The CASE of FEMU: Cheap, Accurate, Scalable and Extensible Flash Emulator

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Parallel M *

CNEXLABS +

What SSD platforms are used?

Simulator

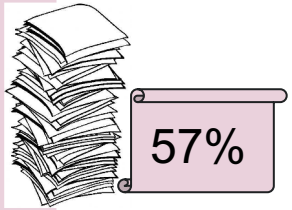
DiskSim+SSD

SSDSim | FlashSim

- Simple
- Time-saving
- Trace driven
- Internal-research only

Emulator

Hardware Platform



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Trends

- Software-Defined Flash
- Split-Level Architecture

Simulator

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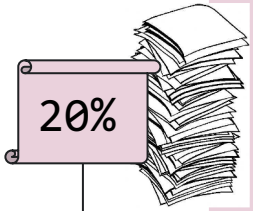
Emulator



19% Single SSD

1% Distributed SSDs

Hardware Platform

OpenSSD OpenChannel-SSD

- Full-stack Research
- Accurate
- Expensive
- Complex to use
- Wear-out

Simulator

DiskSim+SSD

SSDSim | FlashSim

- Simple
- Time-saving
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Guest OS

Emulator

LightNVM's QEMU

VSSIM | FlashEm

- Fullstack Research
- Cheap
- Poor Scalability
- Poor Accuracy

Hardware Platform

OpenSSD OpenChannel-SSD

- Full-stack Research
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The *"CASE"* of FEMU

FEMU: QEMU/Software based Flash Emulator

- **C**heap: $0, https://github.com/ucare-uchicago/femu
- **A**ccurate: 0.5-38% error rate in latency
  - 11% average at microsecond level
- **S**calable: support 32 channels/chips
- **E**xtensible
  - modifiable interface
  - modifiable FTL

What is FEMU?

Typical Fullstack Research

App

Host OS

Hardware Platform

FEMU Fullstack Research

App

Guest OS

VM

NVMe

FEMU

QEMU

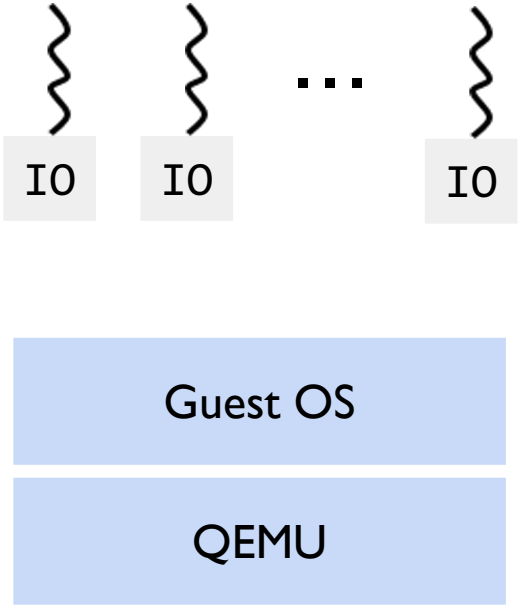
Supported research:

