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Digital Video Technology

Building an Area-optimized Multi-format Video Encoder IP

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Allegro DVT

- Founded in 2003
- Privately owned, based in Grenoble (France)
- Two product lines:

1) Industry de-facto standard video compliance streams

- Decoder syntax, performance and error resilience streams for H.264|MVC, H.265/SHVC, VP9, AVS2 and AV1
- System compliance streams

2) Leading semiconductor video IP

- Multi-format encoder IP for H.264, H.265, VP9, JPEG
- Multi-format decoder IP for H.264, H.265, VP9, JPEG
- WiGig IEEE 802.11ad WDE CODEC IP

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Evolution of Video Coding Standards

- International standards defined by standardization bodies such as ITU-T and ISO/IEC
  - H.261 (1990)
  - MPEG-1 (1993)
  - H.262 / MPEG-2 (1995)
  - H.263 (1996)
  - MPEG-4 Part 2 (1999)
  - H.264 / AVC / MPEG-4 Part 10 (2003)
  - H.265 / HEVC (2013)

  - *Future Video Coding ("FVC")*
    - *MPEG and ISO "Preliminary Joint Call for Evidence on Video Compression with Capability beyond HEVC." (202?)*

- Incremental improvements of transform-based & motion-compensated hybrid video coding schemes to meet the ever increasing resolution and frame rate requirements

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Regional Video Standards

- SMPTE standards in the US
- VC-1 (2006)
- VC-2 (2008)

- China Information Industry Department standards
  - AVS (2005)
  - AVS+ (2012)
  - AVS2.0 (2016)

数字音视频编解码技术标准工作组
Audio Video coding Standard Workgroup of China

The AVS standard is the series of "information technology advanced Audio and Video Coding" standard abbreviation

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Proprietary Video Formats

- Sorenson Spark
- On2 VP6, VP7
- RealVideo
- DivX

- Popular in the past partly due to technical merits but mainly due to more suitable licensing schemes to a given application than standard video video formats with their patent royalties.

Royalty-free Video Formats

- Xiph.org Foundation
  - Theora (2004) was the first free and open video compression format

- WebM project initiated by Google
  - Open-source, royalty-free video formats
    - VP8 (2010)
    - VP9 (2013)

- Alliance for Open Media (AOM)
  - Founded by Amazon, Cisco, Google, Intel Corporation, Microsoft, Mozilla and Netflix in 2015
  - Combining efforts of *Xiph.org's Daala*, *Cisco's Thor* and *Google's VP10*
  - Next-generation interoperable and open video format (AV1)

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AV1 Schedule

- Original target:
  - Improvement of 50 percent over VP9/HEVC with reasonable increases in encoding and playback complexity.
  - Royalty-free for both commercial and non-commercial content, including user-generated content.
  - Bitstream freeze by end of 2016
- Revised target:
  - Materially" better than VP9 or HEVC and plays on a reasonable number of modern computers.
  - Bitstream freeze by end of 2017
- Allegro is an active member of AOM
  - Working on Syntax, performance and error resilience compliance streams

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Need for a Multi-format Encoder

- Several co-existing video codecs
  - Different applications
  - Geographical area requirements
  - Legacy constraints
- Main standards currently in use
  - *MPEG-2*
  - **H.264/AVC**
  - **H.265/HEVC**
  - **VP9**
  - *AVS/AVS+/AVS2.0*

