Advances of Media Technology in Modern Computing

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Contents

- History
- Heterogeneous Computing Architecture
- Video Codec
- Video Processing
- Perceptual Computing Initiatives
- Summary

Contents

Two decades …

Two decades … Video Coding

MPEG2:
- Block motion comp
- Block DCT

AVC/H.264:
- More complex block coding
- Loop filter & CABAC

HEVC/H.265:
- More complex block coding
- More complex loop filter

1993 **2003** **2013**

2X coding efficiency every 10 years

Two decades … Video Coding

MPEG2:
- Standard Definition (SD)
- DVD, Broadcast

AVC/H.264:
- High Definition (HD=6xSD)
- Blu-ray, Internet Streaming

HEVC/H.265 (promises):
- Ultra HD (4K = 24xSD)
- Cellular Wireless Streaming

1993 **2003** **2013**

Complexity compounded by ↑ Resolution & ↓ Power

From Big Screen to Mobile

- HD media becomes ubiquitous
  - Optical media led the digital conversion (2006: Blu-ray)
  - Internet streaming is catching up (2009: 720p, 2012: 1080p)
  - All devices are HD capable (2008: DTV/PC, 2010: Smart Phone)
- Beyond HD – 4K Video is coming (2-3 years to reach consumers)

1.1B users

100h/min uploads

Today, video file >50% internet traffic
In 2016, sum of all video >86% traffic

HD is ubiquitous & We Are Not Done Yet

Two decades … Personal Computing

Intel® Pentium™:
- Performance spiral
- MMX/SSE extensions

(Desktop PC Era)

Intel® Centrino™:
- Low power
- Wi-Fi

(Mobile Computing Era)

Haswell (4th Gen Intel® Core™):
- Breakthrough battery life
- Leading Graphics/Media

(Ultra mobility)

1993 2003 2013

Major transformation each decade

Two decades … Personal Computing

Intel® Pentium™:
- 0.8 um process
- 3.1 millions transistors

(Desktop PC Era)

Intel® Centrino™:
- 0.13 um process
- 77 millions transistors

(Mobile Computing Era)

Haswell (4th Gen Intel® Core™):
- 22 nm process
- ~1.4 billions transistors

(Ultra Mobility)

1993 2003 2013

450x more transistors over 20 years!

Two decades … Personal Computing

1993: Barely getting thumbnail video on PC	2003: Can play DVD; Limited quality.	2013: Multiple HD, 4K playback and encode; High quality HD video processing

1993 2003 2013

Media Technology revolutionized

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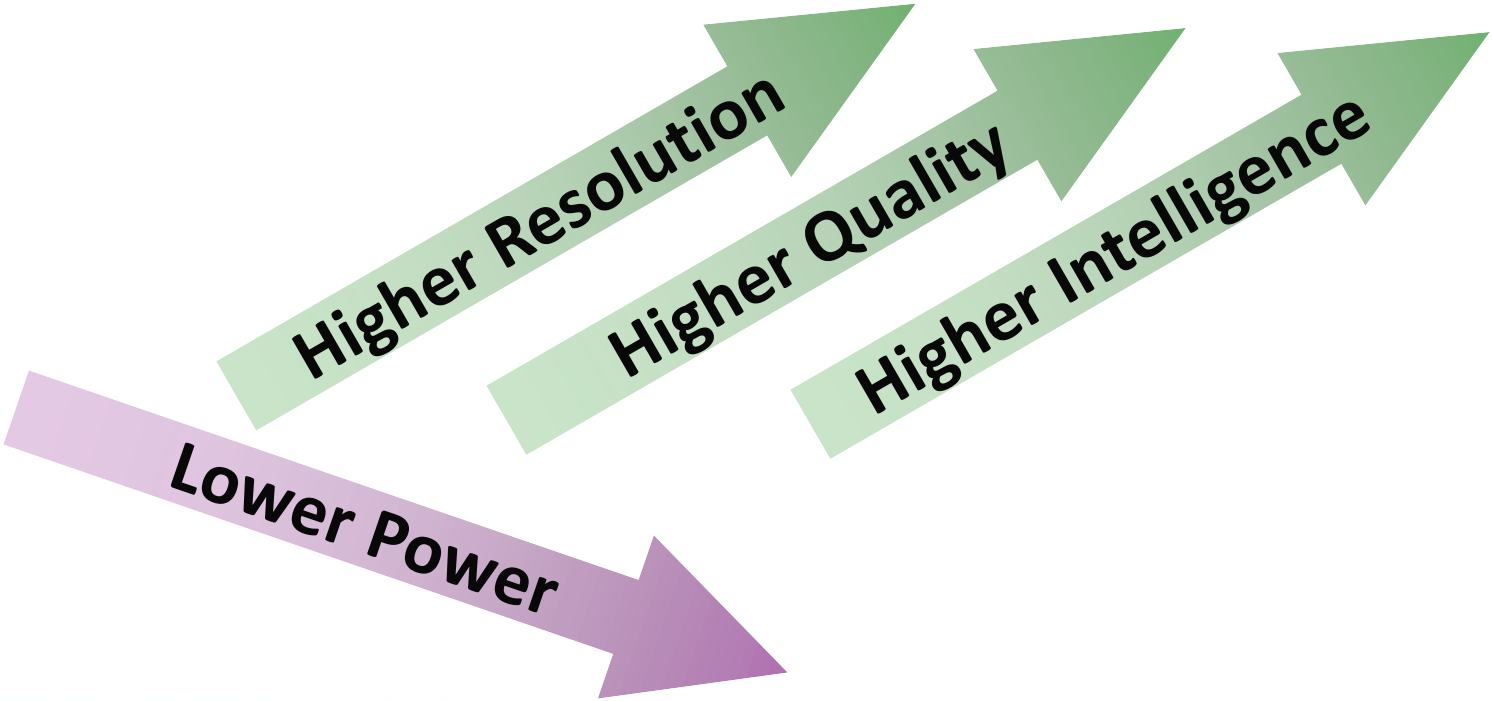
Demands and Challenges



