H.264/AVC High Profile

Thomas Wiegand
Fraunhofer Institute for Telecommunications
Heinrich-Hertz-Institut
wiegand@hhi.de

Stephen Gordon
Broadcom
sgordon@broadcom.com

Ajay Luthra
Motorola
aluthra@motorola.com

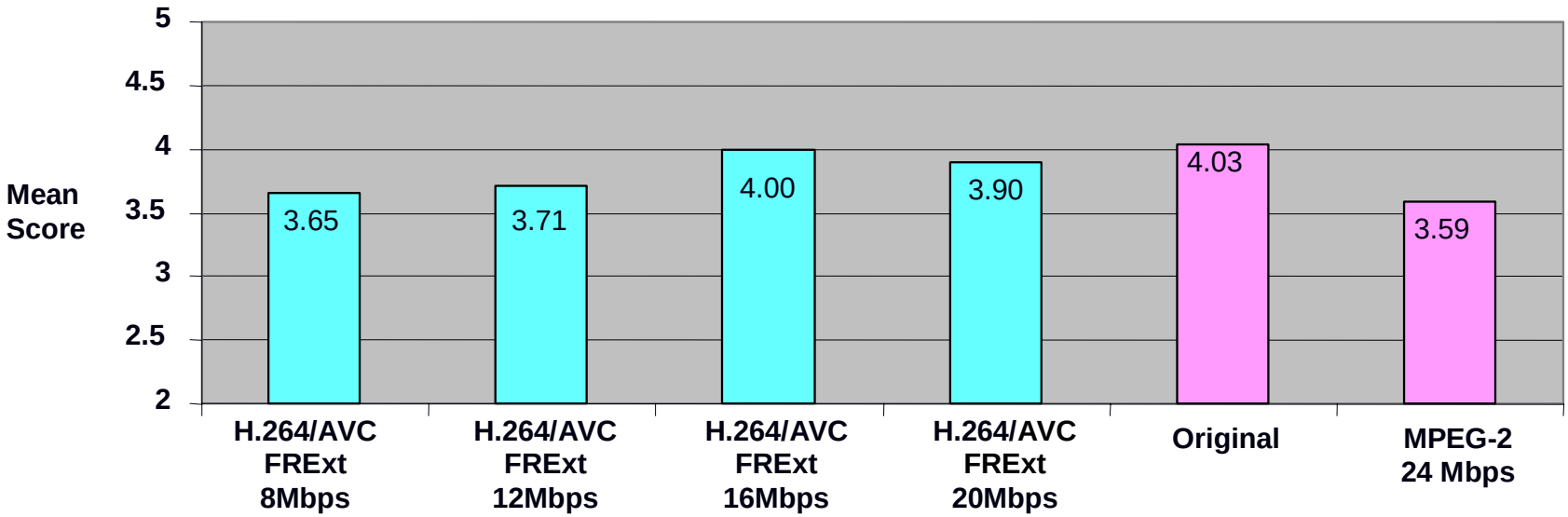
Fraunhofer Institut Nachrichtentechnik Heinrich-Hertz-Institut

High vs. Main Profile Summary

- **High Profile contains:**
  - Main profile
  - Switchable 8x8 transform for residual coding
  - Scaling matrices for subjective quality optimization
- **Coding efficiency impact (**measured as average bit-rate reduction**):**
  - HD Film: 12%
  - HD Video (progressive): 12%
  - HD Video (interlace): 4% (only 2 test clips)
  - SD Video (interlace): 6%
- **Complexity impact**:
  - Implementation beyond Main Profile affects Intra prediction, transform, deblocking filter control, CABAC decoding
  - No increase in computational requirements
  - Slight increase in memory requirements (CABAC, transform)

Blu-Ray Disc Founders High Profile Test

- Reference JVT-L033, M1116, Draft JVT Redmond report
- Beyond MPEG-2, High profile is their first choice
- High at 8 Mbps nominally beat MPEG-2 at 24 Mbps
- Nominally transparent on 1080p24 at 16 Mbps



