Pushing Encoding Quality and Speed with x265

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Contains

1. Where video codec fits in a pipeline

2. Key required features for an industry level video encoder

3. What is x265 and why it is important ?

4. How x265 fulfil industrial need as an encoder
   - ❖ Achieving target bitrate
   - ❖ Visual Quality
   - ❖ Encoding Speed

5. Conclusions and future directions

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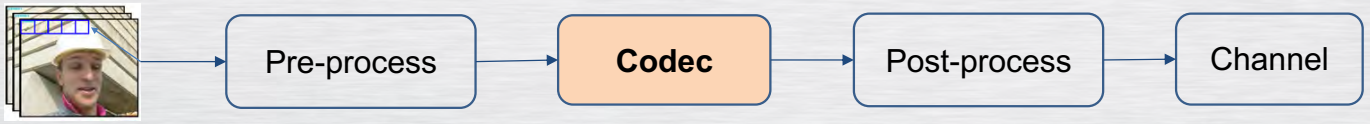
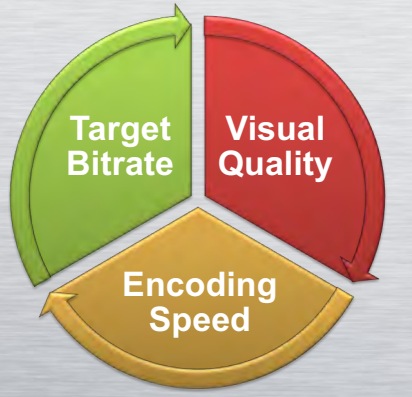
Industry Level Video Codec



High-level industry pipeline for video transmission



Challenges

- A target bitrate must be achieved
- Highest visual quality at the target bitrate
- Encoding speed should be as high as possible

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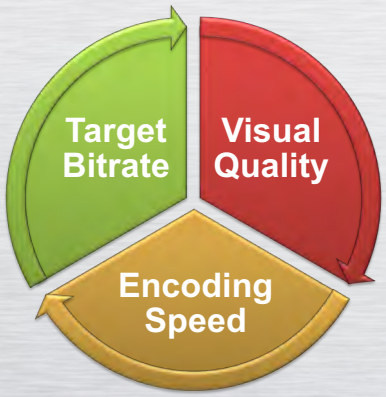
x265 : Open Source HEVC Encoder



What is x265 ?

- One of the most popular HEVC encoder
- Available under GPL v2 open source or commercial license
- Public from July 2013, and continuous improvement
- Used by many leading video services and encoding solution providers

x265 addresses all the above-mentioned challenges

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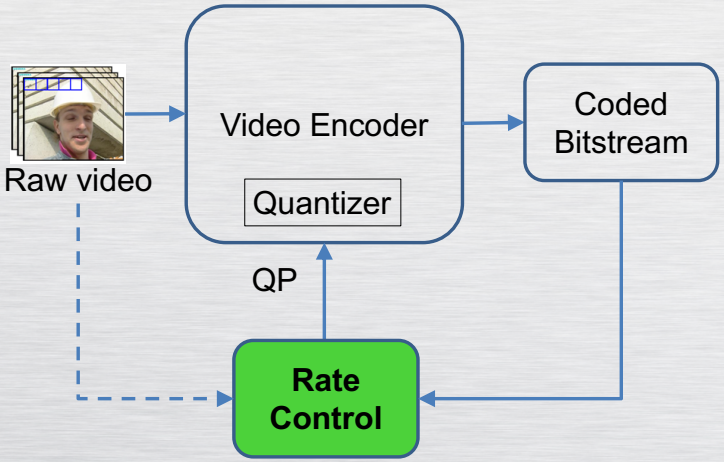
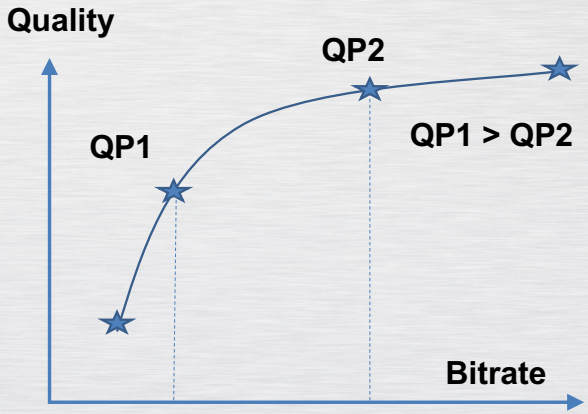
x265 : On Achieving Target Bitrate