Two-Prone Solutions

- Process Technology – Moore's Law
- Architecture Innovation

Intel Tick/Tock Development Model

45nm Process Technology	32nm Process Technology		22nm Process Technology	
Nehalem NEW Intel® Microarchitecture (Nehalem) *TOCK*	Westmere (Nehalem) *TICK*	Sandy Bridge NEW Intel Microarchitecture (Sandy Bridge) *TOCK*	Ivy Bridge (Sandy Bridge) *TICK*	Haswell NEW Intel Microarchitecture (Haswell) *TOCK*

Haswell CPU Family

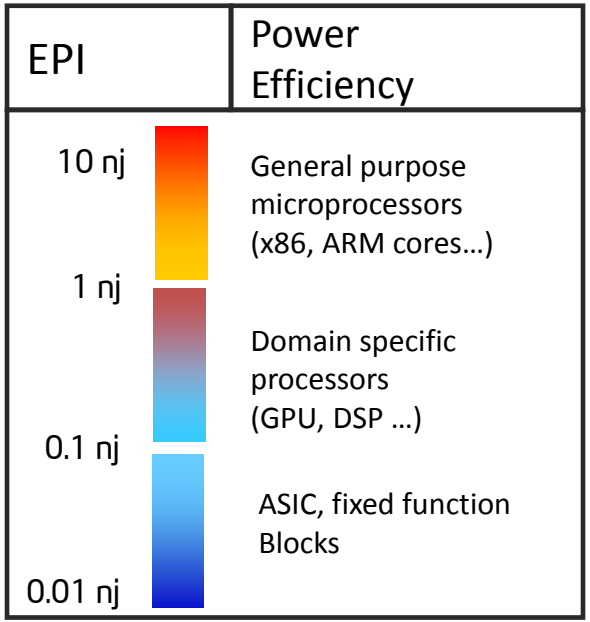
22nm Process Technology

Haswell, 4th Generation Intel® Core™ Processors, builds upon innovations in the previous Core™ generations

Intel® Microarchitecture code name Haswell, Ivy Bridge, Sandy Bridge

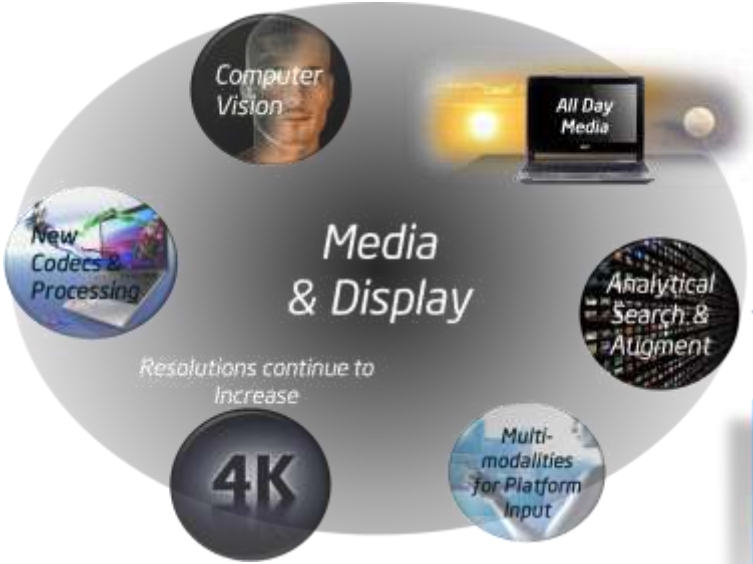
Architecture Concept

- Trends: Higher capability in a lower power budget
- Power considerations drive a Fixed Function solution
- Flexibility considerations requires a Programmable solution



