

IRIS: A Portable Runtime System Exploiting Multiple Heterogeneous Programming Systems

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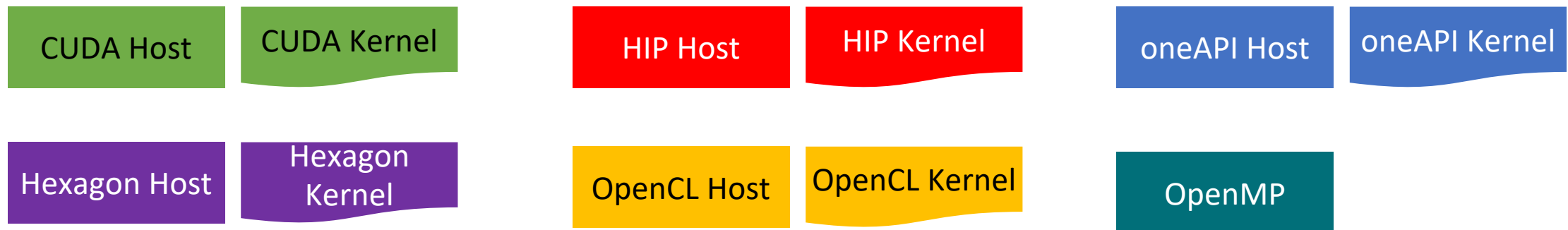
Oak Ridge National Laboratory

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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

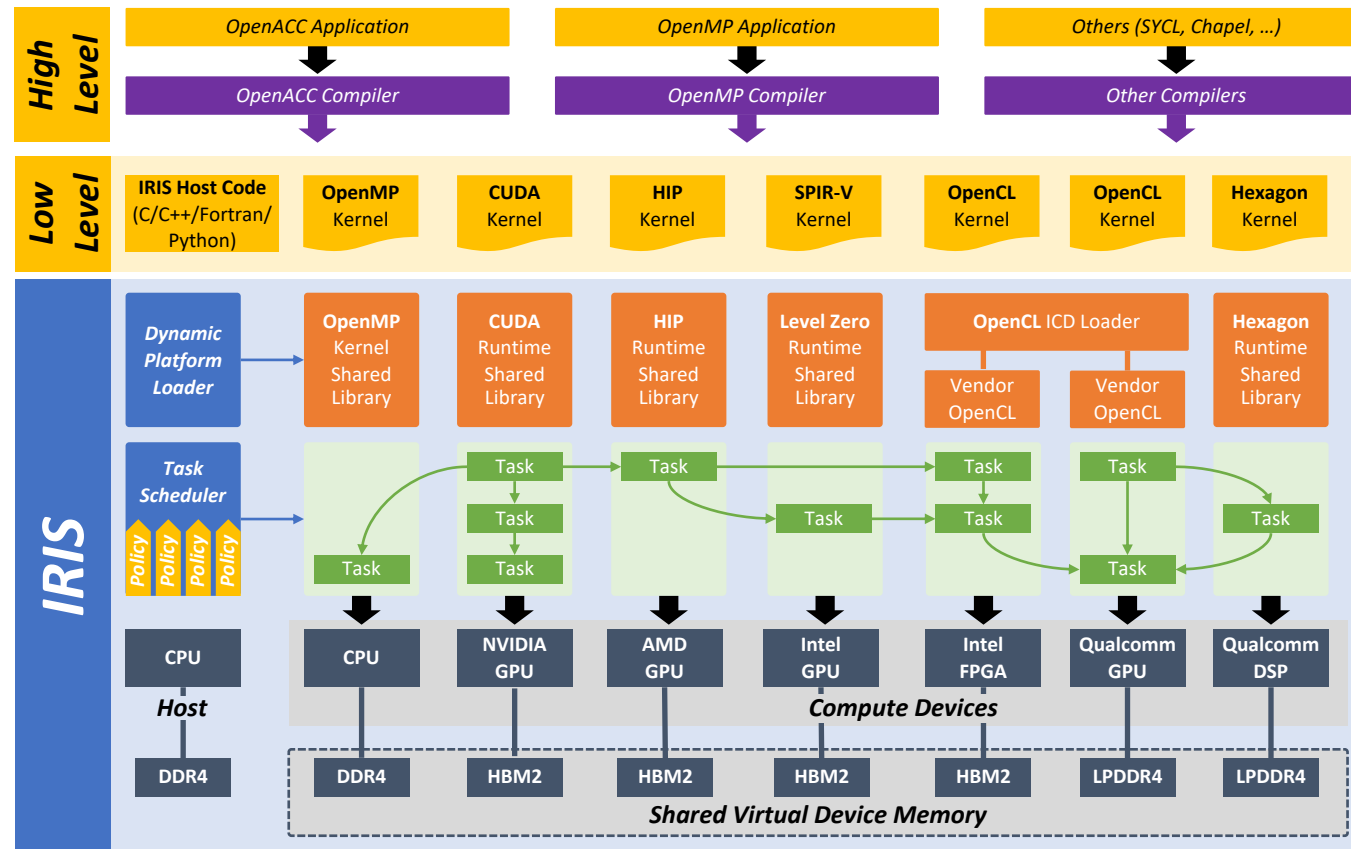
- Not portable program across different HW configurations