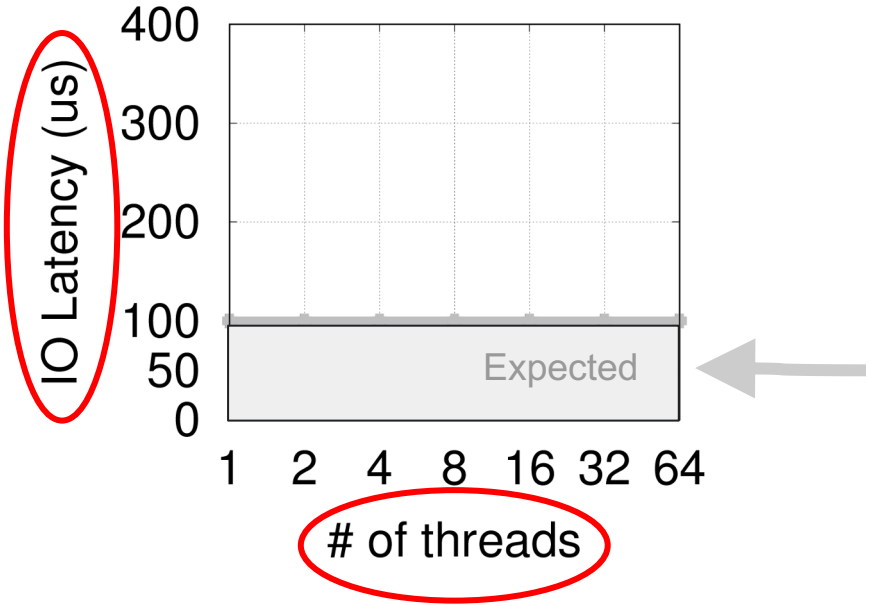
Kernel changes ✓

Interface changes ✓

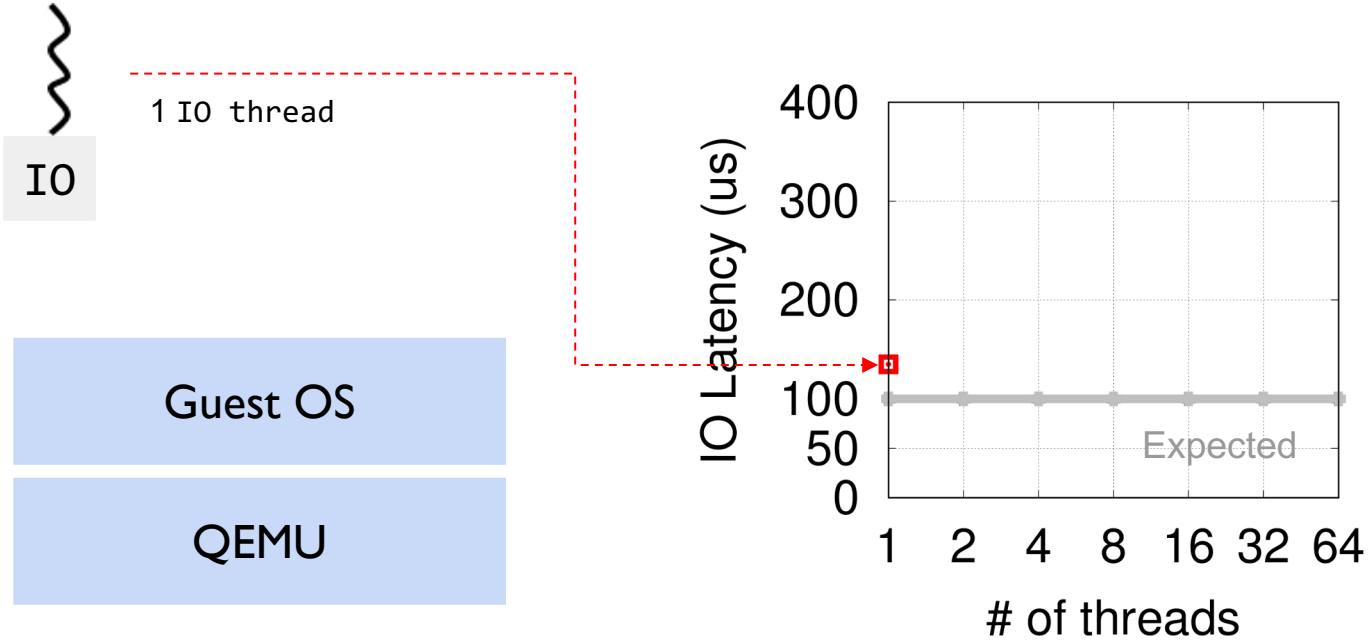
FTL changes ✓

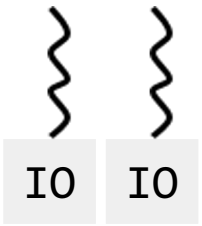
