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Adaptive program delay scheme for Mixed Workload performance improvement. (NVRAMOS 2019)

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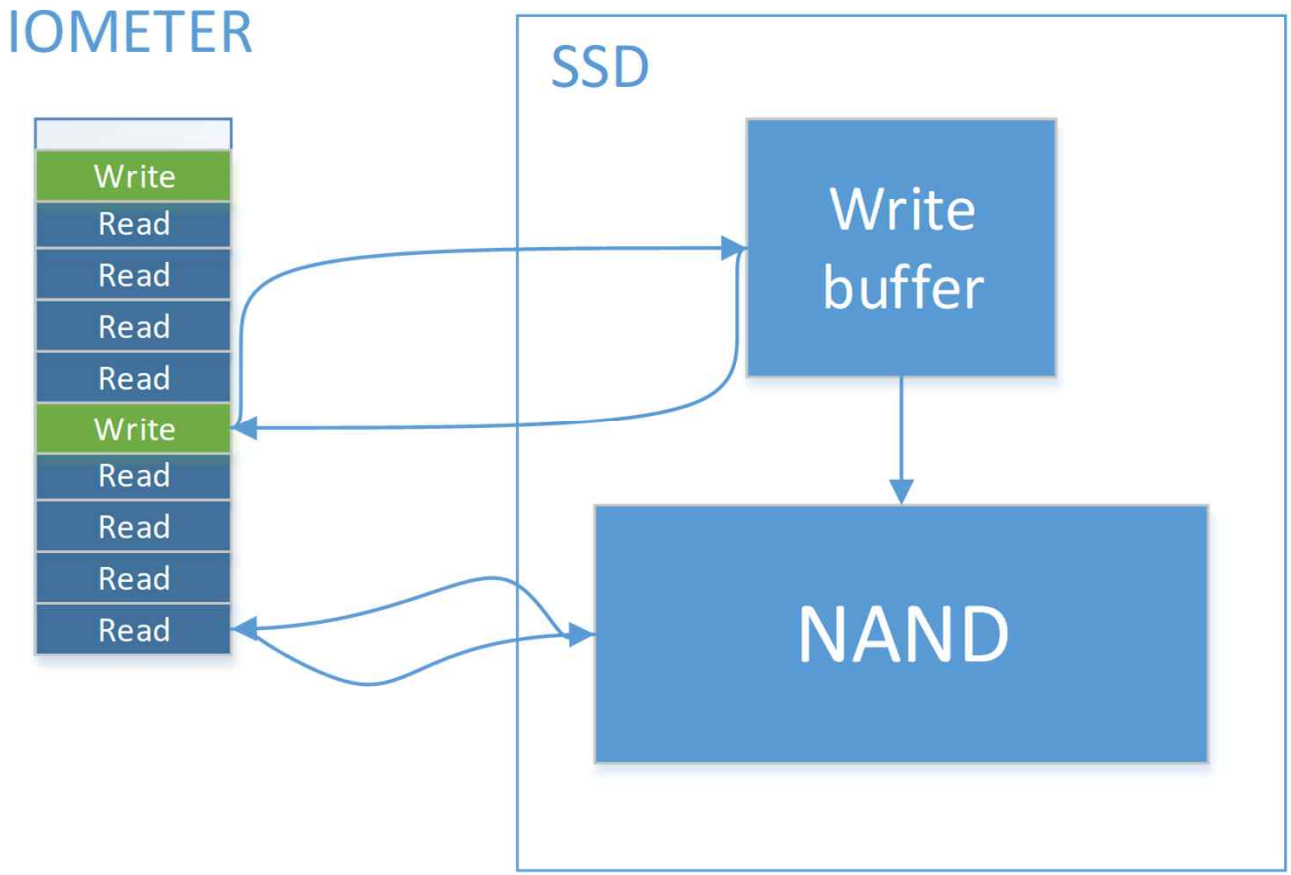
Background

- Mixed workload at sustained condition
  - Generated by IOMETER
    - Random 4KB read
    - Random 4KB write
    - Fixed read / write ratio
  - Simultaneous operation of Internal GC and Host workload
  - Program suspend frequently occurs by Host read