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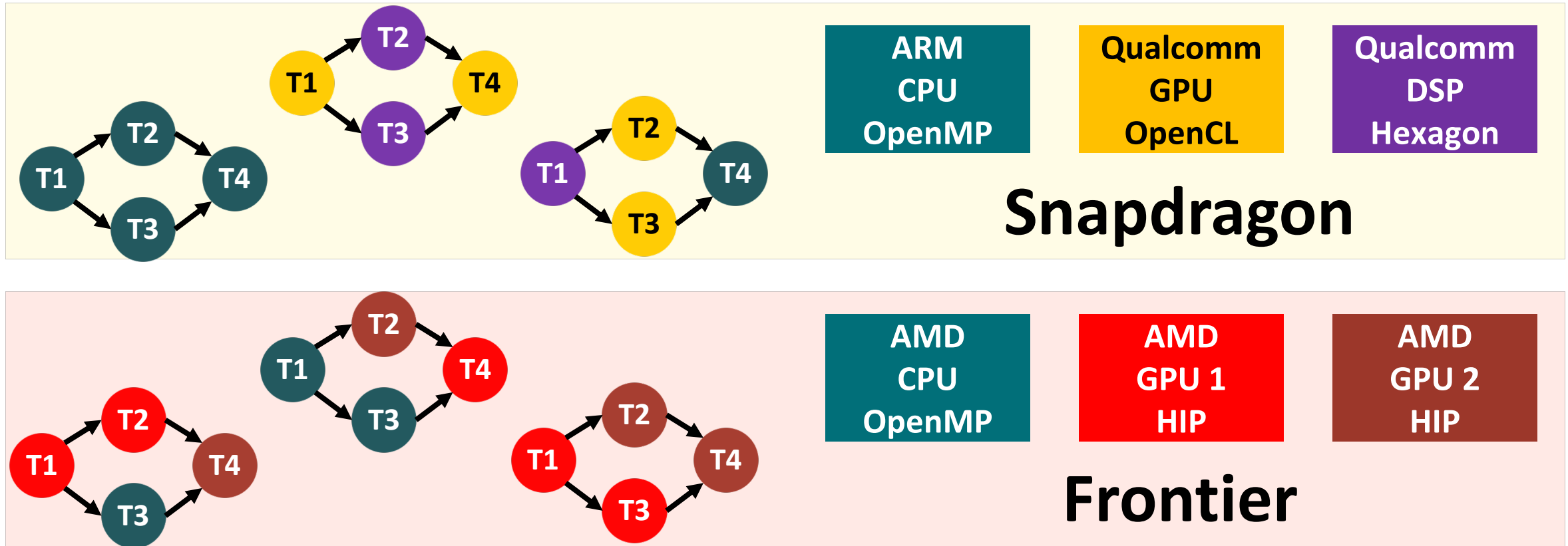
Orchestrating Multiple Programming Systems

• 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)

