

Maximizing Flash Value with the Software-Enabled Flash™ SDK

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OUR MISSION

Uplifting the world with “memory”

KIOXIA is unleashing the potential of “memory” to create new value. By evolving “memory,” we create uplifting experiences and change the world.

The name KIOXIA is a combination of the Japanese word kioku meaning “memory” and the Greek word axia meaning “value” – which forms the foundation of the company’s vision.

Hyperscale has a storage **OPPORTUNITY**

SDC 2020
Eric Ries, SVP
KIOXIA America

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**Maximize the value of
every bit of storage**



X 100,000 Servers

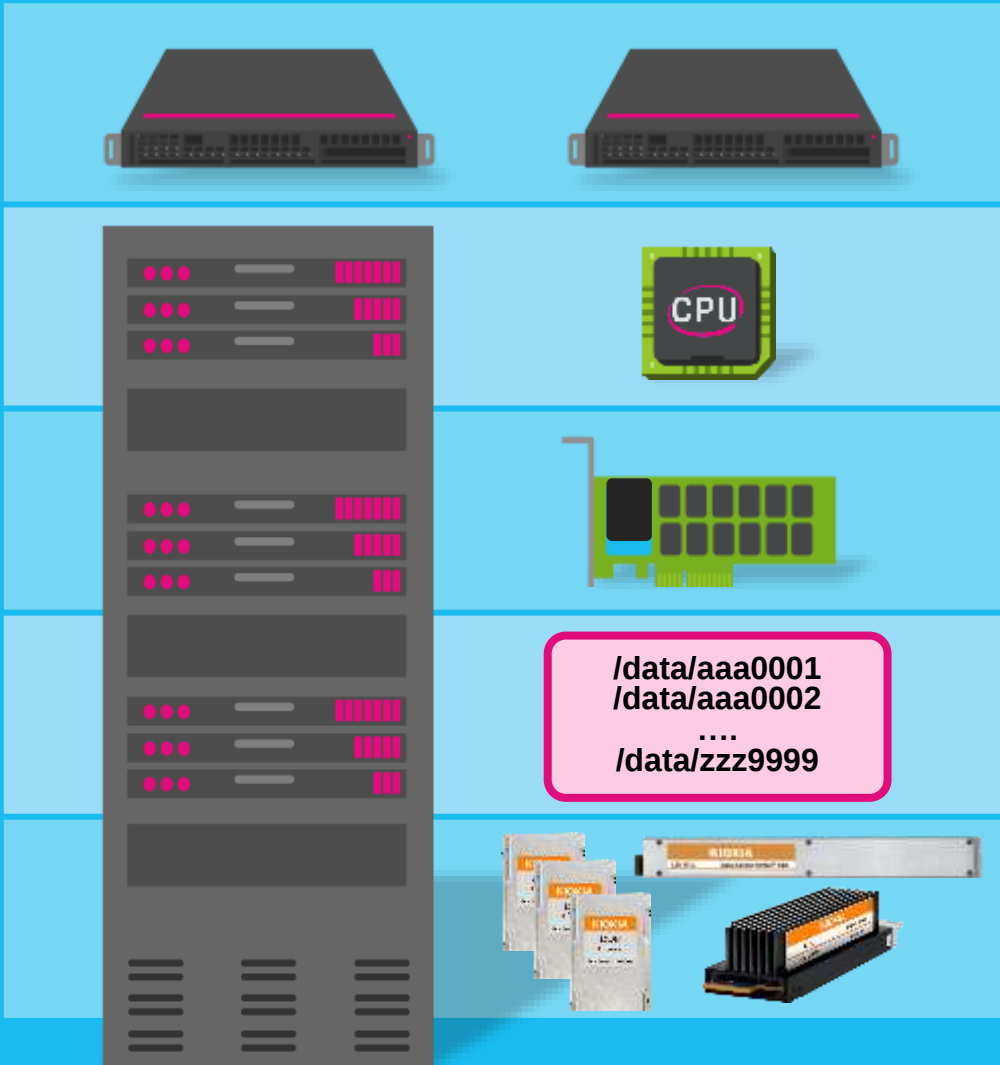
=

**100,000 x Wasted Power
100,000 x Wasted Space
100,000 x Wasted Investment
100,000 x Lost Opportunity**

Hyperscale has a storage opportunity...

**Software-Enabled Flash™
Technology**

The Data Center is Built on Software-Defined...



Software-Defined Networking

Software-Defined Computation

Software-Defined Hardware

Software-Defined Storage

**It's about time to apply the same
logic to flash...**

Software-Enabled Flash™ Open Source API

2020

- Data Placement
- Latency & Queueing
- Isolation
- Offload

**Redefines the relationship
between the host and flash storage.**

Host Applications

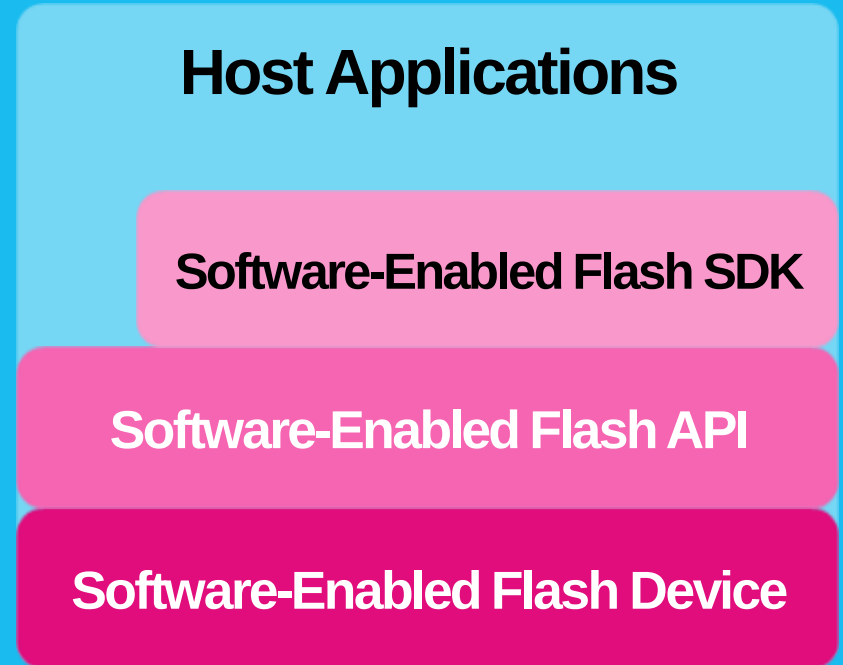
Software-Enabled Flash API

Software-Enabled Flash Device

Software-Enabled Flash™ Open Source SDK

2021

- **Faster Time to Market**
- **Easier Development**
- **Powerful Abstractions**



**Evaluate Software-Enabled Flash
technology without writing a single line of code.**

Software-Enabled Flash™ Capabilities Quick Review

(in case you missed it last year...)

