An Introduction

(for Military Storage Application)

Redefining Flash Storage

August 2014

The Opportunity

- One of very few independent SSD controller chip companies
- 6+ years of R&D and $30M invested to create next generation Solid State Drive (SSD) technologies
  - 237 patents in 56 patent Families
- HQ in Seoul Korea with development offices in California and Ottawa, Canada
- Already completed development of its 2nd generation product development
  - 2Tb HLNAND Flash E/S now available, mass production in Q4
  - 2nd Gen SSD Controller E/S in Q4, 14
  - 4TB/8TB HLSSD ready to ship Q1,15
- Targeting Super High Density SSDs (4TB+) in the enterprise and PCIe/SATA3 SSD controller in the consumer

Proven by various customers and difference applications

Industrial

Fast booting
Supercap mode
Firmware customization
(SSD Health Indicator)
SLC mode
Small form factor

Consumer/PC

Performance optimization
B-grade NAND Support
Power saving mode
Benchmark Score
WHCK

NVS-based SSD produced by over than 20 SSD vendors

Military

Write Protection
AES Encryption / Fusing
Military Secure Erase
Adaptive Thermal Protection
Temp monitoring

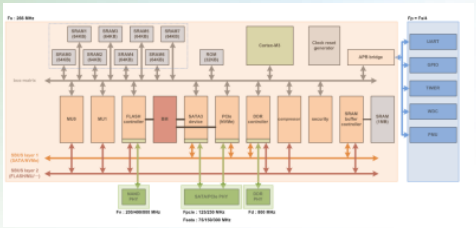
Enterprise

Sustained performance
Constant Low Latency
Higher ECC for eMLC
End to end data protection

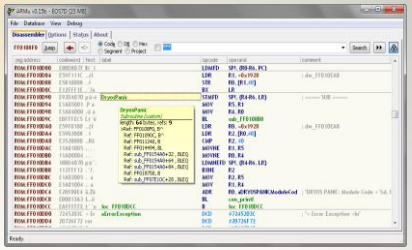
Automotive

Sudden Power Off Protection
Data Retention Issue
Wide temperature
Update tool

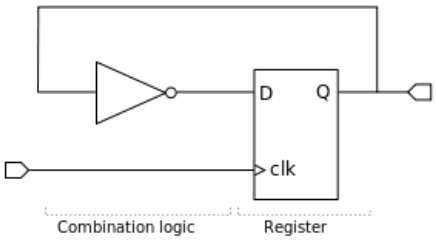
In-house Complete Development Process



Building Architecture



Firmware Development

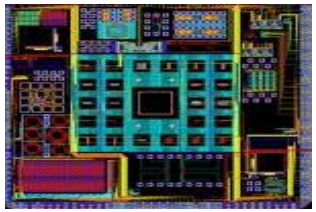


RTL Coding

Maximum Performance
Power Consumption
Power Saving Mode
Product Cost
Flexibility
.....
and more

PCB Board design

FPGA verification



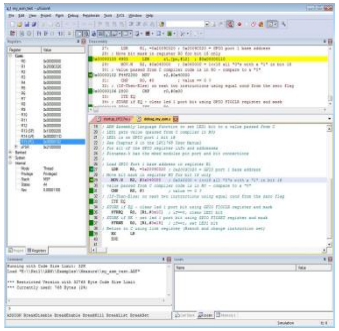
Front-end/Back-end
Chip layout Design

End to End Solution for Flash Storage

SSD Controller

NVS3600
NVS3615
Wafer business

Firmware

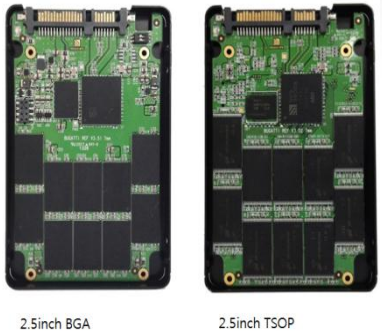


Standard Firmware
Performance optimization
VSC ATA command
JTAG debugging
Advanced functions
(SE, WP, Encryption, Flush)

