

# IRIS: A Portable Runtime System Exploiting Multiple Heterogeneous Programming Systems

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and Jeffrey S. Vetter

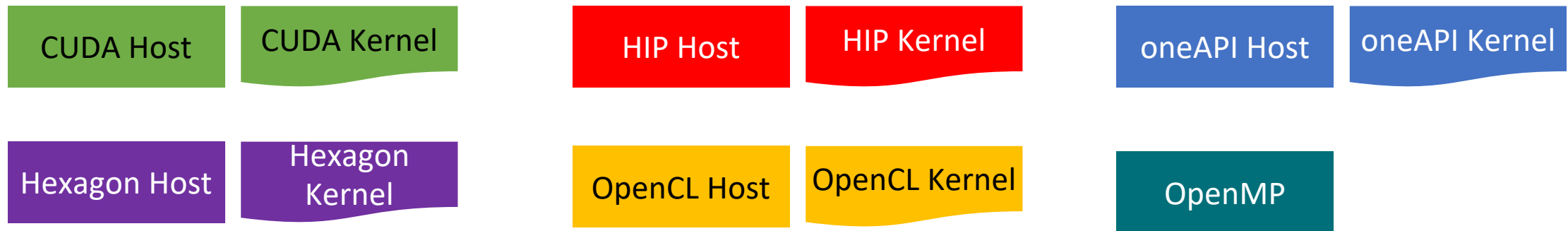
Oak Ridge National Laboratory

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# No De Facto Standard for Heterogeneous Programming

- ORNL Experimental Computing Laboratory (ExCL) systems\*

Systems	Snapdragon	Jetson	Zynq	DGX			Oswald			Summit	Frontier
CPU	ARM	ARM	ARM	I	I	I	I	I	I	IBM	AMD
GPU	Qualcomm	NVIDIA		NVIDIA			NV	NV		NVIDIA	AMD AMD
FPGA			Xilinx				Intel	Intel			
DSP	Qualcomm										



\* ORNL ExCL: <https://excl.ornl.gov/>

# We Need Portability in Heterogeneous Programming

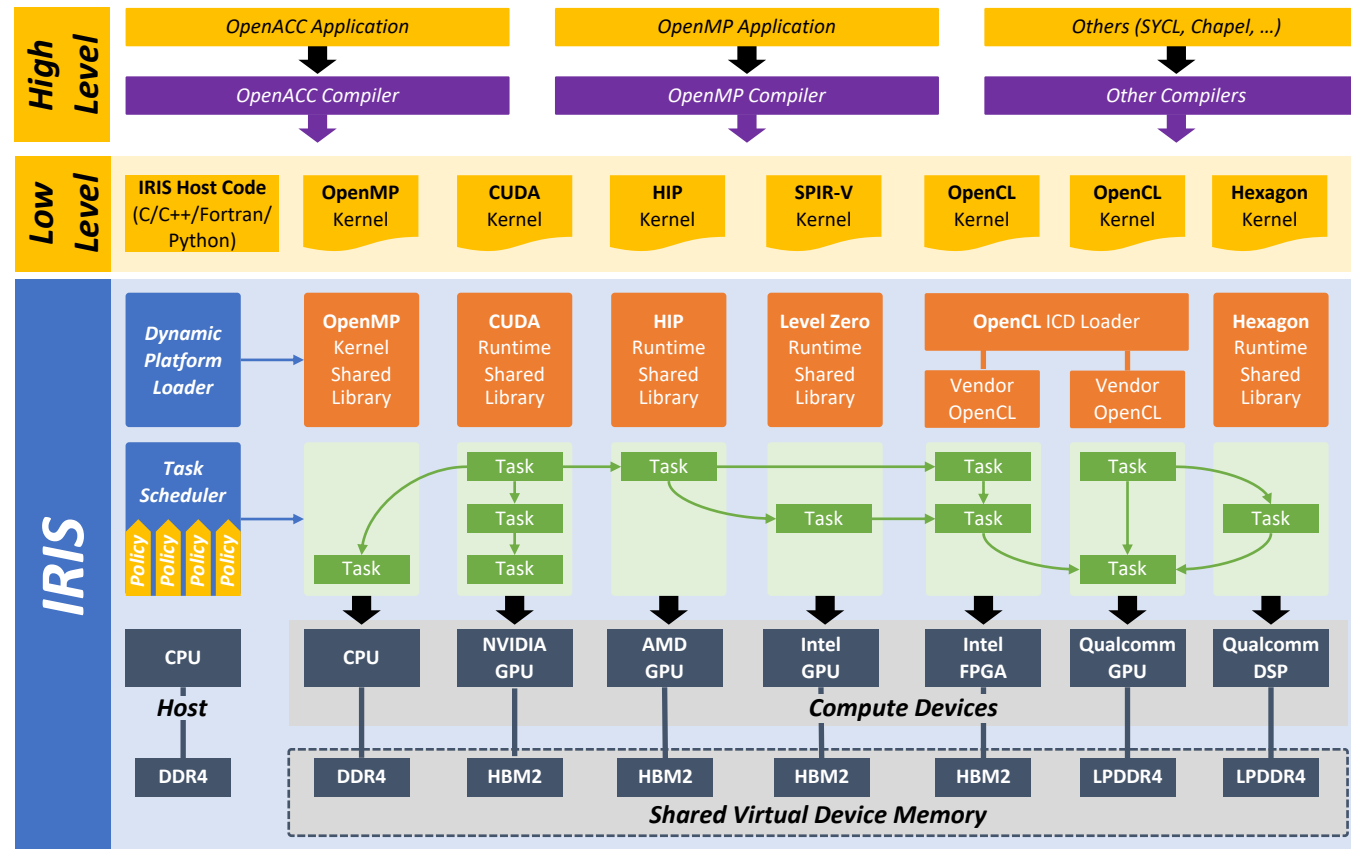
- Not portable program across different HW configurations