EPI: Energy spent per Instruction in nJ

NEW EXPERIENCES

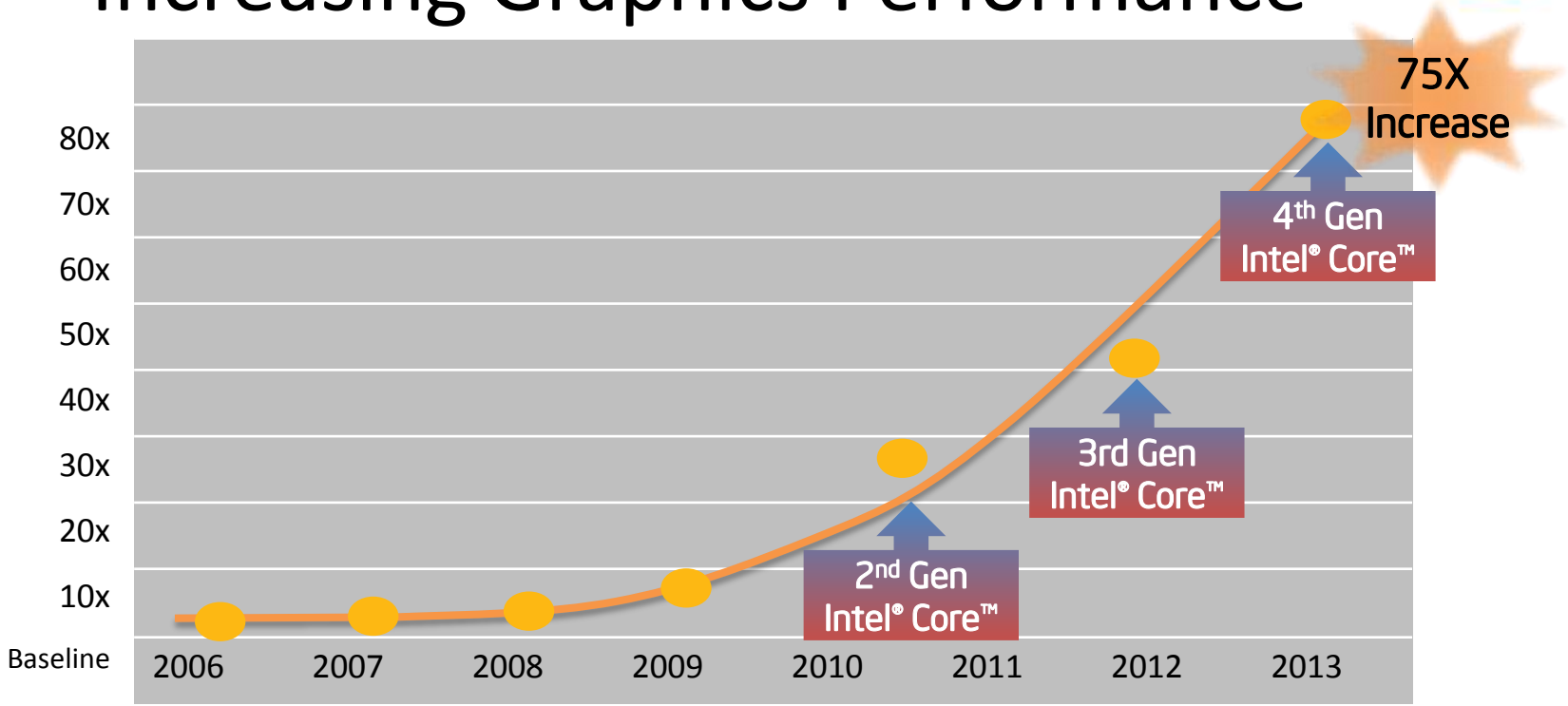


GPU Architecture Playbook for Media Computing

INNOVATIVE FORM FACTORS

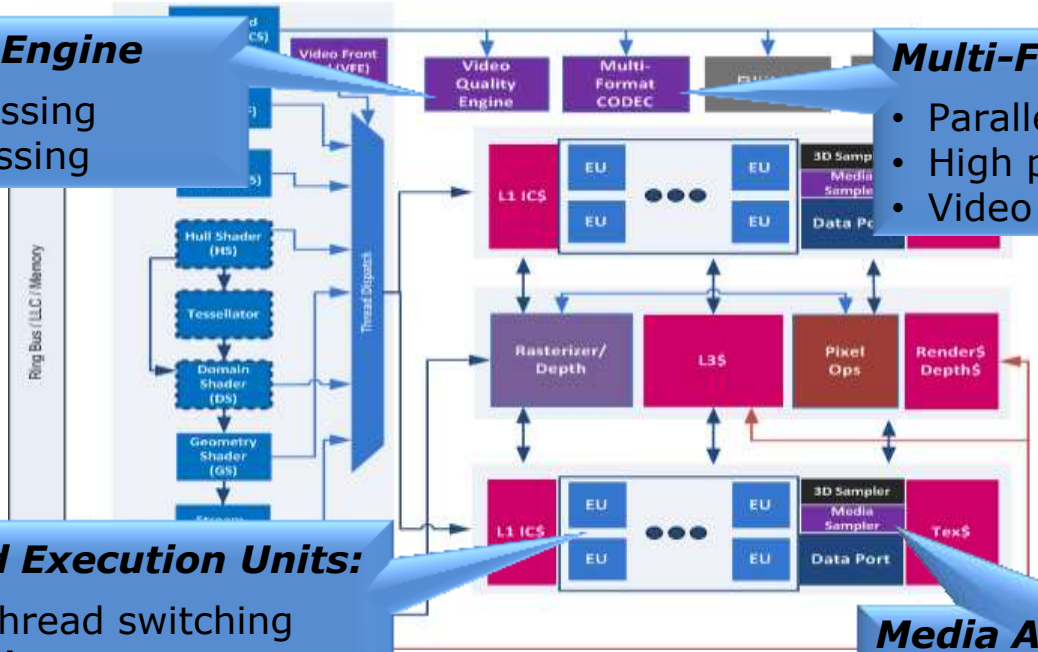
Intel is building Media solutions with Great Power and Scalable Performance for Innovative Form Factors and New Experiences

Increasing Graphics Performance



Source: Intel. 3DMark06

Haswell: Processor Graphics Architecture



Video Quality Engine

- Video Processing
- Color Processing

Multi-Format Codec:

- Parallel engine
- High performance
- Video Decode and Encode

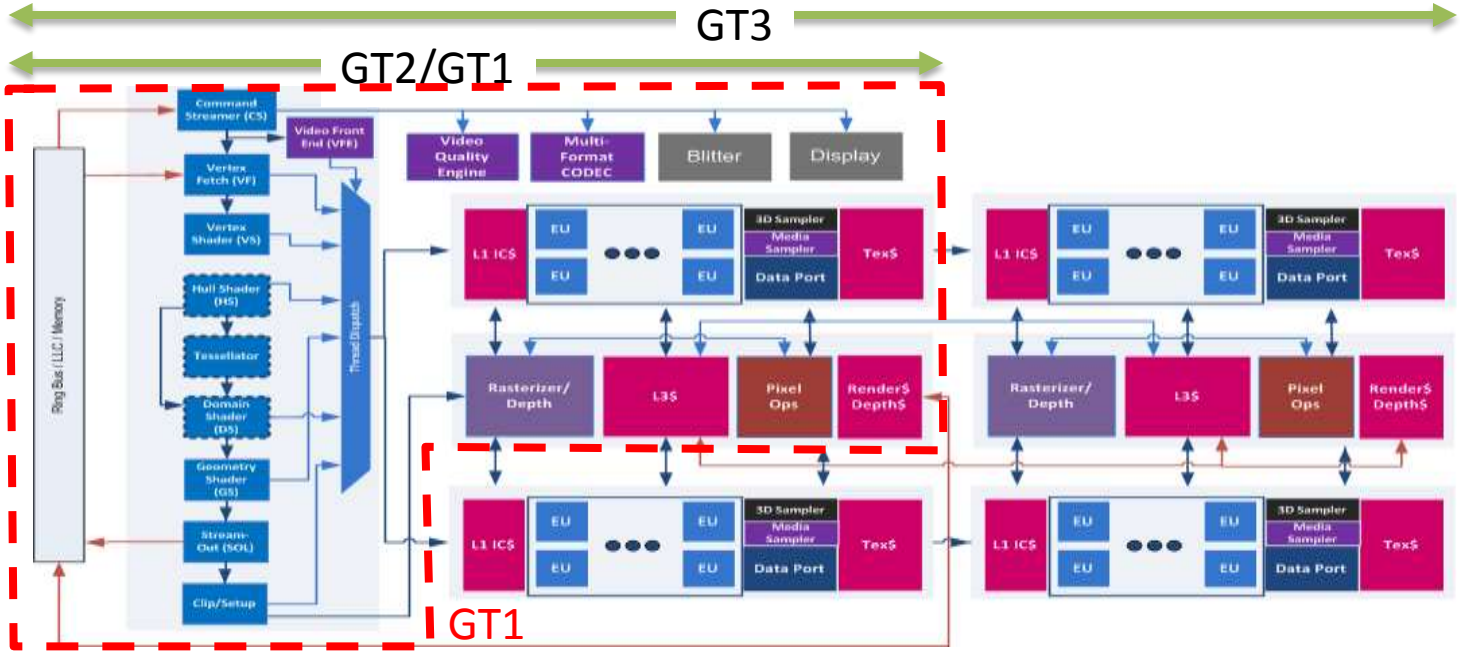
Media Optimized Execution Units:

- Zero overhead thread switching
- Native media ISA
- Vector/Matrix oriented operations

Media Accelerators

- Higher throughput & low power
- Retaining flexibility

A Scalable Graphics Architecture



- Some GT3 sku's come with an 128MB eDRAM, as cache shared with CPU
- Significant generational EU count growth (Top line from 8, 16 to 40 EU's)

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Intel® Quick Sync Video

Video Conversion

Record and Upload

Stereo 3D Creation

HD Video Chat

Intel® Quick Sync Video is HW-based video codec capability:

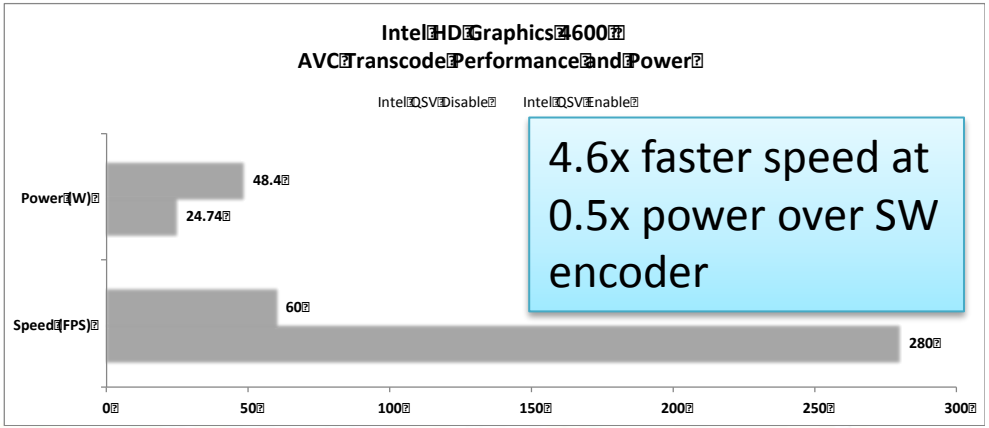
- Break-through performance & quality ➔ new User Experiences
- Many more applications: Wireless Display, Game recording…

Haswell: Quick Sync Video Performance and Power

- 4x-12x real-time transcode at various quality modes
- 10-hour video playback time on latest Apple MacBook Air
- Multi-stream 4K decode
- > real-time 4K Encode

HD Mosaic

4K Mosaic



*Measurements based on Intel Demo Clip in Cyberlink Media Espresso Fast Conversion Mode

Deployment as Media Servers

Example:

- QuickFire Network 1U uServer contains 11 3rd Gen Intel® Core™ mobile processors
- Transcoding over 88 1080p30 HD streams per blade!

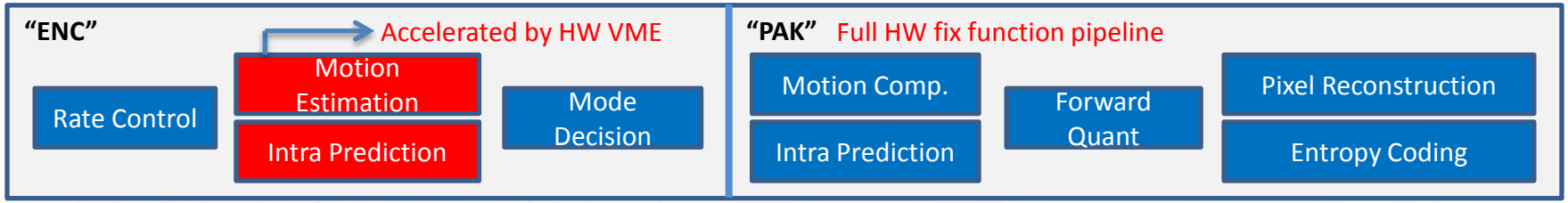
Video Encode: A Balanced Approach

Encode Solutions	Performance	Power	Flexibility
GPGPU	Low	High	High
Traditional Fix Function HW	High †	Low	Low
Flexible Intel Quick Sync Video	High	Low	Balanced