QEMU Scalability





QEMU IDE Scalability

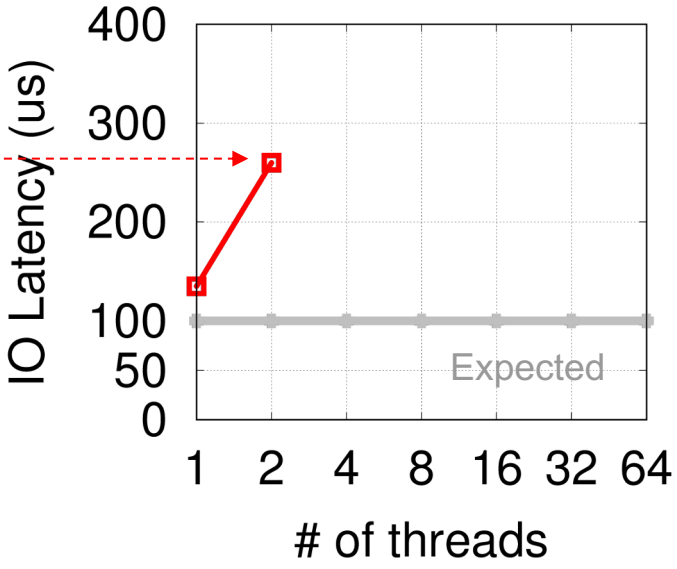


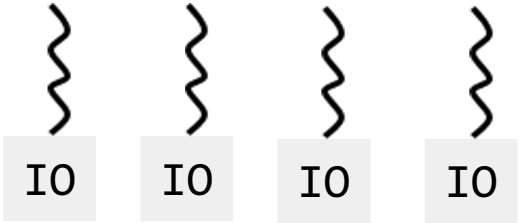


2 IO threads

Guest OS