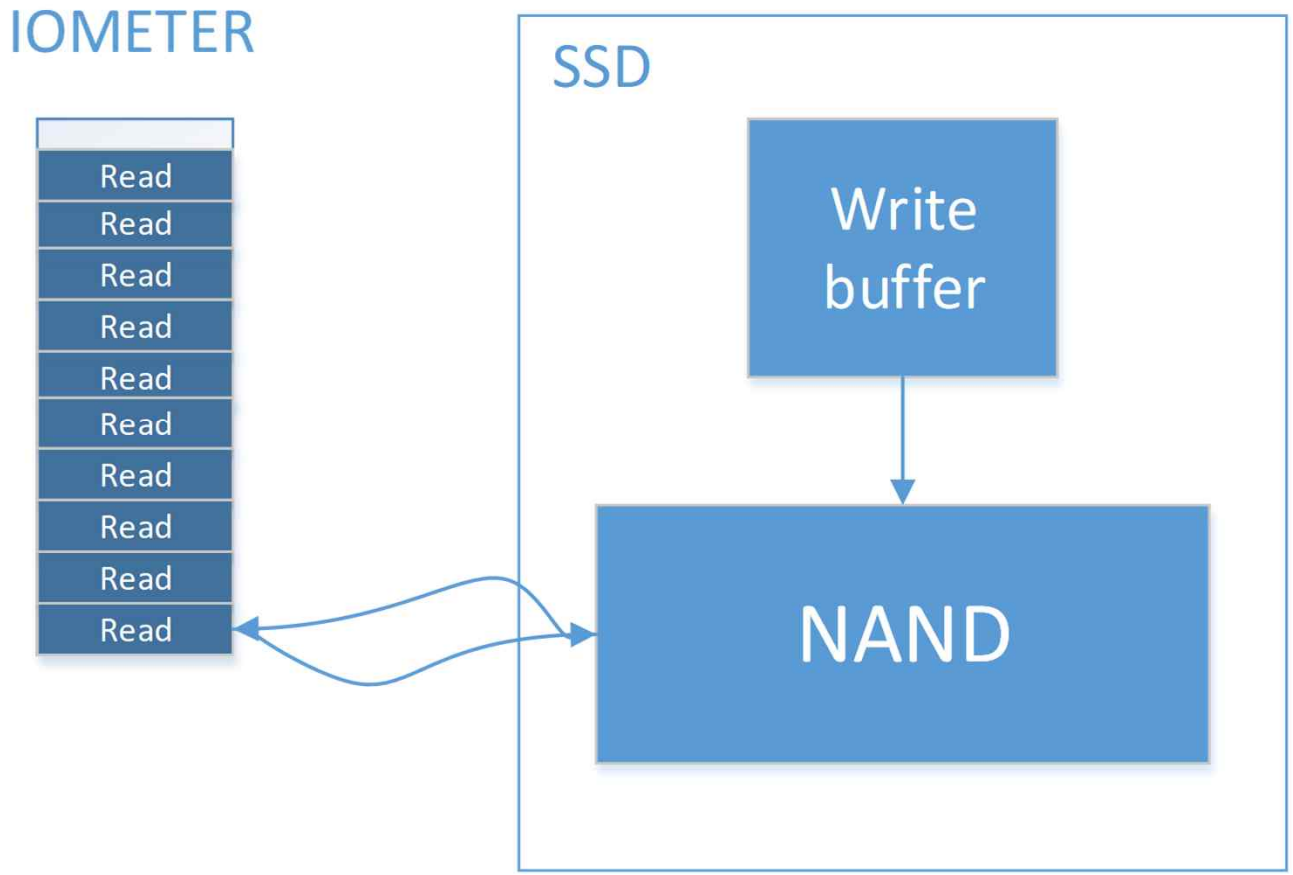
IOMETER Workload

- IOMETER generates random read/write IOs