Rate Control in x265

- It checks the bits consumed in the previous frame to figure out how to meet target bitrate
- Look Ahead (LA) based approach
  - A set of frames is examined (at quarter res) first to get the correct slice type
  - Both temporal and spatial complexities are measured
- Important CLIs regarding LA
  - **--rc-lookahead <integer> :** how many frames in the LA
  - **--qpfile <filename> :** external slice type with corresponding base QP

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x265 : Different Rate Control Techniques

Constant Rate Factor (CRF)

- Tries to achieve a given uniform quality
- No control over bitrate
- Sample CLIs regarding CRF

/x265 -i <input> --crf <value> -o <output>

Average Bitrate (ABR)

- Tries to achieve a given target bitrate
- No control over quality
- Sample CLIs regarding ABR

/x265 -i <input> --bitrate <tar bitrate> -o <output>

Constant QP (CQP)

- Tries to achieve a given uniform base QP
- No control over bitrate
- Sample CLIs regarding CQP

/x265 -i <input> --qp <value> -o <output>

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x265 : Video Buffering Verifier (VBV)

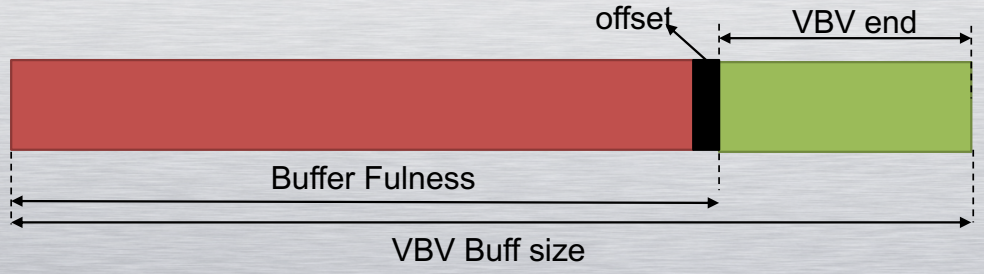
VBV Overview

- It works in a **Leaky Bucket** fashion
- Not deterministic algorithm (by default) – run to run variation
- Provides a confidence not to send more bits than promised
- Highly useful for streaming purpose
- In order to use buffer most effectively, some vbv related parameters need to tuned.
- Sample CLIs regarding VBV

  /x265 -i <input> --bitrate 7000 --vbv-bufsize 21000 --vbv-maxrate 14000 -o <output>

Important x265 CLIs

1. **--vbv-bufsize <integer> :** size of the buffer (kbits)
2. **--vbv-maxrate <integer> :** Maximum local bitrate (kbits/sec)
3. **--vbv-init <float> :** Initial buffer occupancy
4. **--vbv-end <float> :** Final buffer emptiness.



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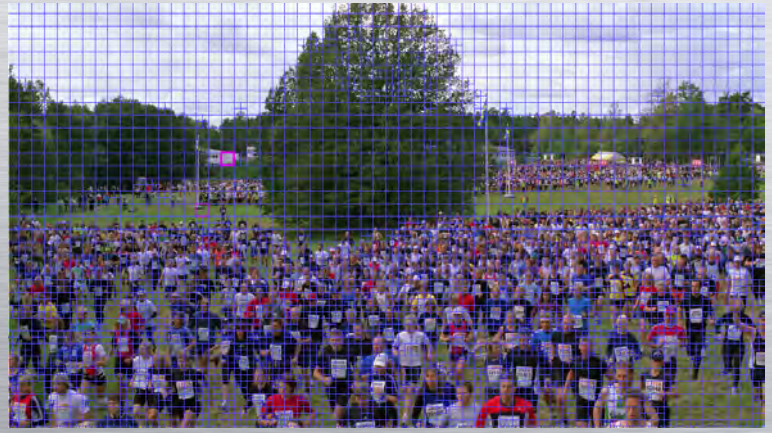
x265 : On Achieving Visual Quality

Adaptive Quantization (AQ) Mode

- More complex the block, the less bits are used
- Complexity is defined by using variance.

CU Tree

- Which blocks are reused more in temporal domain – spend more bits
- Using low res MV (from lookahead) the decision regarding the temporal importance of a block is taken.