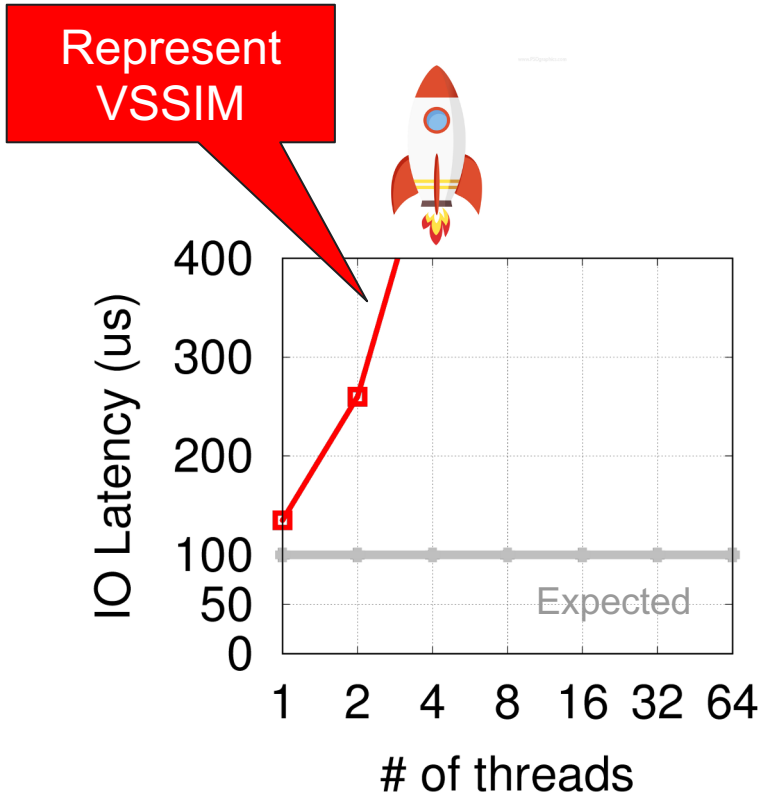
QEMU



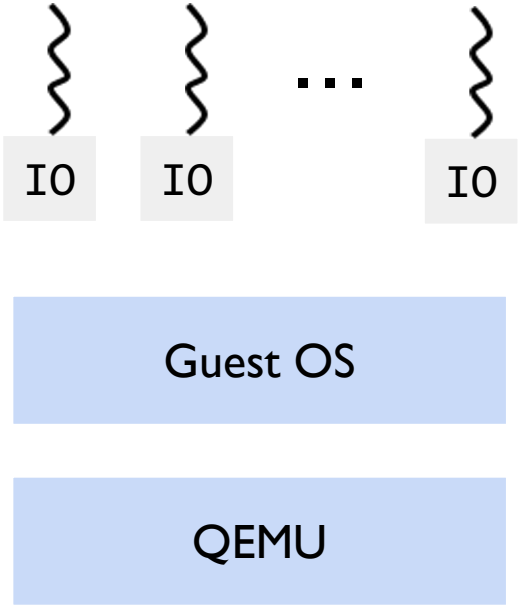


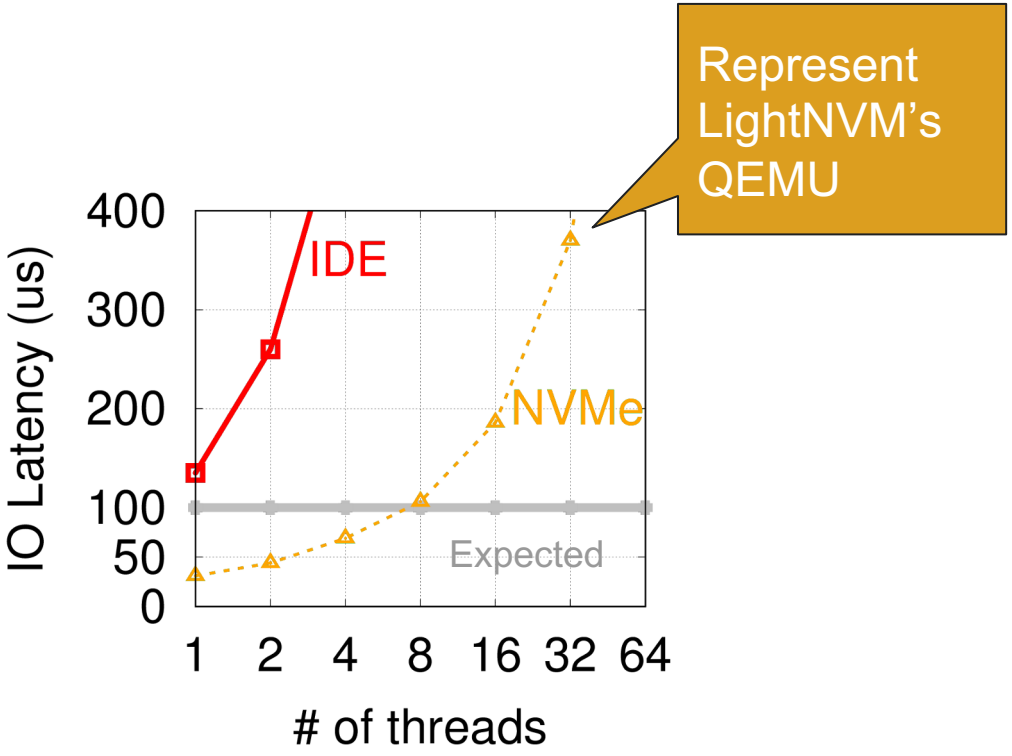
Guest OS

QEMU



QEMU NVMe Scalability