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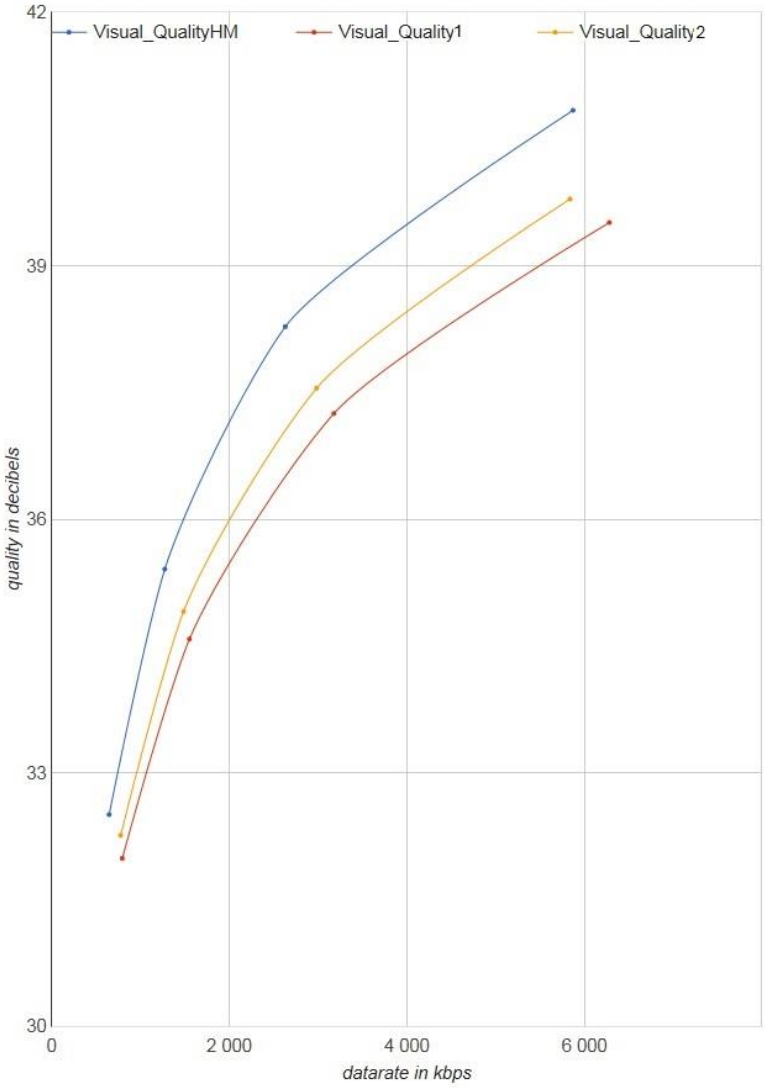
Encoder Differentiation

- Video standards specify only decoding schemes
  - All decoders must be bit-exact
    - Compliance streams
  - Differentiation only in Power, Performance and Area (“PPA”)
- Video encoders can be very different
  - Encoding quality
  - Latency
  - Power, Performance and Area (“PPA”)
    - Flexibility through scalable architecture
    - Minimal silicon area through a *true multi-format architecture*

Source: Sveriges Television

Comparison of Encoders

- Benchmarks
  - Test sequences
    - E.g. JCT-VC
    - Application specific streams
  - Metrics
    - PSNR & SSIM curves (functions of bitrate)
    - Bjøntegaard-Delta (BD-rate, average bitrate reduction)
    - *Subjective testing*
- Encoding quality vs PPA trade-offs
  - Allegro 10+ year know-how in video encoding algorithms, architectures and low-power design



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Building an Efficient Video Encoder

- Difficult to build a video encoder IP with a quality close to a full-feature software reference model
  - Requires complex tools
    - intra prediction
    - inter prediction
    - several transform sizes
    - RDO (Rate-Distortion Optimization)
      - algorithm selecting the best macroblock type & parameters
    - rate control & low-latency rate control
- Selecting cost vs quality trade-off requires deep technical know-how and experience

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Best-in-class Video Quality

- Targeting applications where encoding quality / bitrate matters
  - Surveillance cameras
  - IP cameras
  - Drones
  - Action cameras
  - Transcoding
- CBR, VBR
- Region-of-Interest and other tools for smart encoding

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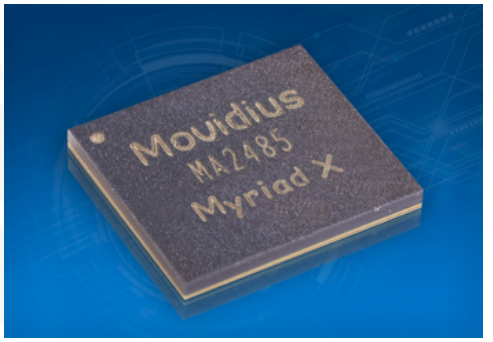
Movidius

