

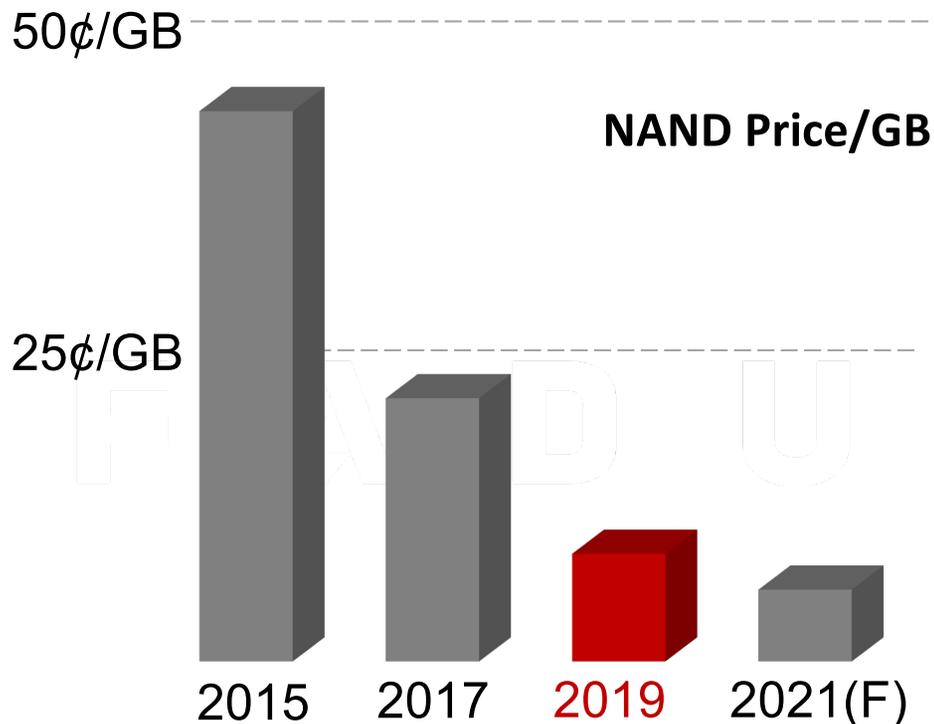
# THE FUTURE OF ENTERPRISE SSD

Jihyo Lee, FADU CEO and Co-Founder  
Flash Memory Summit 2019

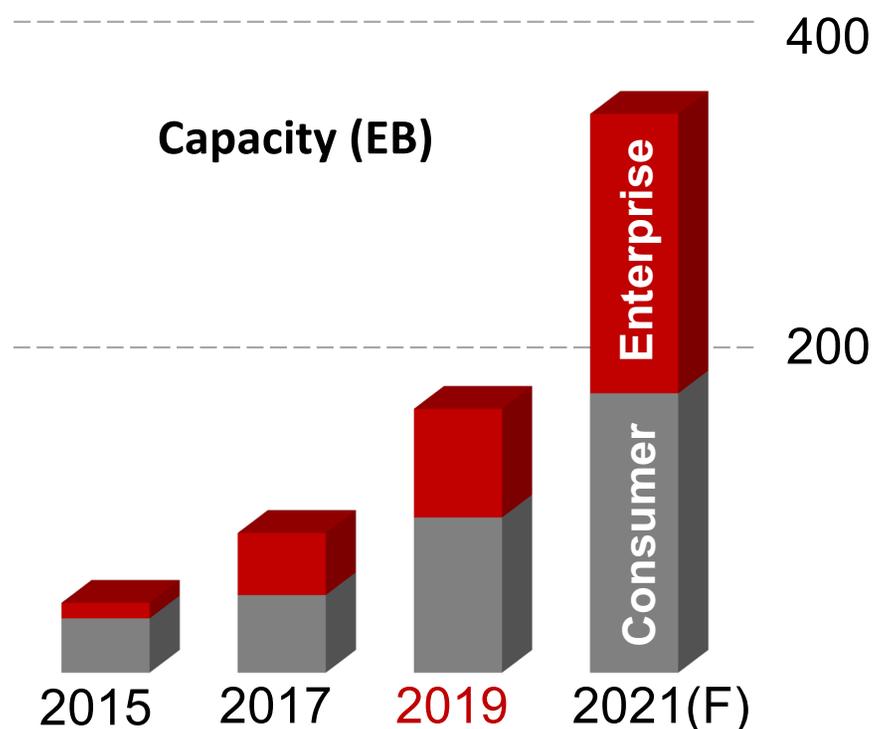


# THE CONSENSUS IS THAT SSD/ENTERPRISE IS EXPLODING

Price is not an Issue



SSD is Exploding

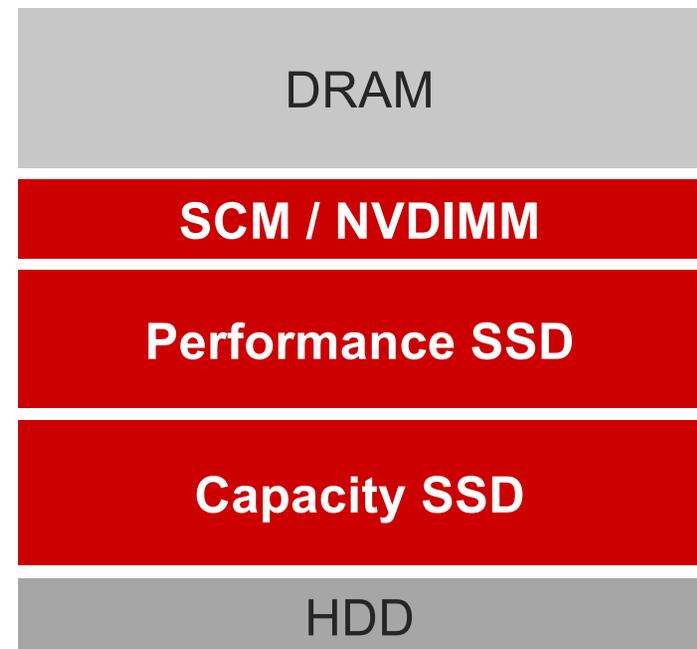


# THE ERA OF SSD (NAND) IS COMING

Past



Future



# MUCH MORE EFFICIENCY IS REQUIRED

Bandwidth

8GB/s

>10X

