



# OSSD: Object-based Solid State Drive

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OSSD

+      **S**   **S**   **D**  
**O**   **S**            **D**

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**O**   **S**   **S**   **D**

# Motivation

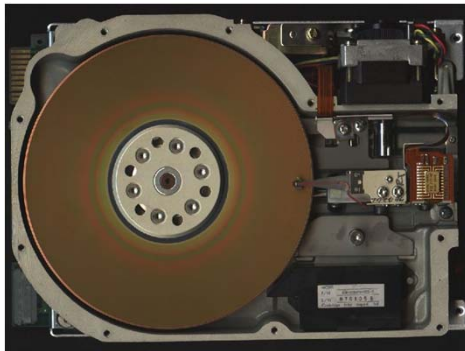
# Storage Interface Evolution

1980, Seagate

1986, SCSI  
1994, ATA

ST-506

Logical block  
addressing



“Dumb”

“Integrated controller”

More intelligence?

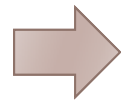
# Graphics Interface Analogy

Setpoint (x, y);

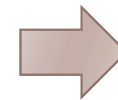
Drawline (x1, x2, y1, y2);  
Drawtext (x, y, "Hello");  
...

Polygons,  
Lighting,  
Z-buffering,  
Texture mapping,  
Alpha blending, ...

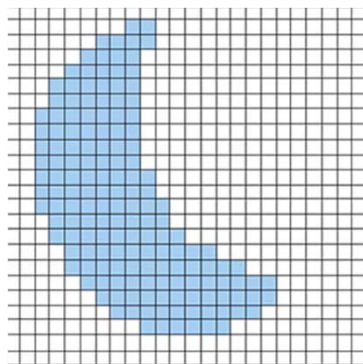
Raster graphics



Vector graphics

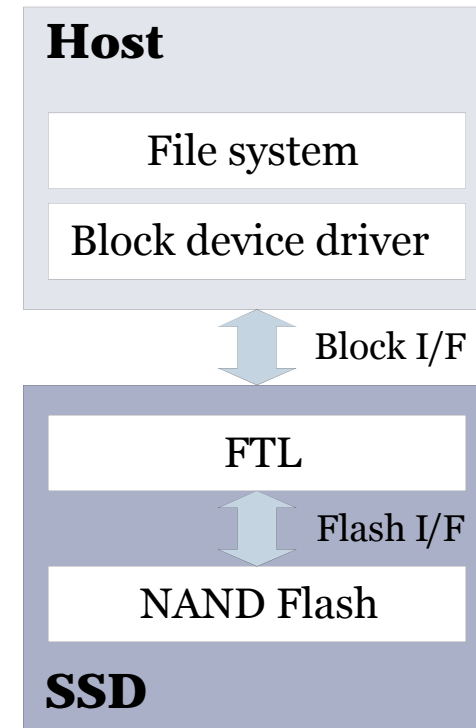


OpenGL  
Direct3D



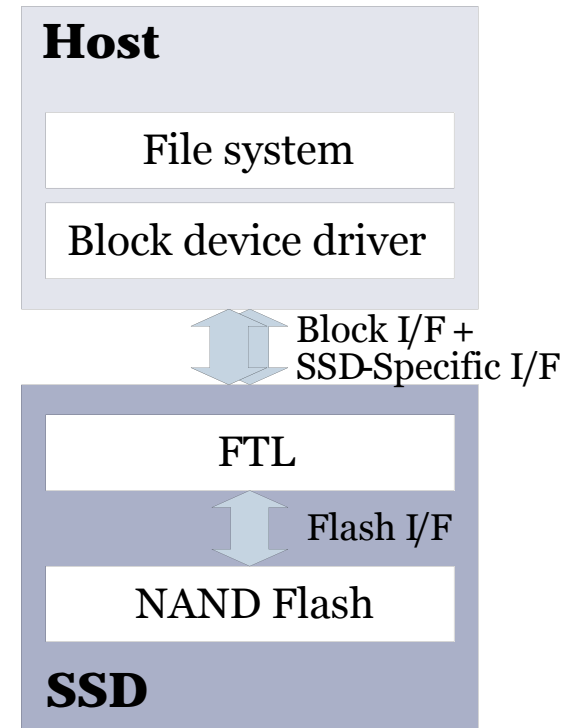
# Interfaces for SSDs (1)

- Traditional block interface
  - ATA/SCSI
  - No block-level liveness information
  - No high-level semantics on data
  - Several “unwritten contracts” do not hold for SSDs



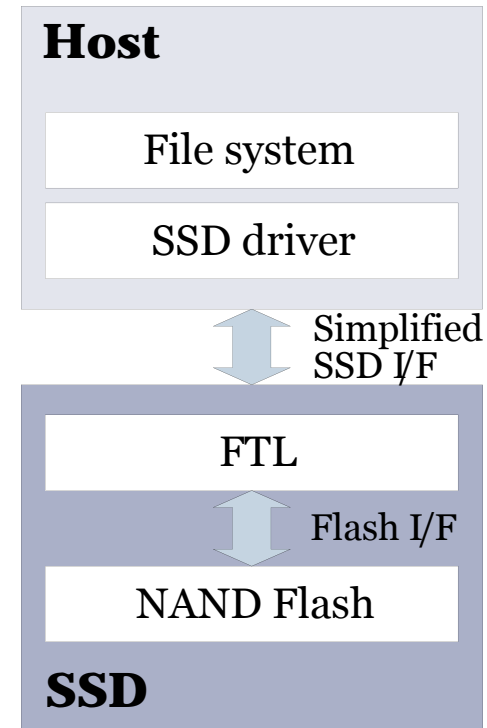
# Interfaces for SSDs (2)

- Block interface with SSD extensions
  - TRIM command
  - What else?
  - Not practical, sometimes impossible



# Interfaces for SSDs (3)

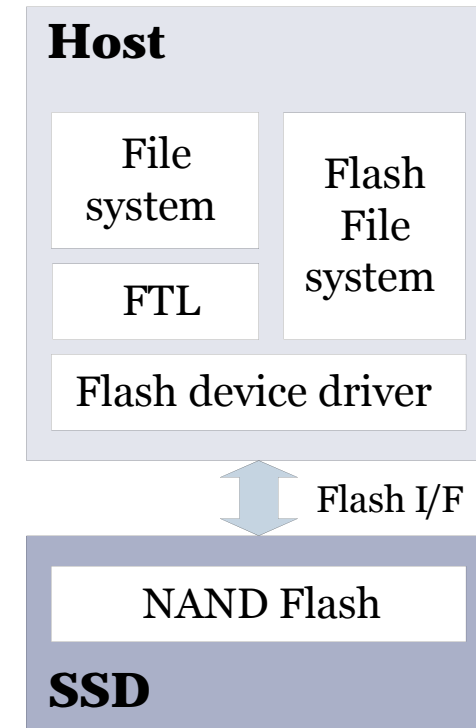
- Simplified SSD interface
  - Interfaces specific to SSDs
  - NVMHCI (Non-Volatile Memory Host Controller Interface)
  - Mainly for PCIe-based SSDs
  - Still works at the block level





