Low Latency meets Large Scale when you CRANK UP THE AMPS

Website: www.crankuptheamps.com

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Achieving Killer Performance with Storage, Networking and Compute in a NUMA World

PUSHING AMPS FURTHER

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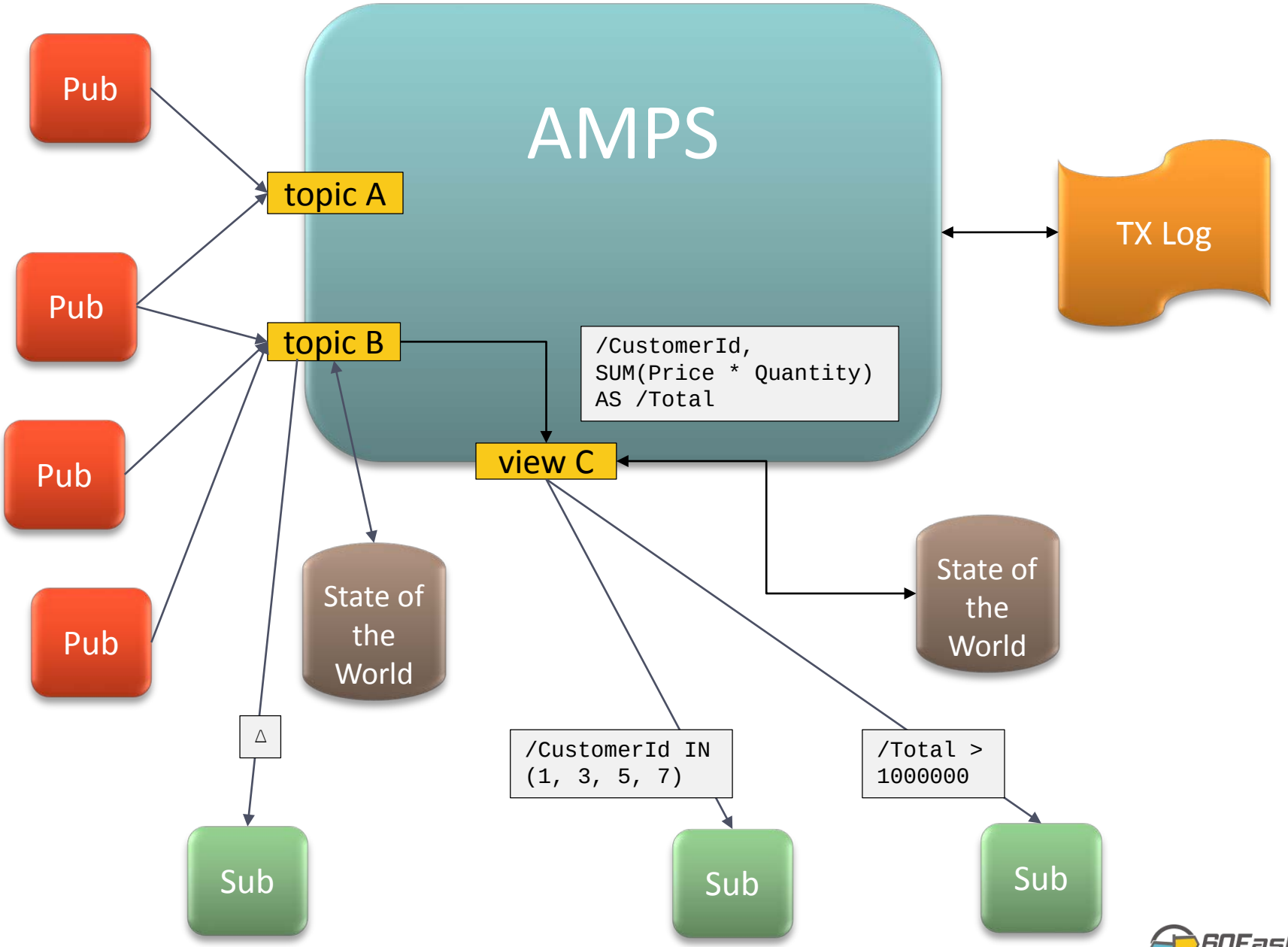
Overview of AMPS



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Fast Publish/Subscribe Solution

High Performance Content Filtering

- Filters resemble SQL-92 + Xpath
- Sub-microsecond processing latencies
- Capacity to do >1M messages/sec/core

Example subscription filters:

XML:

```
/FIXML/Order@Sym = “IBM” and
    /FIXML/Order/OrdQty@Qty >= 5000
```

FIX:

```
/55 = “IBM” and /35 in (‘D’, ‘C’)
```

State of the World (Database)

