GPU Compute Virtualization with VirtIO

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AMD
together we advance_

Team members

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  - Kernel (GPU, Xen)/QEMU/Xen
- Julia Zhang - China
  - Mesa 3D (OpenGL, Vulkan)/Virglrenderer/QEMU
- Honglei Huang - China
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  - Mesa 3D (OpenGL, Vulkan)/Virglrenderer
- Dmitry Osipenko - Russia
  - Mesa 3D/Virglrenderer/QEMU/Kernel VirtIO

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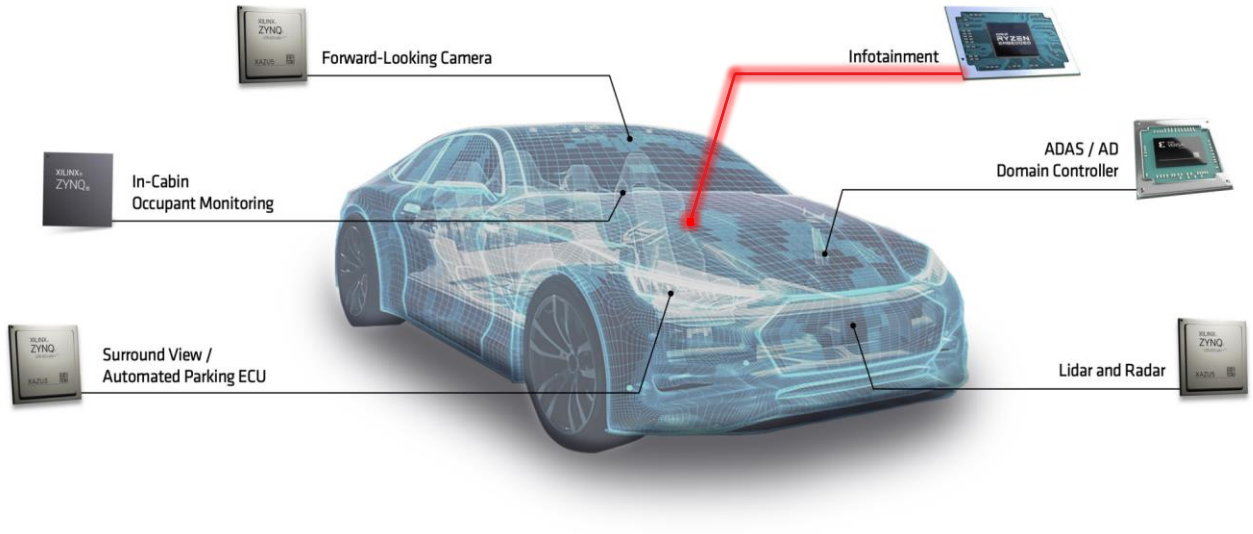
COLLABORA

Last year

- Xen Project Summit 2023 - June
  - Kickoff GPU Virtualization design for Xen
  - Enable and implement traditional 3D Graphic and Multimedia hardware acceleration based on Virgl and Venus - first time to enable Vulkan 3D on Xen
  - Design and implement dGPU passthrough on PVH dom0

- X.Org Developers Conference 2023 - Oct
  - Continue implementing OpenGL and Vulkan 3D libraries support on Xen
  - Continue upstream of dGPU passthrough
  - Introduce the prototype of virtio native context - OpenGL/Vulkan enhancement