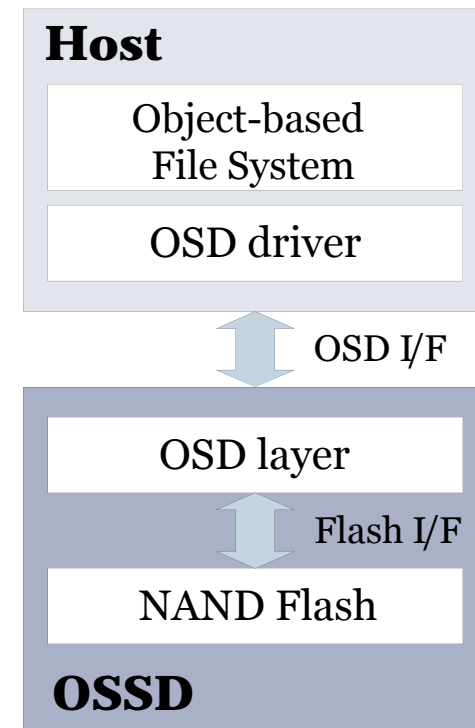
# Interfaces for SSDs (4)

- Native flash interface
  - READ PAGE,  
PROGRAM PAGE,  
ERASE BLOCK
  - Used in many embedded systems
  - Host handles everything, storage remains dumb and simple



# Interfaces for SSDs (5)

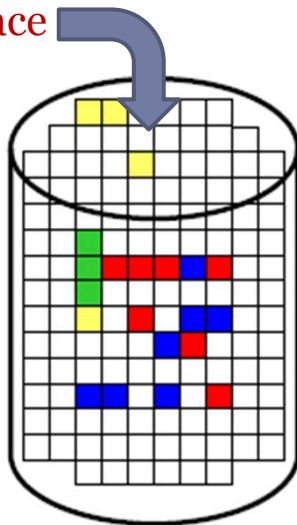
- Object interface
  - More abstract interface
  - Improved drive intelligence
  - OSSD:  
Object-based Solid State Drive



# OSD

- Object-based Storage Device
  - Virtualizes physical storage as a pool of objects
  - Offloads space management to storage devices
  - Standardized as a subset of SCSI command set

Block interface

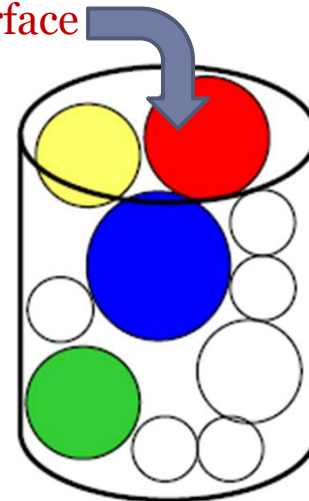


Operations  
read block  
write block

Security  
Weak  
Full disk

Allocation  
External

Object interface

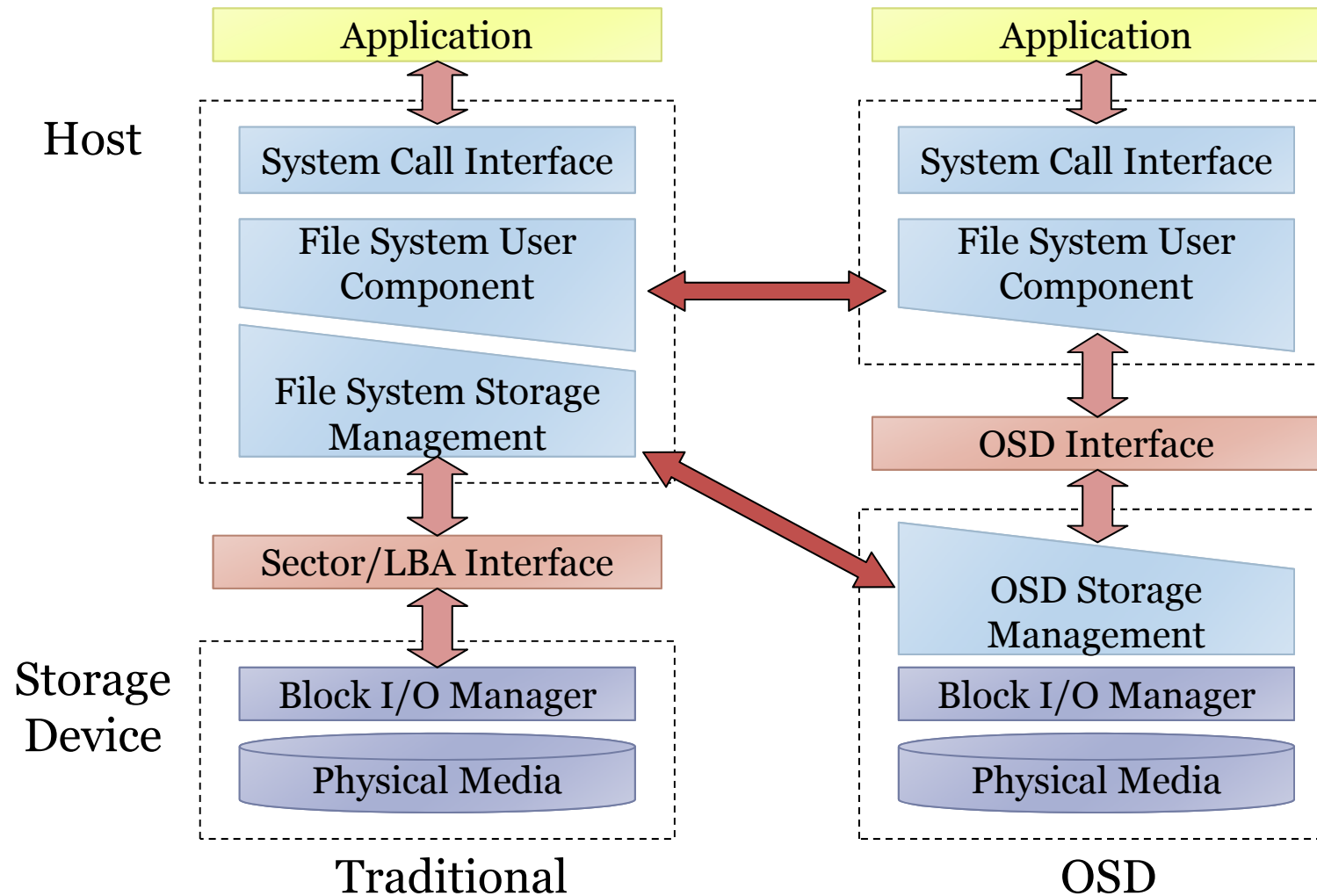


Operations  
read object offset  
write object offset  
create object  
delete object