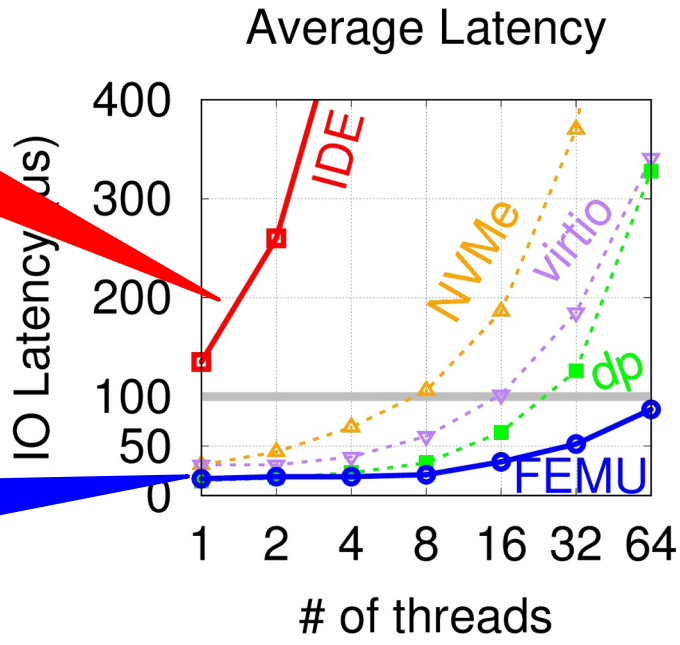




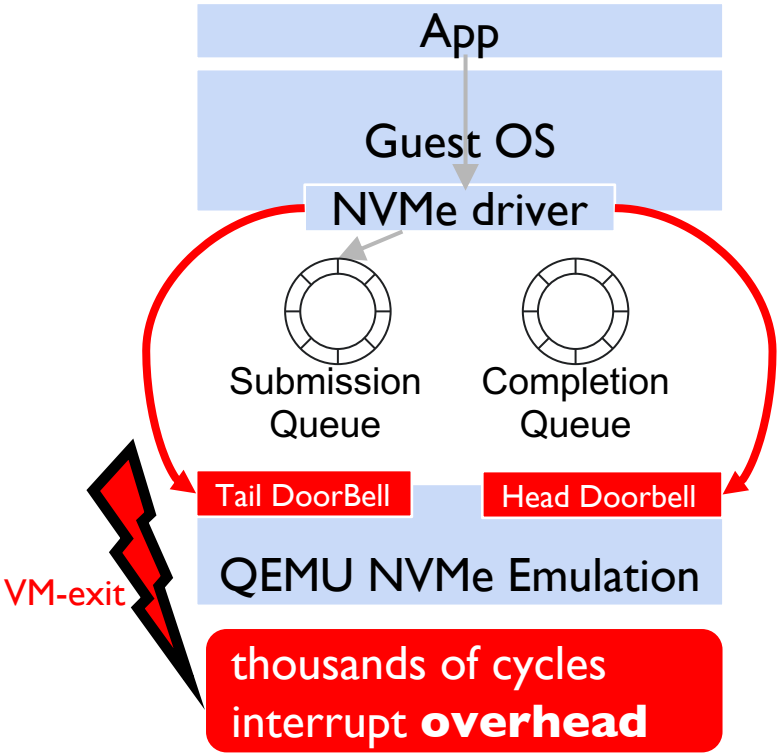
QEMU Scalability

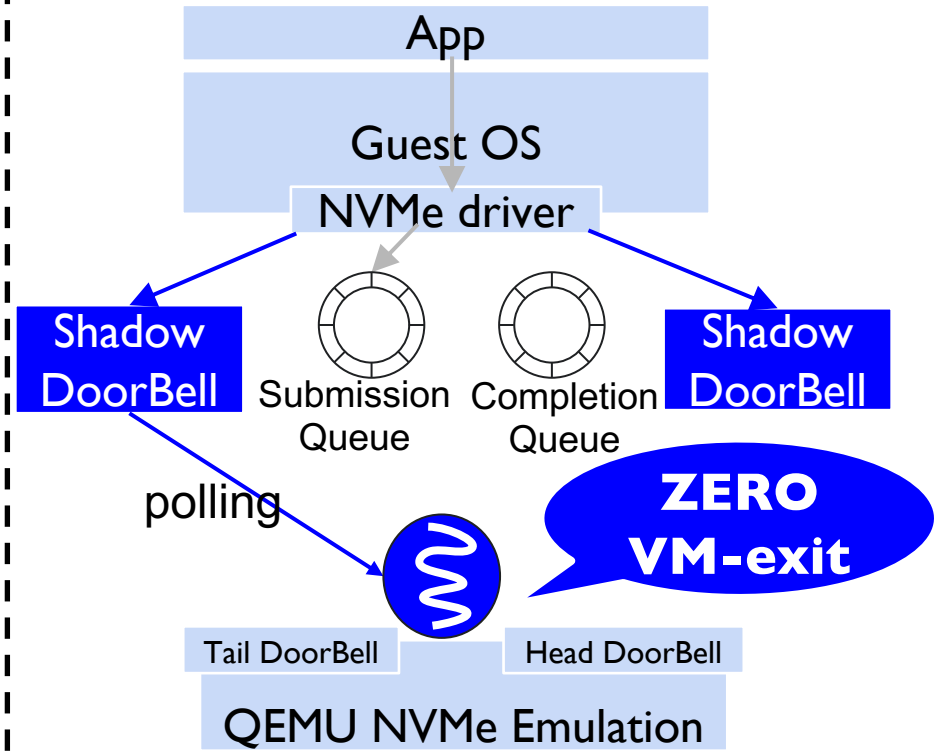
QEMU and existing emulators are NOT Scalable !