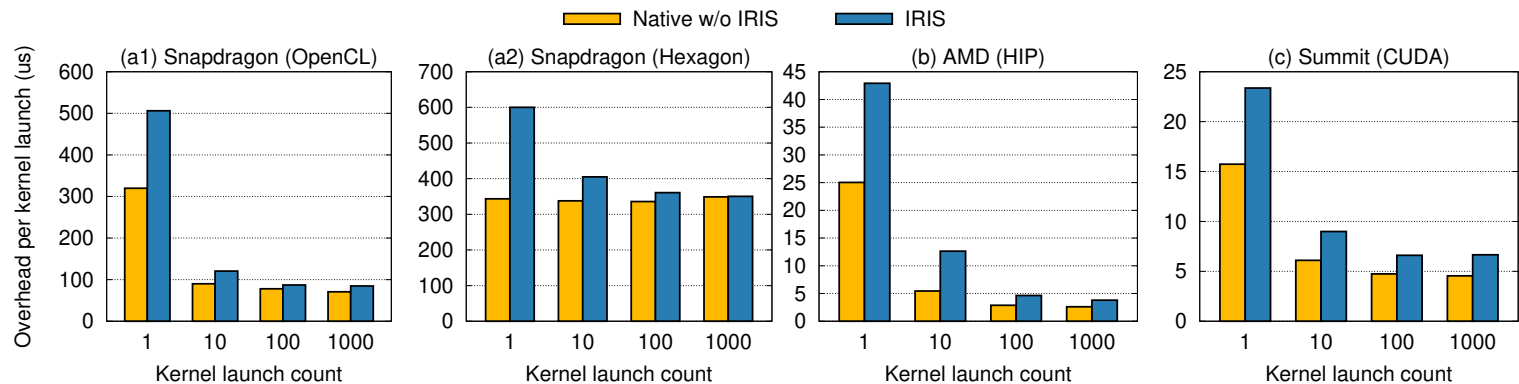
Unified Host + Multiple Native Kernels + Shared VDM → *Flexible Task Scheduling & Portable Application*



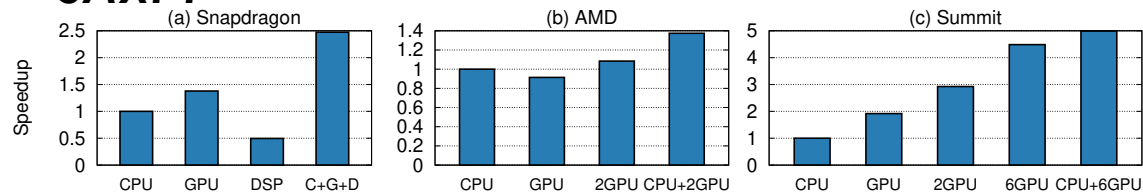
- A task can be freely scheduled and run on any device.
- An IRIS application is portable across different heterogeneous systems.

Evaluation

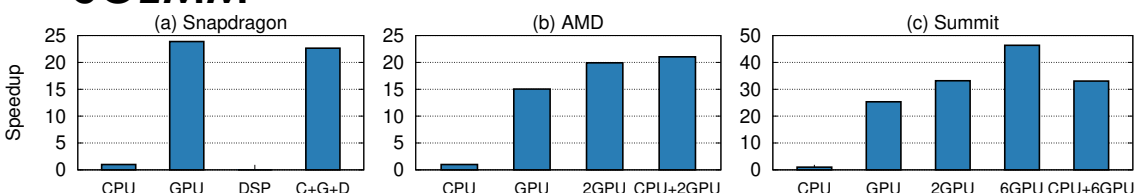
Kernel Launch Overhead



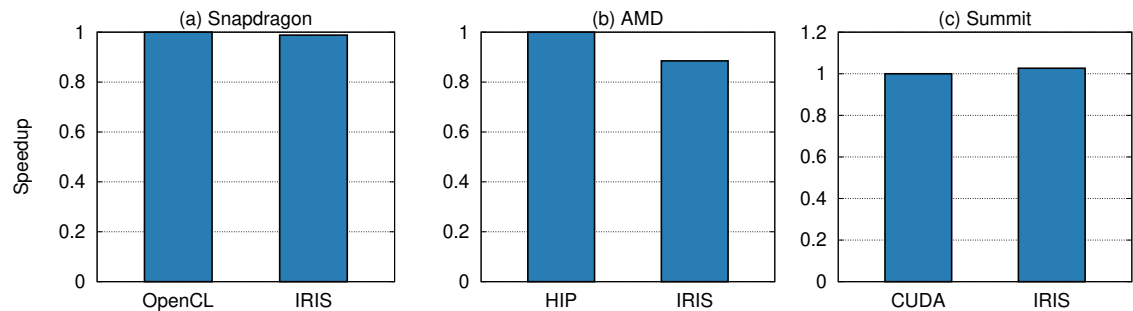
SAXPY



SGEMM



LULESH



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

Recap

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

IRIS is an open source software

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

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