High vs. Main Basic Decision Criteria: Technical

- High profile adds *almost no computational burden* for decoding
- High profile improves *objective* compression quality (significantly for some video, esp. HD video)
- High profile improves *subjective* compression capability with support for quantization weighting matrices
- High profile *includes Main profile as a subset*, so no risk involved

High vs. Main Basic Decision Criteria: Industry Status

- High profile is a *finished international standard* (technical design finished 03/04, final profile definition 07/04, editing complete 08/04)
- The implementation community is *generally comfortable* with High profile in near-term deployment plans
- Blu-Ray Disc Founders and DVD Forum appear to be *embracing* High profile in near-term plans
- Licensing mostly overlaps Main, *likely embraced in current pooling*

→ **With no installed base for Main profile, there's no reason not to *move to High profile Now*.**

High Profile Details: Transform

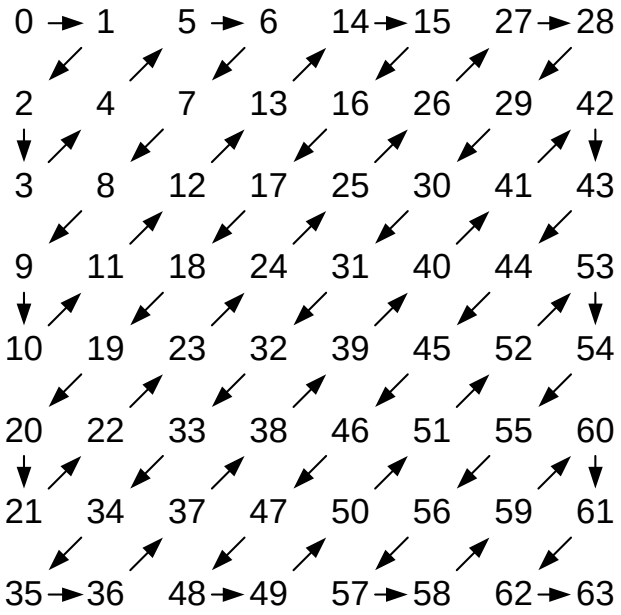
Integer 8x8 Transform (luma only)

$$\begin{bmatrix} 8 & 8 & 8 & 8 & 8 & 8 & 8 & 8 \\ 12 & 10 & 6 & 3 & -3 & -6 & -10 & -12 \\ 8 & 4 & -4 & -8 & -8 & -4 & 4 & 8 \\ 10 & -3 & -12 & -6 & 6 & 12 & 3 & -10 \\ 8 & -8 & -8 & 8 & 8 & -8 & -8 & 8 \\ 6 & -12 & 3 & 10 & -10 & -3 & 12 & -6 \\ 4 & -8 & 8 & -4 & -4 & 8 & -8 & 4 \\ 3 & -6 & 10 & -12 & 12 & -10 & 6 & -3 \end{bmatrix} \cdot /8$$

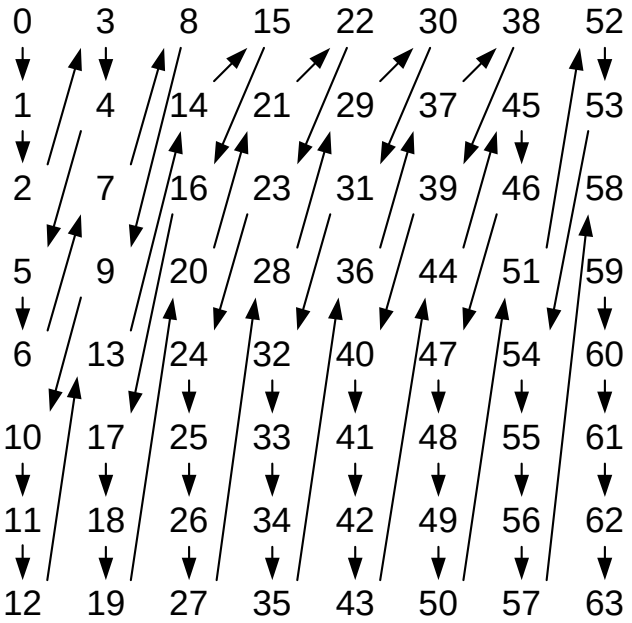
Per 8x8 block, same number of adds (64) and 4 extra shifts (20 vs. 16) compared with four 4x4 transforms.