4GB/s

500MB/s

SATA

PCIe 3.0

PCIe 4.0

7GB/s

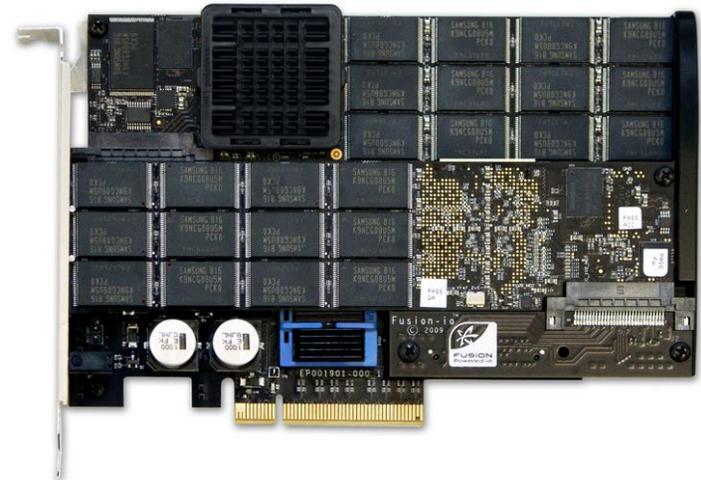
175mm

107mm

>6X

110mm

22mm



**F A D U**

# BUT, AS AN INDUSTRY, WE HAVE BEEN SLOW TO INNOVATE

	SATA SSD		Traditional Enterprise NVMe SSD
Throughput (read)	750MB/s	▶ 4x Better	~3GB/s
IOPS (read)	80K	▶ 7x Better	~600K
Active Power (read)	3W	▶ 7x Worse	~20W
Idle Power	1W	▶ 4x Worse	~4W
KIOPS / Watt	27K / W	Basically No Change	25K / W