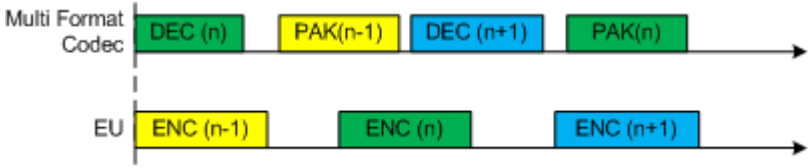
† Subject to actual implementation

- Intel implements a flexible hardware design approach for encoding
  - Hybrid of fix function HW and programmable EU array.
  - Provides balance between performance, power and flexibility

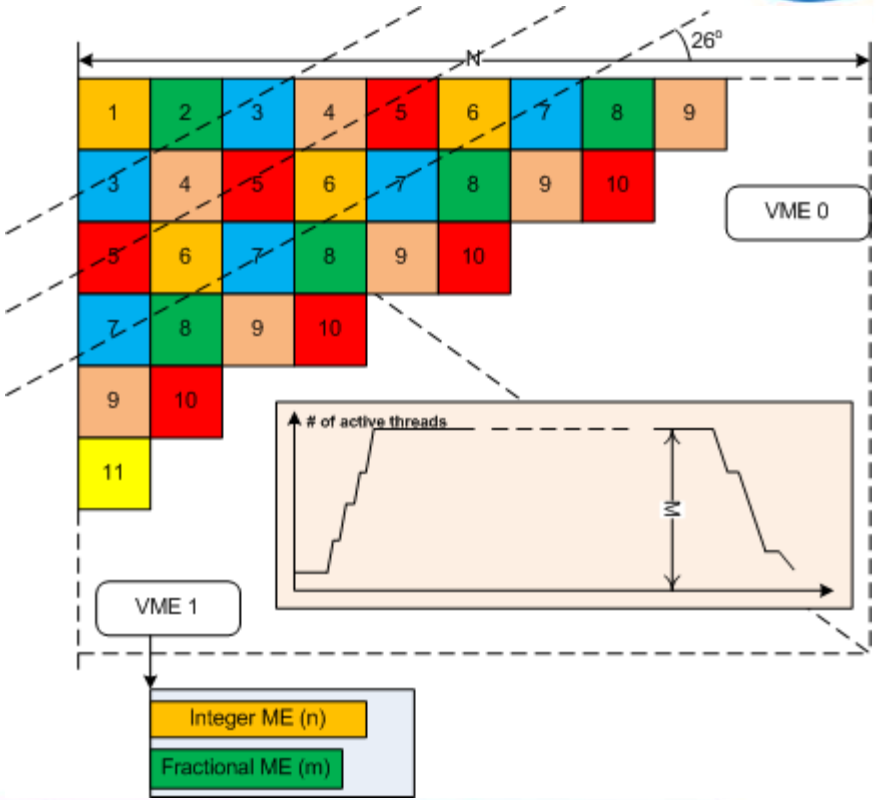
Hybrid 2-Stage Video Encoder:



Encoder Parallelization and Scalability

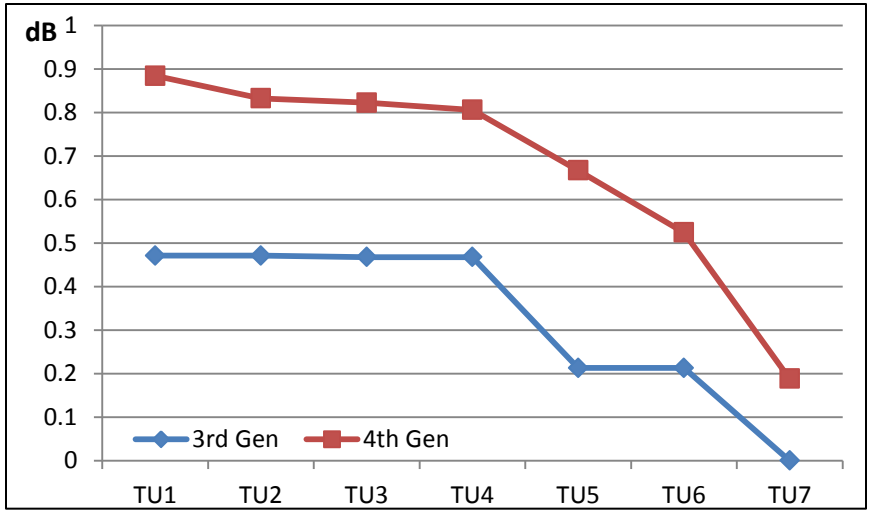


- **Decoupled Encoding Operations**
  - ENC: Multi-threaded in wavefront order macroblocks
  - PAK: Pipelined in raster order macroblocks
- **Multiple level of parallelization**
  - Decoding vs. Encoding
  - ENC and PAK
  - ENC: Multiple Macroblocks in Wavefronts
  - ENC/VME HW: Integer vs. Fractional Search

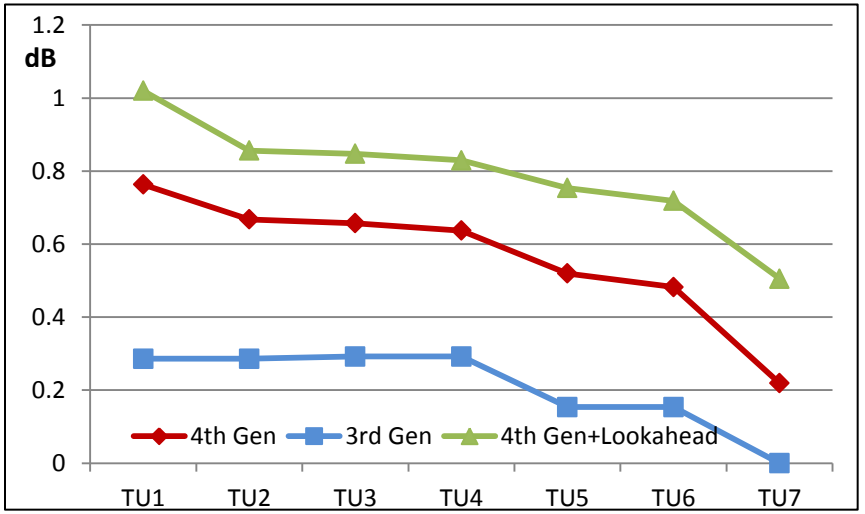


Intel Quick Sync Video – Multi-year Improvements

- Performance: Over 50% hardware CAGR for three generations
- Quality: Hardware features and algorithm improvements
- Usability: Fine grained quality vs. performance tradeoff control



CQP Mode BD-PSNR



VBR Mode BD-PSNR

Data is captured with internal test app over a big set of test clips.

