# Composable Hardware Accelerated Executors

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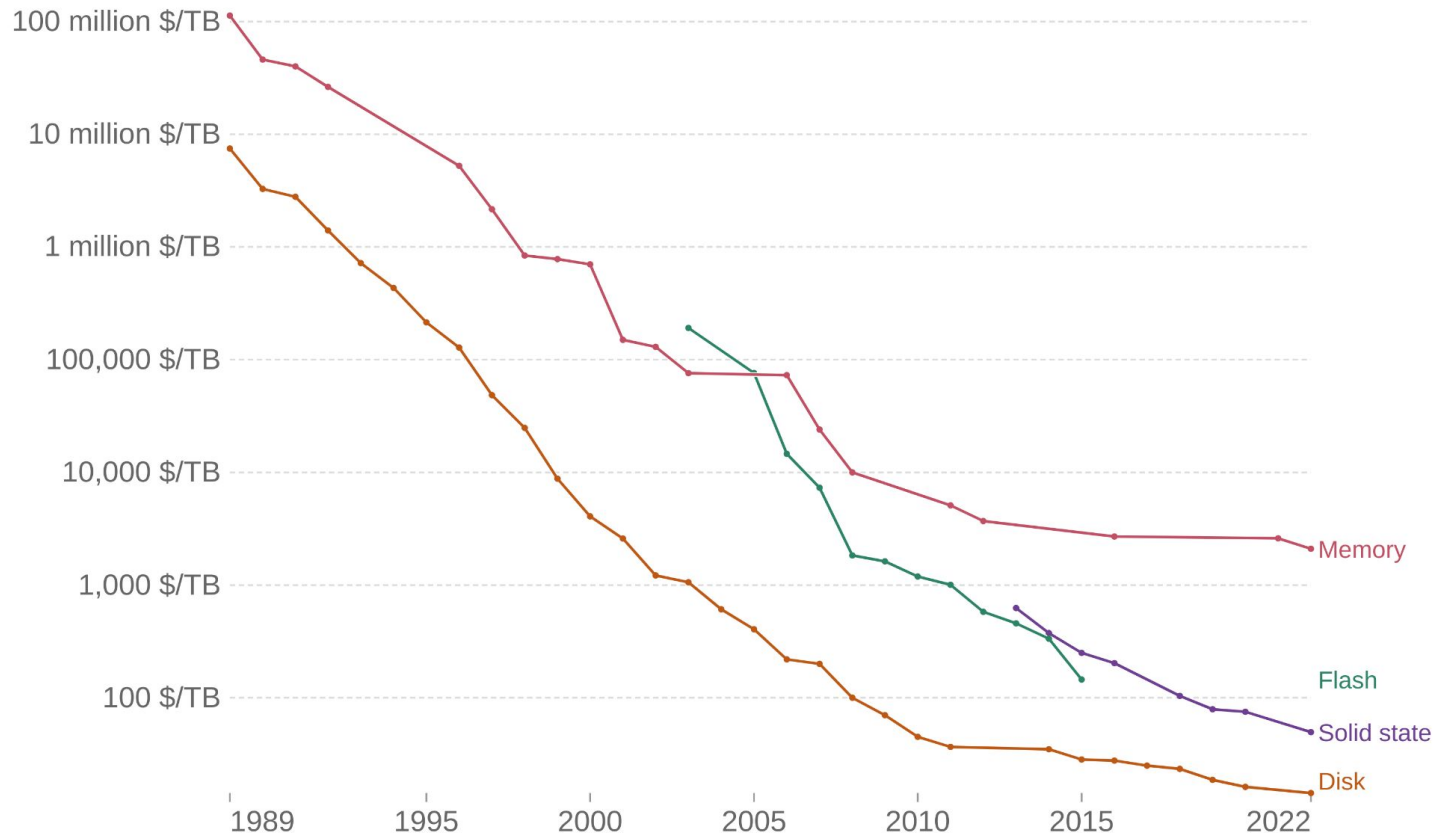Voltron Data Inc.

# Why

- Multiple Hardware Providers
  - GPU, FPGA's, Multicore CPUs
- Multiple Execution Frameworks
  - GPU
    - Rapids, OpenCL, Cub
  - CPU
    - Velox, Arrow Compute, Xsimd
- Rapidly evolving interconnects
  - Nvidia NVLink, PCI-E 5.0, CXL
- Changes to Memory / solid state cost  and performance

