Vision Acceleration

Useful information

- We will work with a virtual machine
- Flash drives are available for those who did not download the virtual image

Khronos Connects Software to Silicon

Open Consortium creating ROYALTY-FREE, OPEN STANDARD APIs for hardware acceleration

Defining the roadmap for low-level silicon interfaces needed on every platform

Graphics, compute, and vision processing

Rigorous specifications AND conformance tests for cross-vendor portability

Acceleration APIs
BY the Industry
FOR the Industry

Well over a *BILLION* people use Khronos APIs *Every Day…*

Vision Processing Power Efficiency

- **Wearables will need 'always-on' vision**
  - With smaller thermal limit / battery than phones!

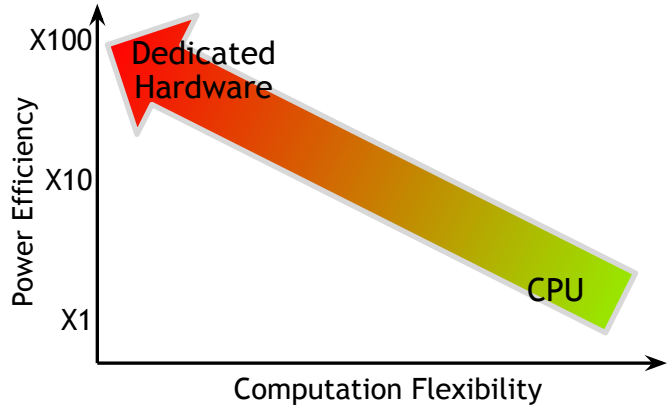
Advanced Sensors

- **GPUs has x10 CPU imaging power efficiency**
  - GPUs architected for efficient pixel handling

Wearables

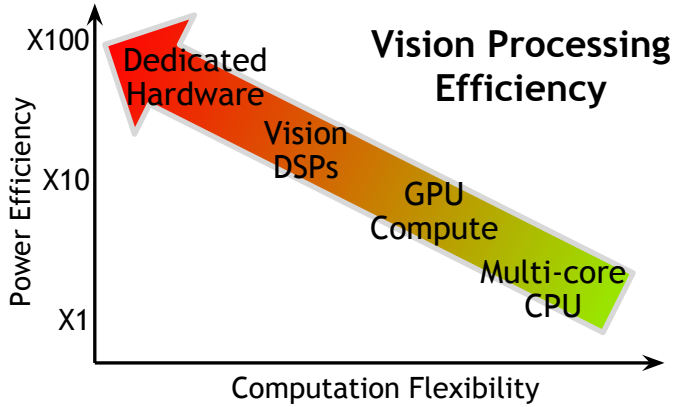
- **Traditional cameras have dedicated hardware**
  - ISP = Image Signal Processor – on all SOCs today

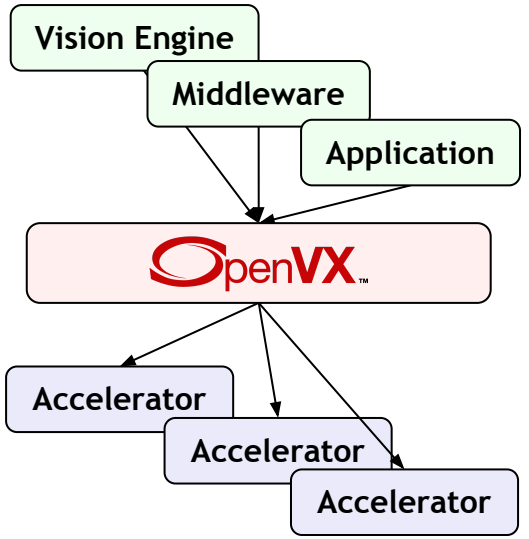
But how to program specialized processors?
Performance and Functional Portability