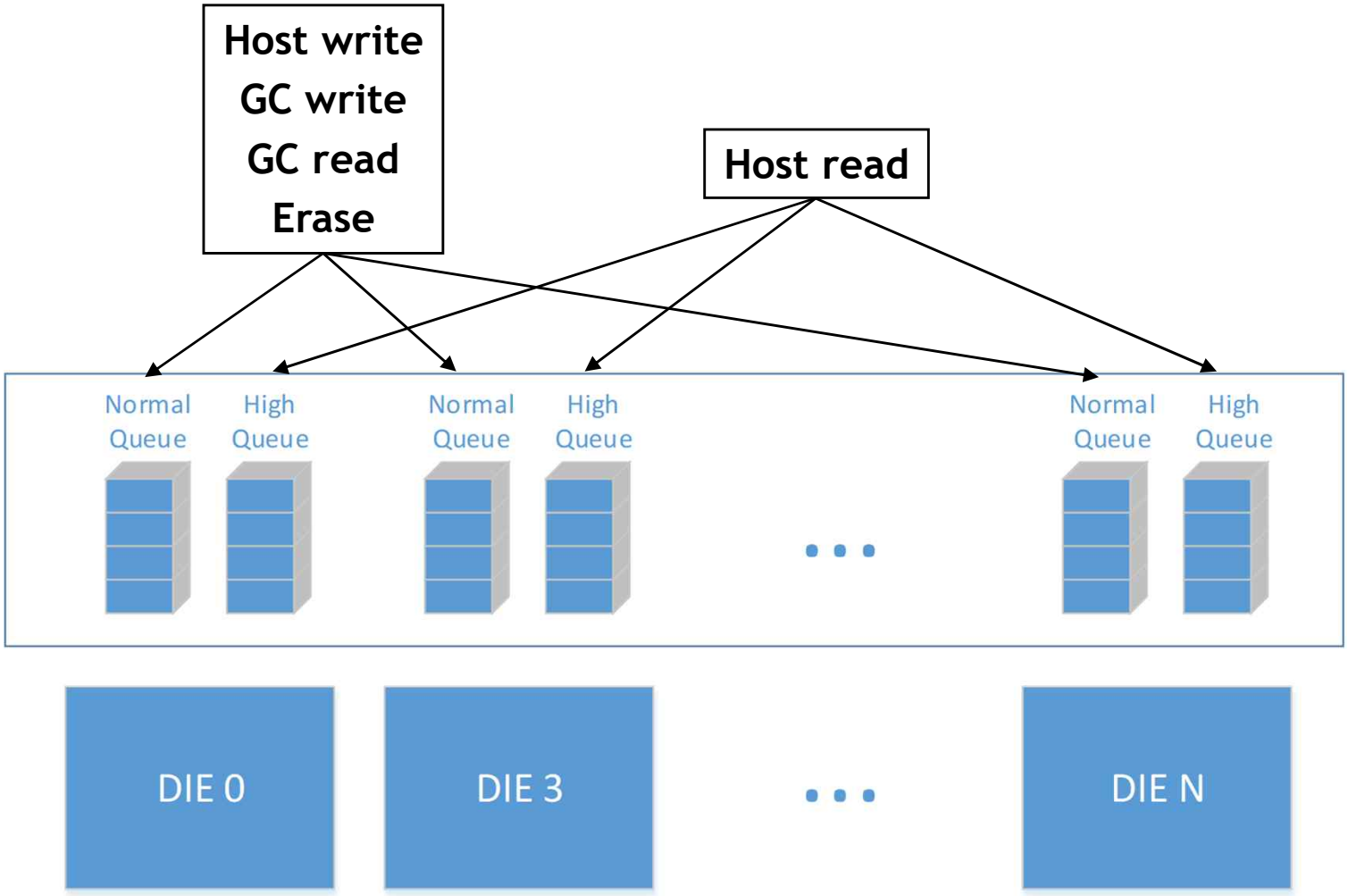
IOMETER Workload

- Total performance is highly affected by Read IO processing speed.