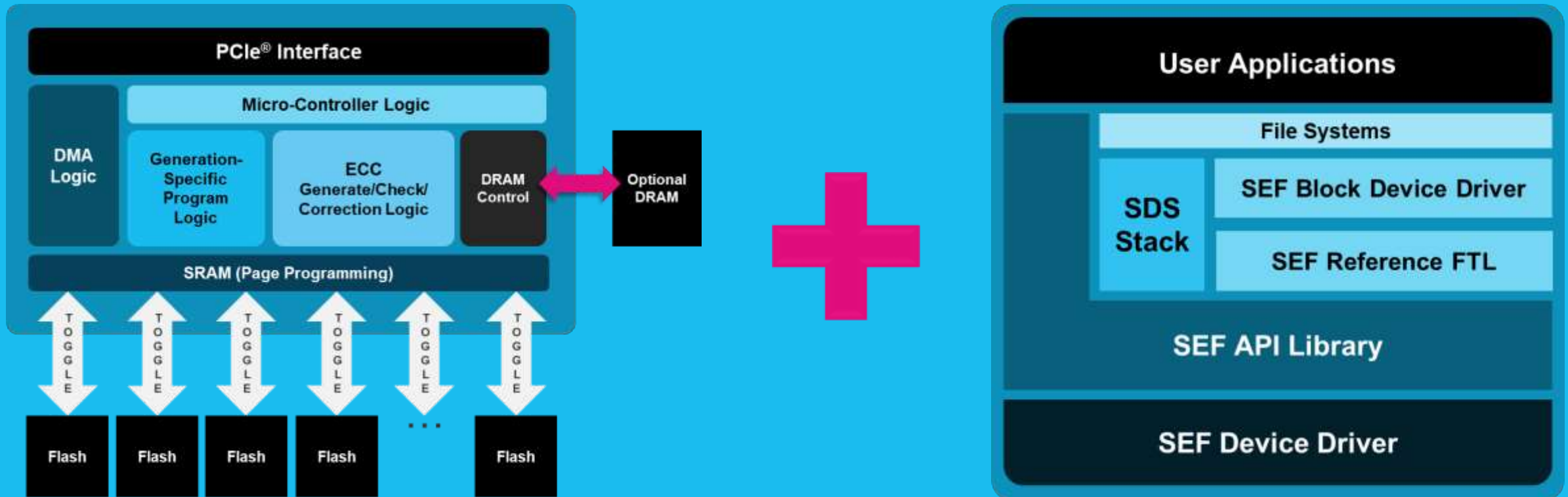
Software-Enabled Flash™ Technology

**Fundamentally
redefines the
relationship
between the host
and solid-state
storage**

- Brings control of media to software
- Host applications have complete control over storage functionality and behavior
- Solves legacy overhead problems and enables new features
- Maximizes flash flexibility, performance and parallelism...

in other words, its value.

Hardware + Software Working Together

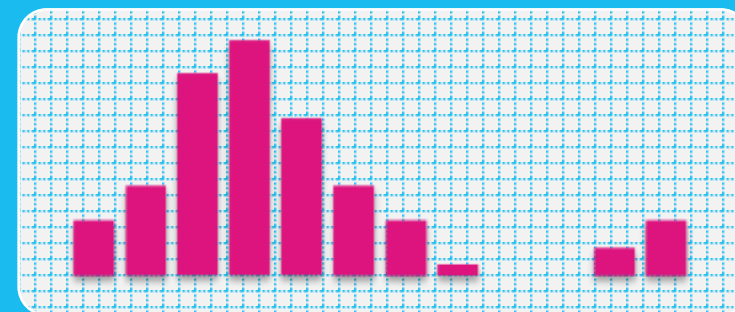


PCIe is a registered trademark of PCI-SIG.