Security  
Strong  
Per Object

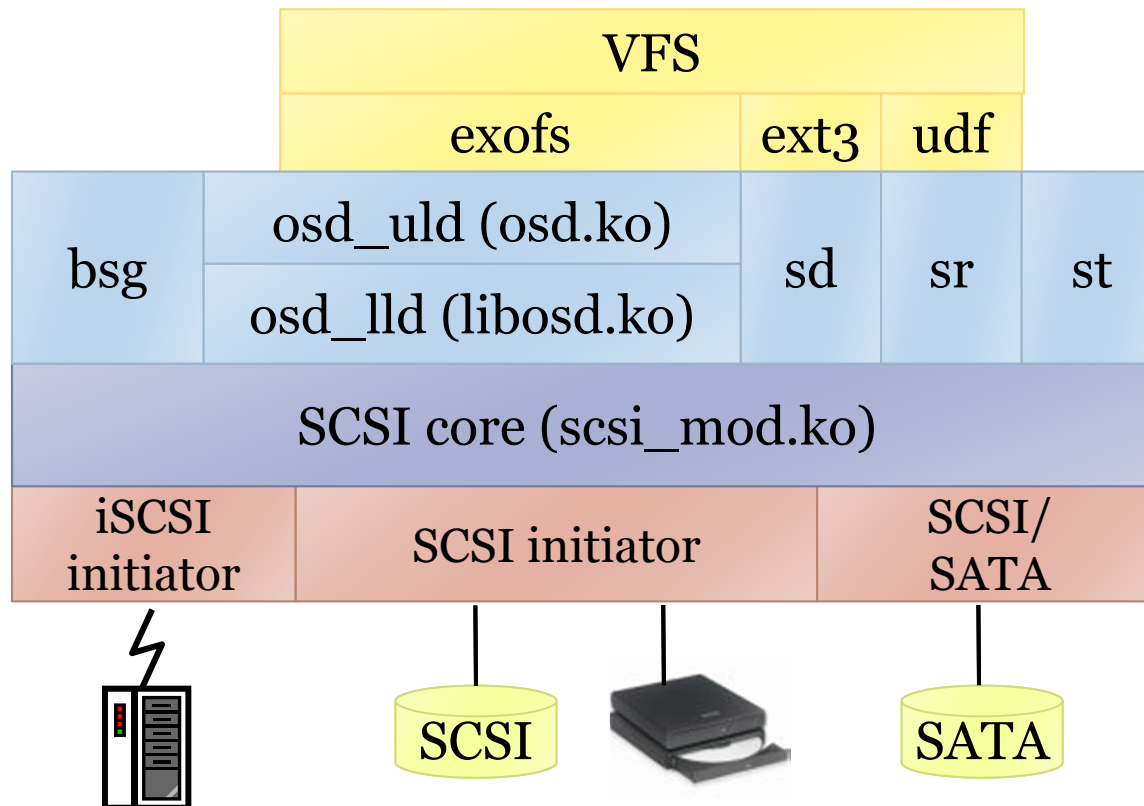
Allocation  
Local

# Storage Model



# Linux Support for OSD

- Since Linux kernel 2.6.30
  - Exofs + OSD initiator + iSCSI transport



# OSSD Benefits (1)

- Simplified host file system
  - No need for SSD-specific parameter tuning
  - File-to-object mapping & access control
- More efficient management of flash storage
  - Block-level liveness
  - Metadata separation
  - Object-aware storage management

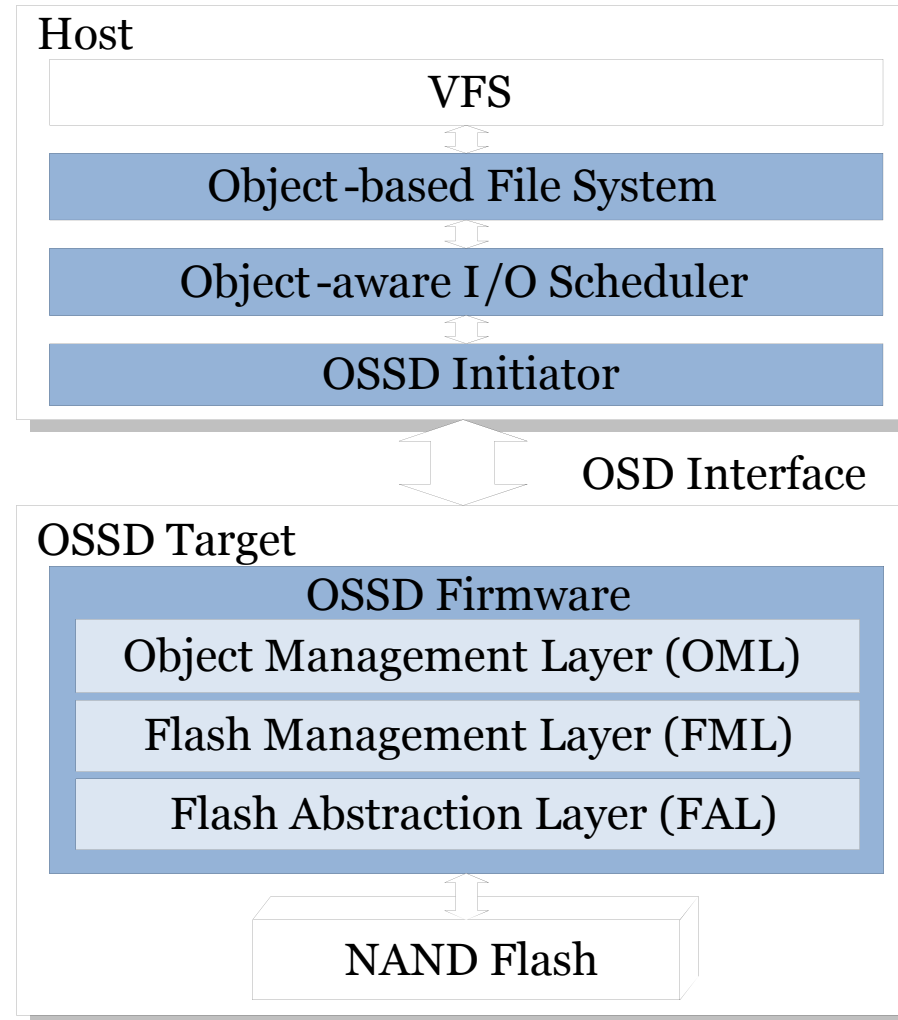
# OSSD Benefits (2)

