

# **Updates in MPEG-4 AVC (H.264) Standard to Improve Picture Quality and Usability**

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**January 2005**

# Overview of MPEG-4 AVC

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- **End of 2001: ISO/IEC and ITU-T started joint project to develop advanced video coding standard known as MPEG-4 AVC or H.264.**
- **Spring of 2003: The basic specification of MPEG-4 AVC (H.264) was approved with the following profiles**
  - Baseline Profile – Mobile phones
  - Extended Profile – Broadband streaming over lossy channels
  - Main Profile – Broadcast, DVD, etc
- **Fall of 2004: The Fidelity Range Extension Amendment was approved, adding picture quality enhancement tools and defining following new profiles**
  - High Profile – Broadcast, optical disc recording, etc.
  - High 10 Profile – Surveillance, high performance display applications
  - High 4:2:2 Profile – Broadcasting and professional video equipment
  - High 4:4:4 Profile – Professional video equipment

# New Profiles from Fidelity Range Extension

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## □ New Profiles

- High Profile
  - 8-bit luma and chroma samples with 4:2:0 chroma format
  - Monochrome pictures
- High 10 Profile
  - 8, 10-bit luma and chroma samples with 4:2:0 chroma format
  - Monochrome pictures
- High 4:2:2 Profile
  - 8, 10-bit luma and chroma samples with 4:2:2 and 4:2:0 chroma format
  - Monochrome pictures
- High 4:4:4 Profile
  - 8, 10, and 12-bit luma and chroma samples with 4:4:4, 4:2:2, and 4:2:0 chroma format
  - Monochrome pictures

# Examples of Frame Rates and Picture Size at Different AVC Levels



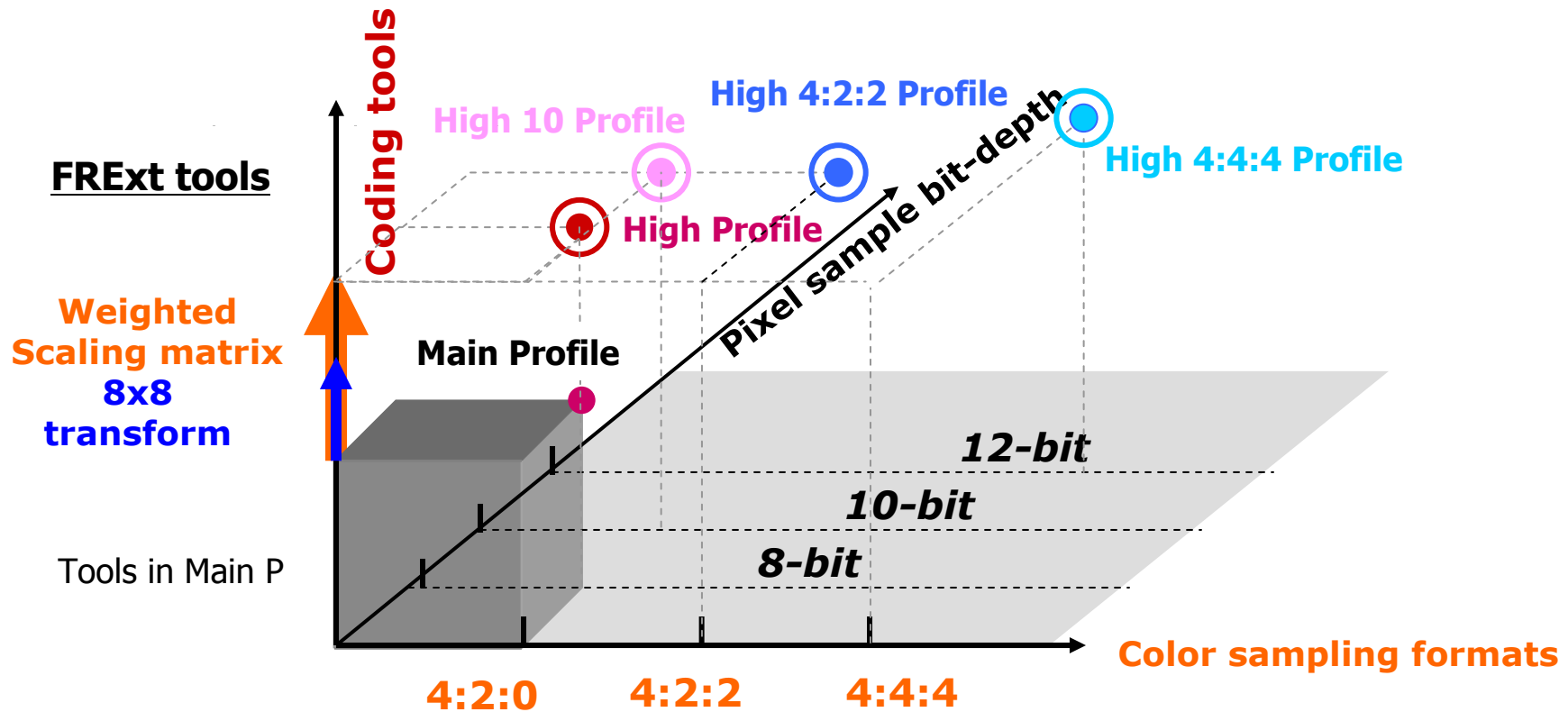
	<b>3.0</b>	<b>3.1</b>	<b>3.2</b>	<b>4.0</b>	<b>4.1</b>	<b>4.2</b>	<b>5.0</b>	<b>5.1</b>
<b>Example 1 Picture resolution /Frame-rate</b>	<b>625 25fps</b>	<b>720p HD (1280x720)  30fps</b>	<b>720p HD  60fps</b>	<b>2Kx1K  30fps</b>	<b>2Kx1K  30fps</b>	<b>2Kx1080  60fps</b>	<b>16VGA  30fps</b>	<b>4Kx2K  30fps</b>
<b>Example 2 Picture resolution /Frame-rate</b>	<b>525 30fps</b>		<b>SXGA 42fps</b>	<b>720p 68fps</b>	<b>720p 68fps</b>	<b>1080HD 64fps</b>	<b>3672x1536  24fps</b>	<b>4096x2304  24fps</b>