CAPABILITIES



Workload Isolation



Latency Management

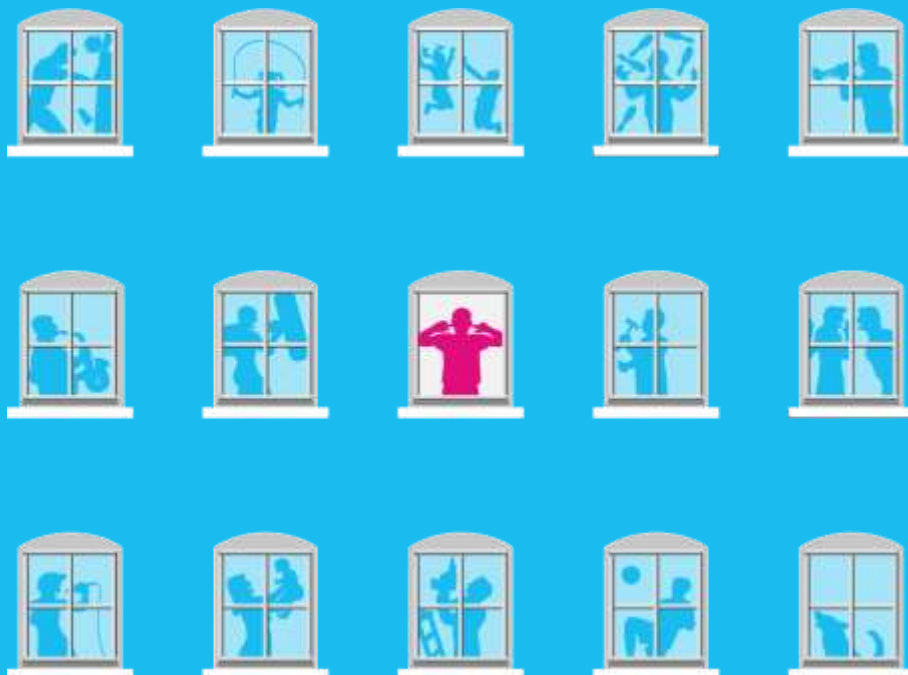


Flash Migration

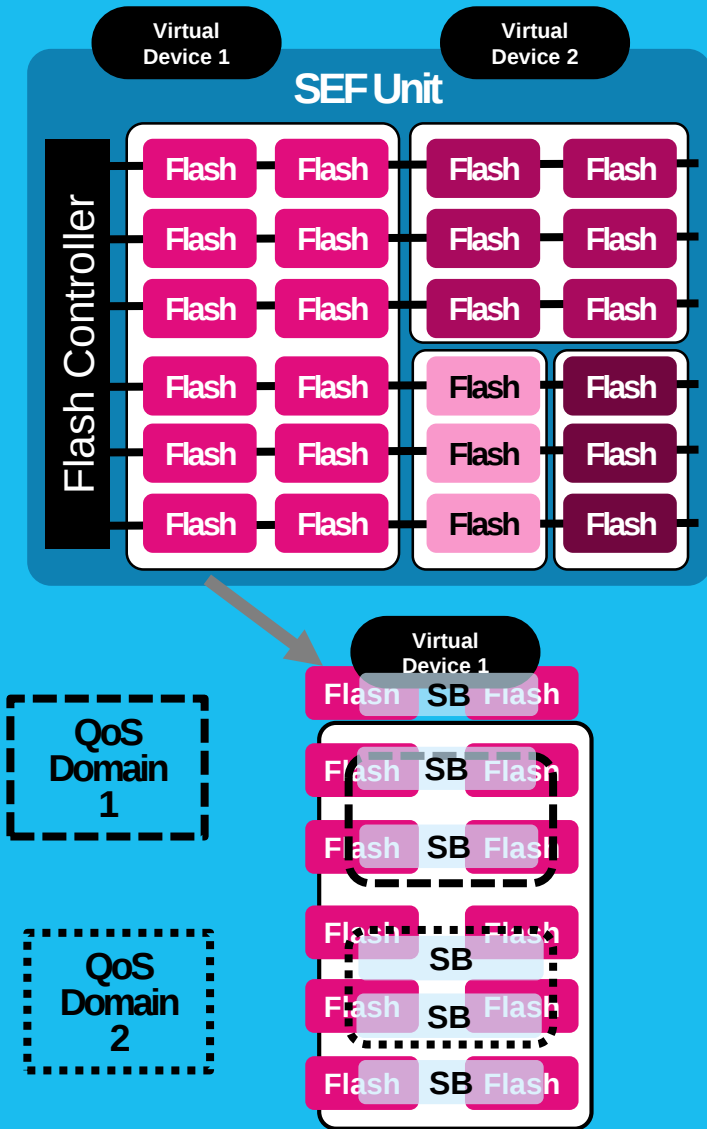


Flash Maintenance

WORKLOAD ISOLATION

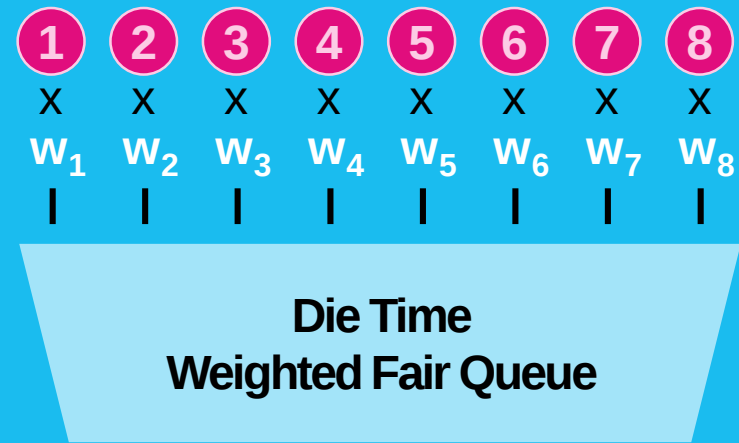
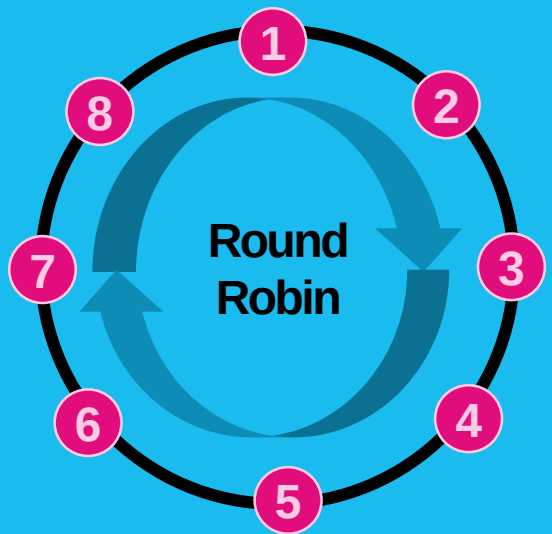
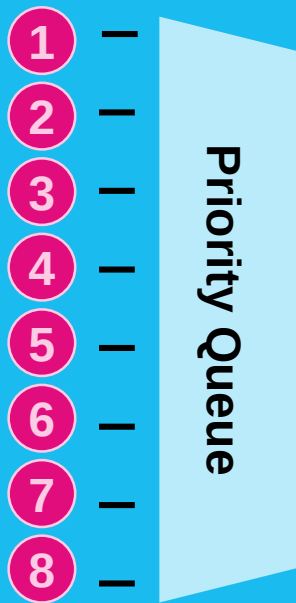
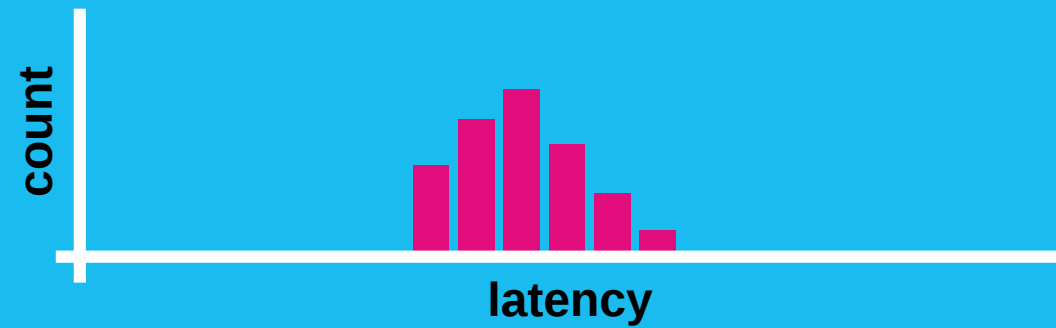
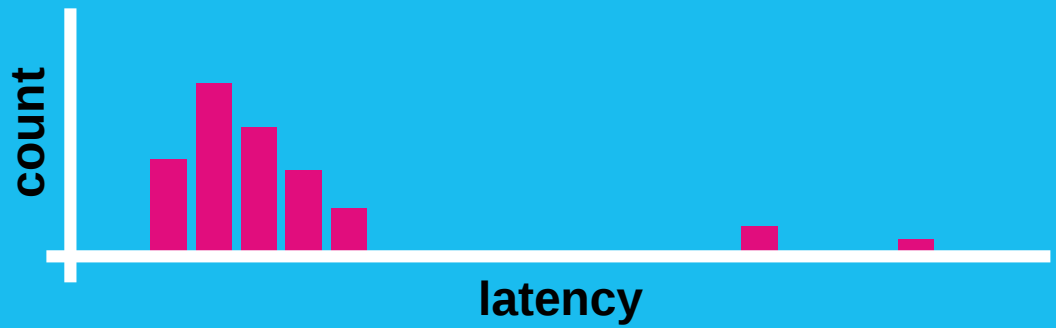