Systems	Snapdragon	Jetson	Zynq	DGX			Oswald			Summit	Frontier
CPU	ARM	ARM	ARM	I	I	I	I	I	I	IBM	AMD
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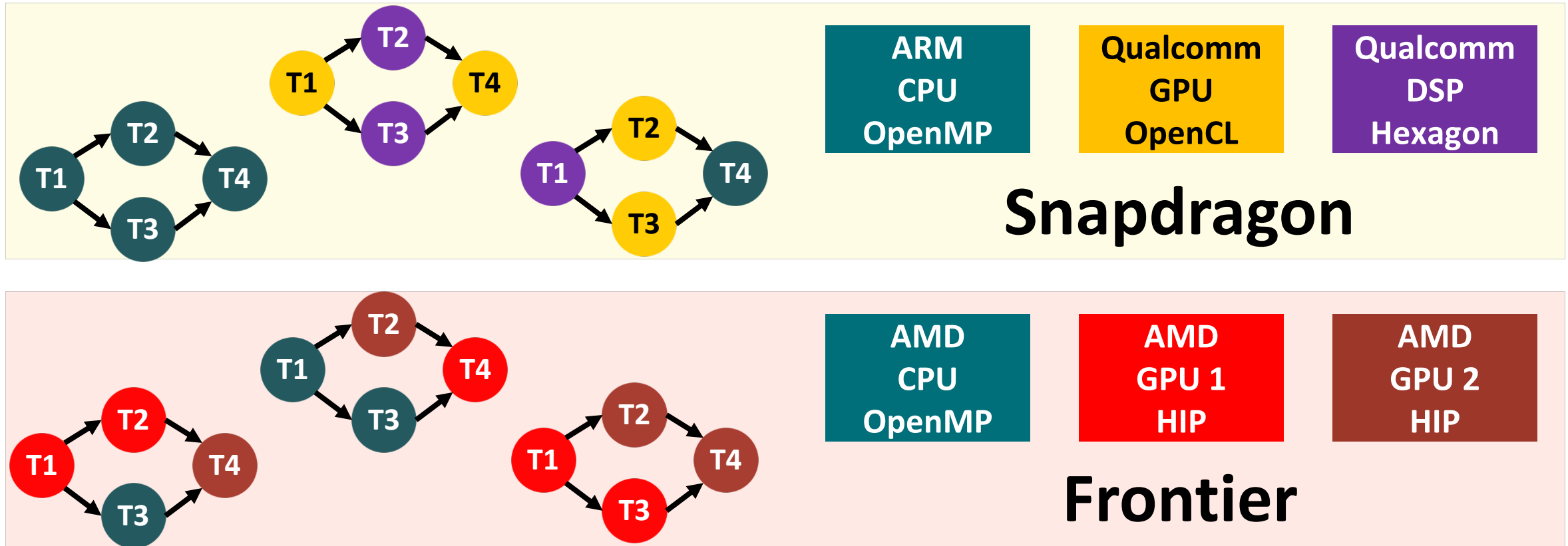
# Orchestrating Multiple Programming Systems

- The IRIS Architecture



- Compilers
  - High level application → IRIS unified host code + native kernels
- Dynamic Platform Loader
  - Automatically discover all available accelerators and their programming systems
- Task Scheduler
  - Task: memory copy + kernel launch
  - DAG-style tasks graph across multiple devices
  - Device selection policies
- Shared Virtual Device Memory (SVDM)
  - An Illusion of single logical device memory across all physical device memories
  - Multiple local copies on multiple device memories (relaxed consistency model)

