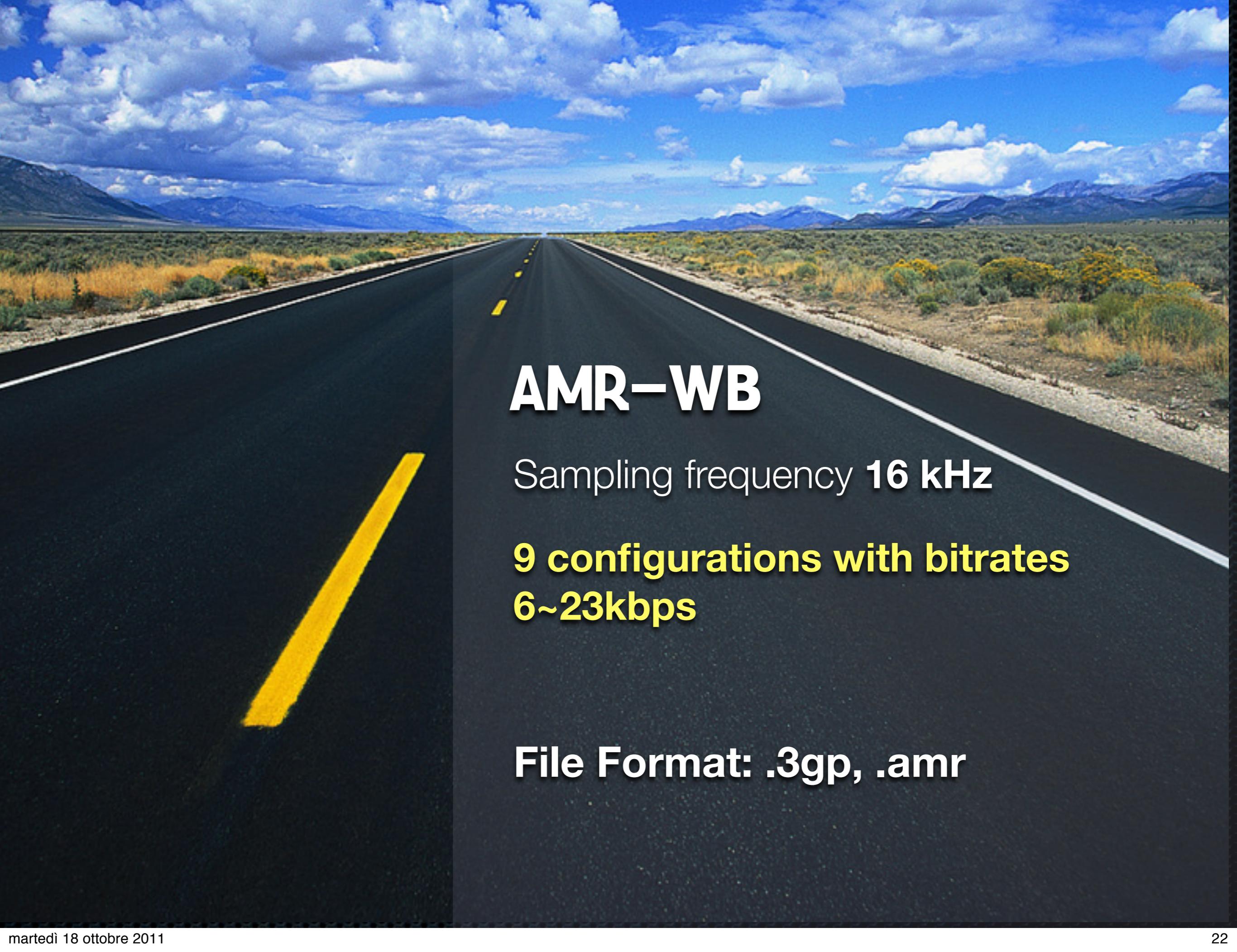
Sampling frequency 8 kHz

8 source codecs with bit-rates range 4kbps~12kbps

Link adaptation

on low signal condition the codec switches to lower bitrate

AMR utilizes Discontinuous Transmission (DTX), with Voice Activity Detection (VAD) and Comfort Noise Generation (CNG) to reduce bandwidth usage during silence periods