Noisy Neighbor Control

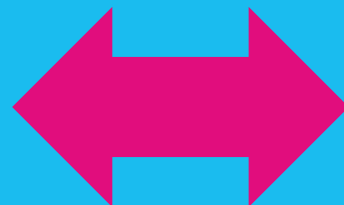


Data placement by die and superblock

LATENCY MANAGEMENT



FLASH MIGRATION



**Orchestrated by host software...
...performed by Software-Enabled Flash™ hardware**

- Garbage collection
 - Wear leveling
 - Flash patrol reads
 - Compaction
- ...and more...**



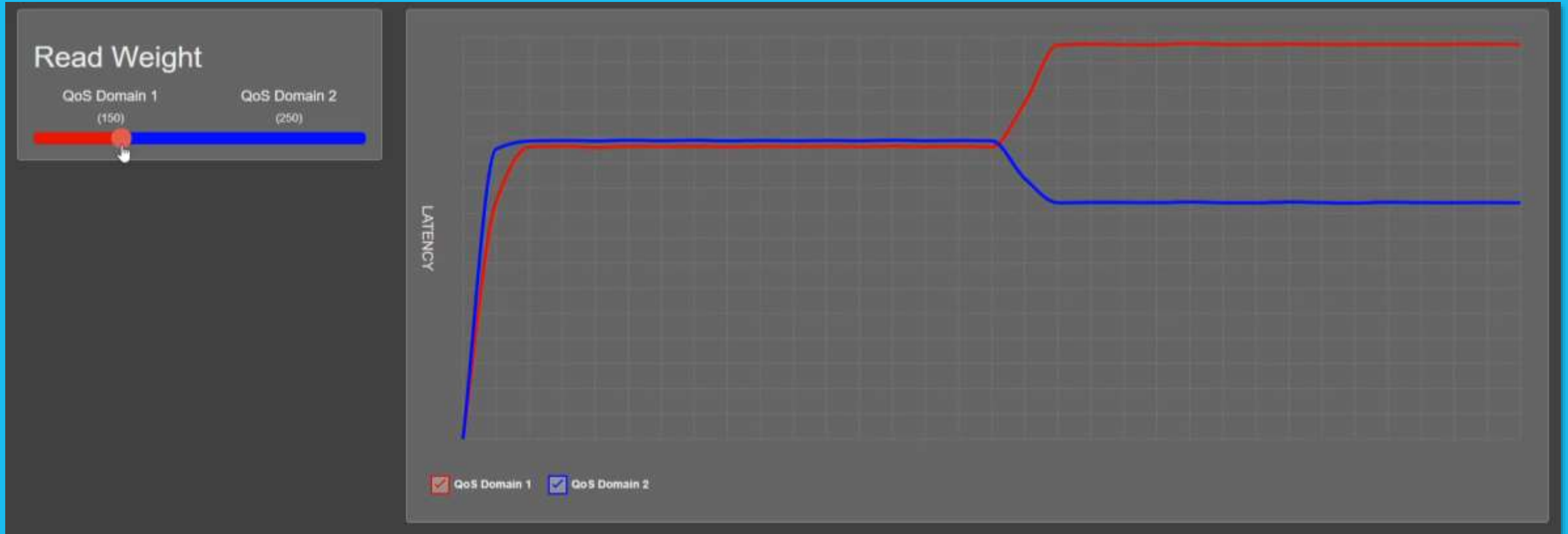
Software-Enabled Flash™

is

Software-Defined Flash

**Some examples of the power that
Software-Enabled Flash™ can deliver
for storage developers...**

Dynamic Latency Outcome Control

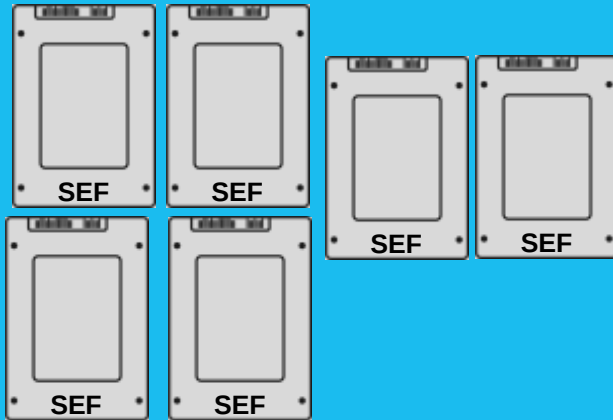


Adjusting workload priorities and latency management is needed to optimize application responsiveness