- Content filtered queries
- Atomic query + subscribe
- Message deltas (both in and out)
- Focus Tracking

Analytics Engine (Real-time Aggregation)

- Casts one topic into another
- Parallel and lock-free design

Analytics Engine (Real-time Aggregation)

- Projects one topic into another
  - Think: Real-time SQL-92 “Materialized View”

Example:

- Project:
  - /11 as /customer
  - /55 as /symbol
  - sum(/14 * /99)/sum(/14) AS /vwap
- GroupBy: /11, 55
- New Topic Name: VWAP

This:

- 11=c01;55=INTC;14=1000;99=34.50;
- 11=c01;55=INTC;14=5000;99=34.75;
- 11=c01;55=INFA;14=100;99=18.75;

Becomes:

- customer=c01;symbol=INTC;vwap=34.70833;
- customer=c01;symbol=INFA;vwap=18.75;

Factors in Performance

Network

Memory

CPU

Storage

GbE
RDMA

NUMA

FLASH

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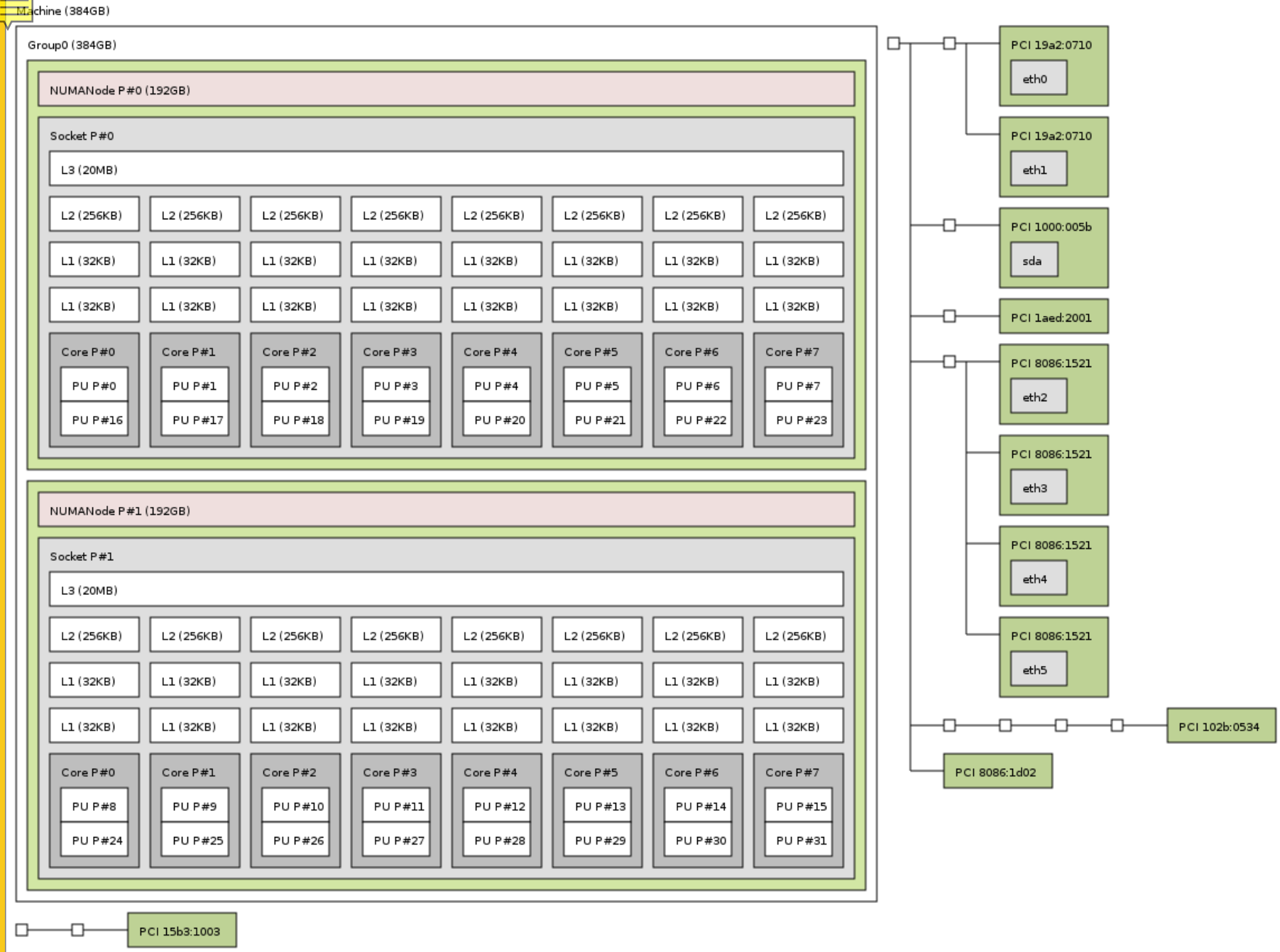
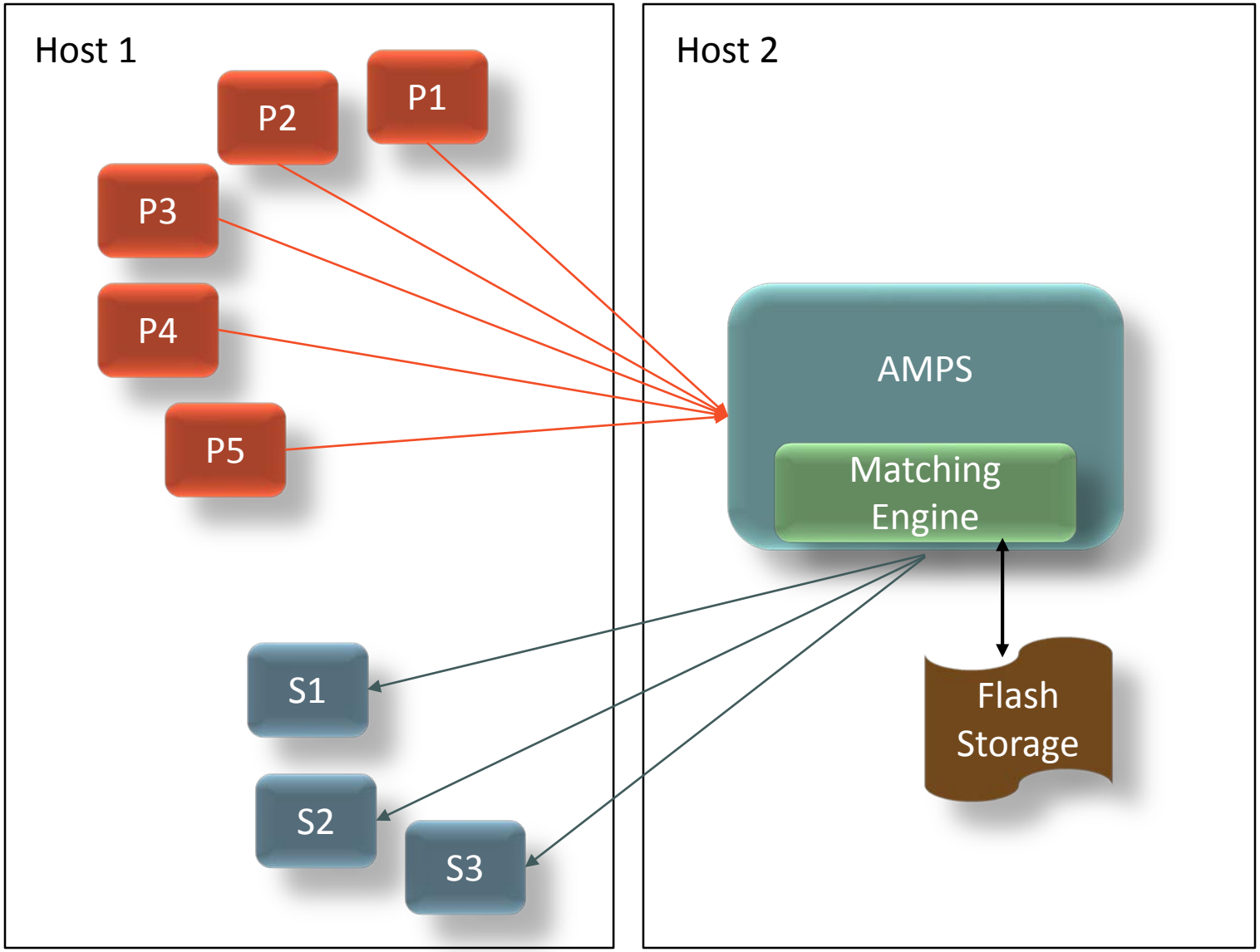
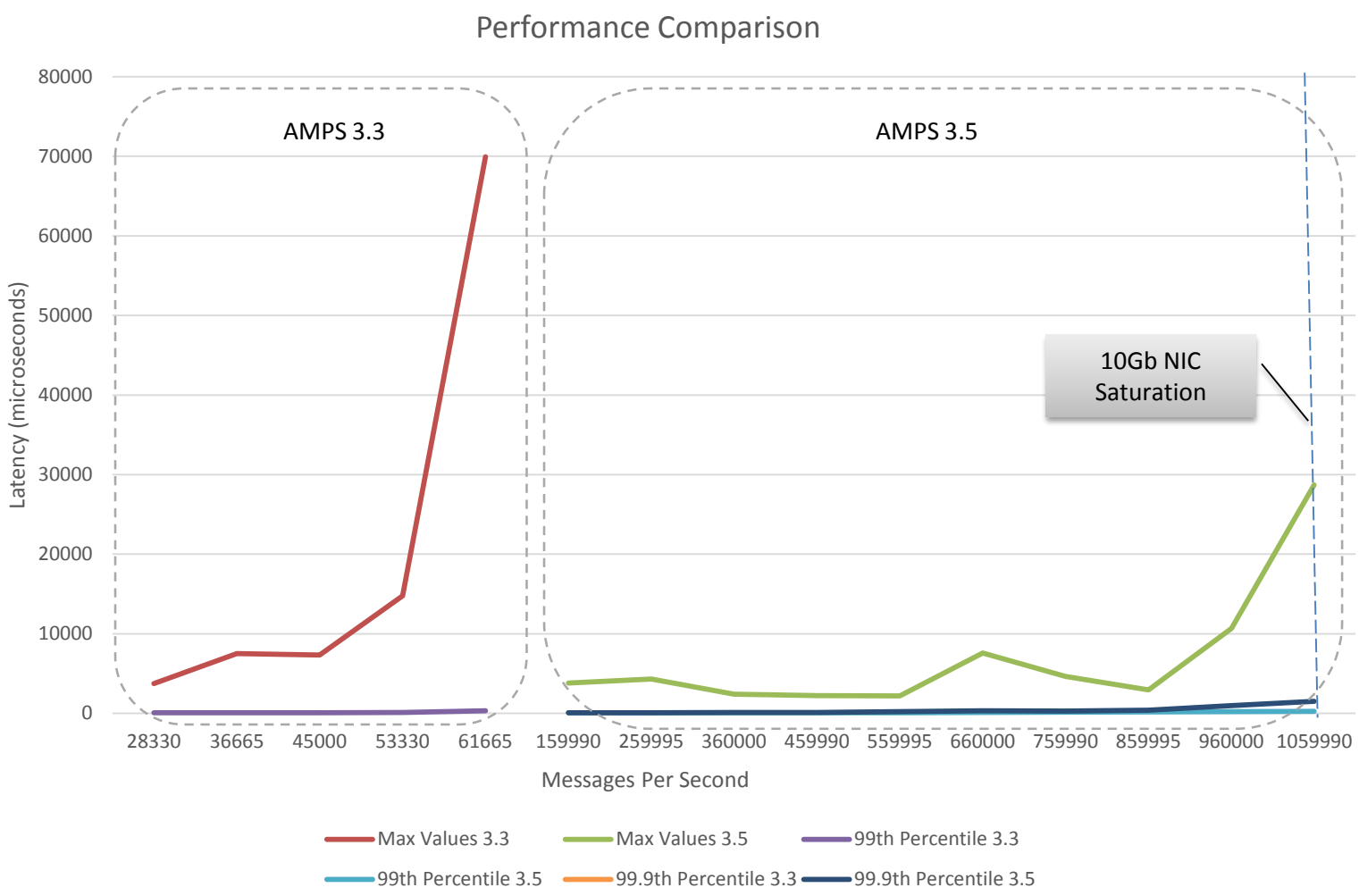
NUMA Architecture (Sandy Bridge)