AMR-WB

Sampling frequency **16 kHz**

**9 configurations with bitrates
6~23kbps**

File Format: .3gp, .amr



Video

Frame rate

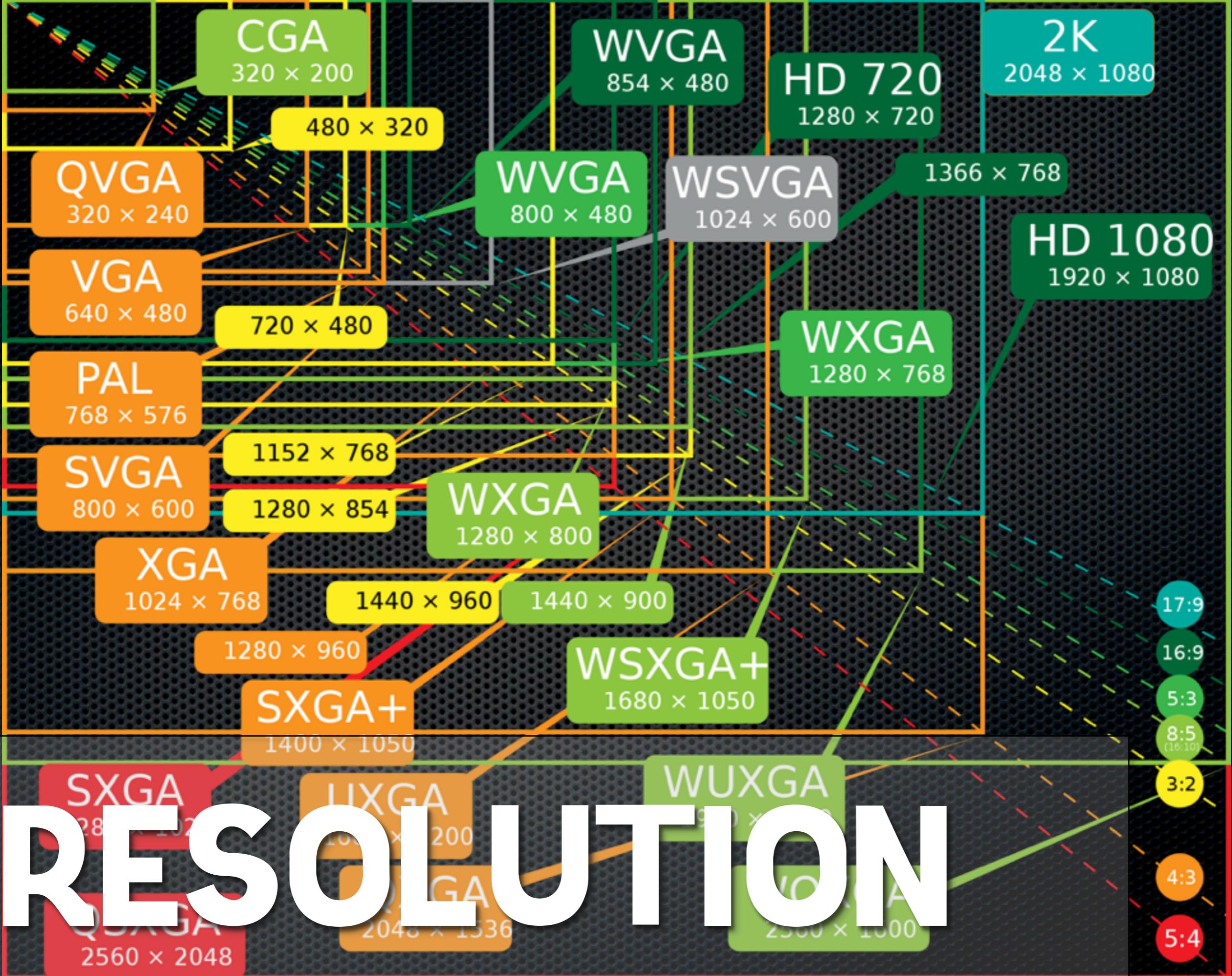
25 fps

Bit Rate

Variable, Constant

Resolution

QVGA, VGA, 720p, 1080p



FRAME RATE

Number of still images in a time unit

10 fps is the minimum frame rate to achieve motion illusion.