Intel HD Graphics 4000 vs. Intel Iris Pro Graphics 5200

Handbrake Enabled

HD Graphics 4000 (3rd Gen)

Iris Pro Graphics 5200 (4th Gen)

- Frame 670 of Star Trek Into Darkness movie trailer transcoded in HandBrake QSV beta. Both set to VBR 2Mbps Best Quality setting under HandBrake High Profile preset
- Same encode quality on Intel 4th Gen Core Processor with HD 4200/4400/4600, Iris, and Iris Pro. Performance varies on different SKUs

Generational quality improvements

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Generational quality improvements

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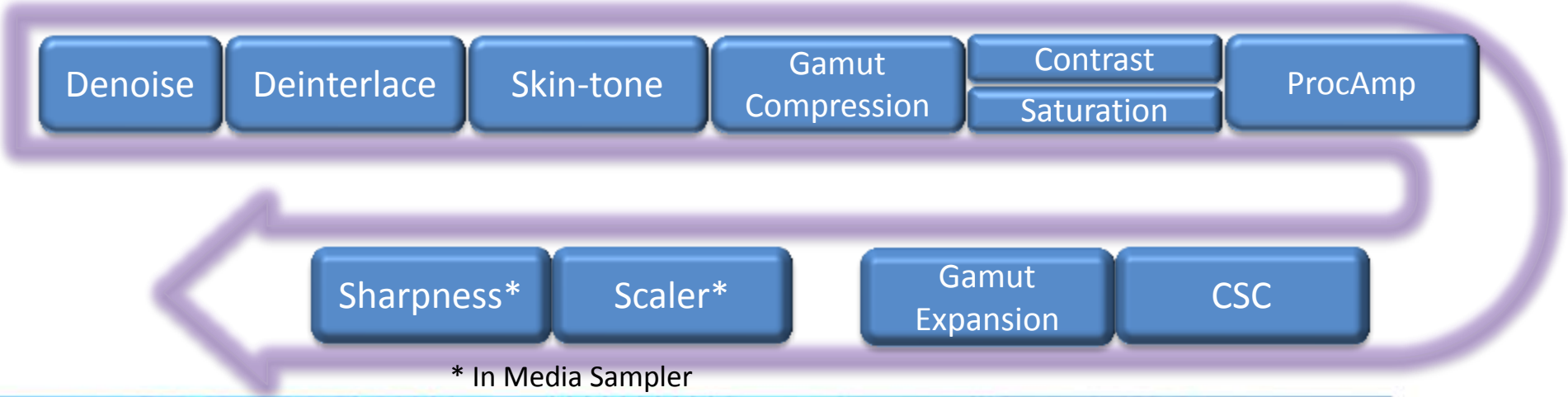
Video Processing Pipe

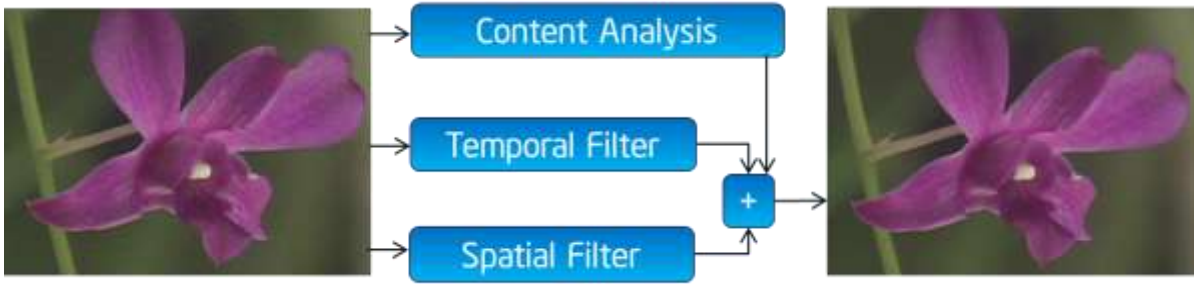
- Migrated to a dedicated VP pipe **Video Quality Engine (VQE)**
- Extensive suite of functions for higher quality video at lower power



* In Media Sampler

De-noise

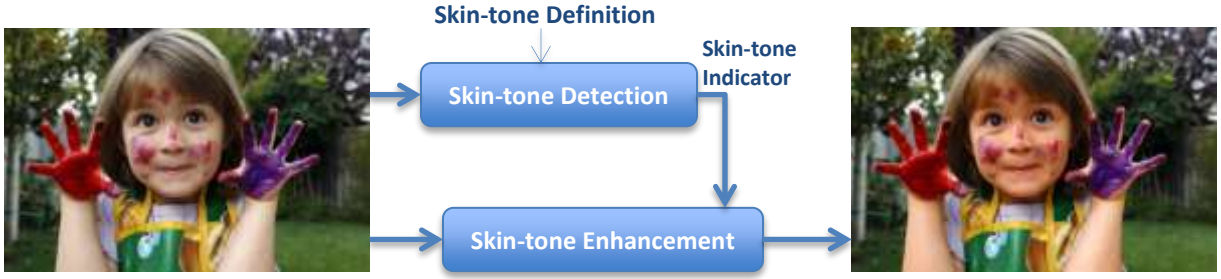
- Spatial and Temporal De-noise Filter
  - Global noise level measurement
  - Content-adaptive spatiotemporal filtering of noise
  - Motion history-based blending of spatial and temporal filter results



