Latency and Throughput in SSD Controllers for Persistent Memory

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SSD Controller Platform

- Mobiveil Inc. is Silicon IP and Platform Provider
- Wide range of customer requirements: Requires high degree of Scalability and Configurability in SSD Controller Platform

- Mobiveil SSD Controller Platform is being deployed for Persistent Memories
- Partnership with Crossbar on ReRAM SSD and ReRAM NVDIMM
ReRAM SSD M.2

**ReRAM**
- 500 MT/s interface
  - 8-bit ONFI 4
- 1us Read Time
- 2us Program Time
- No-Erase Required
- Multi-Bank Architecture

**Controller**
- 8 GT/s per lane
  - PCIe Gen3 X 4 IF
  - 8 ONFI 4 channels
  - ECC
  - No External DRAM

**Block Diagram**

**NVMe Module PCIe M.2**
- Read Performance
  - Random Read Latency: 10us (Max)
  - 6.4M Random 512B IOPS
  - 800K Random 4K IOPS
- Write Performance
  - Write latency: 10us (max, without caching)
  - 6.4 Million Random 512B IOPS
  - 800K Random 4K IOPS
  - No Erase prior to Write command
- Endurance: 10^5 Write cycles
ReRAM NV-DIMM

ReRAM
- 800 MT/s interface
  - 8-bit ONFI 4
- 1us Read Time
- 2us Program Time
- No-Erase Required
- Multi-Bank Architecture

Controller
- 1600 MT/s per lane
  - 64-bit DDR3
- 16 ONFI 4 channels
- ECC
- No External DRAM

Block Diagram

DIMM Module
- Read Performance
  - Random Read Latency: 4us (Max)
  - 24M Random 512B IOPS
  - 3M Random 4K IOPS
- Write Performance
  - Write latency: 4us (max, without caching)
  - 24 Million Random 512B IOPS
  - 3M Random 4K IOPS
  - No Erase prior to Write command
- Endurance: $10^5$ Write cycles
Latency in Error-Correction Coding

- ECC is a necessary element in every memory
  - Wide range of latencies depending on correction capability, word size and type of ECC used
- Minimal latency for small (1 or 2 bit correction) codes

- Most powerful ECC option – LDPC can still have low latency
  - Example from Mobiveil LDPC compiler (decoding latency):
    - BOL: 75 clock cycles, EOL: 155 clock cycles
    - Significant further reduction in LDPC latency is possible
      - Theoretical limit <20 clock cycles EOL