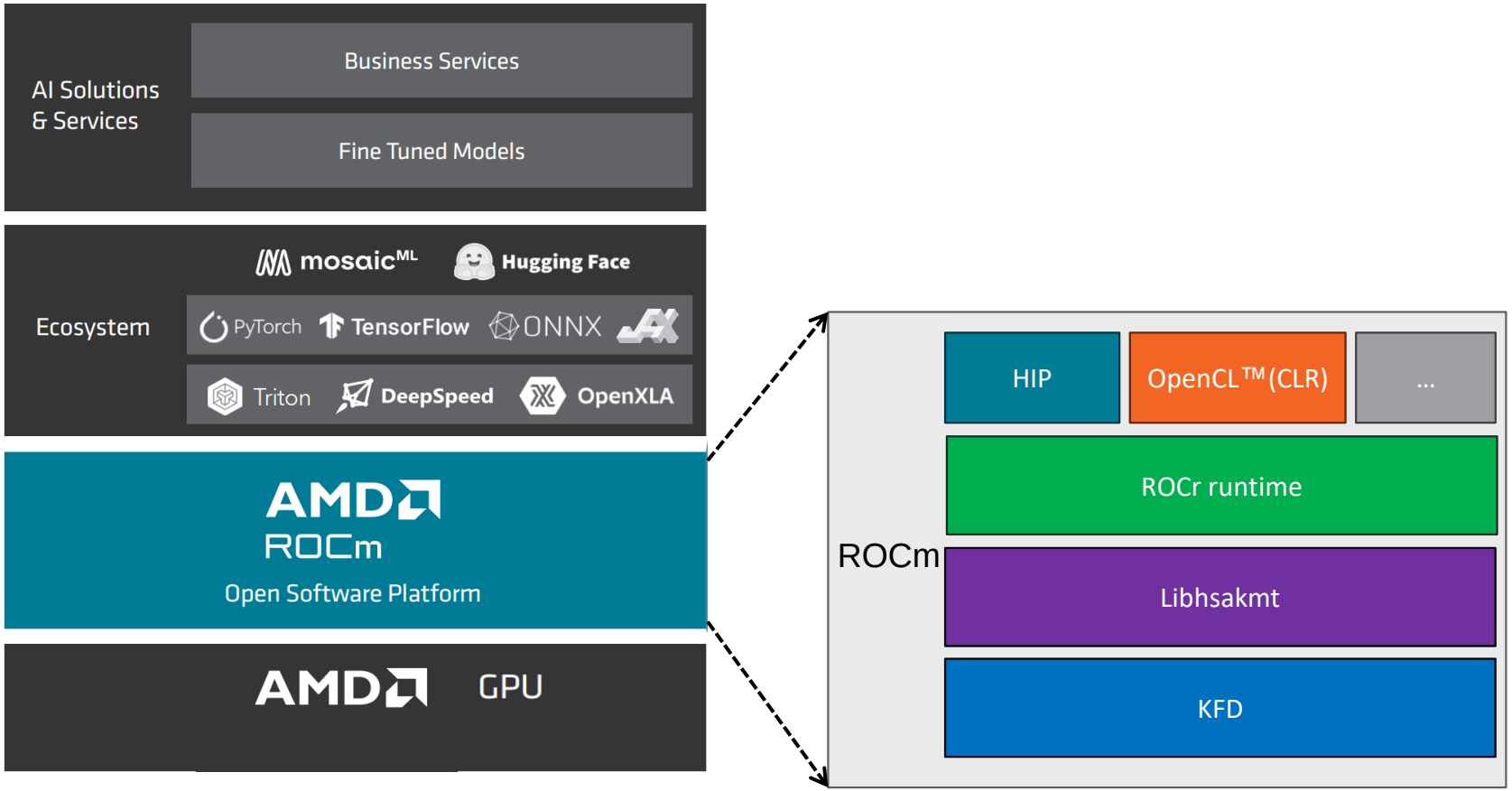
Updates in 2024

- GPU Para-Virtualization
  - Introduce VirtIO native context solution for 3D Graphic and Multimedia hardware acceleration
  - **Prototype AMD ROCm native context solution to support OpenCL™ on VirtIO GPU - coming**
  - Finish PCIe Passthrough on Xen PVH dom0
  - To support VirtIO GPU on PVH guest domU - ongoing
  - To support VirtIO GPU on Xen Hyperlaunch - ongoing