- Block Interface
  - Input: YCbCr 420/422
  - Output: YCbCr 420/422

Skin-tone Processing

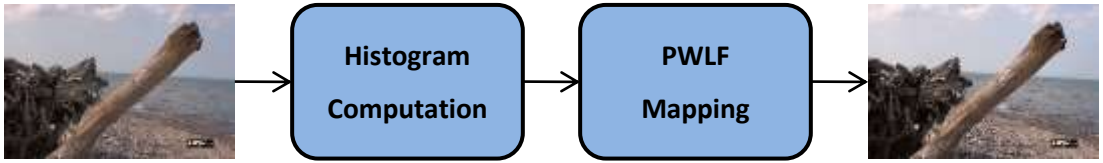
- Per-pixel Enhancement of Skin-tone Pixels
  - Reproduce the natural skin colors on the display screen
  - Skin Tone Detection identifies pixels with skin-like colors with per-pixel indicator
  - Skin Tone Enhancement modifies the Saturation and Hue of the skin-tone pixels



- Block Interface
  - Input: YCbCr444
  - Output: YCbCr444 with modified CbCr components; Per-pixel skin tone indicator

Contrast Enhancement

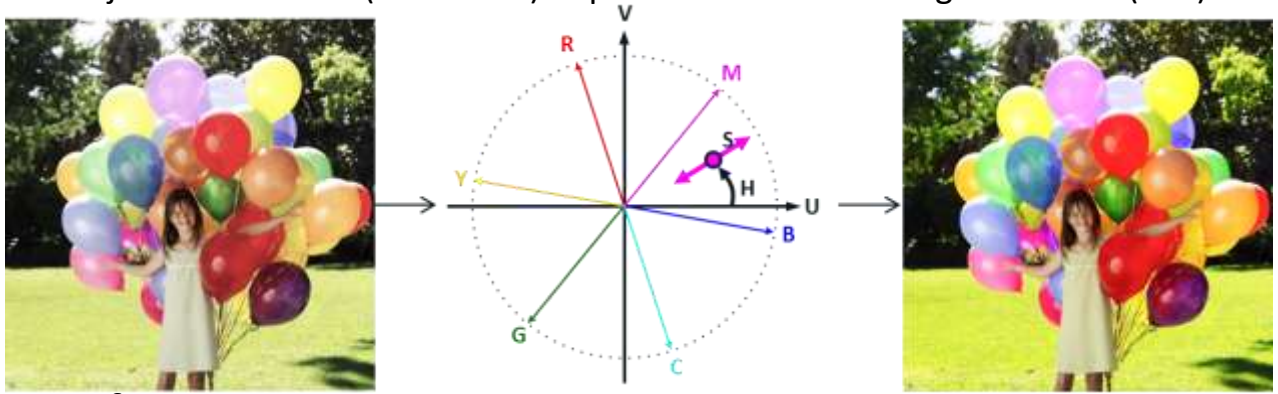
- Automatic Contrast Enhancement: Per-pixel mapping of luma to enhance contrast
    1. Histogram of luma Y pixel values is generated for the input video frame
    2. Piece-Wise Linear Function (PWLF) is generated from luma histogram
    3. Pixel values are modified according to the PWLF



- Block Interface
    - Input: YCbCr 444
    - Output: YCbCr 444 with modified Y

Saturation Enhancement

- Per-Pixel Saturation Enhancement
  - Utilize 6 basic colors as primaries/anchors (Red, Green, Blue, Magenta, Yellow, Cyan)
  - Adjust colorfulness (saturation) of pixels while maintaining their color (hue)



- Block Interface
  - Input: YCbCr 444
  - Output: YCbCr 444 with modified CbCr components

Color Correction

- Display proper colors on display screen
  1. Inverse gamma correction via PWLF
  2. 3x3 matrix multiplication with input/output offset
  3. Forward gamma correction via PWLF

- Block Interface
  - Input: RGB
  - Output: RGB


PRIME BREW
KIRIN


PRIME BREW
KIRIN

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Towards
Natural, Intuitive and Immersive
Human-Computer Interactions