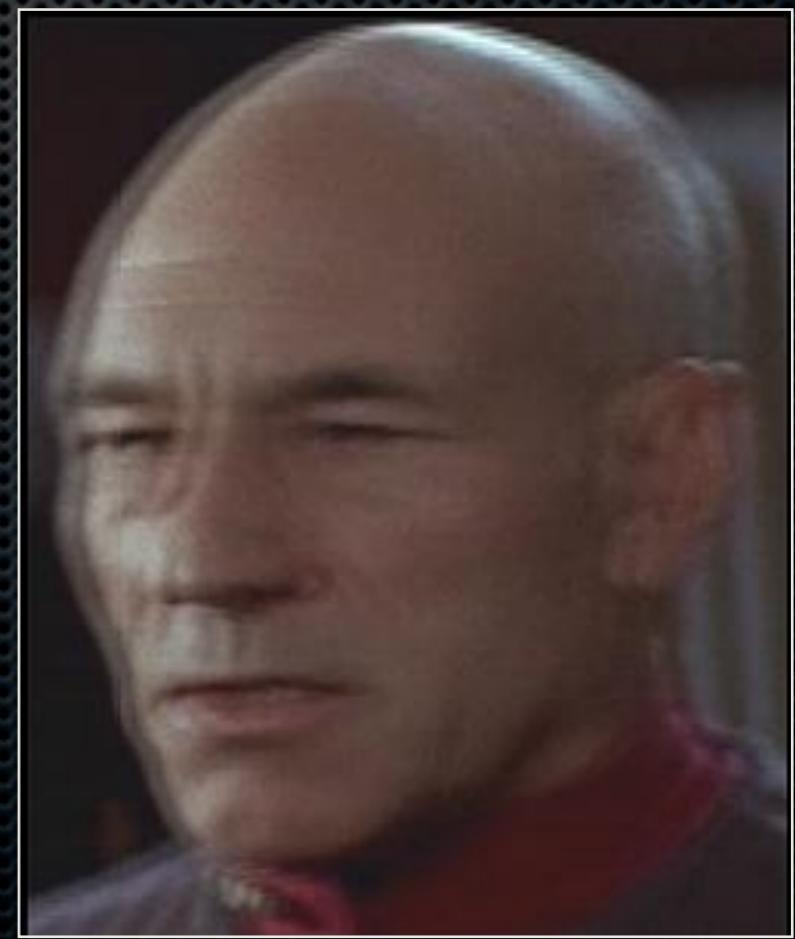
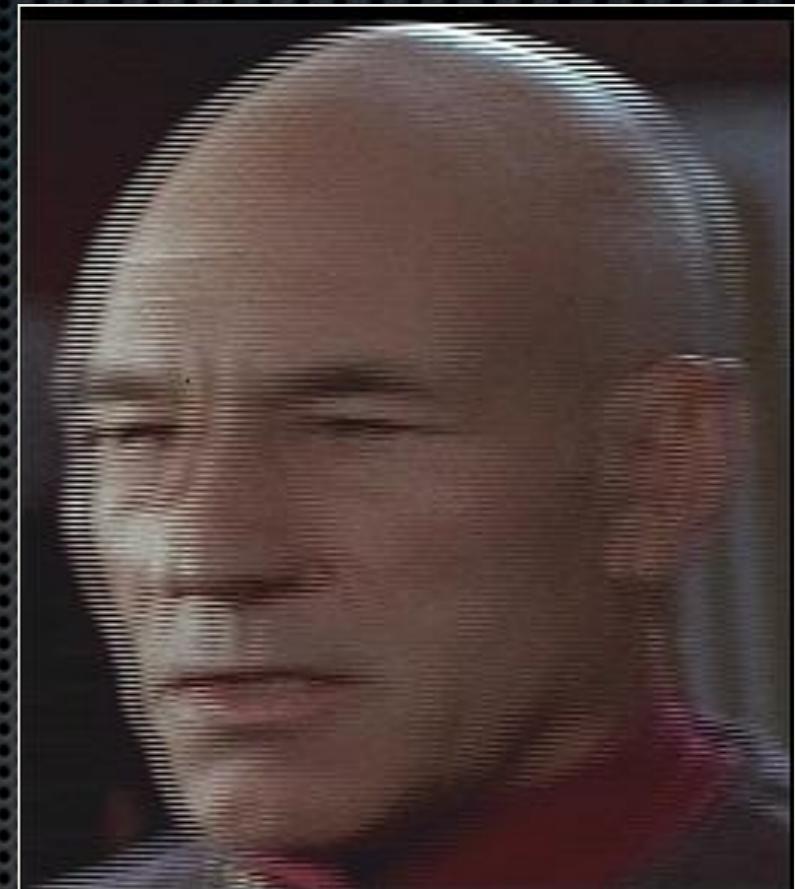
Deinterlace