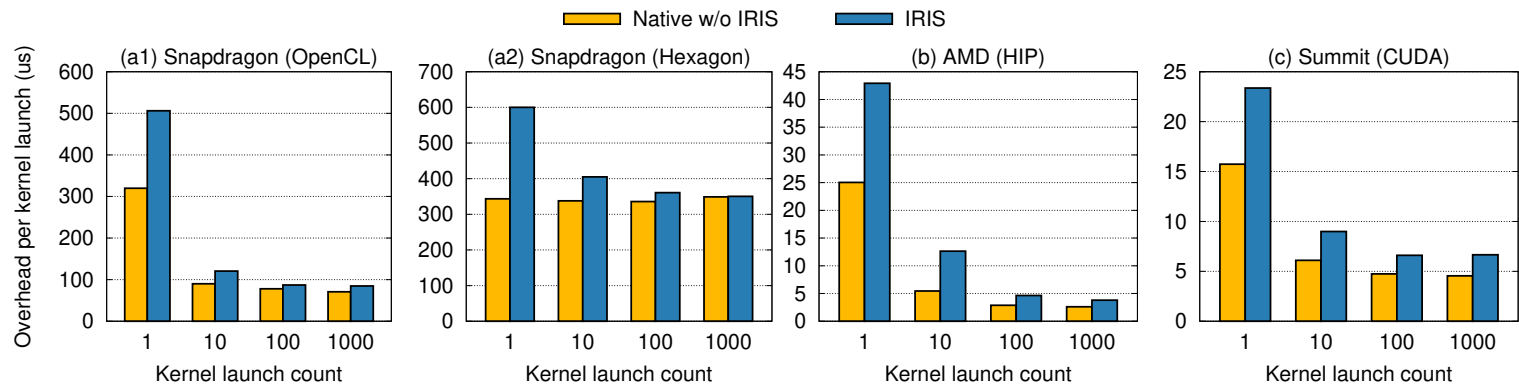
# Unified Host + Multiple Native Kernels + Shared VDM → *Flexible Task Scheduling & Portable Application*



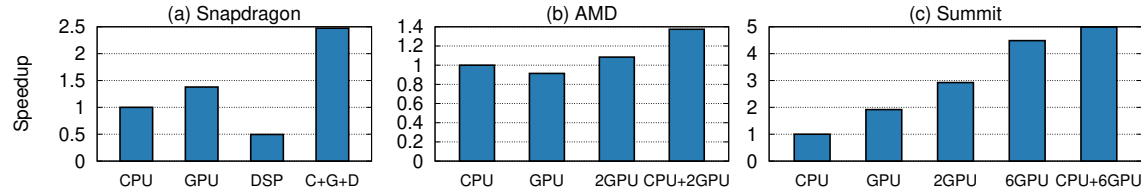
- A task can be freely scheduled and run on any device.
- An IRIS application is portable across different heterogeneous systems.

# Evaluation

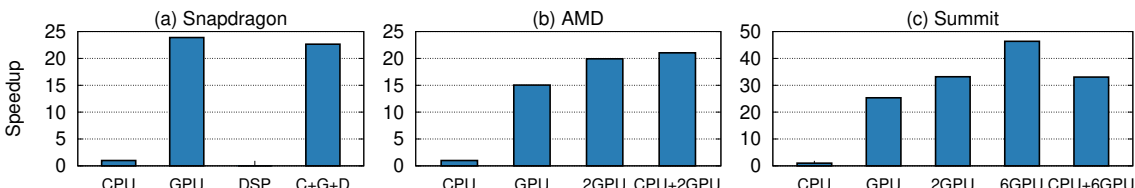
## Kernel Launch Overhead



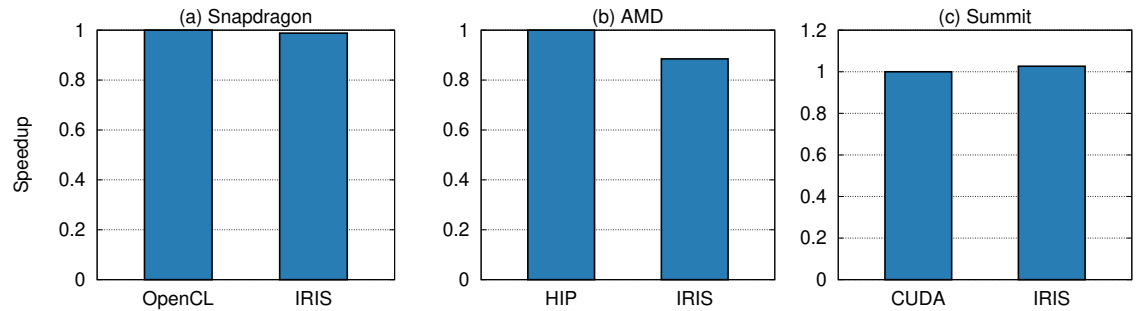
## SAXPY



## SGEMM



## LULESH



Systems	Snapdragon	AMD	Summit
CPU	ARM OpenMP	AMD OpenMP	IBM OpenMP
GPU	Qualcomm OpenCL	AMD HIP	NVIDIA CUDA
DSP	Qualcomm Hexagon		

# Recap

<b>Situation</b>	No de facto standard for heterogeneous programming
<b>Task</b>	Achieving portability in heterogeneous programming
<b>Activity</b>	<p>A new portable runtime system, <b>IRIS</b></p> <ul style="list-style-type: none"><li>• Orchestrating multiple programming systems (CUDA, Hexagon, HIP, Level Zero, OpenCL, OpenMP)</li><li>• Unified Host + Multiple Native Kernels + Shared Virtual Device Memory → Flexible Task Scheduling &amp; Portable Application</li></ul>
<b>Result</b>	IRIS achieves portability, programmability, and performance

IRIS is an open source software

<https://github.com/ORNL/iris>

# Acknowledgments

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