- A licensee of Allegro DVT's multi-format H.264/AVC, H.265/HEVC and JPEG encoder IP (Press release in October 2016)
  - Targeted at Movidius next-generation ultra-low power machine vision platforms (Myriad X).
  - The Movidius award-winning Myriad family of vision processing units (VPUs) feature advanced machine intelligence algorithms implemented in a unique parallel programming architecture specifically targeted at vision processing applications
- Acquired by Intel in September 2016



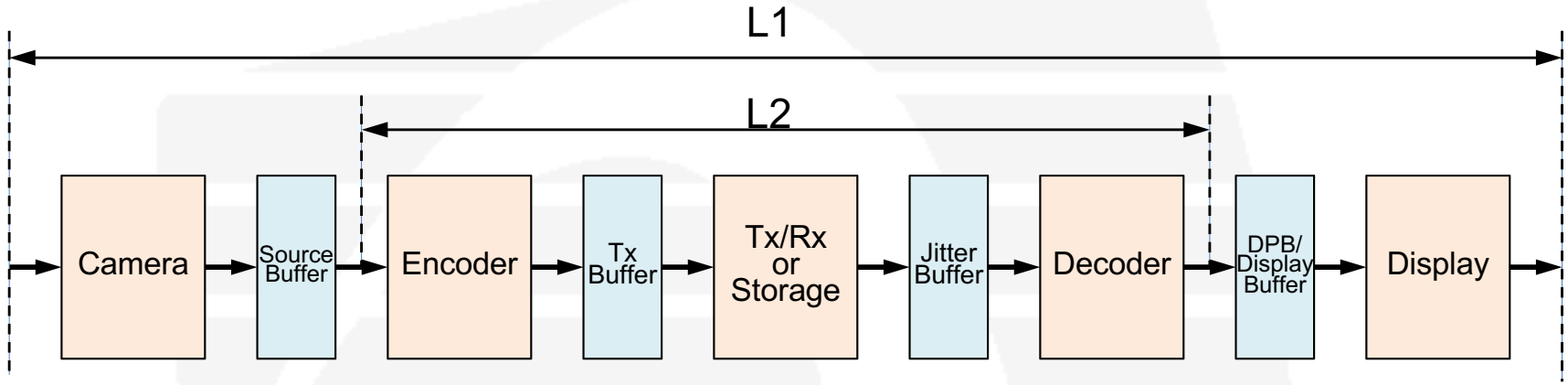
Source: Euro NCAP

Latency

- System latency is critical in many applications
  - Automotive/ADAS
  - Remote control for surveillance and drones
  - Wireless docking, virtual reality, etc.

- Latency requirement can vary from several seconds down to few milliseconds

Glass-to-glass Latency



- Encoder architecture and algorithm choices have a great impact, especially on the decoding latency

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Performance Evolution

- From SD (Standard Definition) to HD (High Definition) to UHD (Ultra High Definition)
  - Larger resolutions:
    - ”4K” = 3840x2160 / 4096x2160
    - more than 20x SD
  - Higher bit depths:
    - 10 bits per component (vs 8-bit)
  - Higher frame rates:
    - progressive 60fps to 120fps (vs p30 / i60)
- Exponentially increasing performance requirements impacting encoder design
- Allegro’s truly scalable multi-core architecture
  - 4K120 / 8K possible today
  - Smart caching for best-in-class bus bandwidth