OpenVX – Low-Power Vision Acceleration

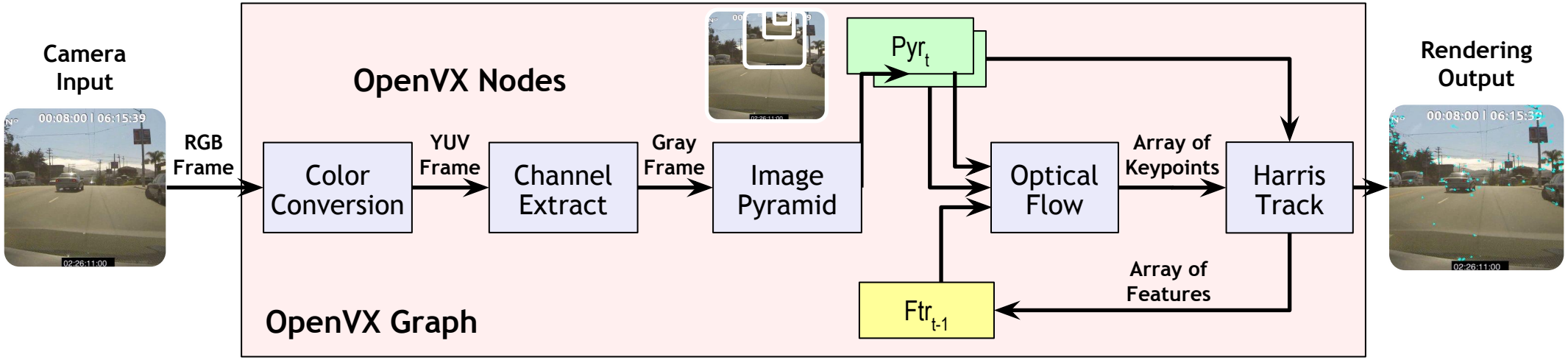
- **Higher-level abstraction API**
  - Targeted at real-time mobile and embedded platforms
- **Performance portability across diverse architectures**
  - Multi-core CPUs, GPUs, DSPs, ISPs, Dedicated hardware, …
- **Extends portable vision acceleration to very low-power domains**
  - Doesn't require high-power CPU/GPU Complex
  - Lower precision requirements than OpenCL