Due to old TVs and technology limits

Not possible to shoot fluid full frame videos
(max 25fps)

Half the frame in two subsequent instants

Progressive displays have to reconstruct
the full frame but the result is not pleasant

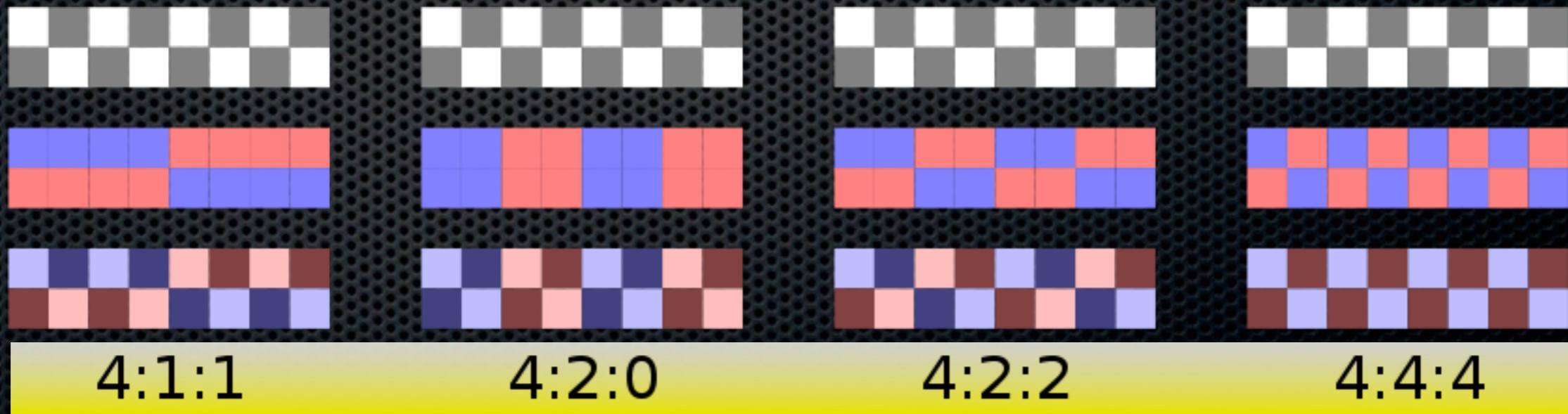


DEINTERLACE ALGORITHMS

Chroma Subsampling

Human eye is **less sensitive to color than luminance**

Bandwidth can be optimized by storing more luminance detail
than color detail
(cones are two times rods)



Common codecs

MJPEG

Sequence of JPEG frames
Easy to process
Highly inefficient
.avi files

MPEG2

Widespread codec for many years
On DVD, DVB, Satellite
Not suitable for low bitrates
.mpg files

MPEG4

Improvements on MPEG2
Used in DivX, Quicktime
.mp4, .m4v, .mov .divx .avi

H.263

developed by ITU-T in 1995
Low bit rate encoding
H.323 (RTP/IP video conf RTP/IP),
H.320 (ISDN video conf), RTSP
(Streaming) and SIP.

H.264

Blu-ray Discs

Streaming (Vimeo, YouTube, and the iTunes Store)

Web software (Adobe Flash Player, Microsoft Silverlight)

Broadcast services for DVB

Direct-broadcast, cable television services

Real-time videoconferencing

H.264

High **efficiency** (50% compared to MPEG-2)

Lot of tools and algorithms that can be combined in different profiles and levels

Quality depends also on the encoder implementation.
H264 defines the structure and the tools but the intrinsic algorithms are open for improvement.