- Application-aware storage management
  - QoS requirements via attributes
  - Application hints
  
- Storage virtualization
  - Dynamic storage pool
  - Multi-tier storage architecture with DRAM, PCM, SLC NAND, MLC NAND, and HDD

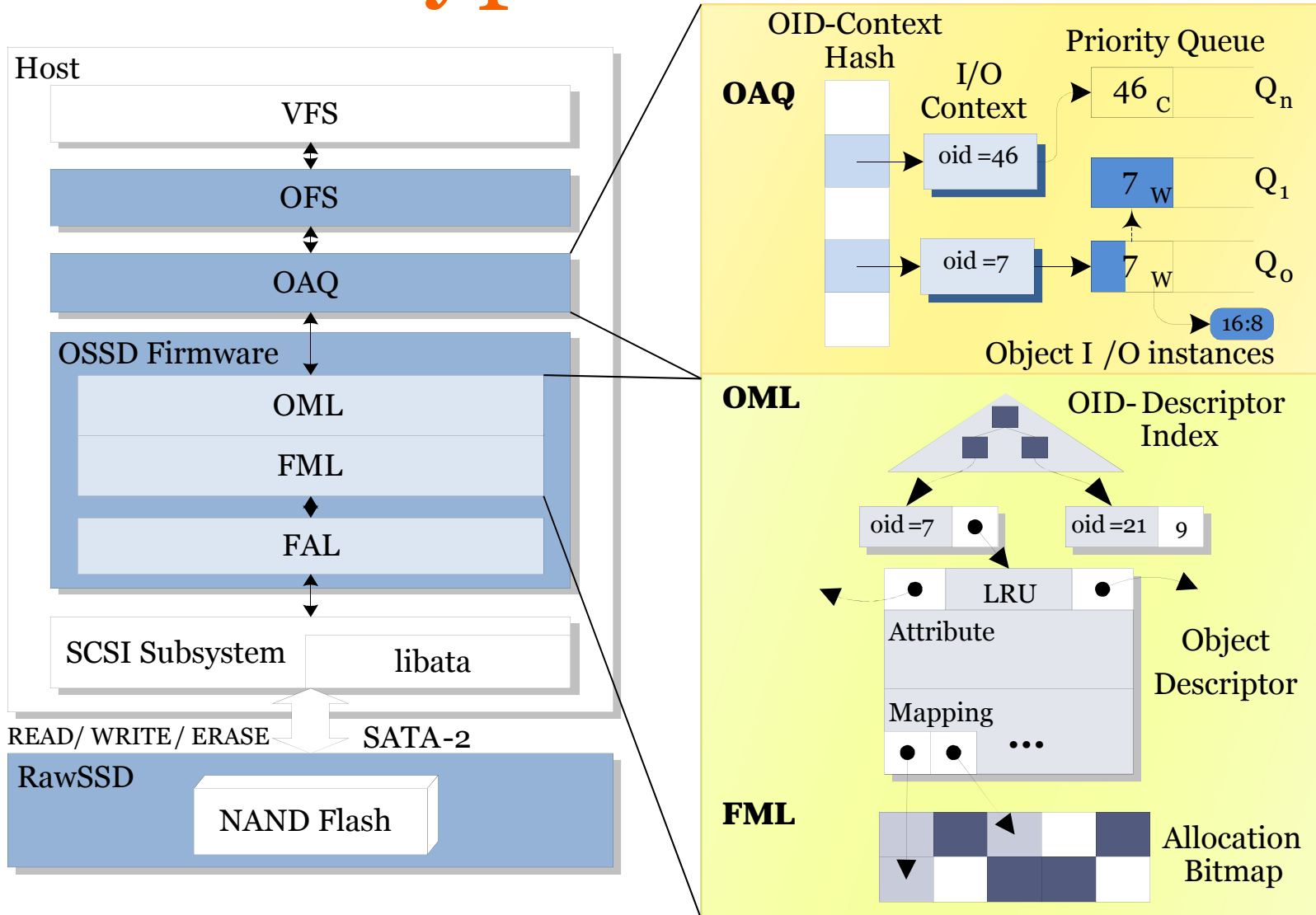
# Prototype Implementation



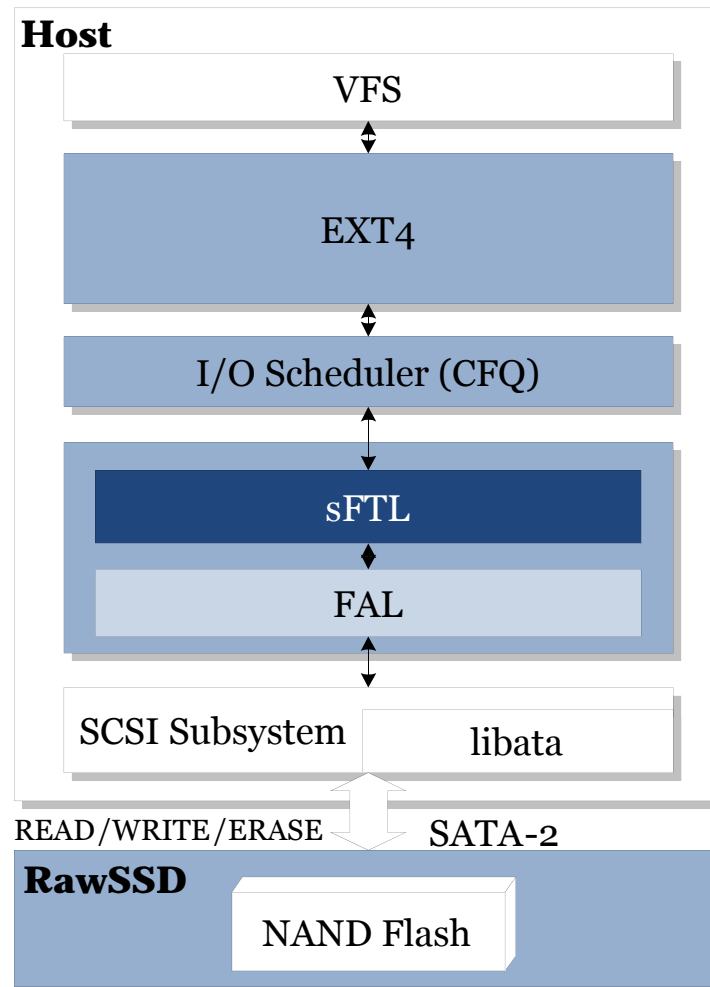
# Overall Architecture



# Prototype Architecture



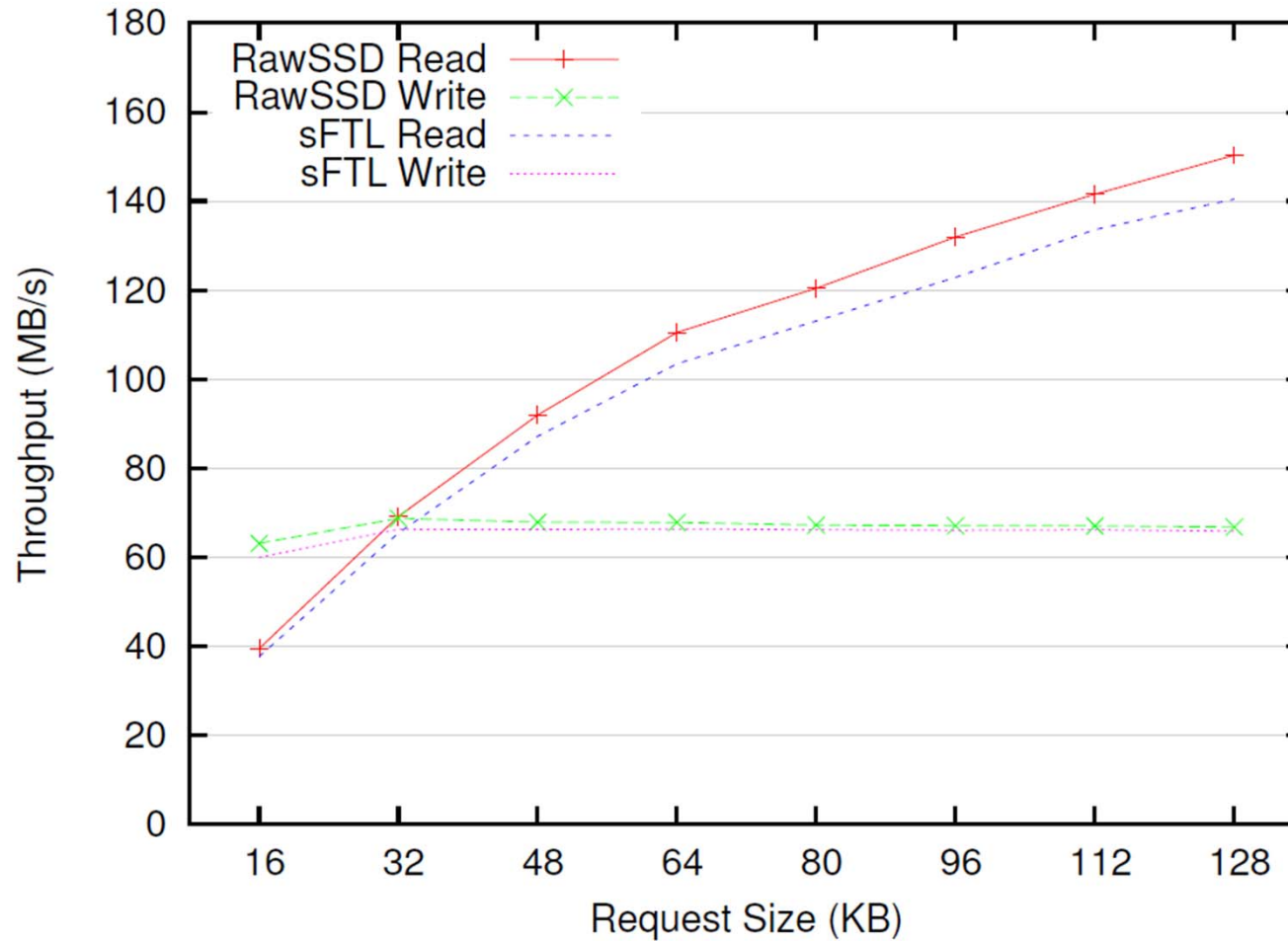