Host 1
P1
P2
P3
P4
P5
S1
S2
S3
Host 2
AMPS
Matching Engine
Flash Storage



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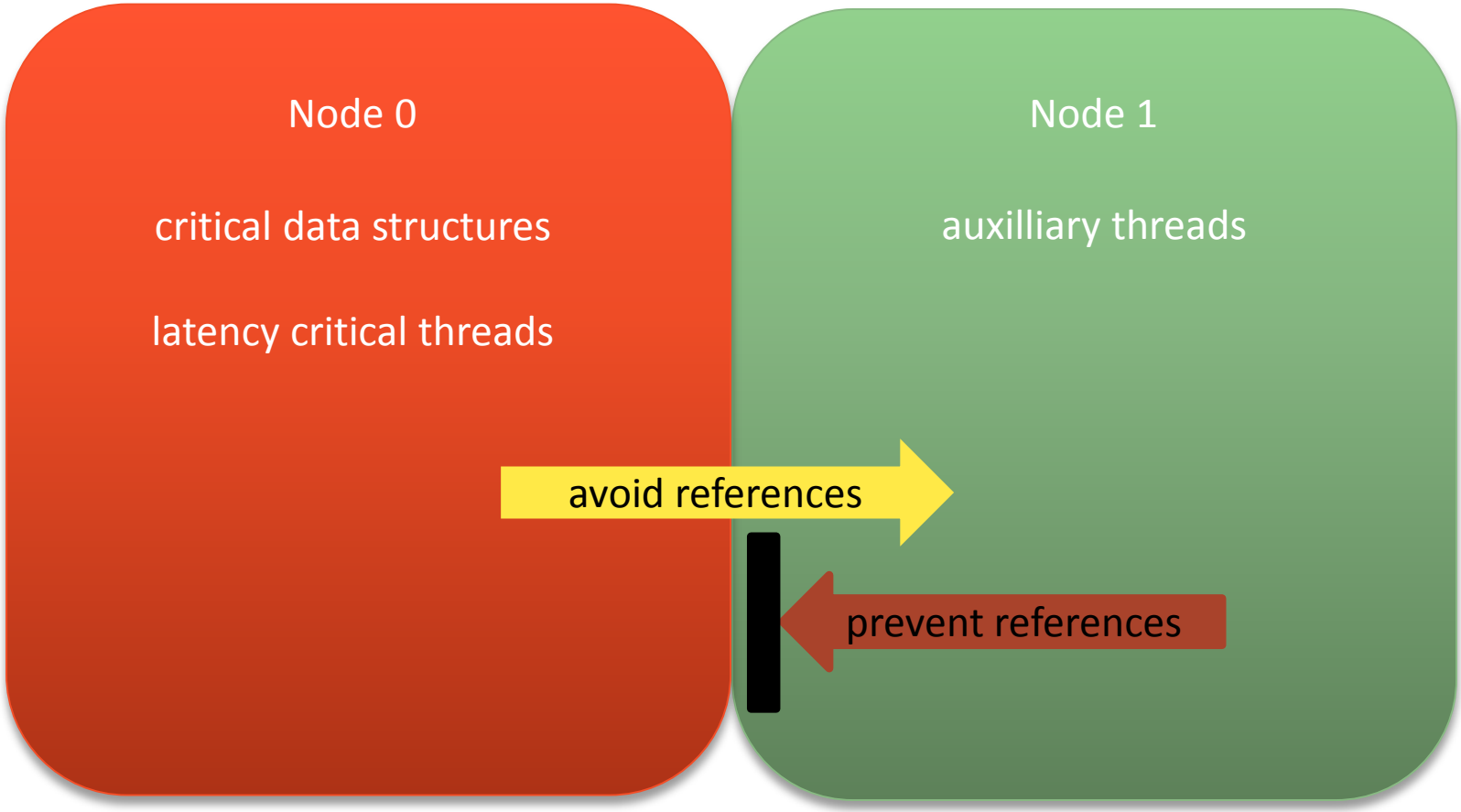

60EAST TOP SECRET ORIGINAL RECIPE SECRET SAUCE

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Manual instrumentation using pieces in libnuma ("man numa")

set affinity

set allocation to prefer:0

look up node for datastructures with move_pages()

We do this in AMPS for assertion level debugging and guarding against regressions

Verification of all memory references using pintool

(http://software.intel.com/en-us/articles/pin-a-dynamic-binary-instrumentation-tool)

We have a pintool to watch cross node memory reads/writes from threads

We're trying to find the best way to share our pintools at the moment

PMU tools (http://github.com/andikleen/pmu-tools)

have you ever run "sudo ./ocperf.py top"? Mind blowing.

the csv lists shipped with pmutools have full list of available counters

numatop (http://01.org/numatop)

Early glimpse of tools of the future

great tool, requires a patch, but may make it into Linux 3.9 kernel.

numatop sample

```
                    NumaTOP v1.0, (C) 2012 Intel Corporation

Monitoring 304 processes and 428 threads (interval: 5.0s)

   PID          PROC      RMA(K)      LMA(K)     RMA/LMA        CPI      *CPU%
  7111          mgen     33097.5         3.7      8835.4      89.61        3.1
  7113       numatop         0.2         0.5         0.3       1.53        0.0
  4510    irqbalance         1.5         1.2         1.3       1.17        0.0
  1289   kworker/9:1         0.0         0.0         0.8       1.22        0.0
     1          init         0.0         0.0         0.0       0.00        0.0
     2      kthreadd         0.0         0.0         0.0       0.00        0.0
     3   ksoftirqd/0         0.0         0.0         0.0       0.00        0.0
     4   kworker/0:0         0.0         0.0         0.0       0.00        0.0
     5   kworker/0:0         0.0         0.0         0.0       0.00        0.0
     7   kworker/u:0         0.0         0.0         0.0       0.00        0.0
     8   migration/0         0.0         0.0         0.0       0.00        0.0
     9        rcu_bh         0.0         0.0         0.0       0.00        0.0
    10     rcu_sched         0.0         0.0         0.0       0.00        0.0
    11   ksoftirqd/1         0.0         0.0         0.0       0.00        0.0

<- Hotkey for sorting: 1(RMA), 2(LMA), 3(RMA/LMA), 4(CPI), 5(CPU%) ->
CPU% = system CPU utilization

Q: Quit; H: Home; R: Refresh; I: IR Normalize; N: Node
```