# NOW IT'S TIME TO FACE REALITY



**F A D U**

# LEGACY ARCHITECTURES HAVE NOT DELIVERED ON THEIR SPECS

## 2TB NVMe SSD Spec

## M.2 in Reality

U.2 7mm

M.2 22110

Read

3.3 GB/s

3.0 GB/s

Write

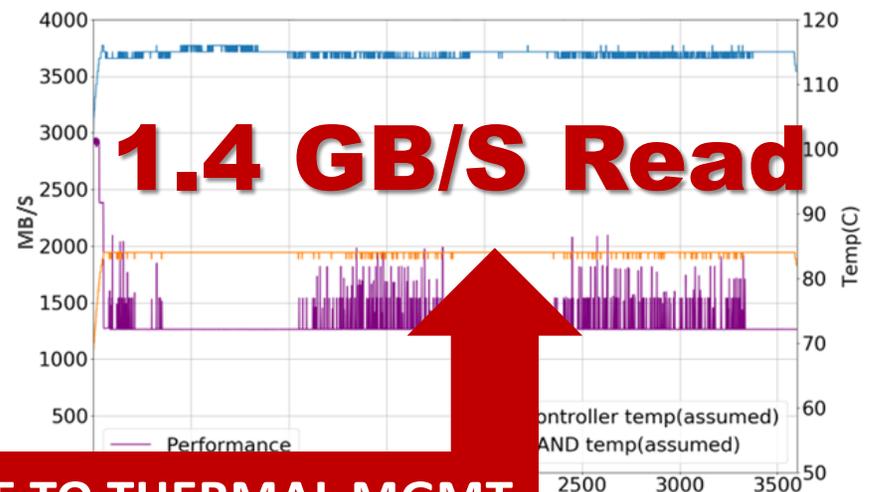
2.0 GB/s

1.4 GB/s

Active Power

12 W

8 W



**> 60% DEGRADATION DUE TO THERMAL MGMT.**



Are we certain that future  
SSDs can deliver?

# ALSO CUSTOMERS ARE ASKING FOR NEW FEATURES

Append Only Stream  
EDSFF  
3D Xpoint  
Zoned Name Space  
Multi-stream  
NVMe Over Fabric  
QLC  
Controller Memory Buffer  
SR-IOV  
I/O Determinism  
Open Channel  
Multiple Name Space  
Computational Storage  
U  
Persistent Memory Region

## BUT WHICH ARE REALLY BEING ADOPTED FOR MAINSTREAM?

# **CUSTOMERS ARE FRUSTRATED BY THE UNCERTAINTY**

Can I secure  
the  
performance?

Can I get the  
required feature?

Can I make my  
system  
competitive?

# SO THEY ARE TURNING TO SELF-BUILD MODEL



**It's been tiring to wait to get the proper SSD from supplier.**

**We found there is no way to get the SSD we look for other than self-build.**



**Consigning NAND is challenging, but is better way to secure price and cost competitive SSD.**



# **WE NEED TO EXECUTE THE BASIC THINGS RIGHT**

- 1 Fully utilize PCIe bandwidth**
- 2 Keep power budget  
and deliver the real performance**
- 3 And deliver real innovation for customers**