# Legacy Stack



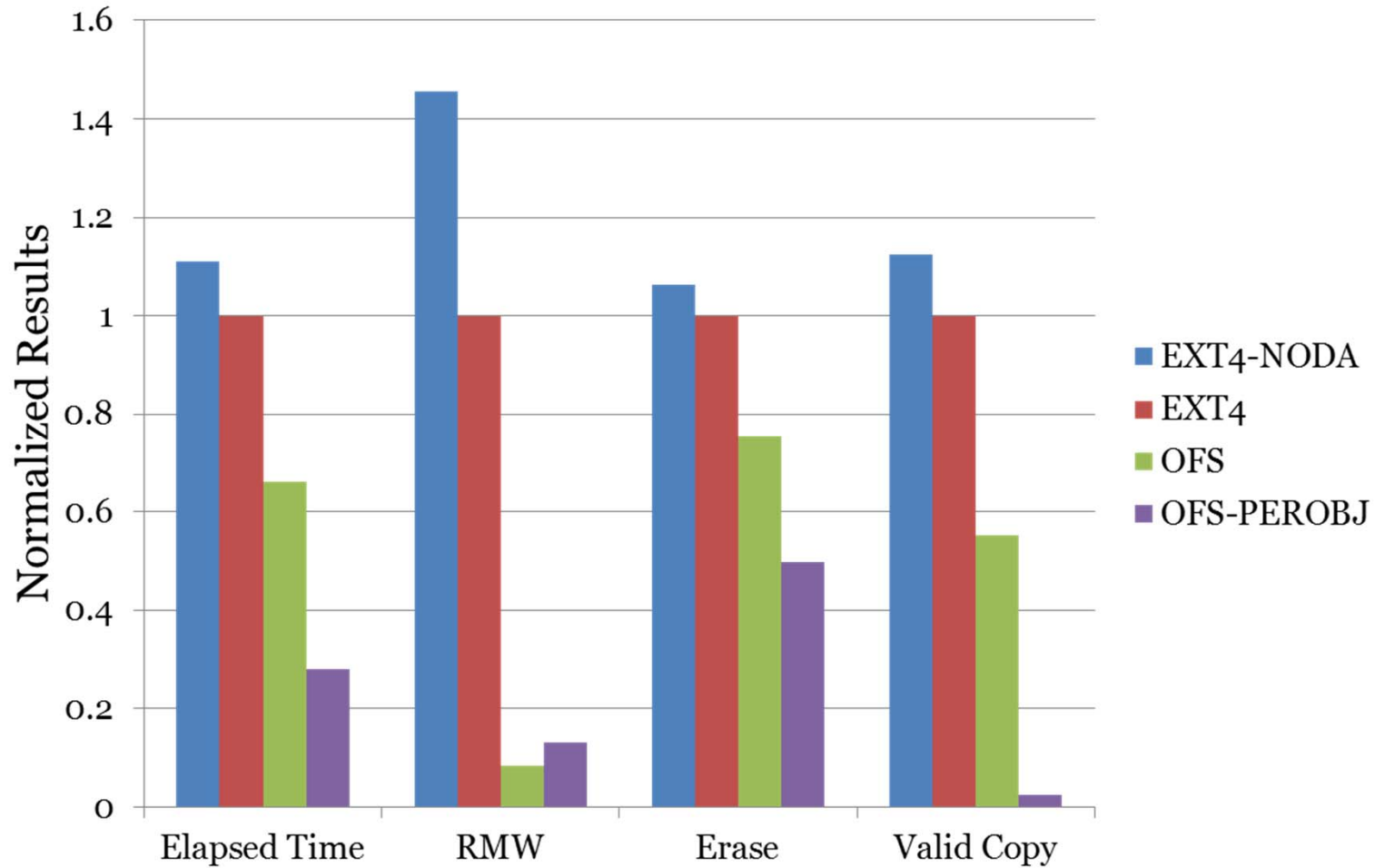
# RawSSD

- Native NAND I/O interface over SATA-2
- $16 \text{ chips} * 8 \text{ dies/chip} * 2\text{GB/die} = 256\text{GB}$
- 8 channels (2 channels logically combined)
- 16KB logical page, 8MB logical block
  - Two dies with two-plane operation
- Page-wise channel-level striping
- Asynchronous writes with DRAM buffer