FEMU is Scalable !

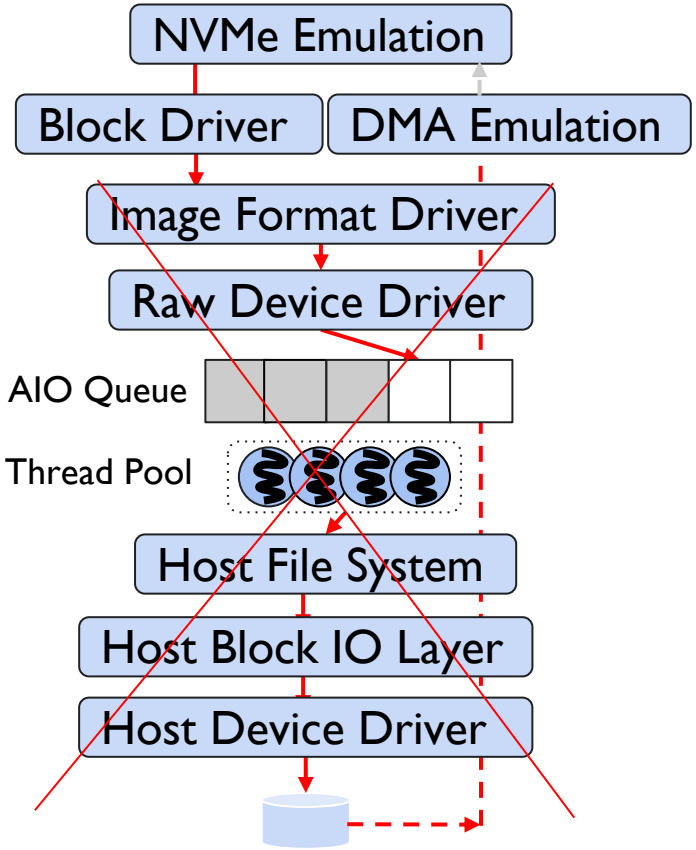


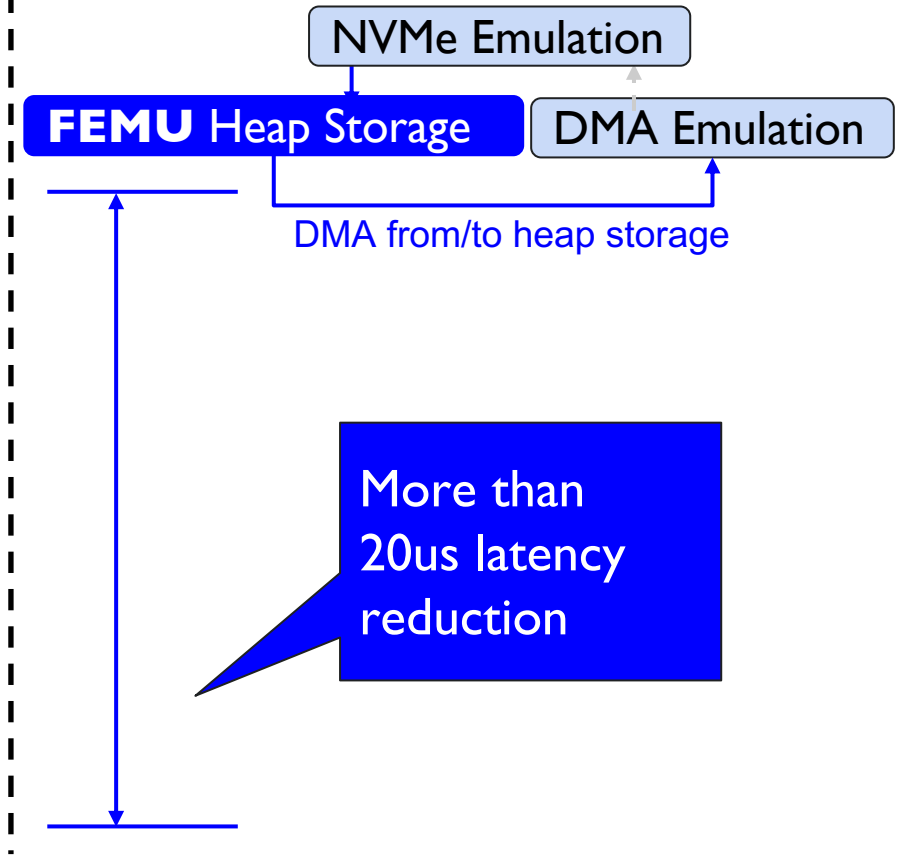
Scalability Root Causes & Solutions (1)