Now

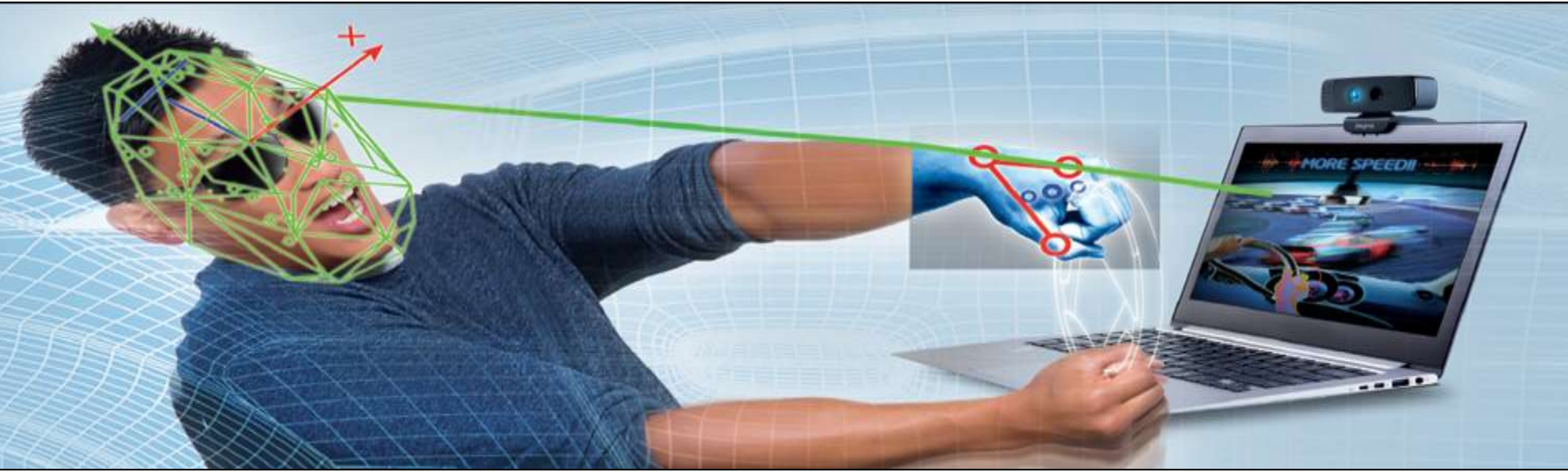
Near Future

The Vision

Perceptual Computing

Adding "Human-like Senses"
to the Computing Devices

Intel® Perceptual Computing SDK



Download the SDK and order the 3D Camera at
intel.com/software/perceptual

Intel® Perceptual Computing SDK

Speech Recognition

Facial Analysis

Hand Tracking

3D Gestures

Object Tracking

Easily Implemented by Application Developers for:

- Games
- Entertainment
- Productivity
- Accessibility
- Immersive Teleconferencing
- Education
- Health
- Enterprises
- Retail
- Industrial

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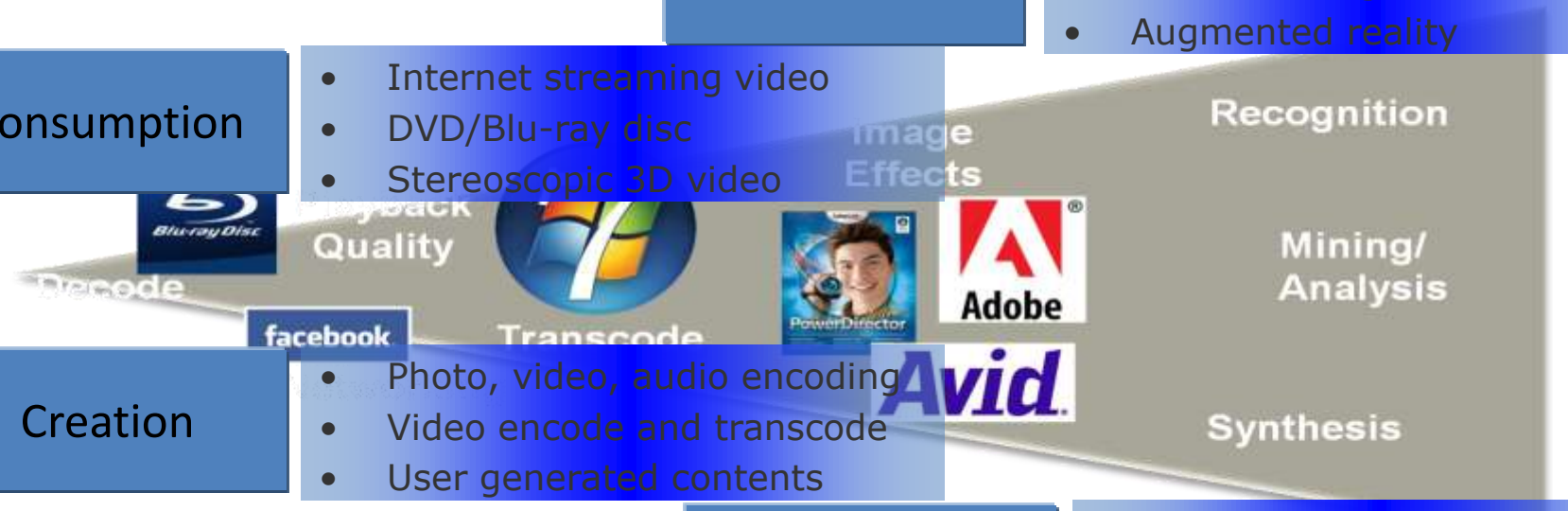
Media Usage Outlook

Interaction

- Video and sensory inputs
- Gesture recognition
- Augmented reality

Consumption

- Internet streaming video
- DVD/Blu-ray disc
- Stereoscopic 3D video



Creation

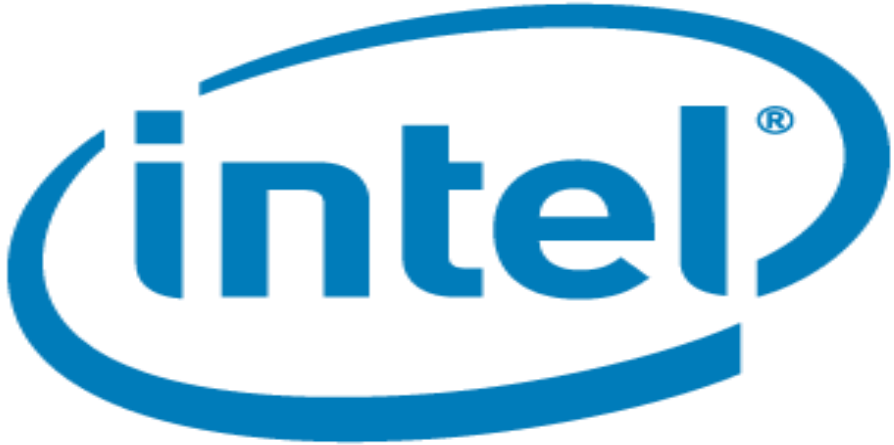
- Photo, video, audio encoding
- Video encode and transcode
- User generated contents

Perception

- Face & object detection
- Scene analysis
- Perceptual computation

Concluding Remarks

- We are in the era of HD digital media
- Moore’s Law inspires Innovations
- Heterogeneous computing addresses the HD media demands
- Media continues to be an exciting fields for years to come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