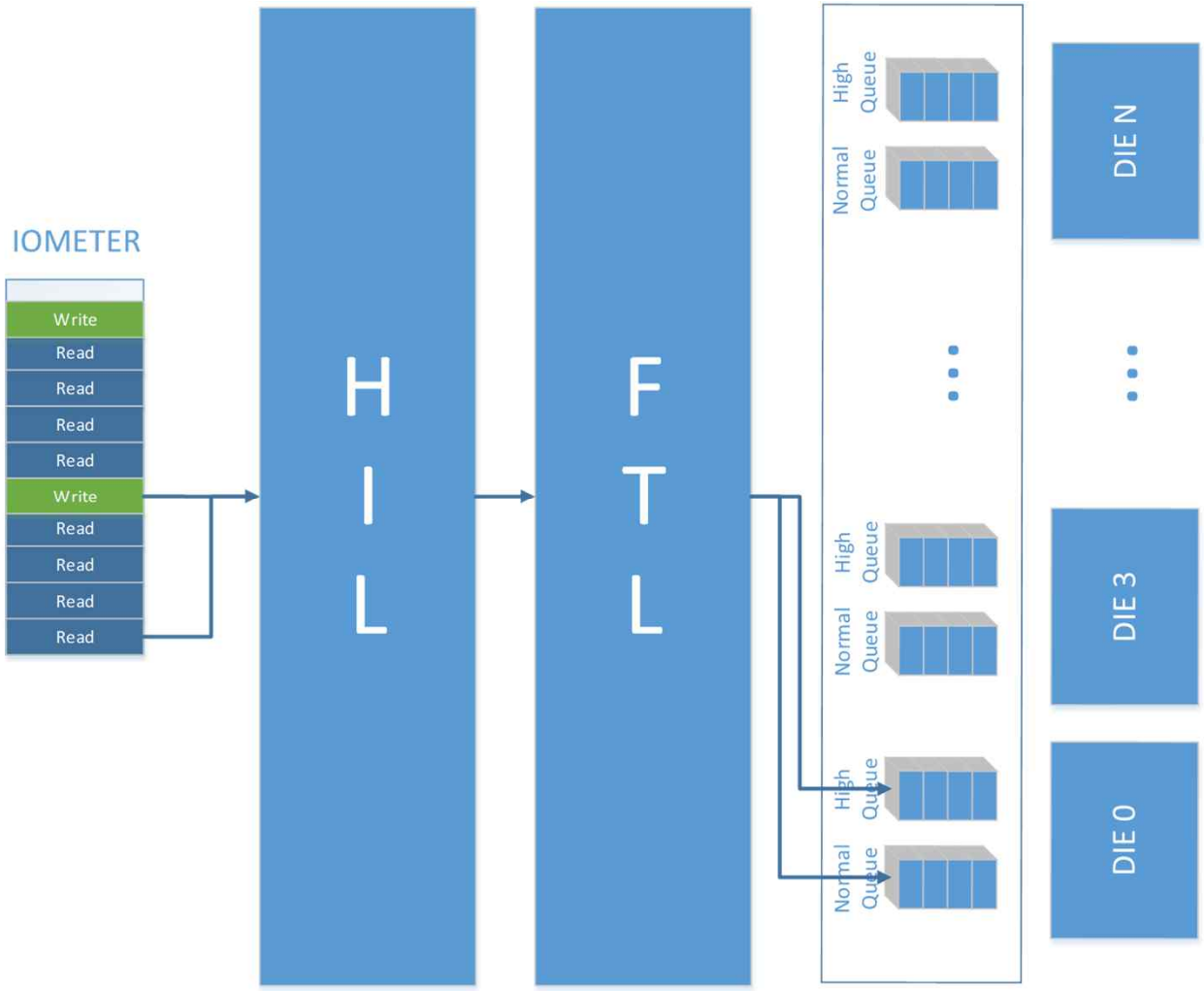
Sustained Condition

- Host write, GC write, erase can be suspended by host read



Limitation of Program Suspend

- Suspend is not available during Data-in (> 240us @ 460MTS).
- Effective tPROG is increased by Suspend. (< 150us)
- Suspend is available after Host read IOP is fetched.



IOP Arrival Delay

- Delay Time from program IOP to Host read IOP Arrival on same die.

IOP Arrival Delay

- Average program to read IOP delay arrival time is measured per a unit time
  - $AVG\_DELAY\_TIME_{pgm\ to\ read}$ > tPROG : Executing received Program IOP right away.
  - $AVG\_DELAY\_TIME_{pgm\ to\ read}$ < Data-in + α : Waiting Read IOP, then executing read IOP first.

- Test result
  - IOMETER 7:3 Mixed read / write workload was executed.
  - Program IOP is selectively delayed by $AVG\_DELAY\_TIME_{pgm\ to\ read}$.
  - Average IOPS was improved about ~6% by adaptive program delay scheme.

Capacity	Default	Adaptive PGM delay
2TB	82.0KIOPS	86.0KIOPS (104%)
4TB	80.7KIOPS	85.9KIOPS (106%)

Thank you.