Scalability Root Causes & Solutions (2)

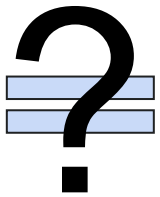




FEMU Accuracy

App

FEMU

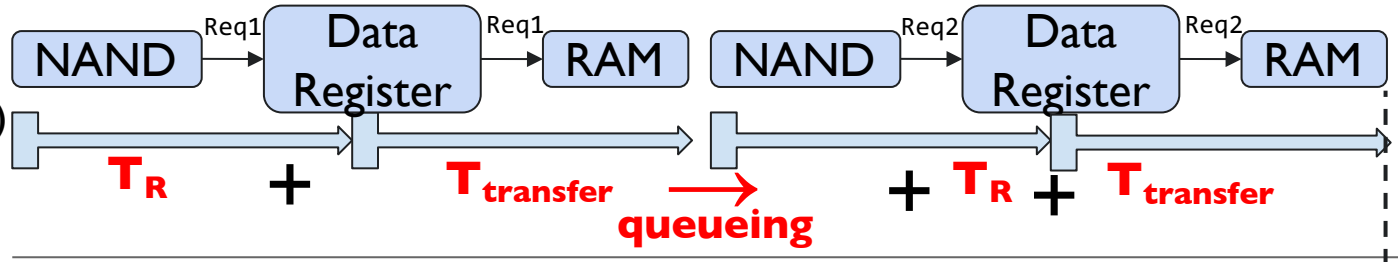


OpenChannel-SSD

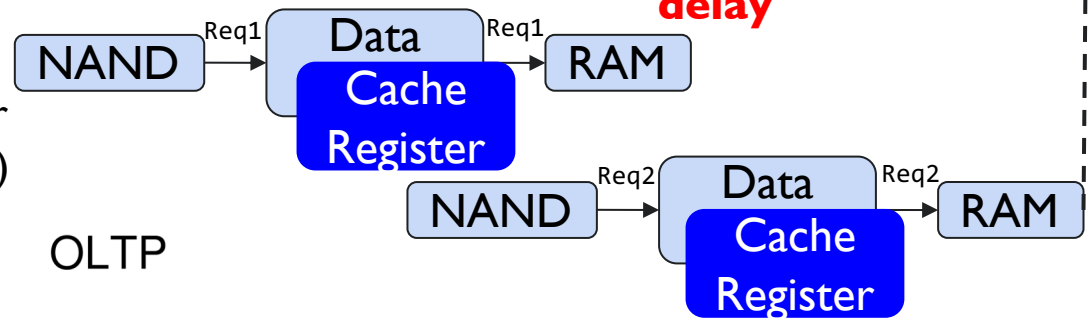
L_{femu} L_{oc}

$$Error = |L_{femu} - L_{oc}| / L_{oc}$$

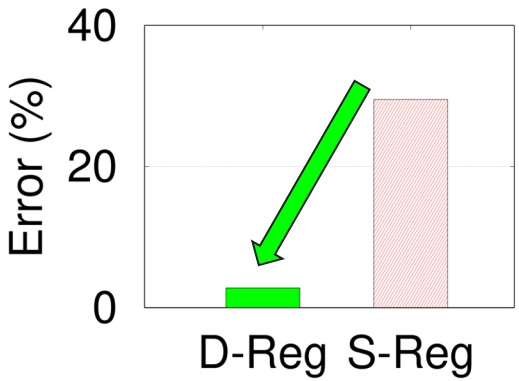
Single-Register model (**S-Reg**)