1

# WE UTILIZE THE FULL PCIe 3.0 BANDWIDTH EVEN IN M.2

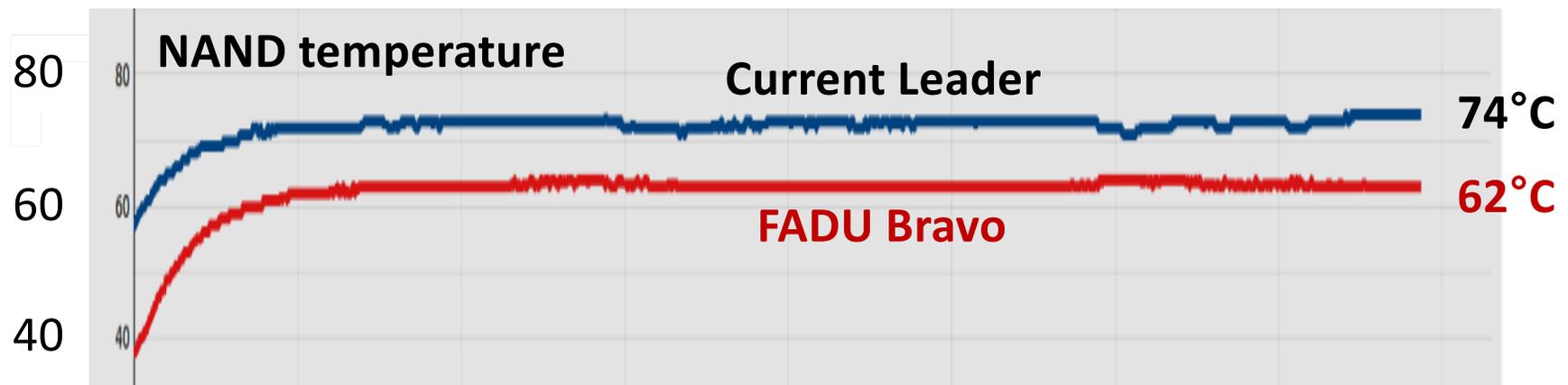
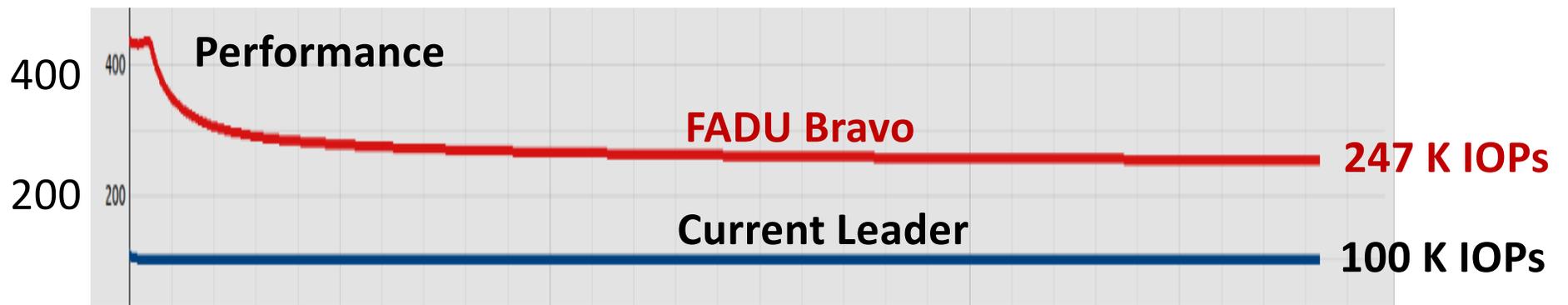
	<b>FADU Bravo</b>	<b>Current Leader</b>	<b>Current Follower</b>
Sequential Read (GB/s)	<b>3,500</b>	3,000	1,900
Sequential Write (GB/s)	<b>2,850</b>	1,400	1,430
Random Read (KIOPS)	<b>820</b>	480	295
Random Write (KIOPS)	<b>100</b>	47	36
Active R/W Power (W)	<b>5 / 8</b>	7 / 8	8.25
KIOPS/W (Read)	<b>164</b>	68	<40