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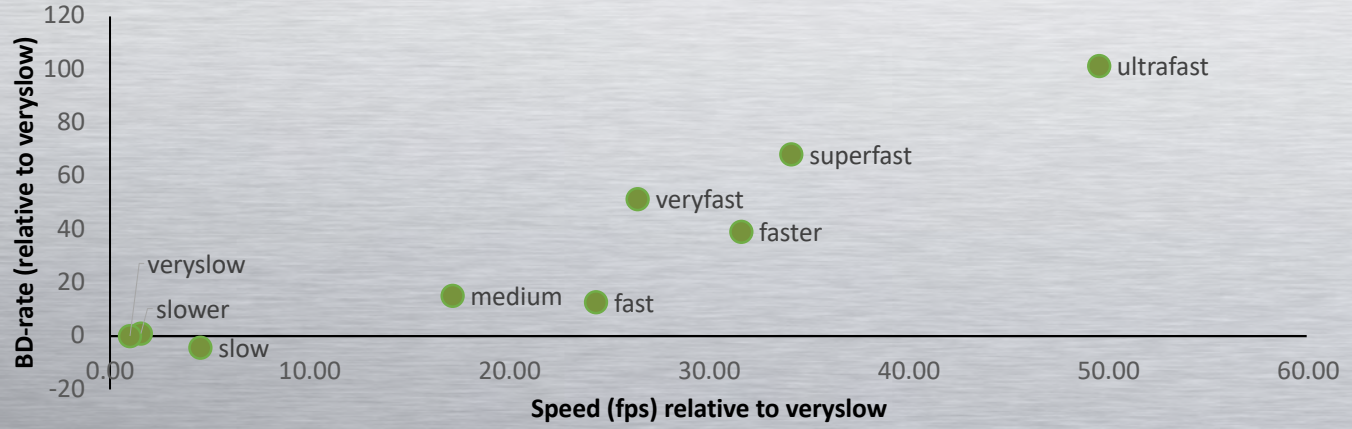
x265 : Preset, Algorithmic Approach

Preset

- Presets are defined by **tuning different fast encoding algorithms**
- x265 has 10 performance presets (speed vs. efficiency)
- Among them most popular three presets are: veryslow (used by VOD), medium (default), veryfast

Aggregate numbers across 4K, 1080p, and 720p content
Measured on dual-socket E5-2699 v3 with x265 v1.9



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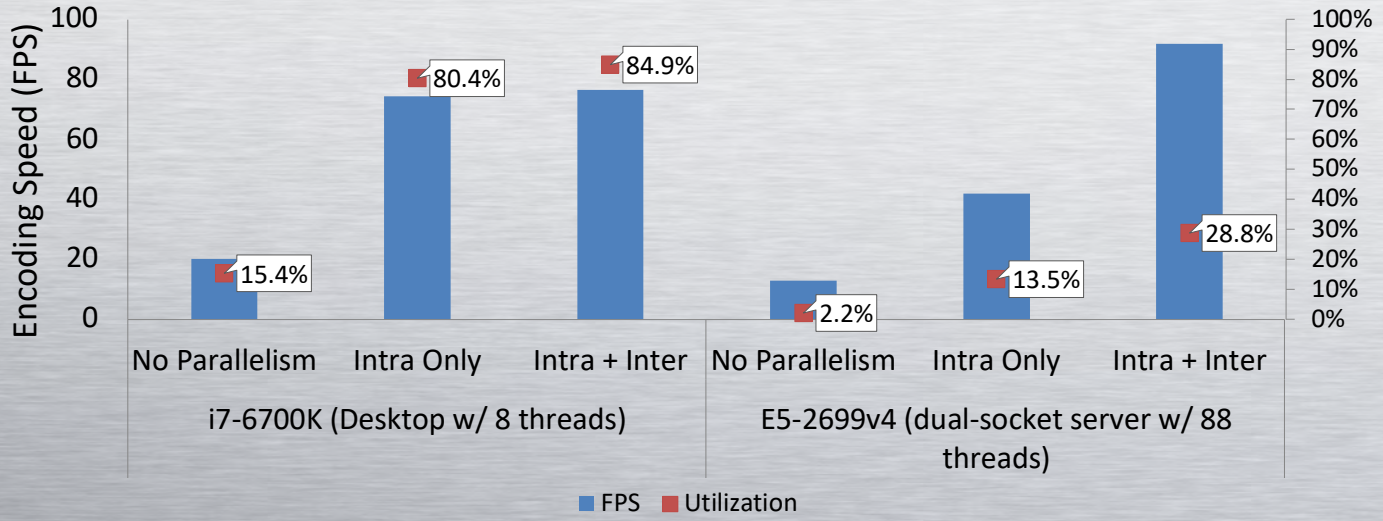
x265 : Parallel Processing

Different parallel encoding techniques

- Multiple frames encoded in parallel - 5 is a reasonable limit
- Each frame encoder calls multiple row encoders in a wavefront (WPP)
- Parallel motion estimation (--pme), parallel mode decision (--pmode)
- Tile level parallelism is not supported yet.