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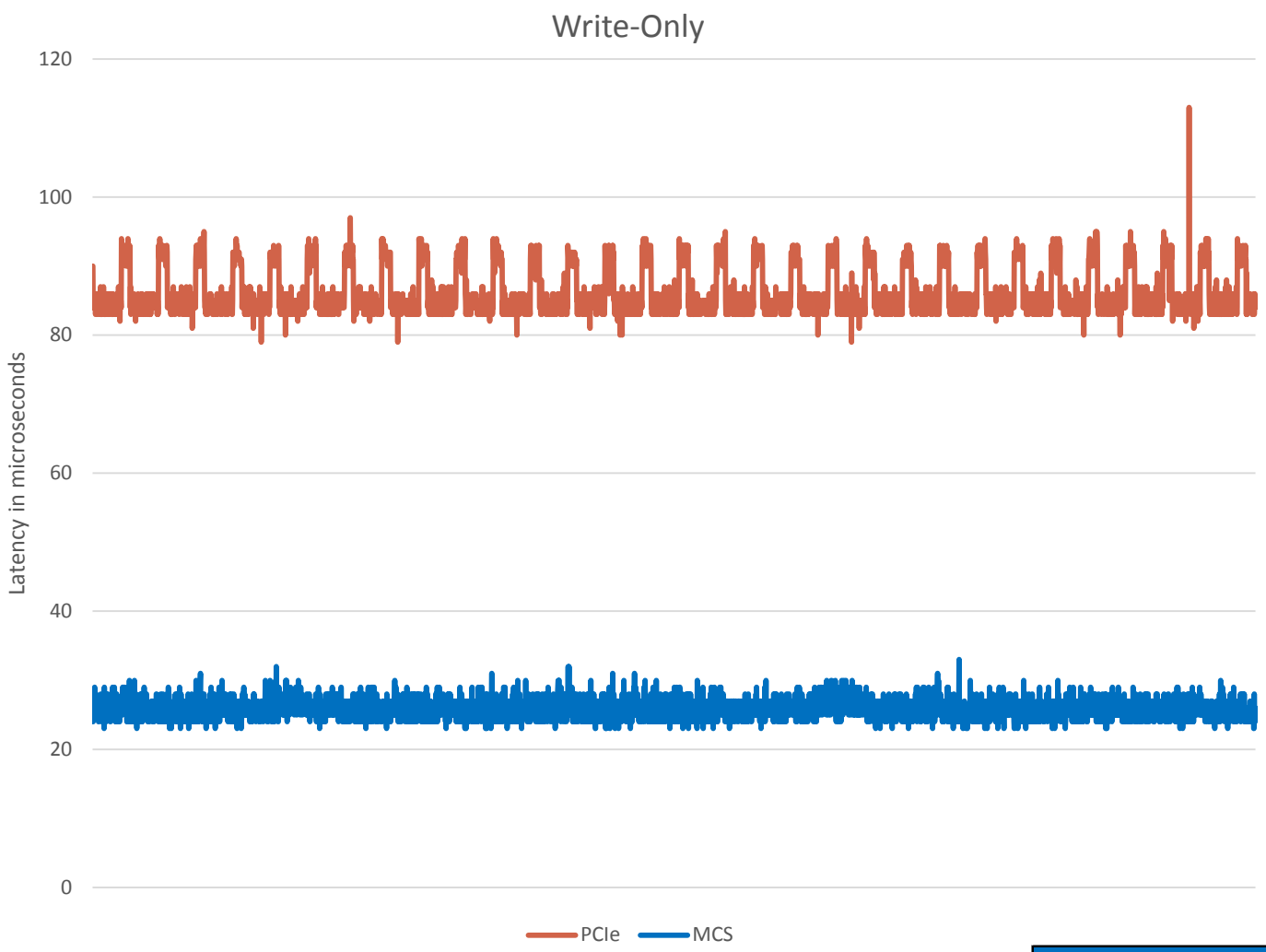
- Experiment
- Read and Learn
  - Dave Dice Blog
  - https://blogs.oracle.com/dave/entry/numa_aware_reader_writer_locks
- Portable Hardware Locality (hwloc)
  - lstopo – display system topology
  - numactl – control NUMA policy
  - numstat – observe cross-node memory requests
  - libnuma – control affinity of threads and memory
- Design with non-uniform access in mind
  - Locality of threads and memory is critical so design processing paths accordingly
  - Try to reduce inter-package communication especially wrt memory access pattterns