# New coding tools in MPEG-4 AVC

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- **All new profiles from Fidelity Range Extension include the following new coding tools. They significantly improves subjective picture quality in high resolution pictures**
  - 8x8 transform
  - Quantization weighting matrix
  - Lossless coding
  
- **For High 4:4:4 Profile**
  - Residual Color Transform improves coding efficiency at very high bitrate
  
- **Other tools**
  - Alpha plane coding

# MPEG-4 AVC Main, High Profiles, and the Superset MPEG-4 AVC Fidelity Range Extension



MPEG-4 AVC Main profile

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8x8 transform  
Weighted Scaling Matrix

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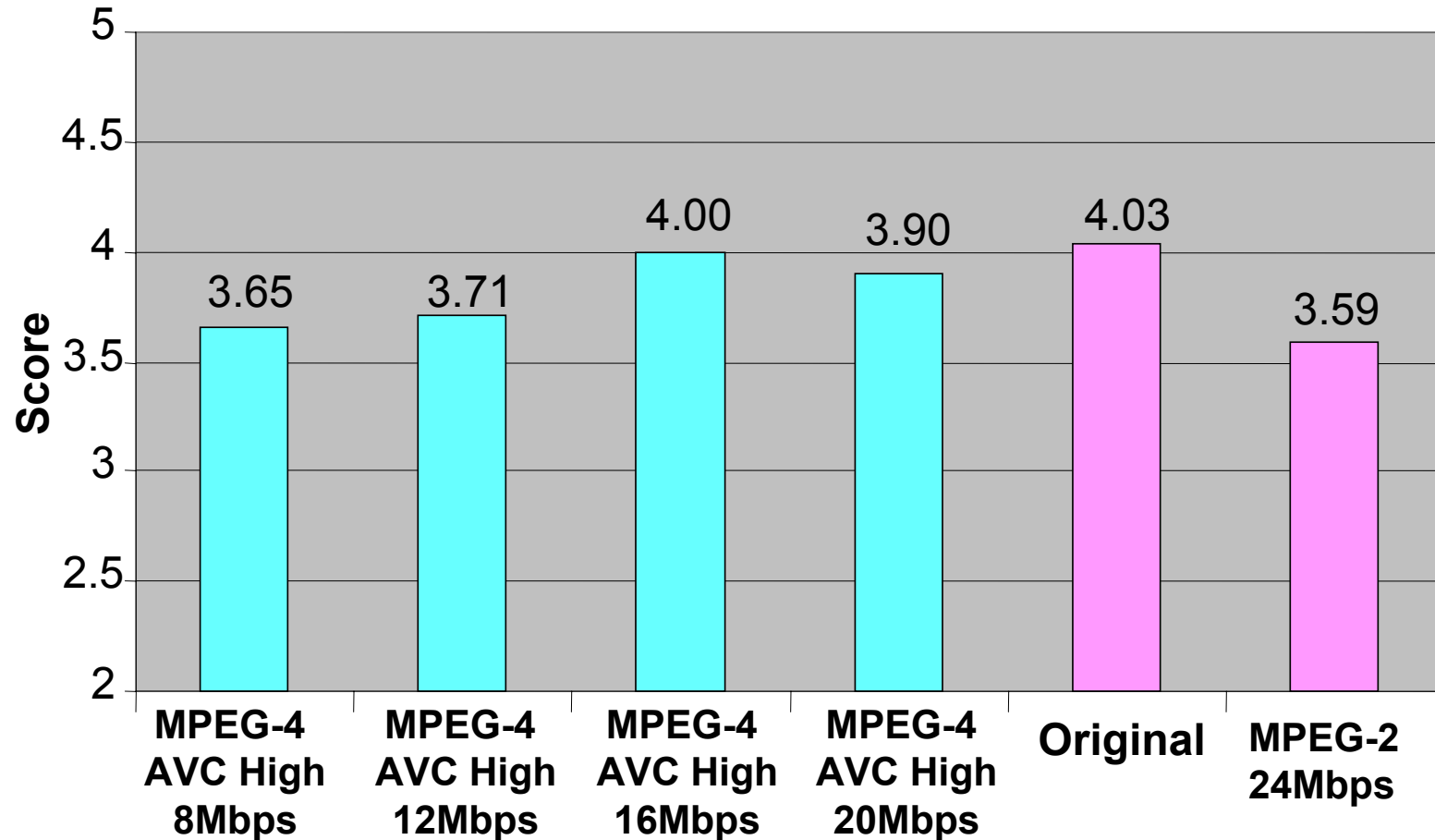
MPEG-4 AVC High Profile