What's ROCm

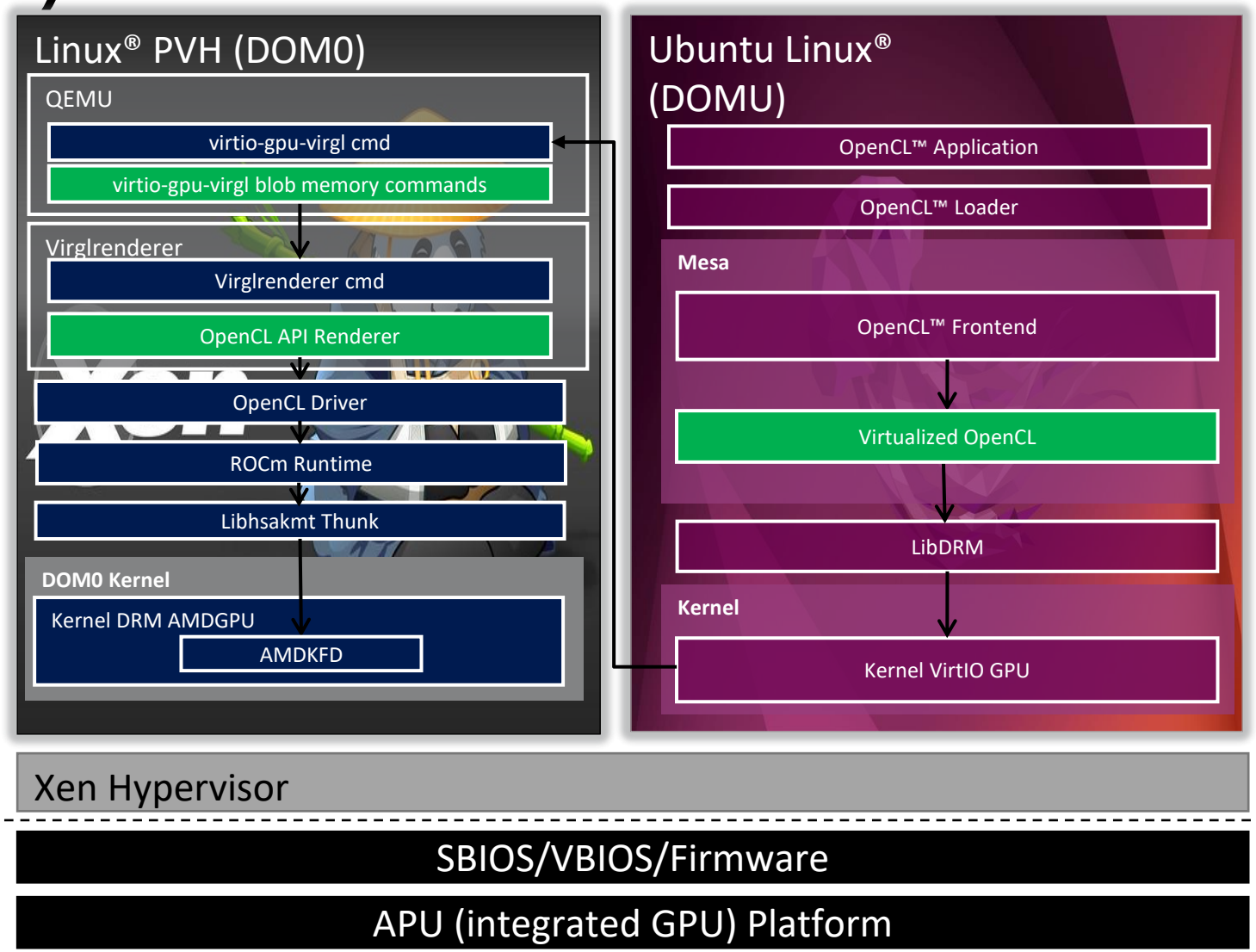
- An open-source software platform for compute/AI on AMD GPU series
  - Provide multiple interface support for popular computing frameworks like HIP & OpenCL™
  - Mainly includes CLR (OpenCL™ runtime), HIP, ROCr runtime, libhsakmt, KFD kernel driver.

- OpenCL™ over ROCm
  - Support OpenCL protocol based on ROCm compute stack on AMD GPU series