**FADU**

# 2

## EVEN AT BEST PERFORMANCE, WE ELIMINATE HEAT ISSUE

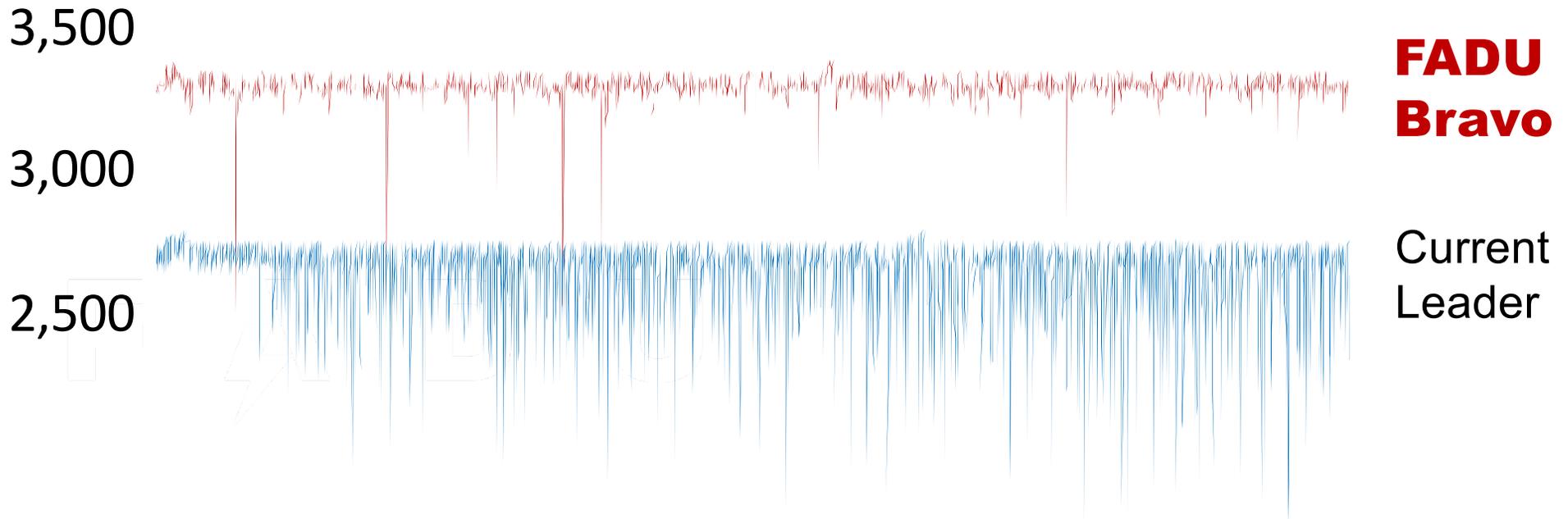
Read : Write = 7:3 (4KB, TC1, QD64)