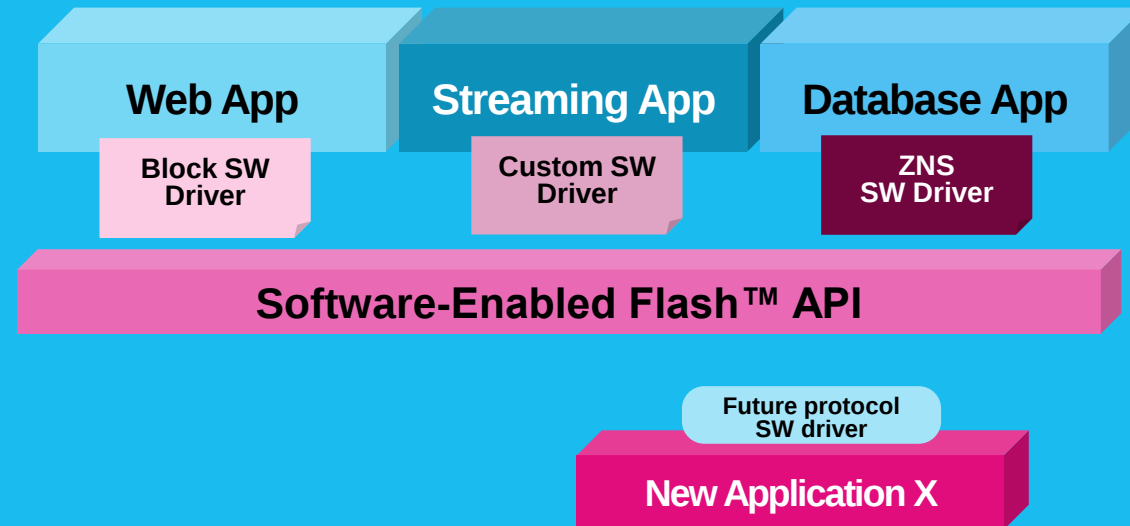
Improved TCO via Multi-Protocol Support

Source a **single type** of
software-defined flash drive

Inventory of SEF devices

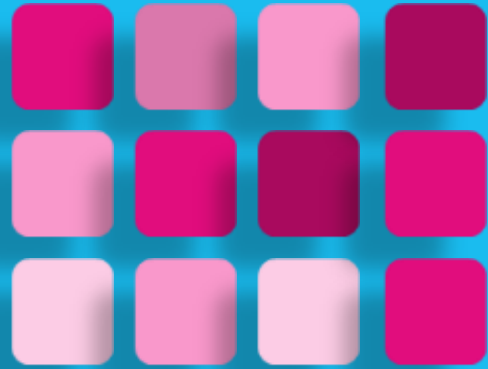


As **applications change**
simply change the software
to **redefine storage** functionality



Improved **TCO**,
more **agile** deployment,
easier repurposing of existing hardware