# History of picture quality improvement in MPEG-4 AVC – Demonstrated by BDA evaluations



- **1<sup>st</sup> Subjective quality evaluation of AVC Main Profile by BDA in 2/2003 – MPEG-2 is better**
  - Subjective picture quality of MPEG-2 was rated better than MPEG-4 AVC by picture quality assurance experts from movie studios.
    - At 24mbps
      - MPEG-2 was acceptable for almost 100% test materials
      - MPEG-4 AVC was acceptable for only 50% of test materials
    - BDF concluded that MPEG-2 should be the primary video codec for BD-ROM
- **2<sup>nd</sup> Subjective quality evaluation of AVC High Profile in 5/2004 by BDA - MPEG-4 AVC High Profile is visually superior over MPEG-2.**
  - At 8mbps MPEG-4 AVC High Profile is already rated higher than MPEG-2 24 Mbps
  - BDF concluded solely on technical basis that MPEG-4 AVC is the advanced video codec for BD-ROM

# MPEG-2 versus MPEG-4 AVC High Profile BDF Subjective Picture Quality Evaluation 2004 Results



- Grading values: 1 – 5
- 5: excellent (as same as original)
- 4: Good
- 3: fair (acceptable for HD package media)
- 2: poor
- 1: Very poor



## MPEG-4 AVC High Profile

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- **Coding tools in AVC High Profile in addition to Main Profile**
  - 8x8 integer-based block transform (approximate DCT transform)
  - Scaling (Quantization) matrix
  - Still maintain 8bit sampling bit-depth and 4:2:0 color sampling rate.

# Weighted Scaling Matrix - examples

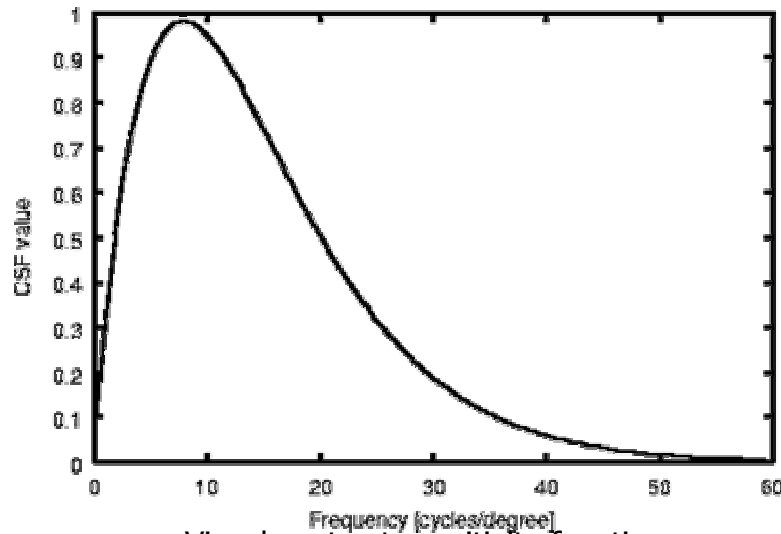
8x8 and 4x4 scaling matrices

1. Quantization weights for DCT frequency components in 8x8 and 4x4 blocks
2. Scaling matrix cells in a column (row) toward further right (down) indicate higher horizontal (vertical) frequencies.