2

# WE GUARANTEE MAXIMUM PERFORMANCE

Seq. Read @ Real Data Center Environment



# 2

## FADU EVEREST: PCIe 4.0 WITHOUT POWER ISSUE

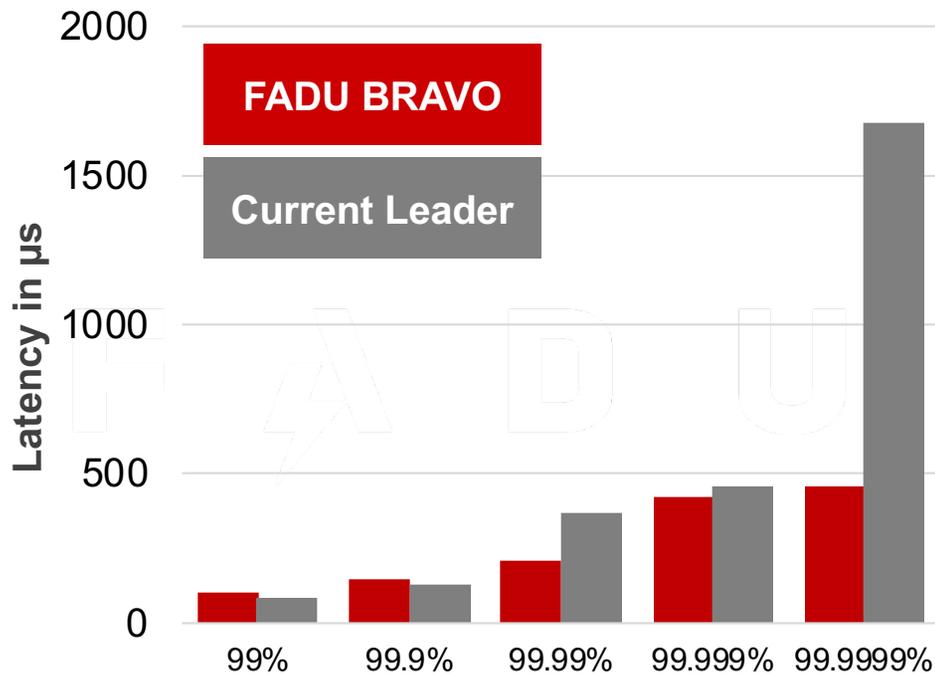
	M.2 / E1.S	U.2 / E1.L
Power	7.5 W	13 W
Sequential Read	7 GB/s	7 GB/s
Sequential Write	3 GB/s	6.5 GB/s
Random Read	1,650 KIOPS	1,650 KIOPS
Random Write	170 KIOPS (7% OP)	540 KIOPS (28% OP)
KIOPS (Read)	212 KIOPS/W	201 KIOPS/W

# 2

# WE KNOW LATENCY AND QOS IS CRITICAL

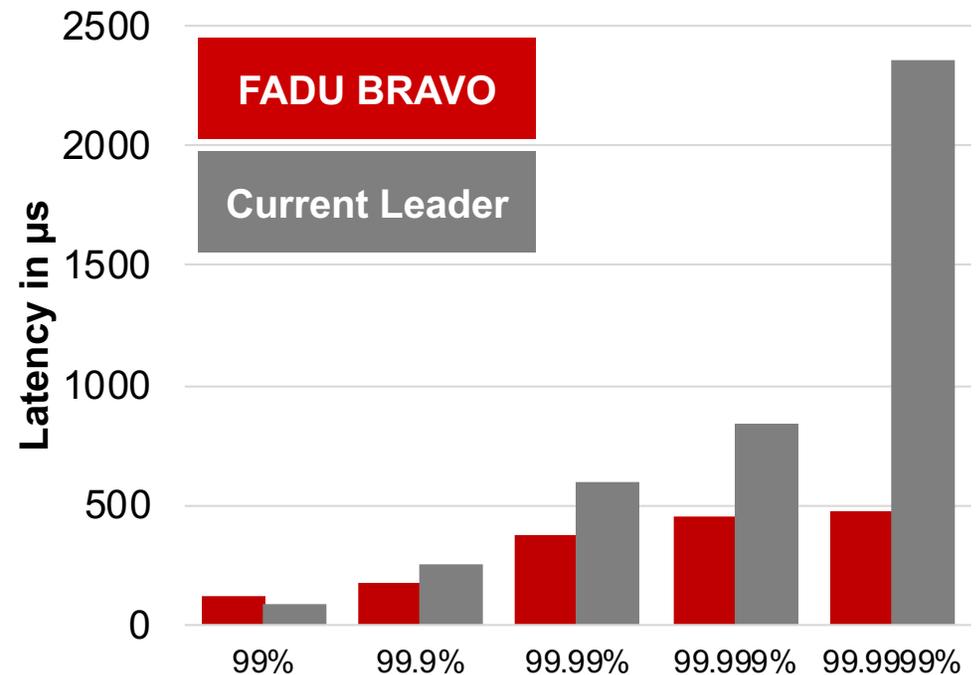
## QOS 4K Read Latency

Synthetic Workload, 5% Seq. Write Injection



## QOS 8K Read Latency

Synthetic Workload, 10% Seq. Write Injection



**3**

# INTRODUCING THE FADU BRAVO XL SSD



Live demo in our booth

Sequential Read	3,500 MB/s
Sequential Write	2,870 MB/s
Random Read	830 KIOPS
Random Write	370 KIOPS
Active power (R/W)	5W / 6.3W
QD1 Avg. Latency	19 $\mu$ s
QD1 QOS (99.9%)	30 $\mu$ s