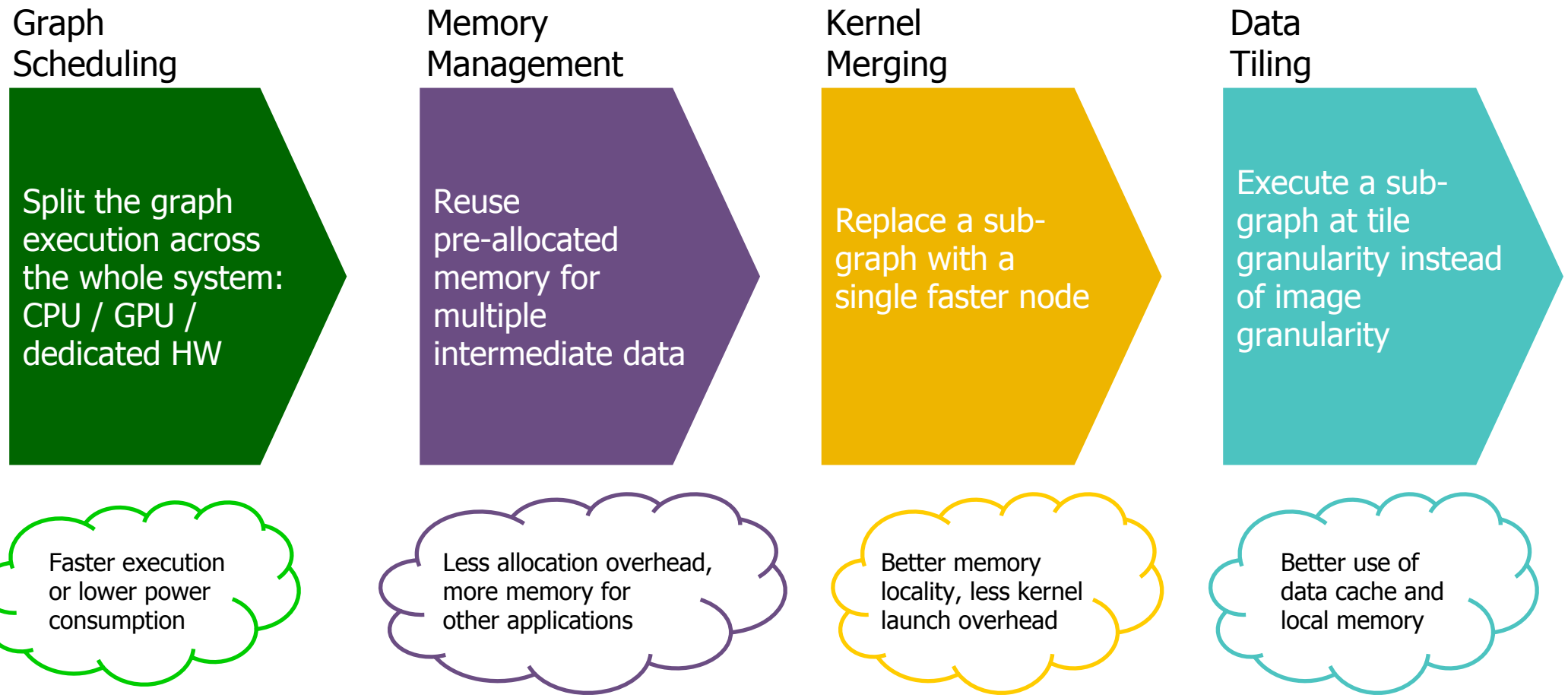


OpenVX Graphs

- **OpenVX developers express a graph of image operations ('Nodes')**
  - Nodes can be on any hardware or processor coded in any language
  - For example, on GPU, nodes may implemented in OpenCL
- **Minimizes host interaction during frame-rate graph execution**
  - Host processor can setup graph which can then execute almost autonomously