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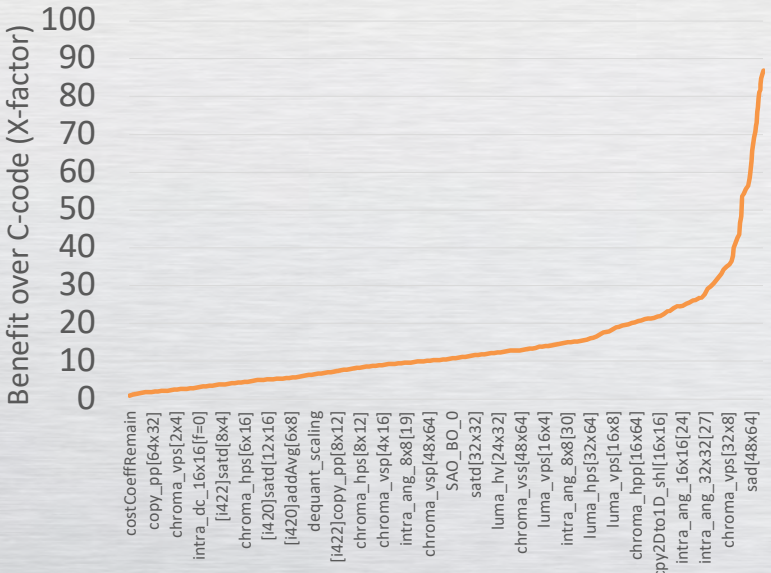
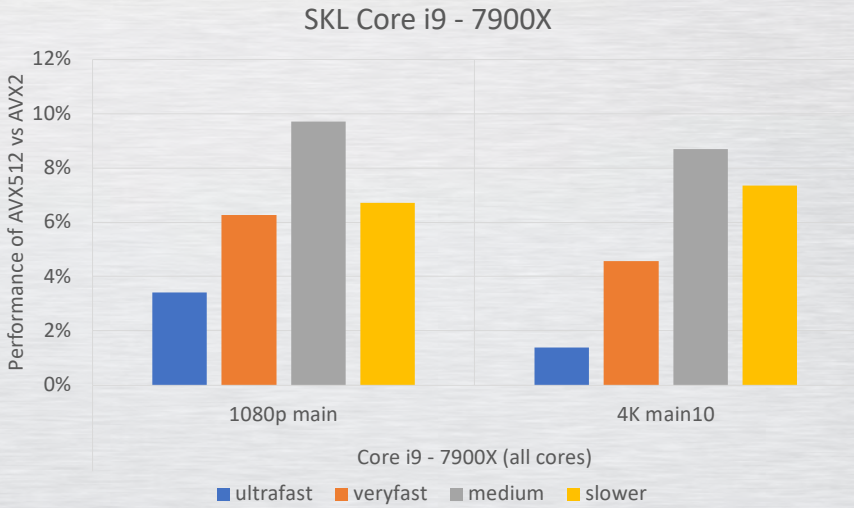
x265 : Assembly Optimization





Assembly Optimization

- Up to 89X improvement in kernel unit-tests, average of 14X
- 5x average performance boost
- Leverage SIMD instructions (SSE, SSE2, SSE3, AVX, AVX2, AVX-512)

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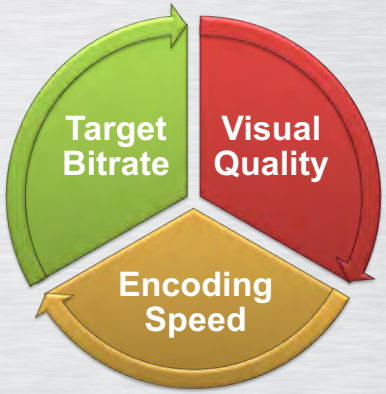
Conclusions and Future Directions

1. The x265 can effectively address all industry level requirements as an video encoder

2. Rate control module is quite robust and successful for VOD application
   - ❖ For the real time scenario, there is a room to improvement

3. x265 provides a good balance between encoder performance and efficiency
   - ❖ However, as a single instance, x265 could not achieve 4K@60
   - ❖ Good scope of research present in this domain

4. Since it's an open source, any suggestions and contributions are highly appreciable



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Thank you

For more info, see me today, visit x265.org
or contact me at kalyan@multicorewareinc.com

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