diablo technologies

Memory Channel Storage™ Architecture

- Flash storage in DIMM package
- Puts storage on memory bus
- Low latency
- Consistent performance



Average Latency		
	PCIe	86.09
	MCS	25.83
Maximum Latency		
	PCIe	113
	MCS	33

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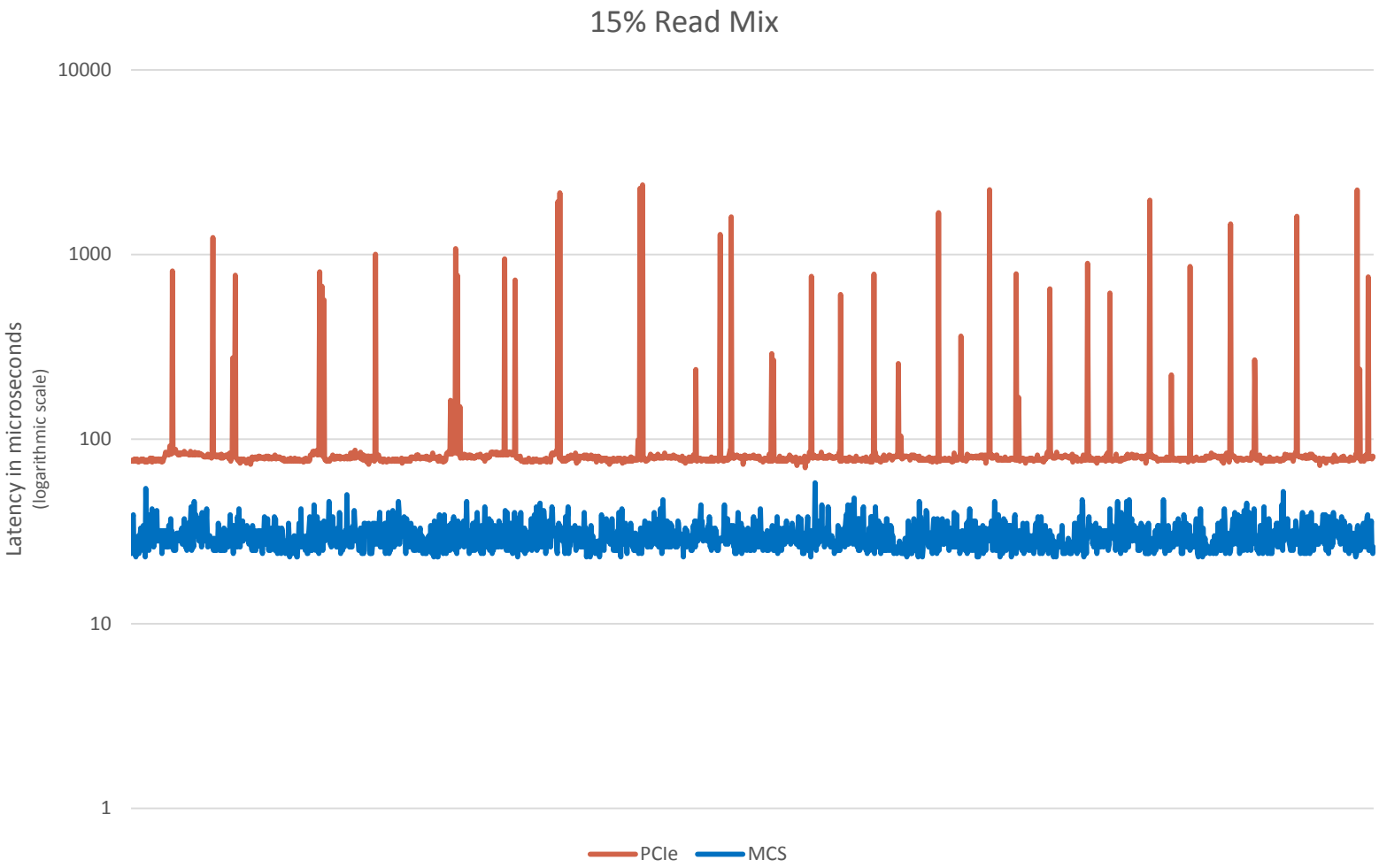