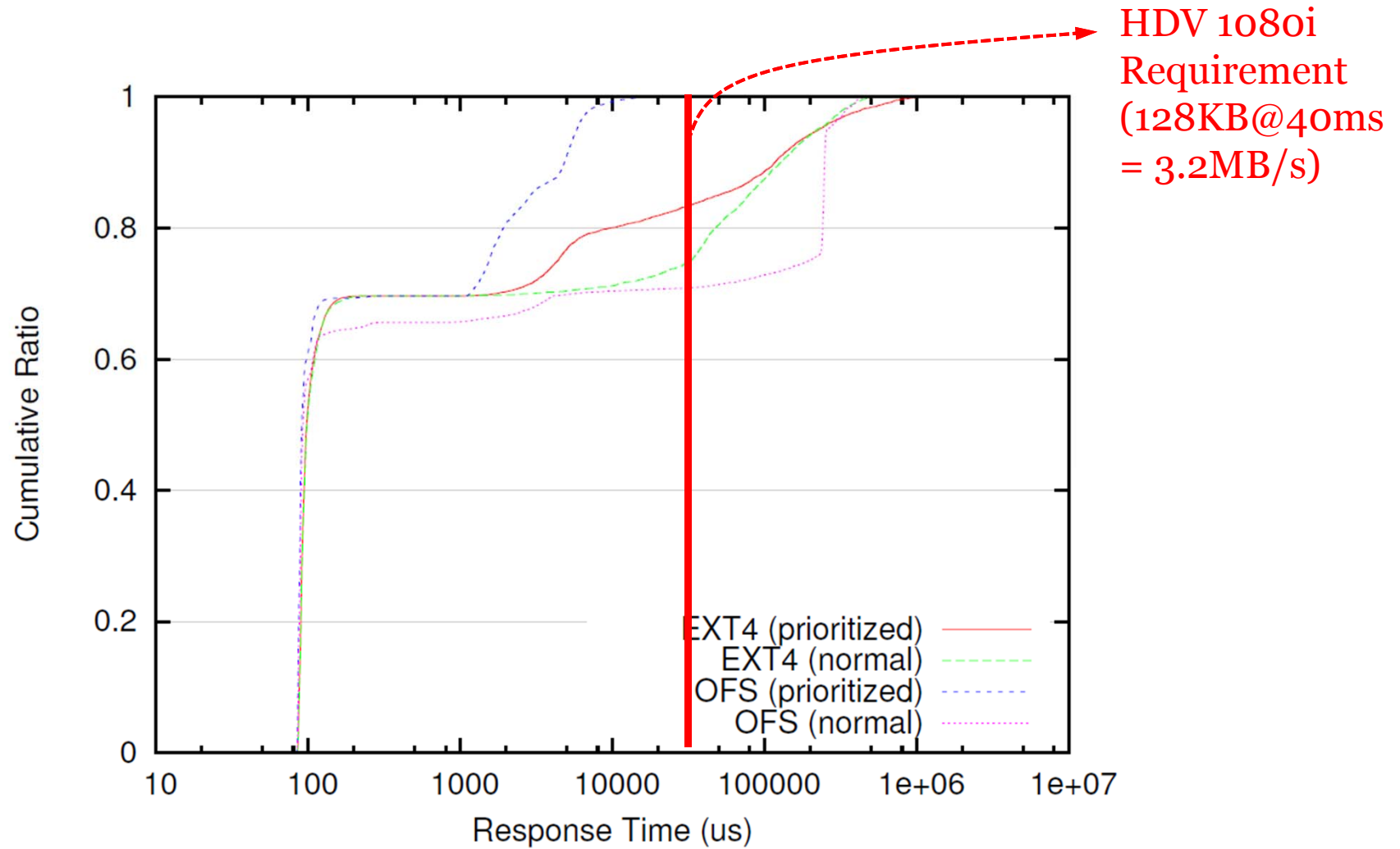
# Base Performance



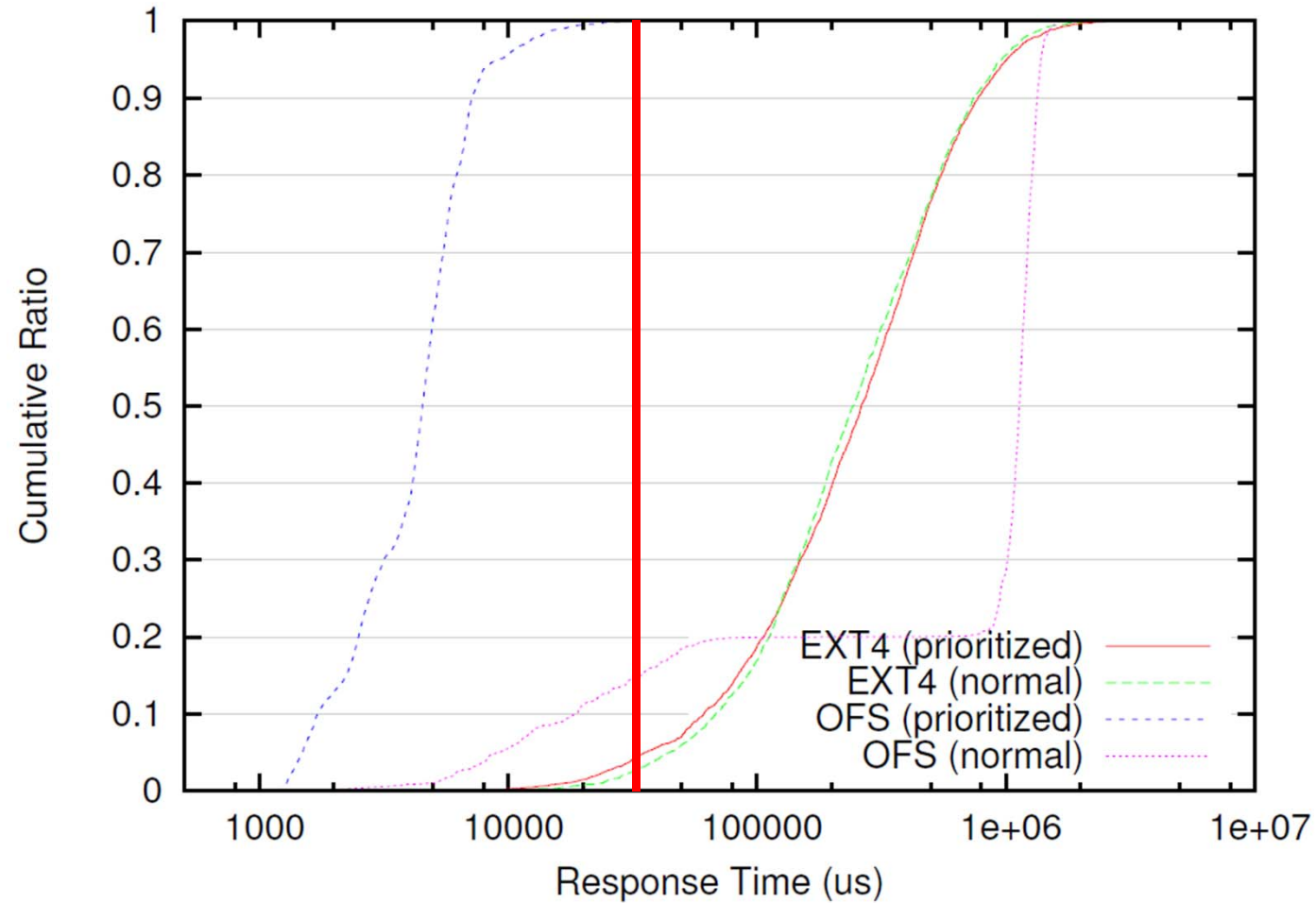
# Multi-threaded writes



# Prioritized Reads



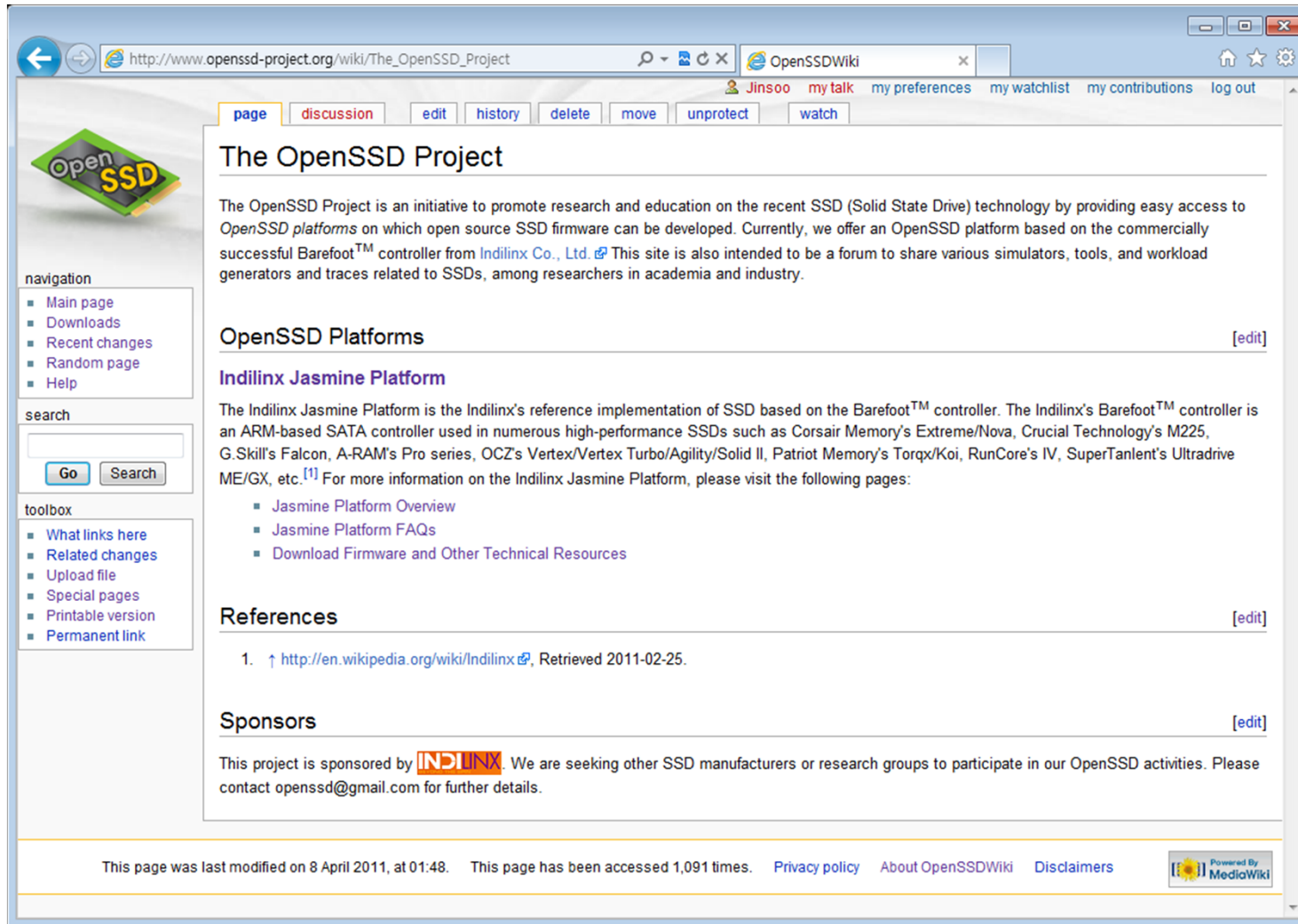
# Prioritized Writes





# The OpenSSD Project

# http://www.openssd-project.org



The screenshot shows a web browser window displaying the OpenSSD Project wiki page. The browser's address bar shows the URL [http://www.openssd-project.org/wiki/The\\_OpenSSD\\_Project](http://www.openssd-project.org/wiki/The_OpenSSD_Project). The page title is "The OpenSSD Project". The main content area includes a description of the project, a section for "OpenSSD Platforms" with a sub-section for the "Indilinx Jasmine Platform", a "References" section with one entry, and a "Sponsors" section. The left sidebar contains navigation links, a search box, and a toolbox. The footer of the page includes modification and access statistics, a privacy policy link, and a "Powered By MediaWiki" logo.