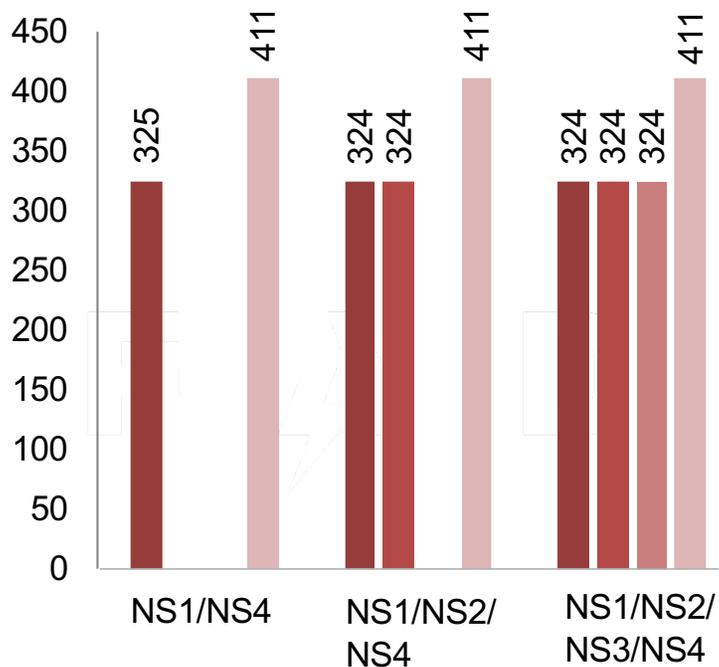
**FADU**

# 3

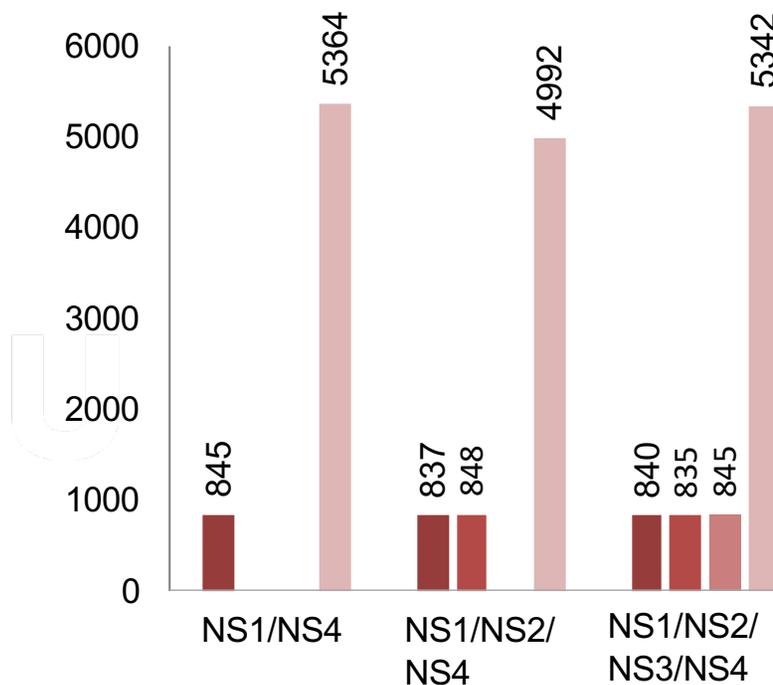
# WE DELIVER WHATEVER OUR CUSTOMERS REQUEST

**IOD actual result (Read in NS 1~3, Write in NS4)**

Throughput (MiB/s)



99.9999% Latency (μs)



**Supporting Features in FADU Bravo**

- SR-IOV**
- Multistream**
- CMB**
- PMR**
- Dual-Port**
- Multiple Namespace**
- IOD**
- Open Channel**