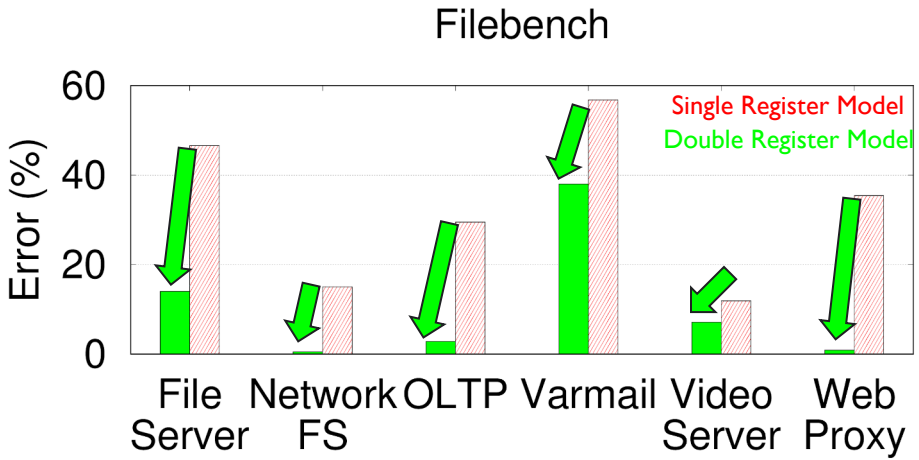
Double-Register model (**D-Reg**)



OLTP



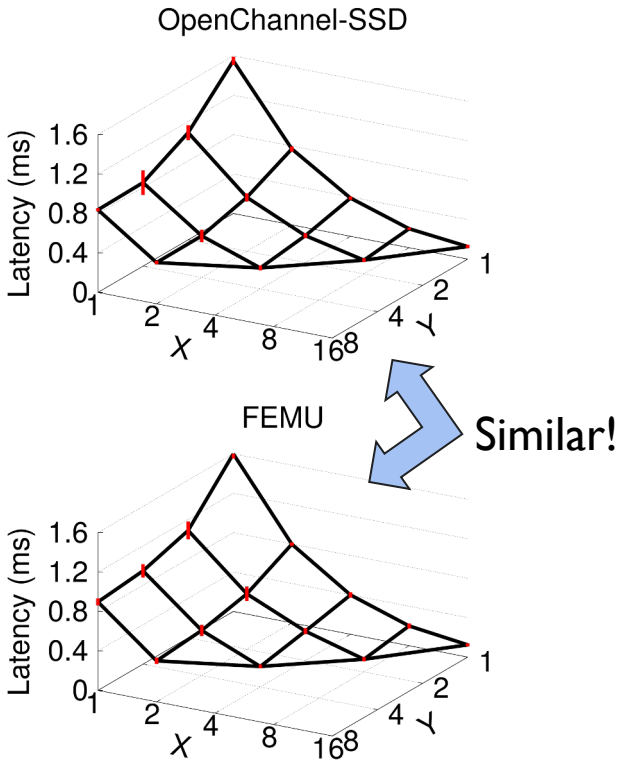
FEMU Accuracy



Latency Error: 11-57% ⇒ 0.5-38%

Single Register Model (**S-Reg**)

Double Register Model (**D-Reg**)



X: # of channels
Y: # of planes per channel

FEMU Limitations

- Further optimizations to support higher parallelism (more scalable)
- Accuracy can be improved
- Not able to emulate large-capacity SSD
- No persistence

Conclusion


FEMU
150mg
Installing, and using FEMU can cause side effects including headache, nausea, agitation, and depression. If your research condition does not improve after using FEMU for a week, please talk to us, your advisor, or your doctor immediately.
Cheap
Accurate
Scalable
Extensible
Order Now
https://github.com/ucare-uchicago/femu

Thank you!
Questions?

FEMU: https://github.com/ucare-uchicago/femu

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