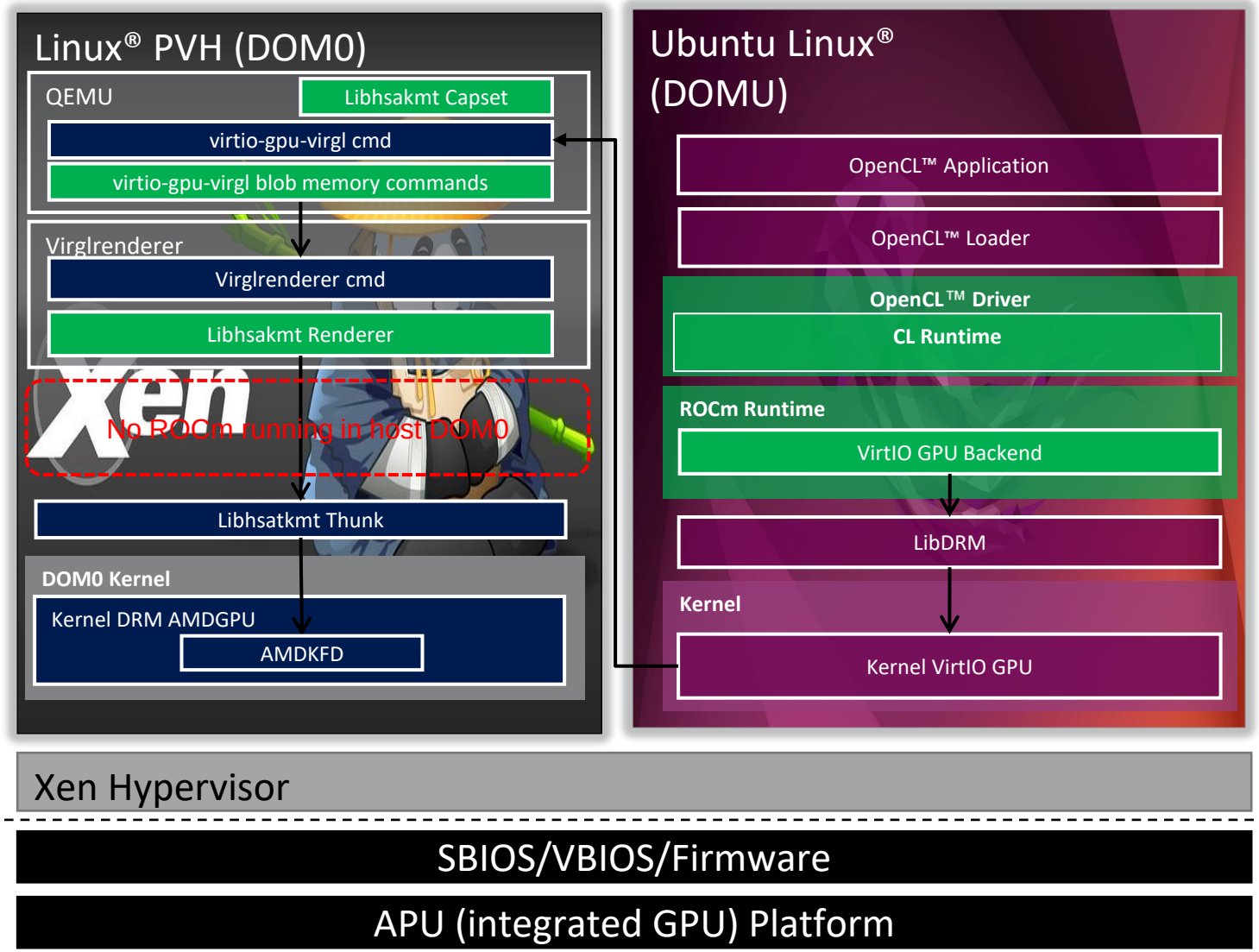
Virtualized OpenCL™ (VirCL)

- AMD ROCm on host DOM0
  - Support OpenCL™ over ROCm on host
- API Forward for OpenCL™
  - Introduce Virtualized OpenCL in Mesa driver to talk with VirtIO GPU
  - Leverage blob memory
  - Add OpenCL™ renderer in virglrenderer to talk with OpenCL™



ROCm with VirtIO Native Context

- AMD ROCm on guest DOMU - coming
  - Support OpenCL™ over ROCm for virtualization
  - Also inspired by VirtIO native context on graphic design
- API Forward for Libhsakmt (Thunk)
  - Introduce VirtIO GPU backend in ROCm runtime and OpenCL™ runtime
  - Add libhsakmt capacity in QEMU
  - Leverage blob memory
  - Add libhsakmt renderer in virglrenderer
- Kickoff upstream in Freedesktop
  - https://gitlab.freedesktop.org/virgl/virglrenderer/-/merge_requests/1370