empirical GPU FLOP/s per dollar
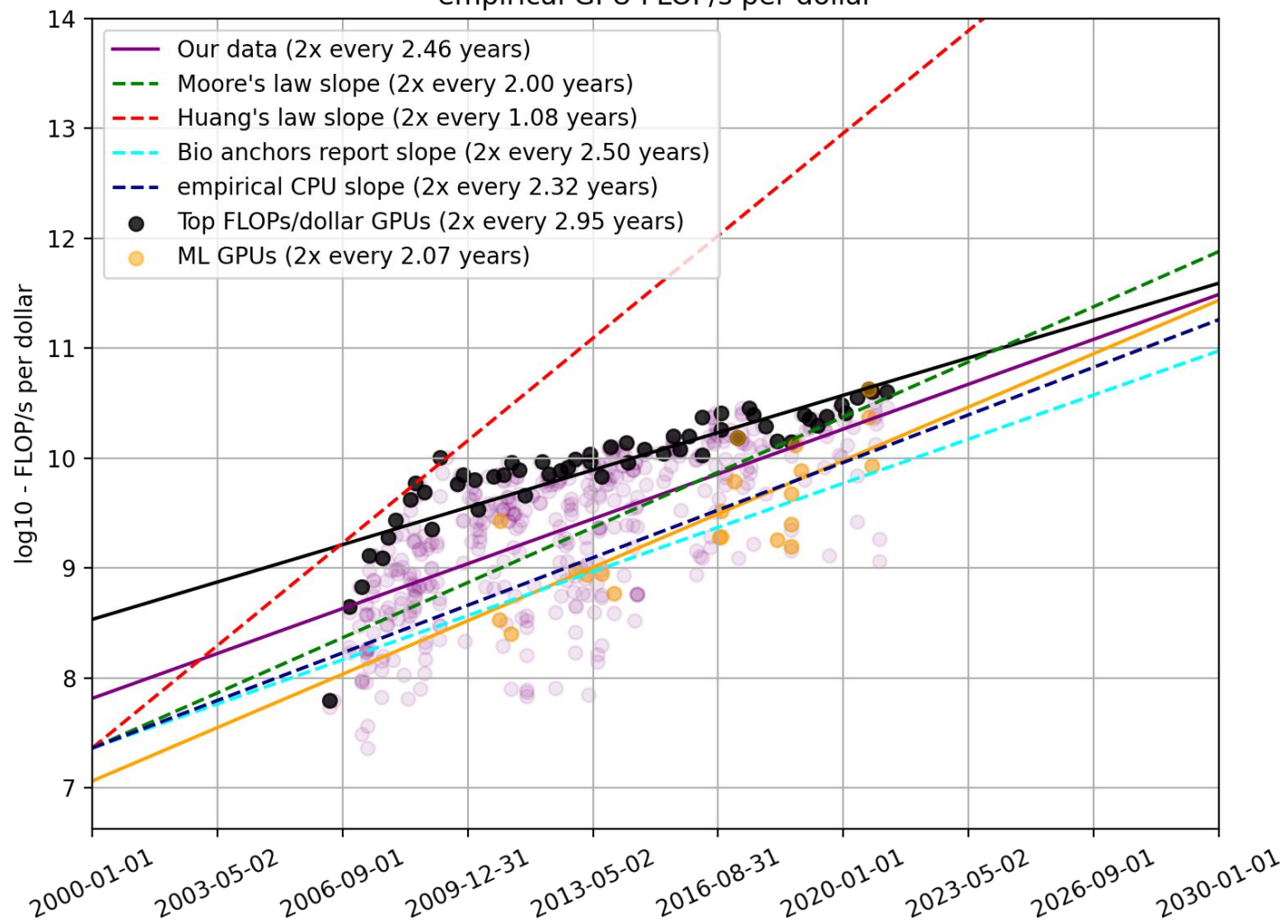
# Historical cost of computer memory and storage

This data is expressed in US dollars per terabyte (TB). It is not adjusted for inflation.

Memory

Flash

Solid state

Disk

100 million $/TB

10 million $/TB

1 million $/TB

100,000 $/TB

10,000 $/TB

1,000 $/TB

100 $/TB

1989    1995    2000    2005    2010    2015    2022

Note: For each year, the time series shows the cheapest historical price recorded until that year.

# Some Components of Comosable Executors

- Memory Management
- Logical and Physical Plans
- Task Management
- Data Flow

# Memory Management

- Executors Allocators must be customizable
  - Tracking allocations
  - Managing resource constraints
- Need APIs for reserving memory
- Memory needs to be managed in centralized place

# Logical and Physical Plans

- Logical Plans are necessary to integrate with multiple Client types
- Physical Plan are necessary to leverage multiple Backends
    - A physical plan per backend is often necessary
    - Heterogenous plans are also possible

# Task Management

- Tasks Need to be able to recover from resource exhaustion
- Tasks Should be specific to an execution backend
- Tasks should be pipelined to executors in order improve performance

# Data Flow

**Worker**

**Memory Management**
- GPU Memory
- CPU Memory

**Executors**
- CUDF Executor
- Velox Executor

**FileSystem Interface**
- S3
- HDFS
- GCS
- NFS4
- POSIX

**Flight (Control Plane)**

**Local Planner**

**Query Graph**
- Kernel

Task Queue

-Tasks-

Logical Plan

Physical Plans