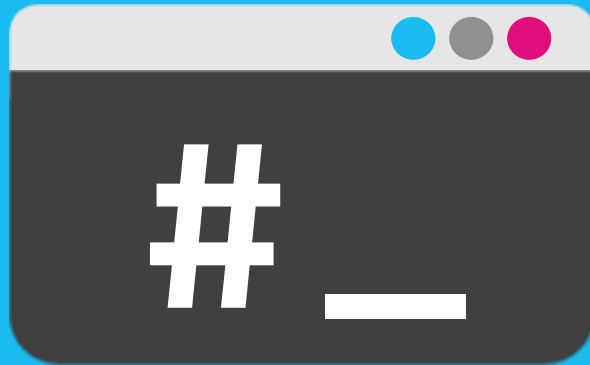
SDK COMPONENTS



**Reference
Flash Translation Layer (FTL)**



**Reference
Virtual Drivers**

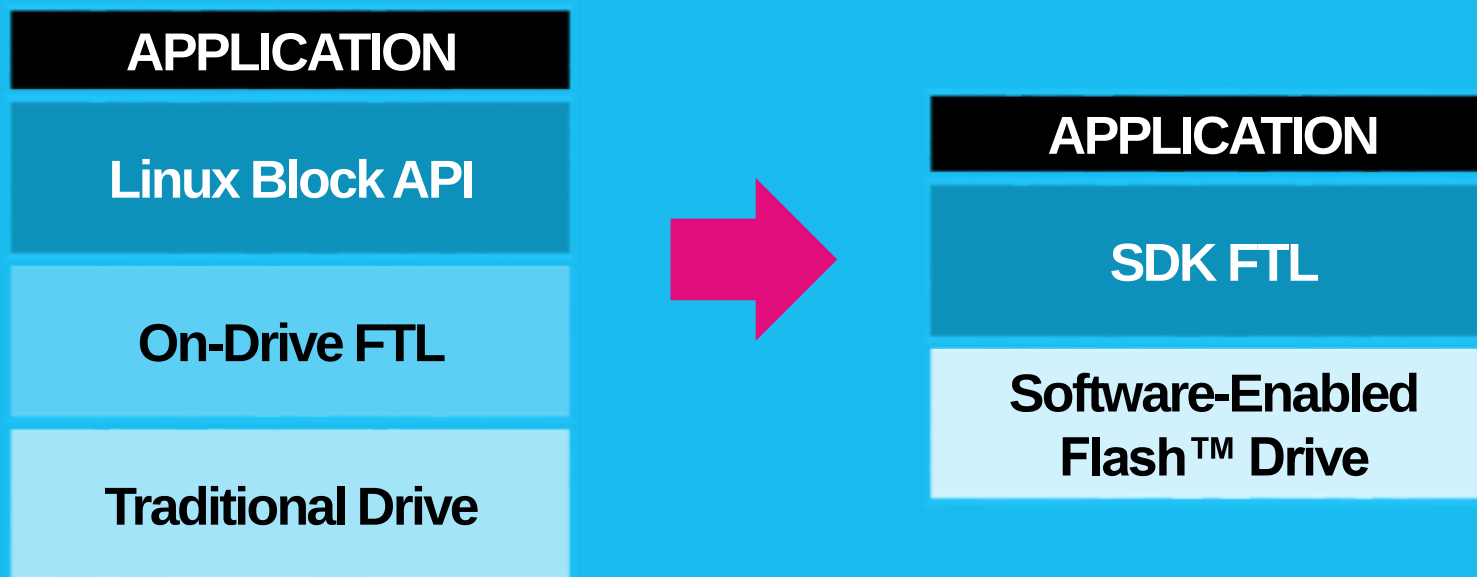


**Command Line Interface
(CLI)**



**Performance Test Tool
(FIO)**

Eases transition to Software-Enabled Flash™ for faster application time-to-market

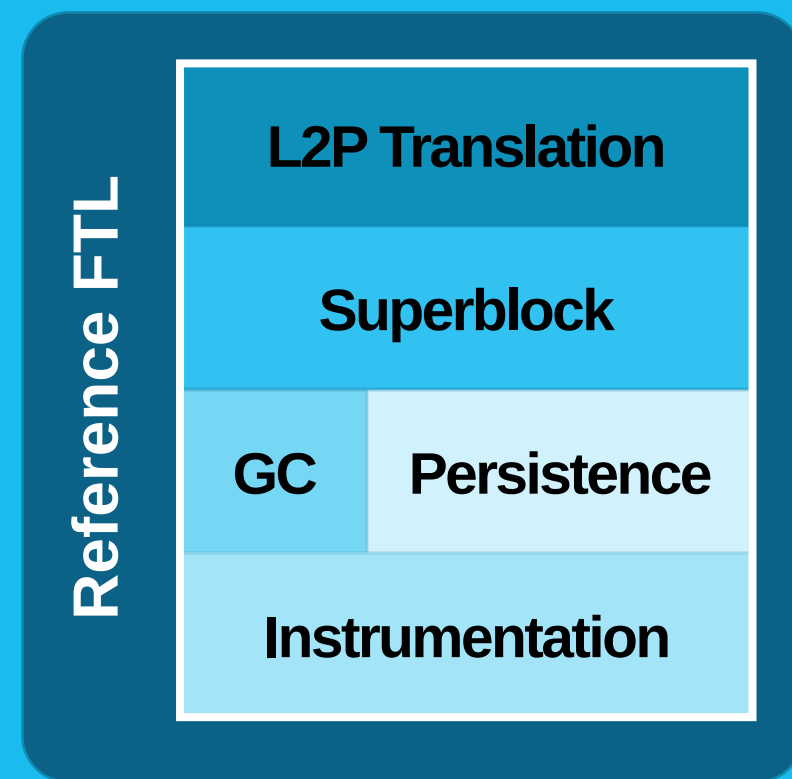


```
SEFMultiContext ct = { .ftlContext = FTL, .lba = 0, .lbc = N,  
    .iov = IOV, .ioType = kSEFRead, .completion = cb, ..};
```

```
SEFStatus submit_status = SEFBlockIO( &ct );
```

Provides apps with SEF power using a simple-to-use interface

- Simple code conversion
- Modular, documented
- Full C source provided



Leverages KIOXIA heritage of SSD innovation to deliver:

- 1. Lockless FTL Implementation**
- 2. Full multithreading support**
- 3. Using Software-Enabled Flash™ offload capabilities**

Supports all Software-Enabled Flash™ QoS and latency control options

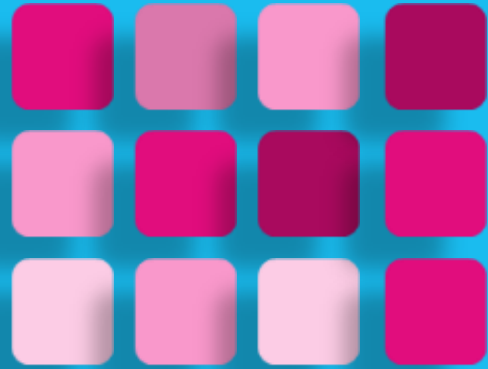
- Full latency and QoS control
- App-controlled garbage collection
- Overprovisioning control
- Data placement control for isolation and write amplification



Top-line and Bottom-line Benefits

- **Fast transition to Software-Enabled Flash™**
- **Configurable to meet application needs**
- **Faster initial application time-to-market**
- **Maximize flash utilization with app-specific FTLs**