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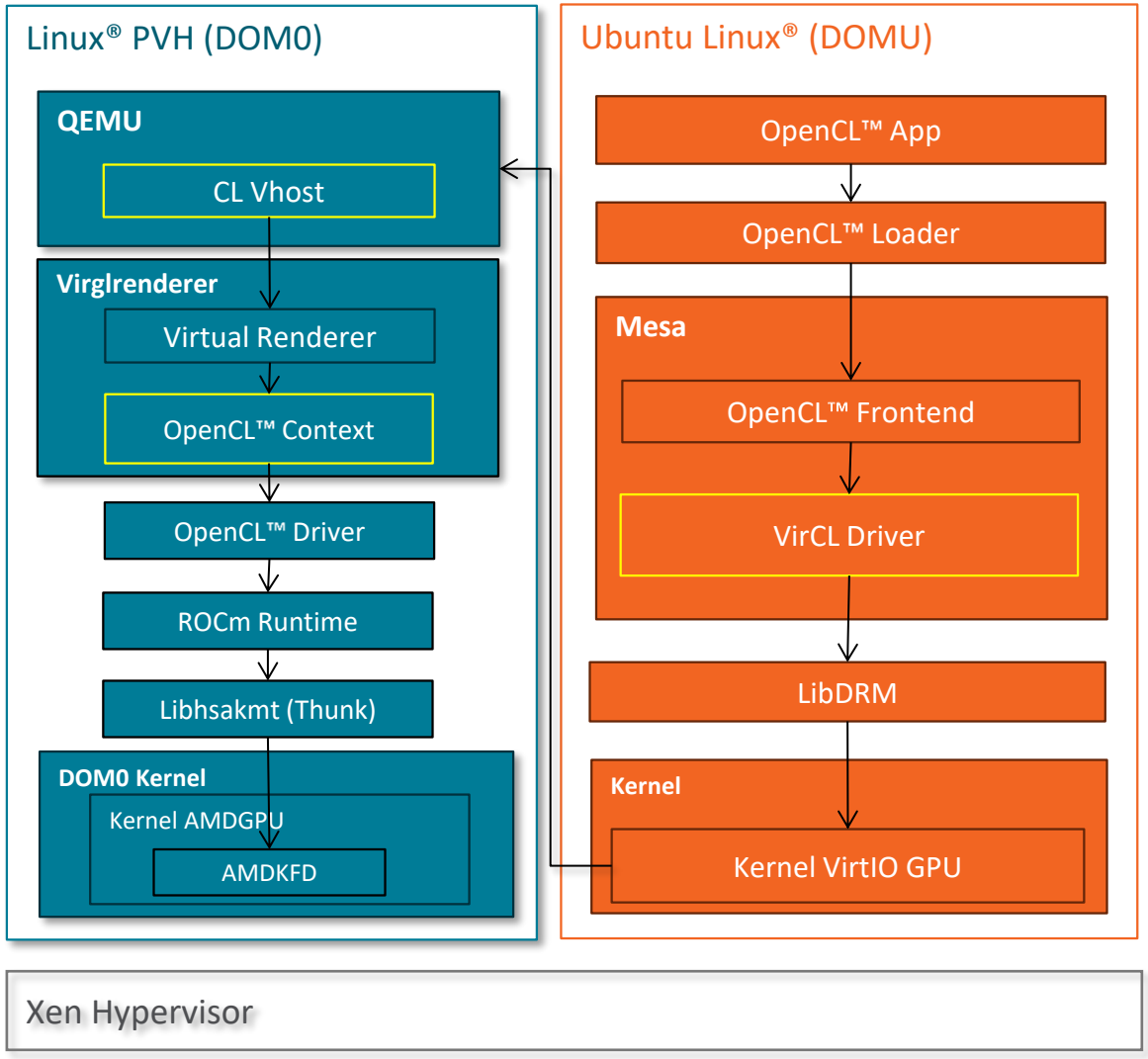
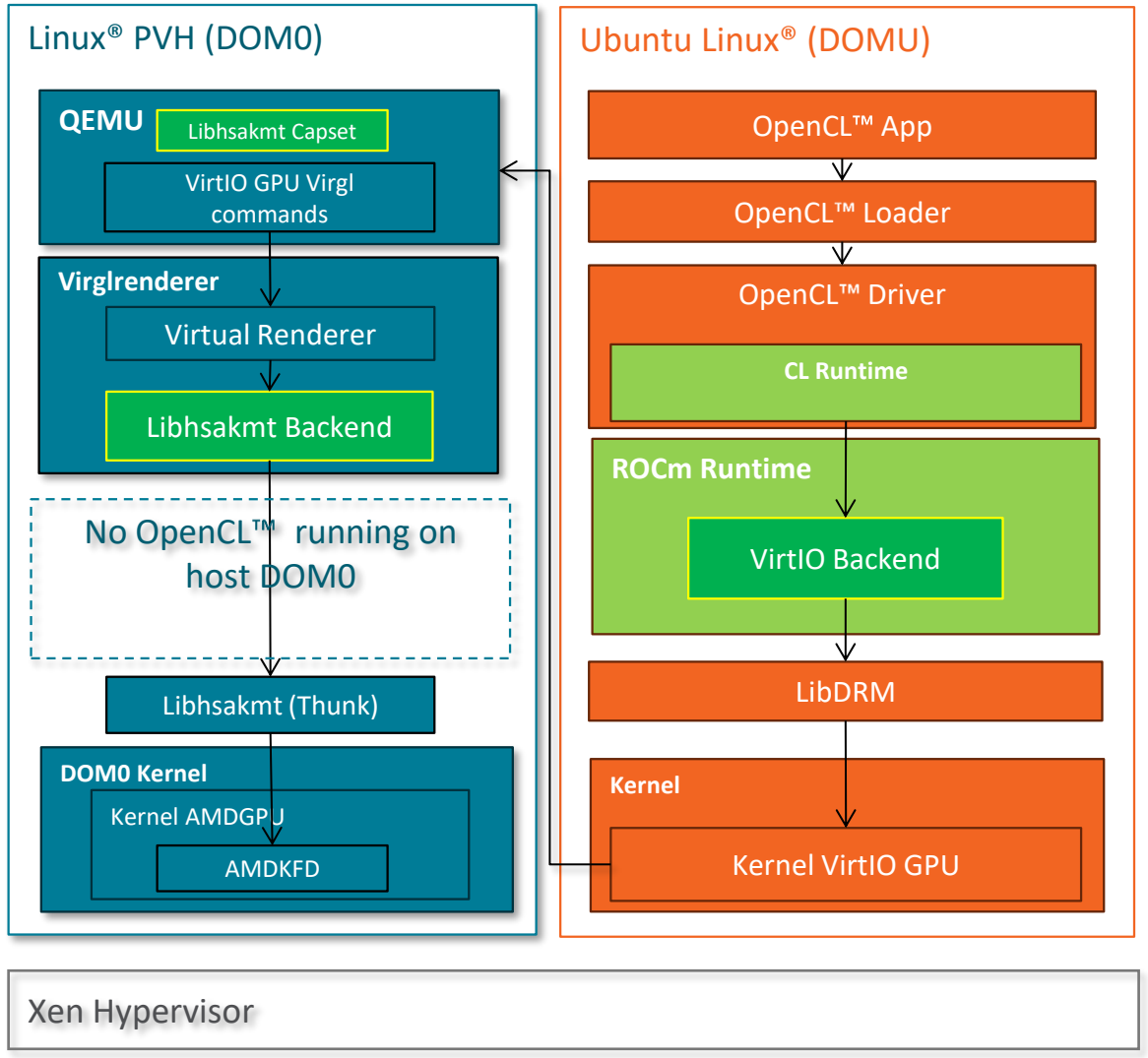
VirCL

