MPEG-2

MPEG-2 Video

MPEG-2 video = MPEG-1 Video + Enhancements
Features

- It allows for interlaced inputs, higher-definition inputs, and alternative subsampling of chroma channels
- It offers a scalable bitstream
- It provides improved quantization and coding options
Chroma Subsampling

- 4:2:0
- 4:2:2
- 4:4:4
Coding Interlaced Video

• MPEG-2 accepts both progressive and interlaced inputs.
  – Two new pictures
    • frame pictures (two fields are encoded together as a composite frame)
    • field pictures (every field can be encoded independently)
  – Field/frame DCT options per MB
  – New MC prediction modes for interlaced video
Frame Pictures

- Frame pictures are obtained by interleaving lines of even and odd fields to form composite frames.
  - Frame pictures can be I-, P- or B-type.
- Field pictures are simply the even or odd fields treated as separate pictures.
  - Each field picture can be I-, P- or B-type.

Picture types in MPEG-2

- Progressive Video
  - Frame Picture, I, P, or B type
- Interlaced Video
  - Frame picture
    - I, P, or B type
  - Field picture
    - I, P or B type
Field and Frame DCT

• Field DCT
  – suitable for macroblocks containing high motion

• Frame DCT
  – little or no motion, but containing high spatial activity
Prediction in Frame Pictures

Reference Frame

16X16

10X8

10X8

10X8

10X8

Predicted Frame

16X16

Frame Prediction

or

Field Prediction

Field Prediction in Field Pictures

Reference

16X16

16X16

Field Prediction in first field

Current

or

Field prediction in second field
Dual-Prime Prediction

Frame Picture

Field Picture

Dual-Prime Prediction in V-T
16X8 Motion Compensation

Scalable Extensions

- It is the ability to decode only certain part of bit-stream to obtain video at the desired resolution.
  - Spatial Scalability
  - SNR Scalability
  - Temporal Scalability
  - Data Partitioning
  - Hybrid Scalability
Spatial Scalability

- A single video source is split into a
  - Base Layer (lower spatial resolution)
  - Enhancement Layer (higher spatial resolution)
- MPEG-1 can be used for coding the Base Layer

Example of Spatially Scalable Encoder

Data Partitioning

- A single video source is split into a
  - High-Priority Partition that can be better protected
  - Low-Priority Partition
- Priority Breakpoints specify which syntax elements (e.g., 2nd DCT coefficient and higher) are coded as Low Priority.

Example of Data Partitioning Encoder
Other Improvements

• Alternate Scan (better fit for interlaced video)

• Finer quantization of DCT
  – 11 bits for DC coefficient (8 in MPEG-1)
  – AC coefficients are quantized [-2048, 2047] (MPEG-1 [-256, 255])
  – In non-intra macroblocks all coefficients are quantized into [-2048, 2047] (in MPEG-1 [-256,255])

Ziz-zag Scans

![Zig-zag Scans Diagram]

8x8 Blocks of Quantized DCT Coefficients


Alternate Zig-Zag Scan. Not used in MPEG-1. Option in MPEG-2.
Other Improvements

• Finer adjustment of MQUANT
  – in addition to integers between 1 and 31, an optional set of 31 values between .5 and 56

MQUAINT

.5  1.0  1.5  2.0  2.5
2.5  3.0  3.5  4.0  5.0
6.0  7.0  8.0  9.0 10.0
11.0 12.0 14.0 16.0 18.0
20.0 24.0 26.0 28.0 32.0
36.0 40.0 44.0 48.0 52.0
56.0
Parameter Constraints for levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Max pixels</th>
<th>Max lines</th>
<th>Max fps</th>
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<td>288</td>
<td>30</td>
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<tr>
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<td>720</td>
<td>576</td>
<td>30</td>
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<tr>
<td>High-1440</td>
<td>1440</td>
<td>1152</td>
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</tr>
<tr>
<td>High</td>
<td>1920</td>
<td>1152</td>
<td>60</td>
</tr>
</tbody>
</table>

Profiles

- **Simple**
  - no B frames
  - only main level
  - max bitrate 15 Mbps
- **Main**
  - all four levels
  - max bitrates 4, 15, 60 and 80 Mbps
  - no scalability allowed
Profiles

- **SNR Scalable**
  - supports main and low levels with maximim bitrates of 4(3) and 15(10) Mbps.
- **Spatial Scalable**
  - only high-1440 level with max bitrate of 60(15) Mbps
- **High**
  - main 20(4), high-1440 80(20), High 100(25)

Profiles and Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Simple</th>
<th>Main</th>
<th>SNR</th>
<th>Spatial</th>
<th>High</th>
<th>4:2:2</th>
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<tbody>
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</tbody>
</table>

Key: Max H Size Max V Size Max Frame Rate

Notes: 1) A split box shows constraints on Enhancement Layer (left) and Base Layer (right).
2) In general, a compliant decoder must also handle all lower Profile and Level compliance points.
ATSC Video Formats (HDTV)

• 1920 X 1080 (16:9)
  – 24 fps progressive
  – 30 fps progressive
  – 30 fps interlaced (CBS & NBC)
• 1280 X 720 (16:9)
  – 24 fps progressive
  – 30 fps progressive (ABC & Fox)
  – 60 fps interlaced

ATSC Video Formats (SDTV)

• 704 X 480 (16:9)
  – 24 fps progressive
  – 30 fps progressive
  – 30 fps interlaced
  – 60 progressive
• 704 X 480 (16:9)
  – 24 fps progressive
  – 30 fps progressive
  – 30 fps interlaced
  – 60 progressive
ATSC Video Formats (SDTV)

- 640 X 480 (4:3)
  - 24 fps progressive
  - 30 fps progressive
  - 30 fps interlaced
  - 60 progressive

MPEG-2 Decoding
MPEG-1 & MPEG-2 Artifacts

- **Blockiness**
  - poor motion estimation
  - seen during dissolves and fades
- **Mosquito Noises**
  - edges of objects (high frequency DCT terms)
- **Dirty Window**
  - streaks or noise remain stationary while objects move

MPEG-1 & MPEG-2 Artifacts

- **Wavy Noise**
  - seen during pans across crowds
  - coarsely quantized high frequency terms cause errors
Where MPEG-2 will fail?

• Motions which are translation
  – zooms
  – rotations
  – non-rigid (smoke)
  – dissolves

• Others
  – shadows
  – scene cuts
  – changes in brightness