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8K

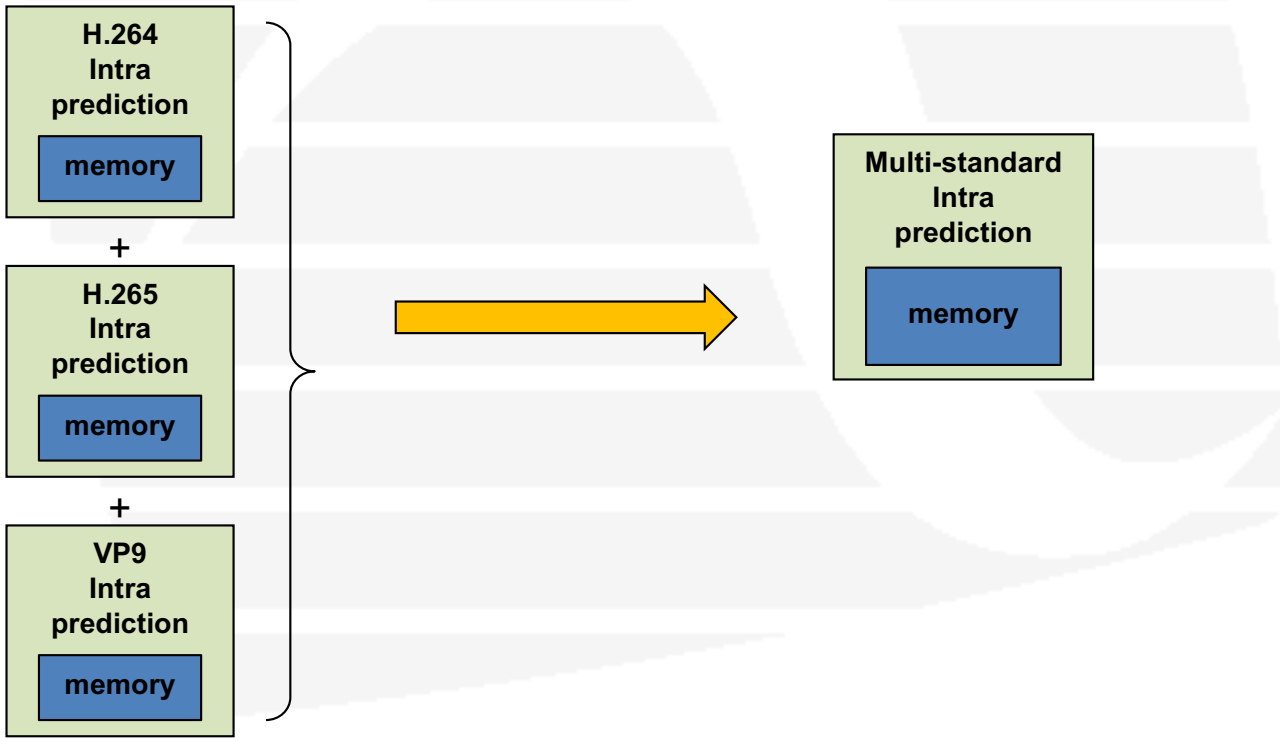
- At IFA2017, Sharp's AQUOS 8K Series of 8K-compatible TVs and displays was announced
  - Planned for release in China in 10/2017 and in Japan in 12/2017.

Photo: Sharp

- In 2016 Sharp released the advanced wideband digital satellite broadcast receiver compatible with 8K ultra-high-definition (UHD) broadcasts.

True Multi-format Architecture

- Allegro encoder IPs support multiple video standards in a deeply optimized way by using multi-format hardware blocks