Other codecs

VC-1

Started by Microsoft as a proprietary protocol and released in 2006 as a SMTPE standard

Used In HD-DVD, BlueRay, Silverlight, Windows Media (.wmv)

Theora

Open Codec Developed By Xiph.org

OGG Container And Matroska (.mkv)

Same Performance As MPEG4 Part 2 Codec

The Future



WebM

WebP

H.265

JpegMini

JpegXR

AMR-WB+



Original

JPEGmini

Download
Photo

JPEGmini

322KB

Original

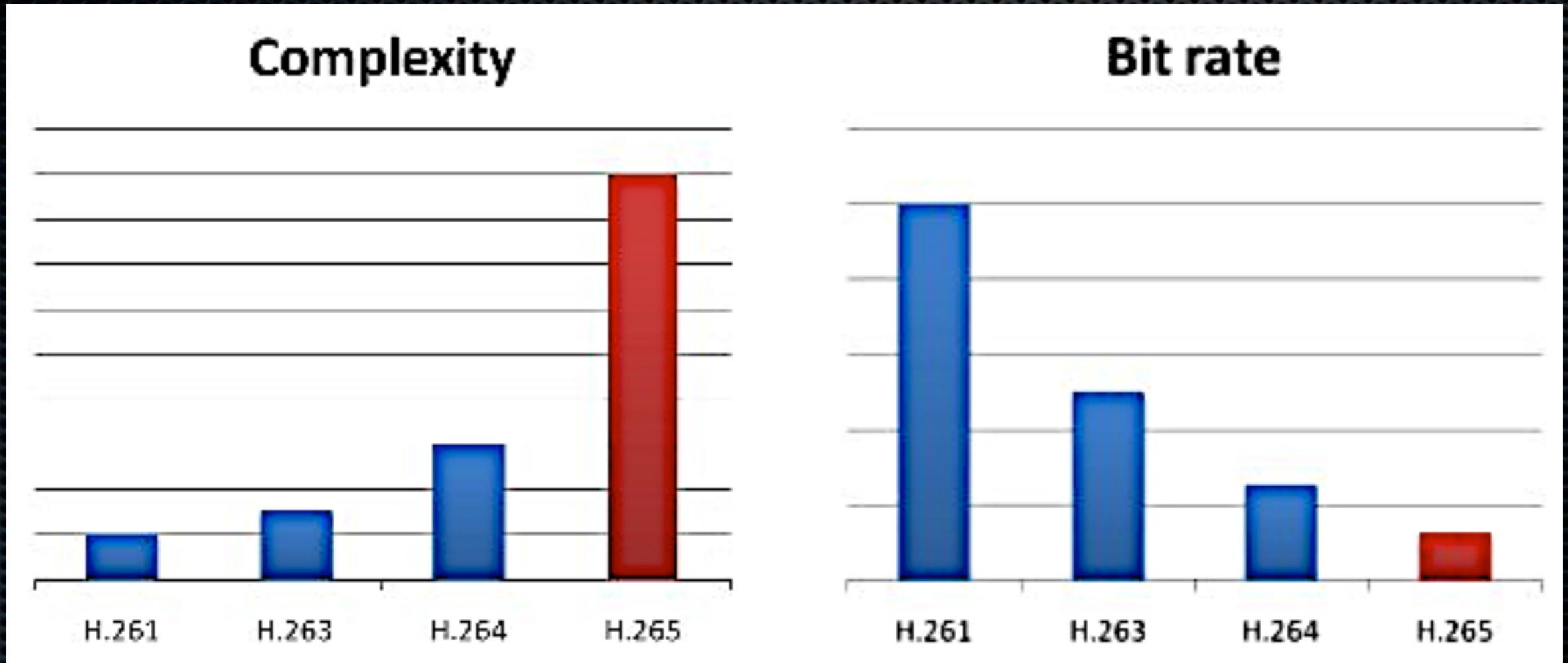
1626KB

THIS PHOTO
REDUCED BY

5X

H.265

High Efficiency Video Coding (HEVC)



50 percent increase in efficiency and 3 times complexity

H.265 – Timeline



Higher Resolutions

UHD

HD

SD

Focus is not on encoding but on **delivery**

Dull scene for codecs lately

Adaptive Bit Rate Streaming

Product	Technology	As Of Version	Vendor	Notes
Android		3.0 Honeycomb ↗	Google	
VLC		1.2 ↗		note ↗
iOS		3.0	Apple	
iPhone	iOS	iOS 3.0	Apple	
iPad	iOS	All with iOS 3.2	Apple	
iPod Touch	iOS	iOS 3.0	Apple	
QuickTime Player		10+	Apple	
Roku Digital Video Player		Roku OS / SDK 2.6	Roku	

HTTP Live Streaming
Apple

HTTP Dynamic Streaming
Adobe



Questions?