Hardware acceleration for Machine Learning and Computer Vision through Khronos open standard APIs

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Workshop agenda

9:05 AM	Khronos/OpenCL/SPIR-V (Neil Trevett, NVIDIA) – 35 minutes
9:40 AM	OpenCL/SYCL (Andrew Richards, Codeplay) – 20 minutes
10:00 AM	Break – 15 minutes
10:15 AM	SYCL presentation (Konstantin S. Bobrovsky, Intel) – 45 minutes
11:00 AM	OpenVX presentations (Frank Brill, Cadence, Niclas Danielsson and Mikael Pendse, Axis – 1 hour)
12:00 PM	Lunch – 1 hour
1:00 PM	OpenVX presentation (Mike Schmit, AMD) – 30 minutes
1:30 PM	NNEF presentation (Gergely Debreczeni, Almotive) – 30 min
2:00 PM	NNEF hands-on (Gergely Debreczeni, Almotive) – 30 min
2:30 PM	OpenVX hands-on part 1 (Rajy Rawther and Kiriti Nagesh Gowda, AMD) – 30 minutes
3:00 PM	Break – 15 minutes
3:15 PM	OpenVX hands-on part 2 (Rajy Rawther and Kiriti Nagesh Gowda, AMD) – 2 hours
5:00 PM	Finish

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Portable performance via the OpenVX™ computer vision library

Frank Brill
Cadence Design Systems
May 2019

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OpenVX Extensions

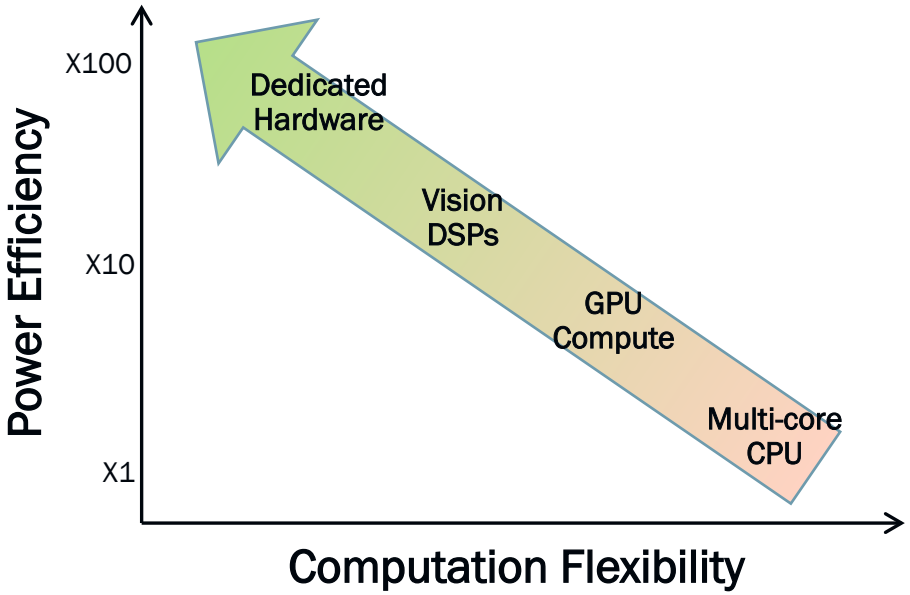
- Neural Network: run inference as part of a graph
  - Layers are represented as OpenVX nodes
- Classification: detect and recognize objects in an image based on a set of features
  - Import a cascade detector/classifier model trained offline
  - Classify objects based on a set of input features
- Pipelining: increase hardware utilization and throughput
  - Provide a way of pipelining, streaming, and batch processing
  - Multiple initiations of a graph with different inputs and outputs
- OpenCL Interop: interop between OpenVX and OpenCL application & user-kernels
- Import/Export: provide a way of exporting and importing pre-verified graphs & objects
- Import Kernel: import pre-compiled vendor binary (e.g., pre-compiled NN as a kernel)

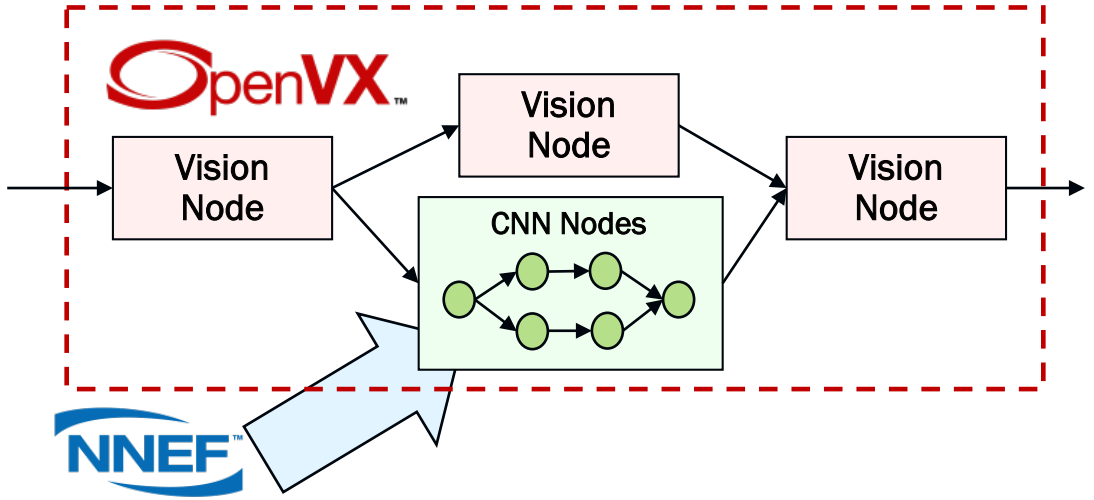
OpenVX

- Wide range of vision hardware architectures
- OpenVX provides a high-level Graph-based abstraction
  - Enables Graph-level optimizations!
  - Can be implemented on almost any hardware or processor!
- Portable, Efficient Vision Processing!