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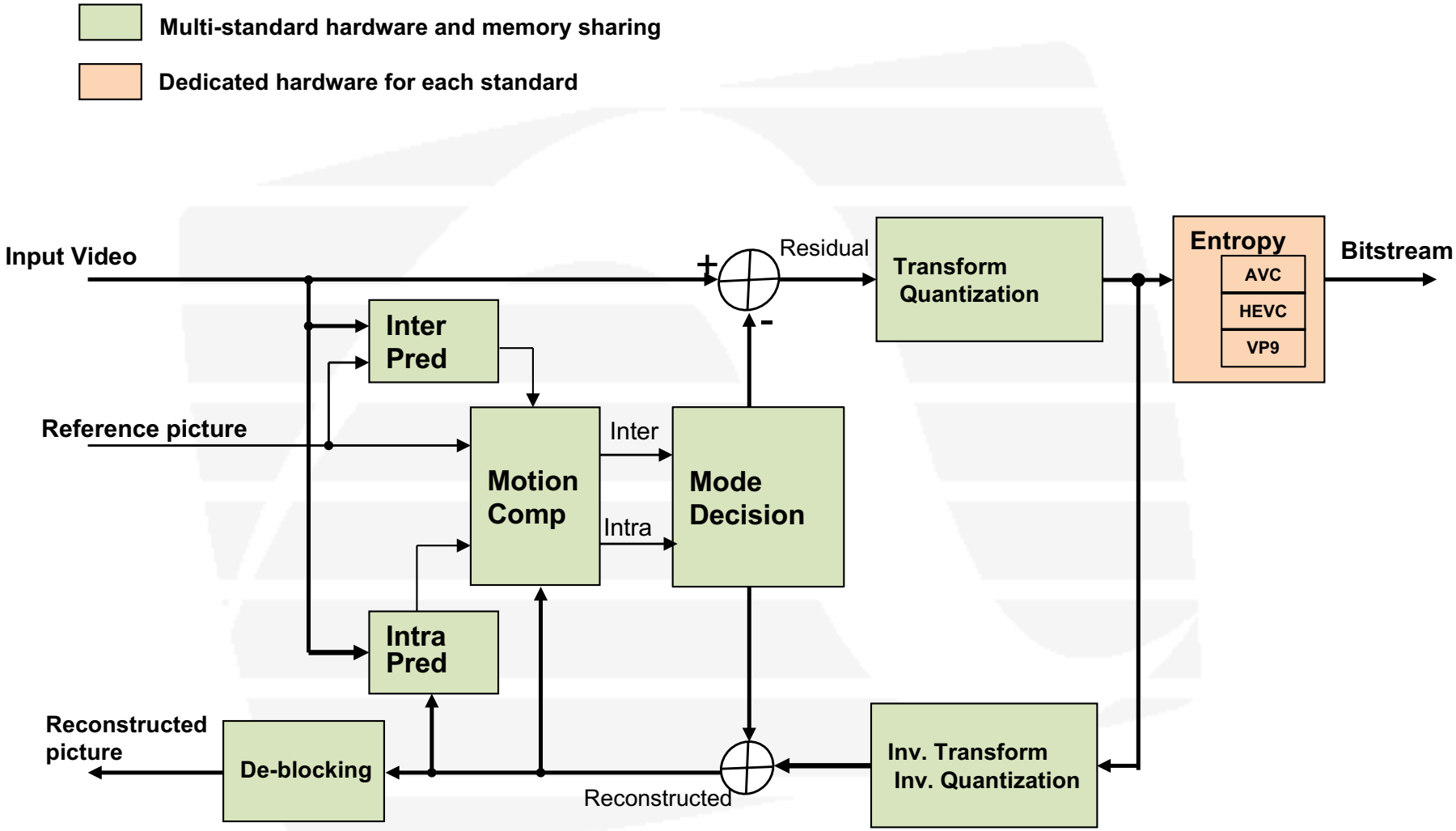

Area Savings

- RTL design is configurable at synthesis in order to include/remove support for various standards and features
- Additional area for AVC and VP9 support, compared to the size of the HEVC-only encoder configuration:

Configuration	Total Area
HEVC only	T
HEVC + AVC	1.13 * T
HEVC + AVC + VP9	1.49 * T

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Allegro Encoder IP Products

- AL-E110
  - High-end Multi-format Encoder
    - H.264/AVC, H.265/HEVC and VP9
    - Best-in-class visual quality at very low power consumption and silicon area
    - Support for 4:2:2
    - Scalable architecture from HD to 4K/8K resolutions
- AL-E110L
  - Area-optimized architecture
    - H.264/AVC, H.265/HEVC and VP9
    - Great visual quality for consumer applications
    - Industry leading silicon area for 4K30 in 28 nm
    - Attractive silicon area for high-end performance points (4K120)

THANK YOU !

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