3

# WE'RE ALSO INNOVATING THE WAY AN SSD IS MADE

You Choose/Supply your NAND

We Deliver What You Need

TOSHIBA

Micron®  
NAND U

SK hynix

SOC

Firmware

Hardware Design

Testing / Validation

End SSD Product

Controller + Firmware

Full Turnkey Solution

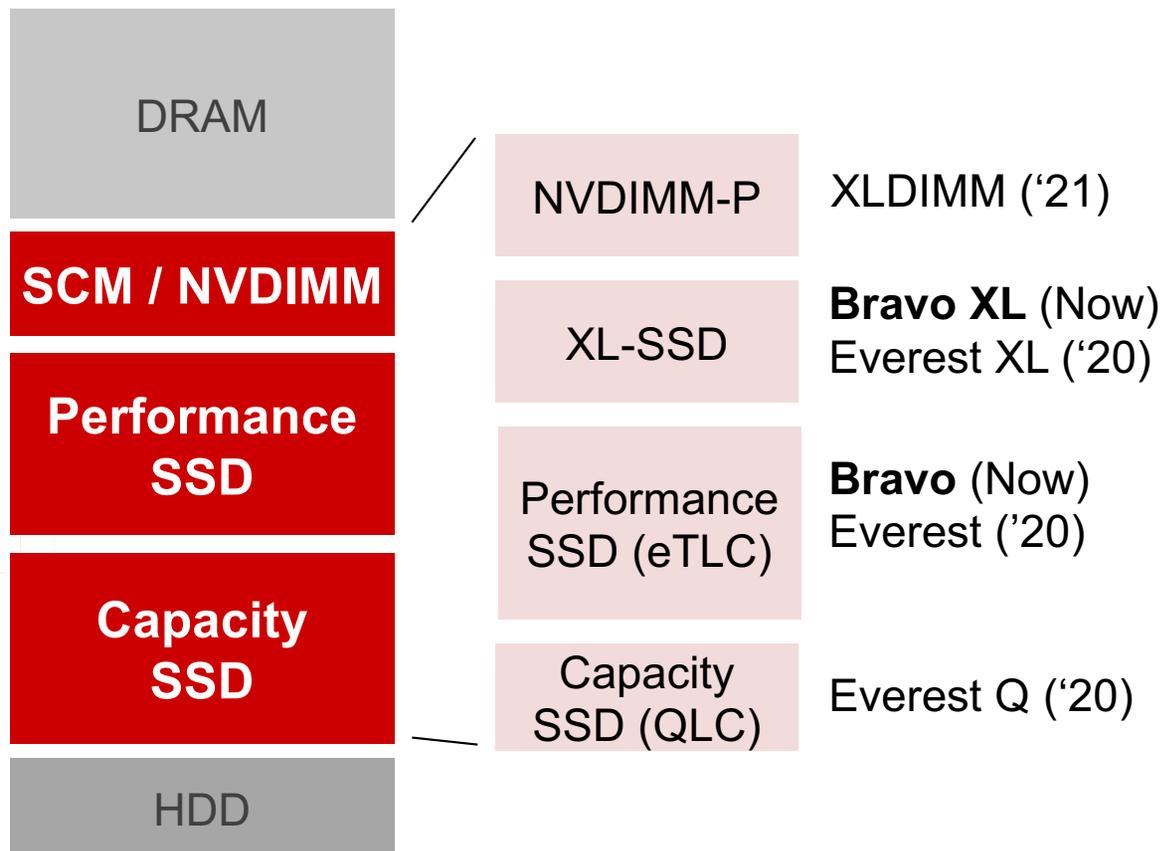
Fully Consigned SSD

# THE SSD INDUSTRY NEEDS TO MOVE IN THE RIGHT DIRECTION

**1 Fully utilize bandwidth**

**2 Keep power budget**

**3 Deliver real innovation**





**THE SSD EXPERT**

For more information visit our booth #940 and [www.fadu.io](http://www.fadu.io)