**The OpenSSD Project**

The OpenSSD Project is an initiative to promote research and education on the recent SSD (Solid State Drive) technology by providing easy access to *OpenSSD platforms* on which open source SSD firmware can be developed. Currently, we offer an OpenSSD platform based on the commercially successful Barefoot™ controller from [Indilinx Co., Ltd.](#) This site is also intended to be a forum to share various simulators, tools, and workload generators and traces related to SSDs, among researchers in academia and industry.

### OpenSSD Platforms [edit]

#### Indilinx Jasmine Platform

The Indilinx Jasmine Platform is the Indilinx's reference implementation of SSD based on the Barefoot™ controller. The Indilinx's Barefoot™ controller is an ARM-based SATA controller used in numerous high-performance SSDs such as Corsair Memory's Extreme/Nova, Crucial Technology's M225, G.Skill's Falcon, A-RAM's Pro series, OCZ's Vertex/Vertex Turbo/Agility/Solid II, Patriot Memory's Torqx/Koi, RunCore's IV, SuperTalent's Ultradrive ME/GX, etc.<sup>[1]</sup> For more information on the Indilinx Jasmine Platform, please visit the following pages:


- [Jasmine Platform Overview](#)
- [Jasmine Platform FAQs](#)
- [Download Firmware and Other Technical Resources](#)

### References [edit]

1. ↑ <http://en.wikipedia.org/wiki/Indilinx>, Retrieved 2011-02-25.

### Sponsors [edit]

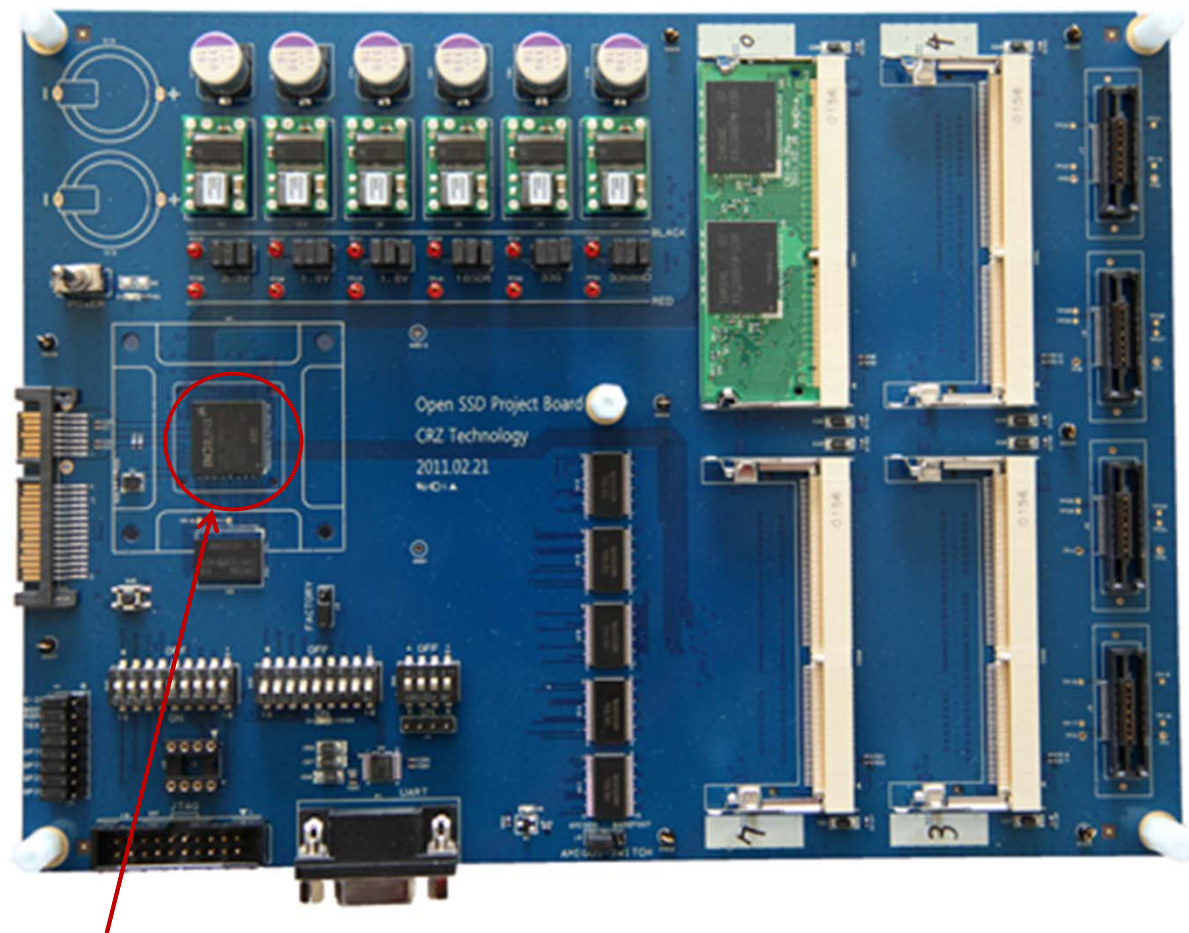
This project is sponsored by **INDILINX**. We are seeking other SSD manufacturers or research groups to participate in our OpenSSD activities. Please contact [openssd@gmail.com](mailto:openssd@gmail.com) for further details.

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# Why OpenSSD?

- No more simulations
- Broaden research horizon
- Train people
- Share expertise
- ...
- Initiated with Prof. Sang-Won Lee (SKKU) and Indilinx

# Jasmine OpenSSD Platform



Indilinx Barefoot controller

# Jasmine Firmware

- Firmware 1.0.0 released on April 7, 2011
- The latest version: 1.0.2 (April 15, 2011)
- Three sample FTLs
  - Tutorial FTL (By Indilinx)
  - Greedy FTL (By VLDB Lab. @ SKKU)
  - Dummy FTL (By Indilinx)
- Toolchains
  - ARM RVDS
  - Codesourcery G++ lite edition

# Participants

- 30 sets shipped to 9 institutions (15 labs)
  - Sungkyunkwan U., Hanyang U., Ajou U., Hongik U., Korea U., Kwangwoon U., POSTECH, Soongsil U., U of Seoul
- 1 set shipped abroad
- We plan to have a workshop in May.

# Jasmine Resources

- FAQs
- Board schematics
- Technical Reference Manual
- FTL Developer's Guide
- Barefoot Controller Technical Reference
- Contributions from community
  - Developer Information (by Jeremy Brock)
  - ...

**Thank You!**