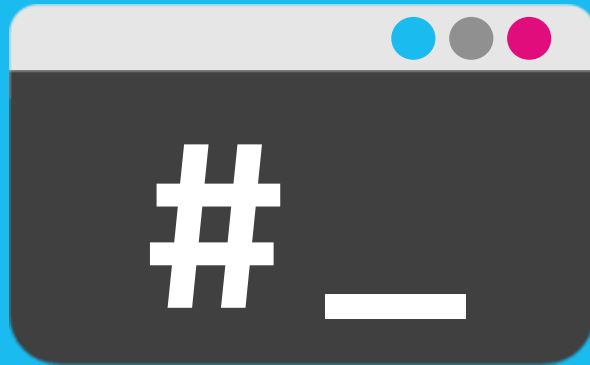
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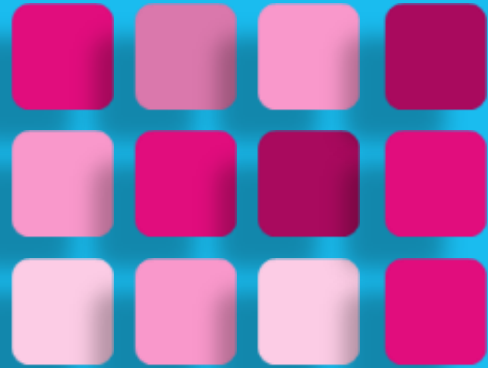
Manages the full lifecycle of Software-Enabled Flash™ storage with easy integration to cloud deployments

```
# sef-cli create qos -s 0 -v 0 -q 2 \  
  --flash-capacity 1024000 \  
  --num-fmq 4 \  
  --weight-read "150 150 150 150" \  
  --weight-erase "200 200 200 200" \  
  --weight-program "300 300 300 300" \  
  --weight-copy-read "150 150 150 150" \  
  --weight-copy-erase "200 200 200 200" \  
  --weight-copy-program "300 300 300 300" \  
  --fmq-read 0 --fmq-program 1 \  
  --fmq-copy-read 0 --fmq-copy-program 1
```

Top-line and Bottom-line Benefits

- Easily scriptable, easily integrated
- Full Software-Enabled Flash™ lifecycle management
- Enables dynamic provisioning of storage on a per-application, per-VM, or per-container basis

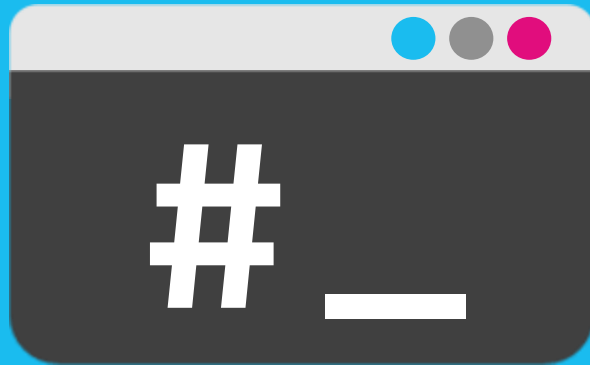
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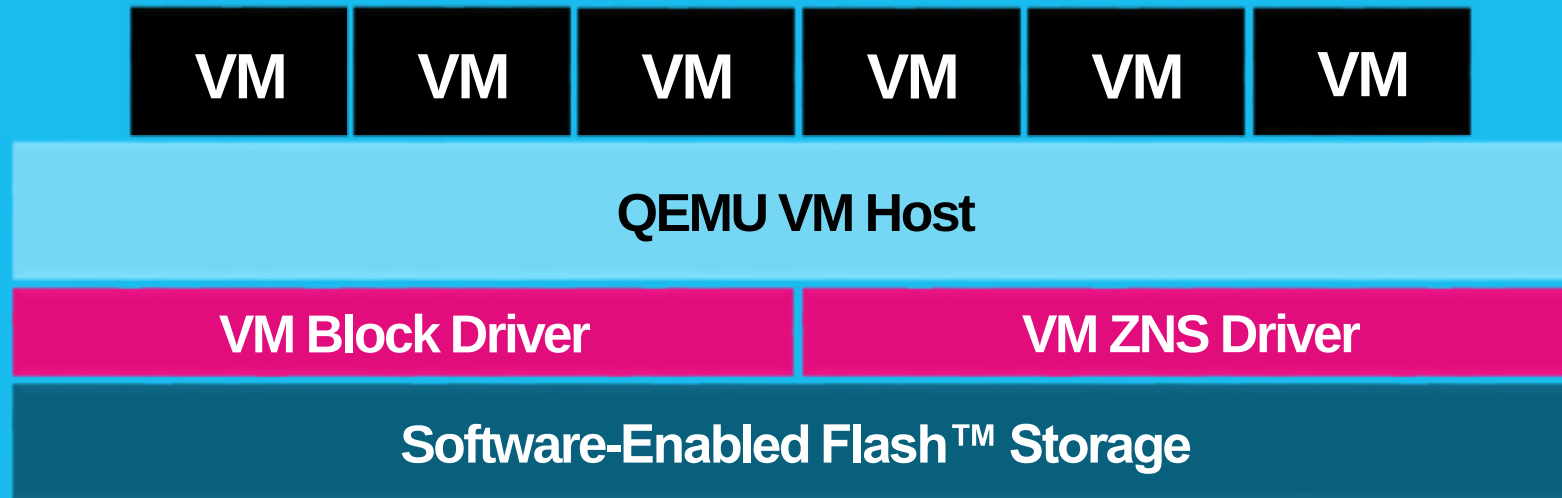


**Command Line Interface
(CLI)**



**Performance Test Tool
(FIO)**

**Allows virtual machines to use
Software-Enabled Flash™ storage
transparently, with no code changes.**



Minimal friction way to implement Software-Enabled Flash™ storage

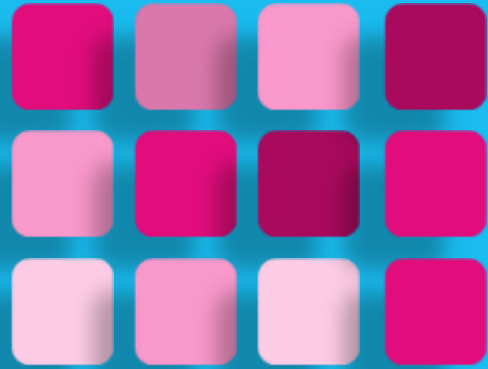
- Guest OS transparent
- Source code provided
- Block and ZNS emulation
- Full QoS and isolation support



Top-line and Bottom-line Benefits

- **Customize overprovisioning per-VM**
- **Maximize utilized flash capacity with thin provisioning**
- **Implement multiple VM classes on single drive**
- **Run ZNS and block-based VMs on single drive**
- **Preserve data and performance isolation**