Average Latency		
	PCIe	98.27
	MCS	29.74
Maximum Latency		
	PCIe	2382
	MCS	58

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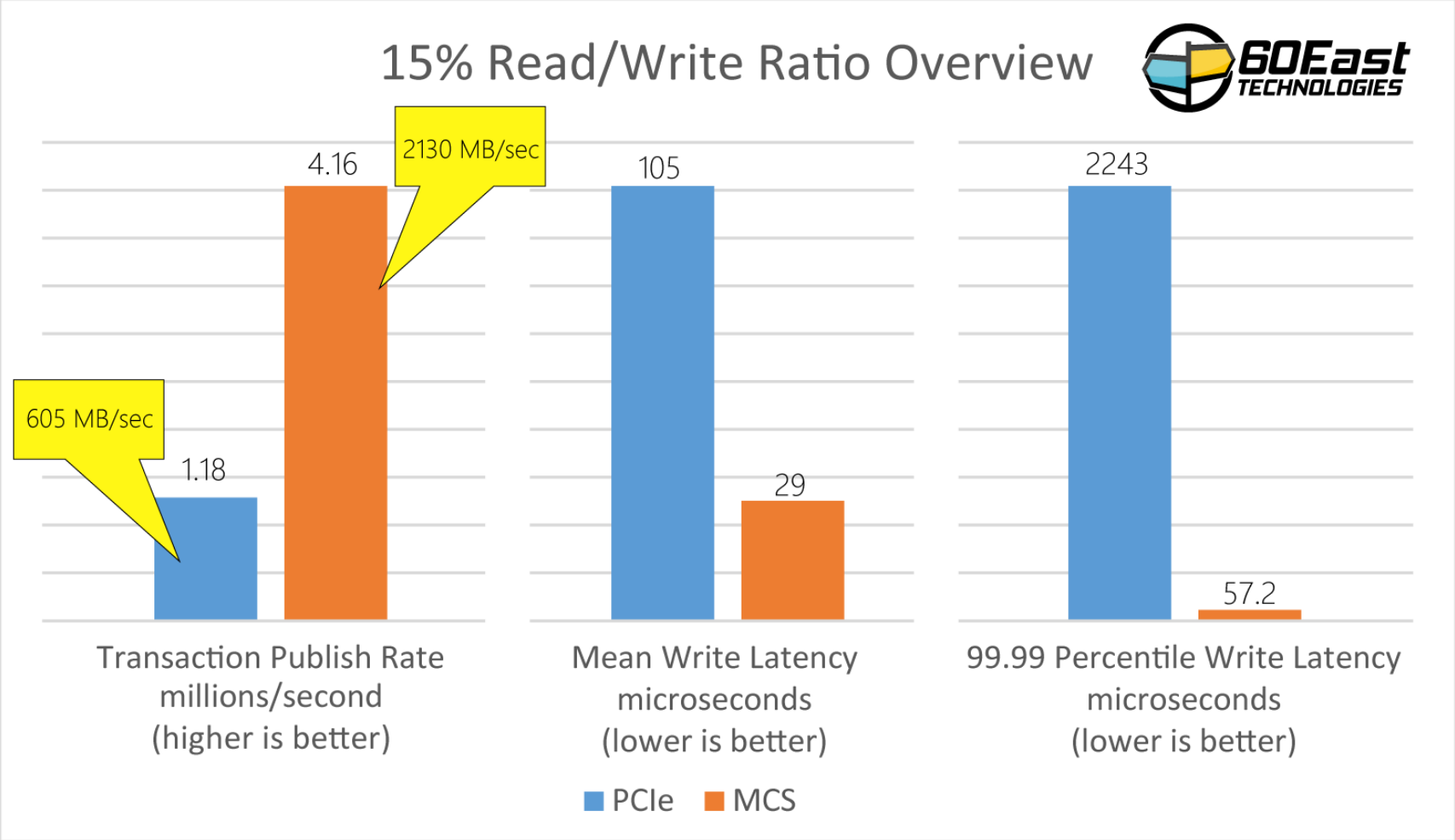
15% Read/Write Ratio Overview
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605 MB/sec
2130 MB/sec
1.18
4.16
105
29
2243
57.2
Transaction Publish Rate
millions/second
(higher is better)
Mean Write Latency
microseconds
(lower is better)
99.99 Percentile Write Latency
microseconds
(lower is better)
PCIe
MCS

For More Information

- Slides for this talk
- Slides and video links for previous talks
- Evaluation version of AMPS
- 60East blog

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