AMD cadence CEVA Ceva-Neuflek intel Imagination QUALCOMM SYNOPSYS NVIDIA Texas Instruments socionext VeriSilicon

Shipping Implementations





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OpenVX Efficiency through Graphs

Graph Scheduling

Split the graph execution across the whole system: CPU / GPU / dedicated HW

Faster execution or lower power consumption

Memory Management

Reuse pre-allocated memory for multiple intermediate data

Less allocation overhead, more memory for other applications

Kernel Fusion

Replace a sub-graph with a single faster node

Better memory locality, less kernel launch overhead

Data Tiling

Execute a sub-graph at tile granularity instead of image granularity

Better use of data cache and local memory

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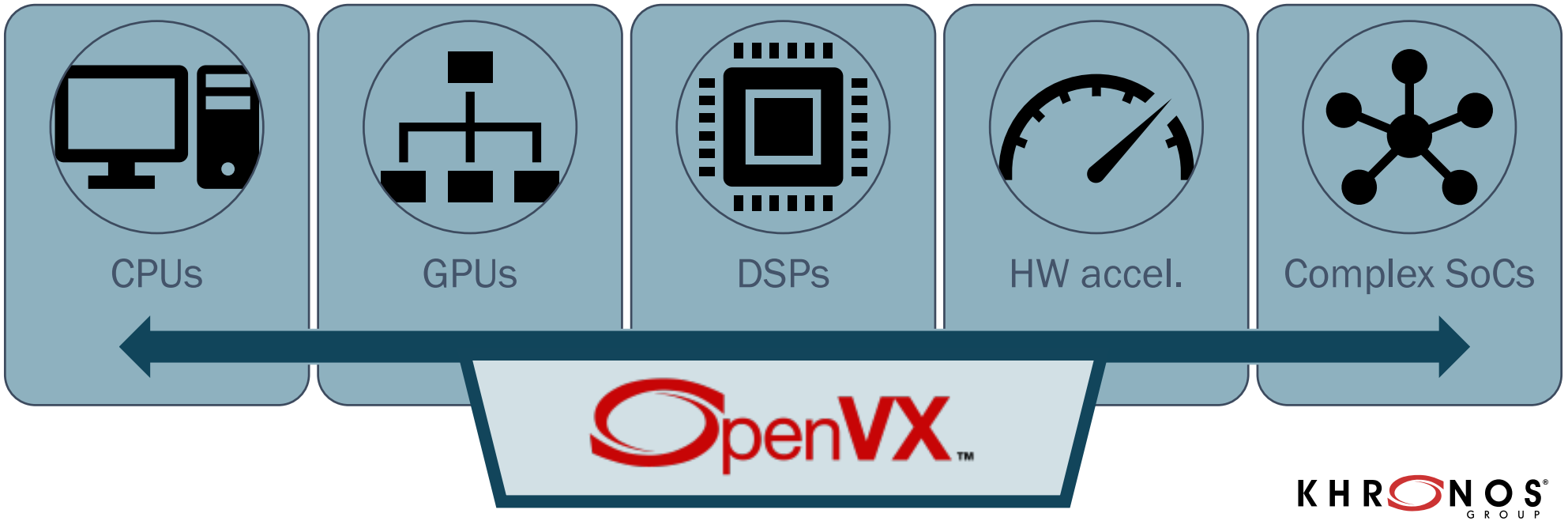
OpenVX delivers portable performance

- Application code **portable** across a broad range of hardware platforms
- **Performance** comparable to hand-optimized, non-portable code
  - Real, complex applications on real, complex hardware
  - Much lower development effort than hand-optimized
- **Integrate** neural-network and pre/post processing to **optimize** globally



OpenVX Roadmap and Resources

OpenVX Roadmap

- OpenVX 1.3 expected to be approved for release in July
  - **Enhanced neural-network support**
    - NNEF import with conformance tests
  - **Feature sets to enable compliance for diverse application spaces**
    - Classical computer vision / image processing
    - Neural networks via OpenVX extension nodes or NNEF import
    - Binary (one bit) image processing
  - **Merge safety-critical features into single main specification**
- Open-source implementation on Raspberry Pi in development
  - MulticoreWare, mostly ARM NEON via ARM Compute Library (ACL)
  - OpenCL / VC4CL: https://github.com/doe300/VC4CL
  - Blog: https://www.element14.com/community/community/raspberry-pi/blog/2019/01/22/raspberry-pi-now-with-opencl-gpu-support-vc4cl-videocore-iv-opencl
  - Target September

OpenVX and NNEF resources

- OpenVX Overview: https://www.khronos.org/openvx
- OpenVX Specifications: current, previous, and extensions
  - https://www.khronos.org/registry/OpenVX
- OpenVX implementations, tutorials, reference guides, etc.
  - https://www.khronos.org/openvx/resources
- NNEF Specification: https://www.khronos.org/registry/NNEF
- Embedded Vision Summit Workshop

  "Hardware acceleration for Machine Learning and Computer Vision through Khronos open standard APIs"

  Thursday, May 23, 2019 from 9:00am-5:00pm

  https://www.khronos.org/events/2019-embedded-vision-summit

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