Tools for Management and Testing

NC SMART Tool (extended)
Bugatti Tool (debug mode)
NC MP Tool (for production)
NC SE Tool (for military)

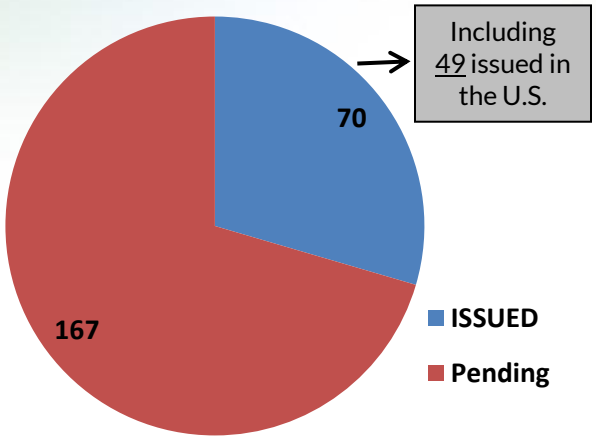
Turnkey Reference Design



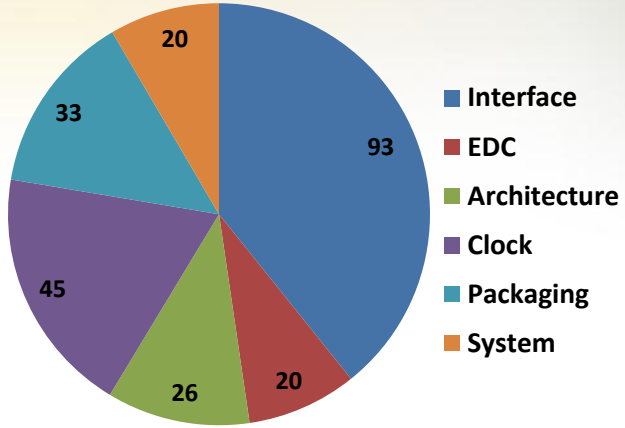
Schematic
Gerber
BOM
Review board design