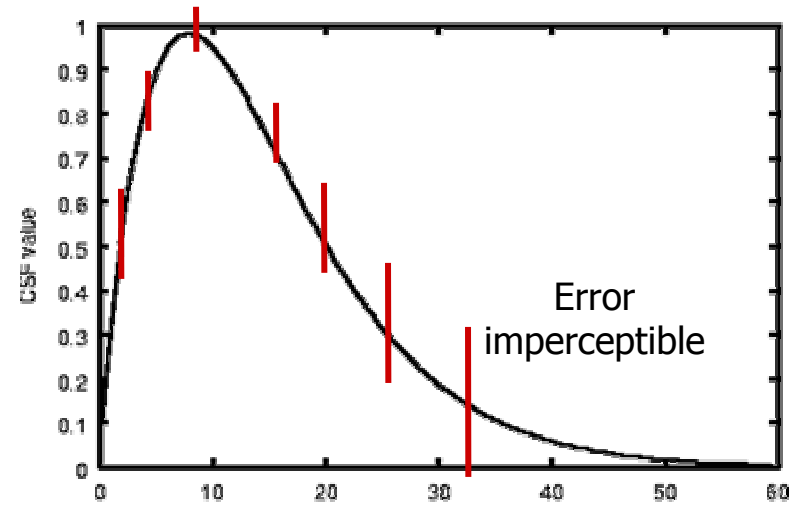
6	10	13	16	18	23	25	27
10	11	16	18	23	25	27	29
13	16	18	23	25	27	29	31
16	18	23	25	27	29	31	33
18	23	25	27	29	31	33	36
23	25	27	29	31	33	36	38
25	27	29	31	33	36	38	40
27	29	31	33	36	38	40	42

6	13	20	28
13	20	28	32
20	28	32	37
28	32	37	42

# Weighted Scaling Matrix – Use Bits Wisely



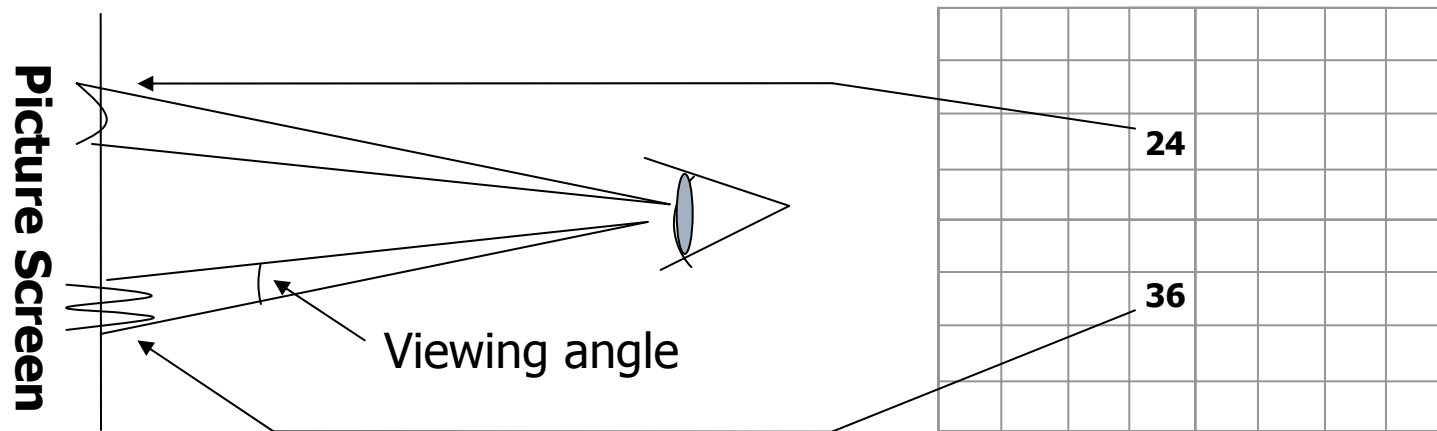
Visual contrast sensitivity function  
X: cycles per degree, Y: sensitivity



Decreasing visual sensitivity yields increasing error tolerance

# Weighted Scaling Matrix – Use Bits Wisely

Error tolerance low -> smaller weighting -> Less Compression



Error tolerance high -> larger weighting -> More compression

# Pictures from High Profile and Main Profile

1920x1080/24p Movie Material



ORIGINAL



High Profile  
@8Mbps



Main Profile  
@8Mbps

# Pictures from High Profile and Main Profile



1920x1080/24PsF Movie Material



ORIGINAL



High Profile  
@8Mbps



Main Profile  
@8Mbps