OpenVX Framework Efficiency

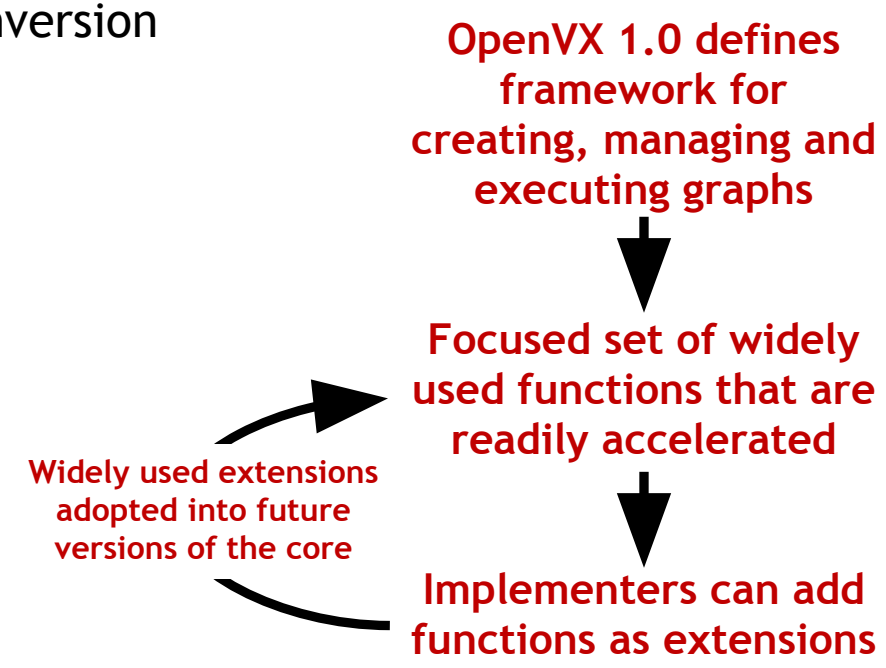


OpenVX 1.0 Function Overview

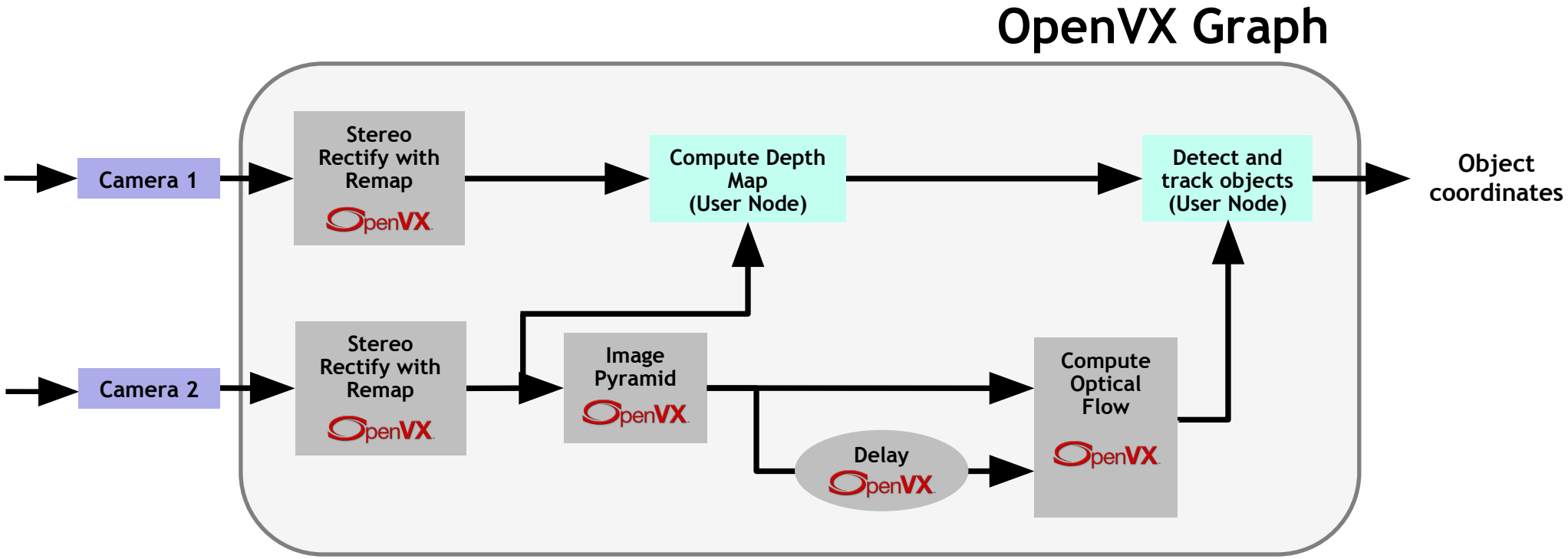
- **Core data structures**
  - Images and Image Pyramids
  - Processing Graphs, Kernels, Parameters
- **Image Processing**
  - Arithmetic, Logical, and statistical operations
  - Multichannel Color, BitDepth Extraction, and Conversion
  - 2D Filtering and Morphological operations
  - Image Resizing and Warping
- **Core Computer Vision**
  - Pyramid computation
  - Integral Image computation
- **Feature Extraction and Tracking**
  - Histogram Computation and Equalization
  - Canny Edge Detection
  - Harris and FAST Corner detection
  - Sparse Optical Flow

OpenVX Specification Is Extensible

Khronos maintains extension registry



Example Graph - Stereo Machine Vision



Tiling extension enables user nodes (extensions) to also optimally run in local memory

OpenVX and OpenCV are Complementary

	OpenCV	OpenVX
Implementation	Community-driven open source library	Open standard API designed to be implemented by hardware vendors
Conformance	Extensive OpenCV Test Suite but no formal Adopters program	Implementations must pass defined conformance test suite to use trademark
Consistency	Available functions can vary depending on implementation / platform	All core functions must be available in all conformant implementations
Scope	Very wide 1000s of imaging and vision functions Multiple camera APIs/interfaces	Tight focus on core hardware accelerated functions for mobile vision – but extensible Uses external/native camera API
Efficiency	Memory-based architecture Each operation reads and writes to memory	Graph-based execution Optimizable computation and data transfer
Typical Use Case	Rapid experimentation and prototyping - especially on desktop	Production development & deployment on wide range of mobile and embedded devices

OpenVX Status

- **Finalized OpenVX 1.0 specification released October 2014**
  - OpenVX 1.0.1 spec maintenance update released June 2015 www.khronos.org/openvx
- **Khronos open source sample implementation of OpenVX 1.0.1 released**
  - https://www.khronos.org/registry/vx/sample/openvx_sample_1.0.1.tar.bz2
- **Commercial conformant products**
  - Intel, Imagination, NVIDIA, Synopsis, Vivante, and many more coming…
- **Publicly available commercial and open-source implementations**
  - https://www.khronos.org/openvx/resources

Summary

- **Khronos is building a trio of interoperating APIs for portable / power-efficient vision and sensor processing**
- **OpenVX 1.0.1 specification has been released**
  - Full conformance tests and Adopters program
  - First commercial implementations released