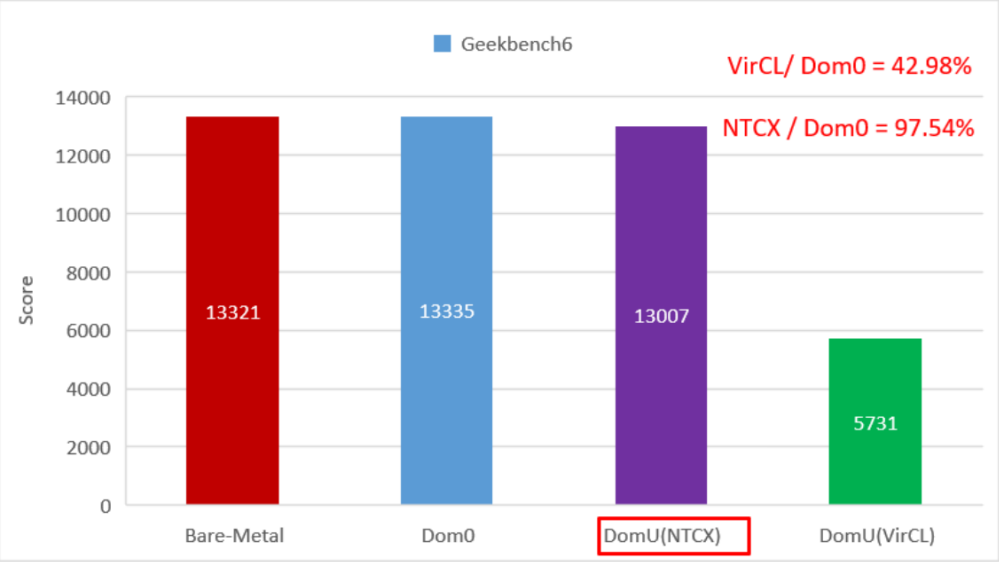


CL Native Context



OpenCL™ Performance Preview in Virtualization

- OpenCL™ Comparison between Bare-metal, DOM0, VirCL (DOMU), and Native Context (DOMU)



Test Cases (Unit: Score)	Bare-Metal - Native	DOM0 - Native	DOMU - VirCL	DOMU - OpenCL Native Context
GeekBench6	13321	13335	5731 (42.98%)	13007 (97.54%)

The Best is Yet to Come

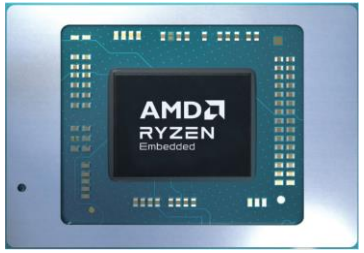
- Continue upstream for the whole solution - ongoing
- Support multiple processes on AMD KFD for native context
- **Support HIP in ROCm stack for virtualization**
- Support leading AI Frameworks over ROCm for virtualization

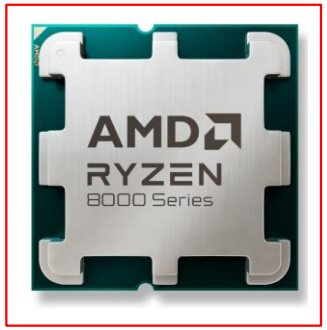
AMD ROCm

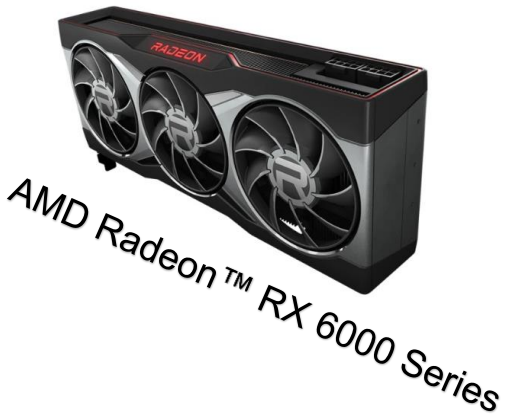
TensorFlow

PyTorch

References







AMD Radeon™ RX 6000 Series

- Hardware
  - AMD Ryzen™ Embedded V2000 Series
  - AMD Radeon™ RX 6000 Series GPUs
  - AMD Ryzen™ 8000 Series (ongoing)
- VirtIO GPU and Passthrough GPU Support for Xen
  - Xen Project Summit 2023
  - https://xen2023.sched.com/event/1LKln
- Xen based GPU virtualization - VirtIO/Passthrough
  - X.Org Developer's Conference 2023
  - https://indico.freedesktop.org/event/4/contributions/216/
- dGPU prime on VM
  - X.Org Developer's Conference 2023
  - https://indico.freedesktop.org/event/4/contributions/189/
- GPU Para-Virtualization on Xen
  - Xen Project Summit 2024
  - https://xenprojectsummit2024.sched.com/event/1bCFX

Demo, Q&A, and Thank You

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