High Profile Details: Scan

Two scans as for 4x4 transform switched for frame / field coding



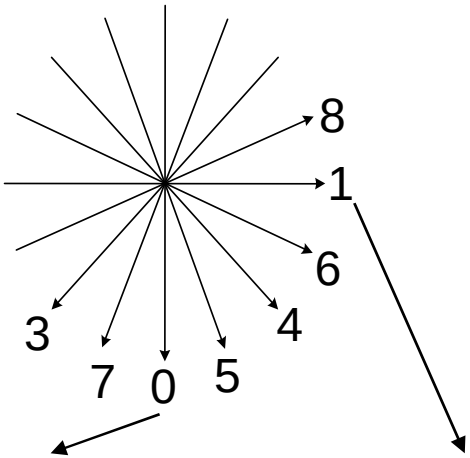
Frame scan



Field scan

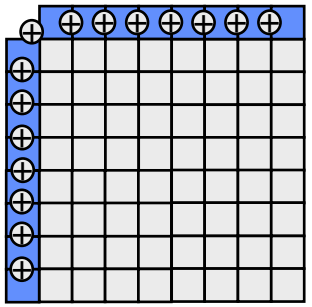
High Profile Details: Intra Prediction

Nine Intra_8x8 prediction modes
similar to the nine modes for Intra_4x4

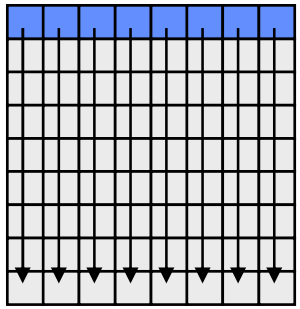


&

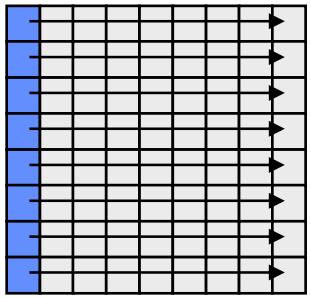
Mode 2 - DC



Mode 0 - Vertical



Mode 1 - Horizontal



High Profile Details: Scaling Matrices

- Similar to MPEG-2 Video
- Matrix can be transmitted in SPS and PPS
- Separate Matrix for 4x4 and 8x8 transforms
- Separate Matrix for Inter and Intra

$$\begin{bmatrix} 6 & 10 & 13 & 16 & 18 & 23 & 25 & 27 \\ 10 & 11 & 16 & 18 & 23 & 25 & 27 & 29 \\ 13 & 16 & 18 & 23 & 25 & 27 & 29 & 31 \\ 16 & 18 & 23 & 25 & 27 & 29 & 31 & 33 \\ 18 & 23 & 25 & 27 & 29 & 31 & 33 & 36 \\ 23 & 25 & 27 & 29 & 31 & 33 & 36 & 38 \\ 25 & 27 & 29 & 31 & 33 & 36 & 38 & 40 \\ 27 & 29 & 31 & 33 & 36 & 38 & 40 & 42 \end{bmatrix}$$

High Profile Details: Deblocking Filter, CABAC, Signaling

- **Deblocking Filter:**
  - Only control of filter is adjusted: do not filter 4x4 blocks
  - No change to filter operation itself

- **CABAC:**
  - 61 new contexts and corresponding initialization values
  - No change to CABAC engine

- **Signaling**:
  - 8x8 transform on/off flag at PPS level
  - 8x8 transform on/off flag per macroblock allows adaptive use