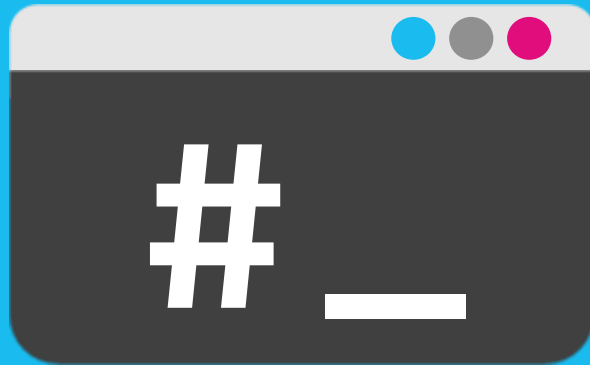
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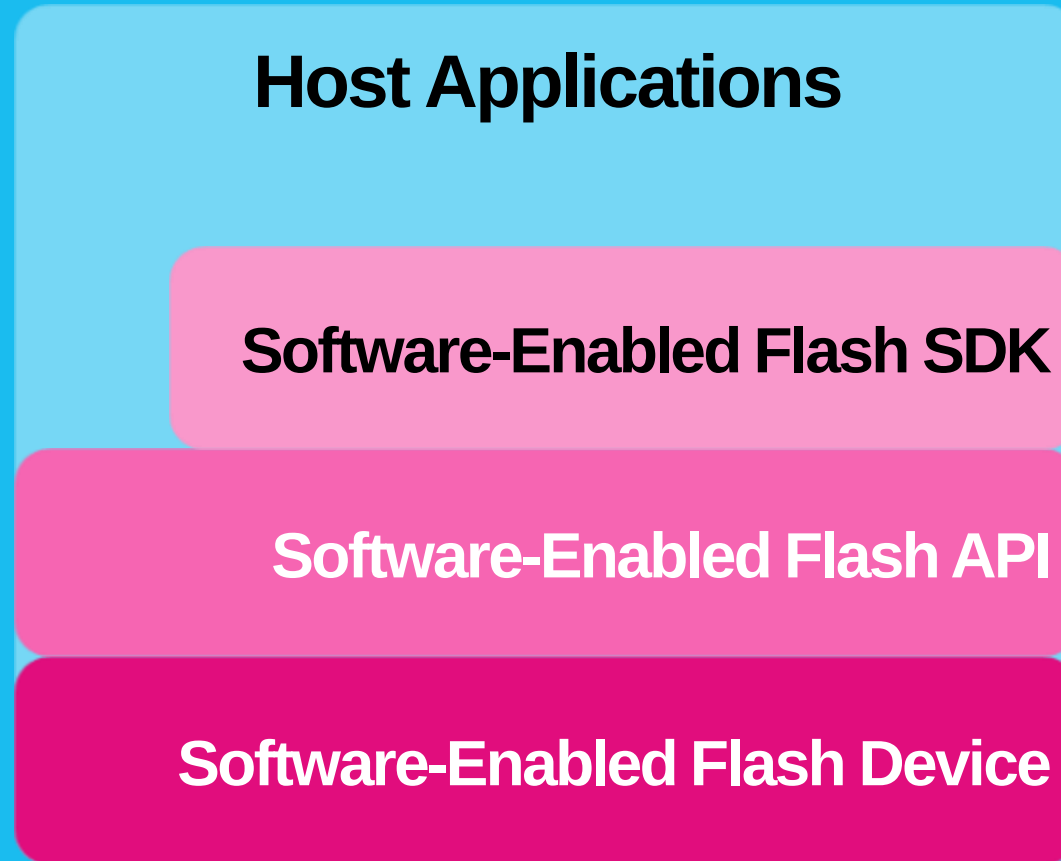
**Performance Test Tool
(FIO)**

Use the industry-standard tool you know to rapidly explore configuration options

- **Software-Enabled Flash™ FIO storage engine**
- **Explore SEF configuration options**
- **Test latency and isolation controls**
- **Prototype system performance**
- **Full sources included in SDK**



Software-Enabled Flash™ + API + SDK



Software-Enabled Flash™ API + SDK = TCO

- Accelerated development processes
- Faster application time-to-market
- Tested base for new development
- New options for Virtualized/Containerized application classes
- Exposes the full digital nature of the flash for storage developers

Software-Enabled Flash™ Technology

**maximizes the value of flash while making
it easier to use and faster to deploy.**

Software-Enabled Flash™ SDK

- ✓ Reference FTL, Virtual Drivers
- ✓ Fast, simple evaluation
- ✓ Scriptable CLI and test suite
- ✓ Reduced time-to-market

Software-Enabled Flash Technology

- ✓ Software-defined, purpose-built hardware for flash media
- ✓ Building-block for multiple drive protocols
- ✓ Open-Source, flash-native API
- ✓ Full host control with ease of integration

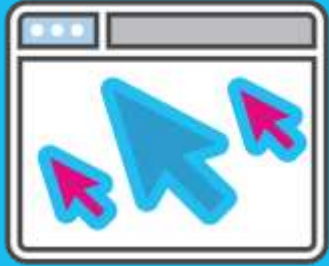
Establishing Open Source Project...



- **BSD 3-Clause licensed code**
- **Public software and documentation repositories**
- **Enable broad adoption by developers and co-travelers**
- **Industry-led technical steering**
- **Independent, neutral direction**

For More Information on Software-Enabled Flash™ Technology

1



microsite

www.SoftwareEnabledFlash.com

2



white papers

Available on the microsite

3



api

<http://github.com/kioxiaamerica>

**Software-Enabled Flash™ Technology,
a force multiplier in data center economics.**

KIOXIA

Definition of capacity: KIOXIA defines a megabyte (MB) as 1,000,000 bytes, a gigabyte (GB) as 1,000,000,000 bytes and a terabyte (TB) as 1,000,000,000,000 bytes. A computer operating system, however, reports storage capacity using powers of 2 for the definition of $1\text{GB} = 2^{30} = 1,073,741,824$ bytes and therefore shows less storage capacity. Available storage capacity (including examples of various media files) will vary based on file size, formatting, settings, software and operating system, such as Microsoft Operating System and/or pre-installed software applications, or media content. Actual formatted capacity may vary.

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