237 Patents in 56 Patent Families

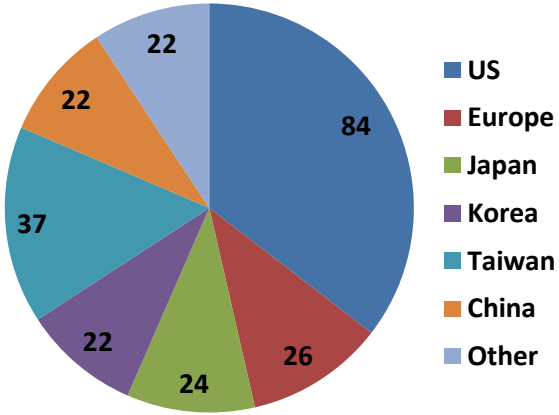
Issued & Pending



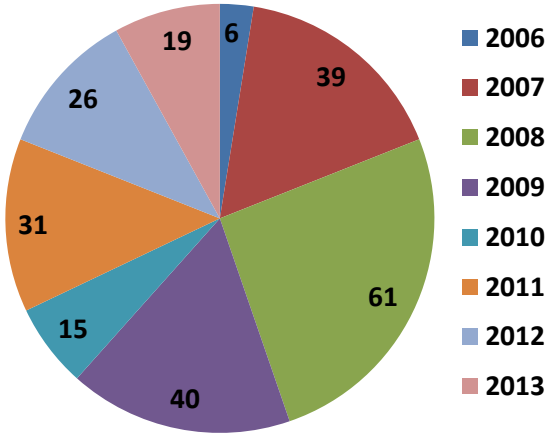
Technologies



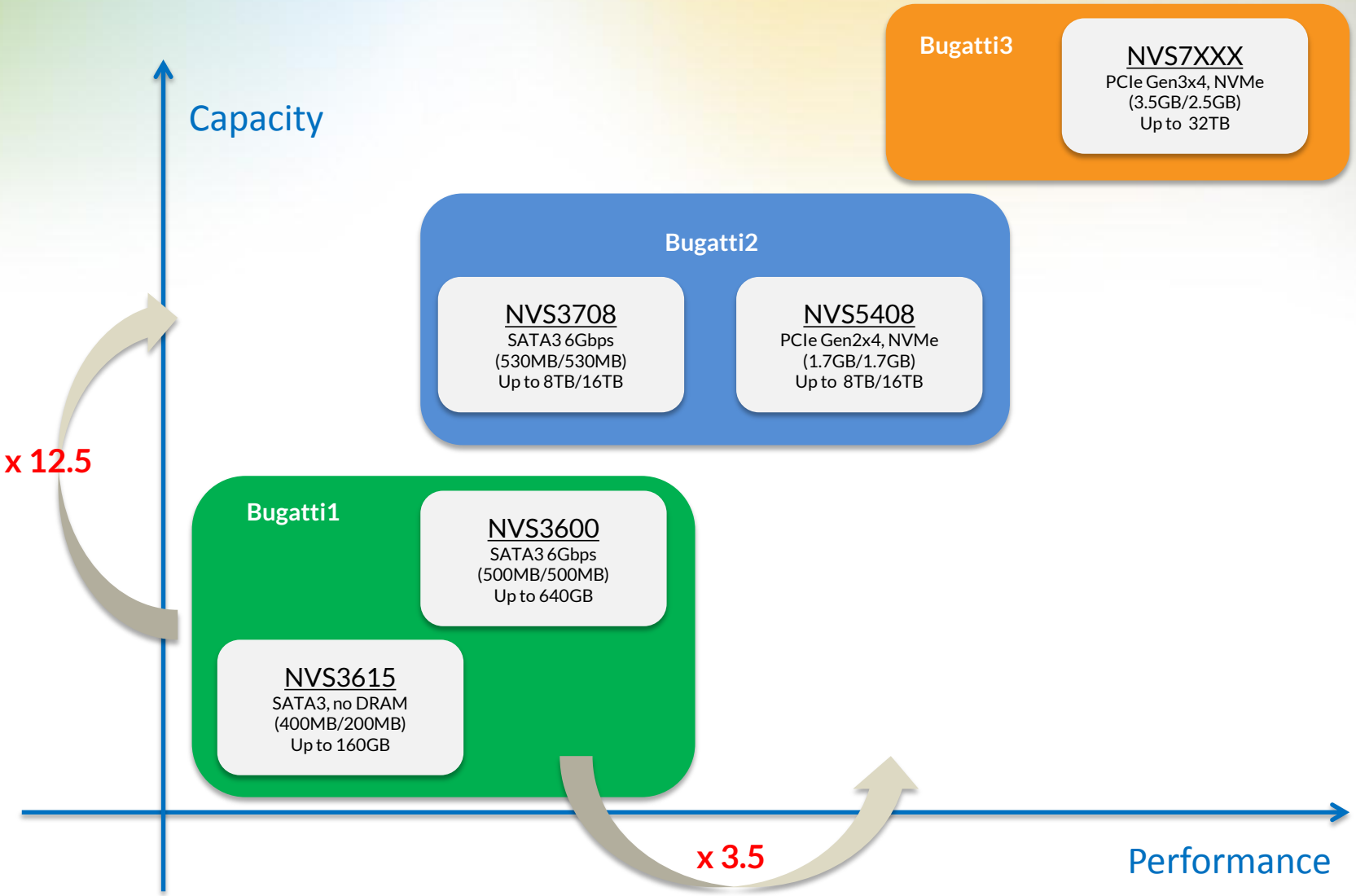
Geography



Filing Date



SSD Controller roadmap



HLSSD Product Offering

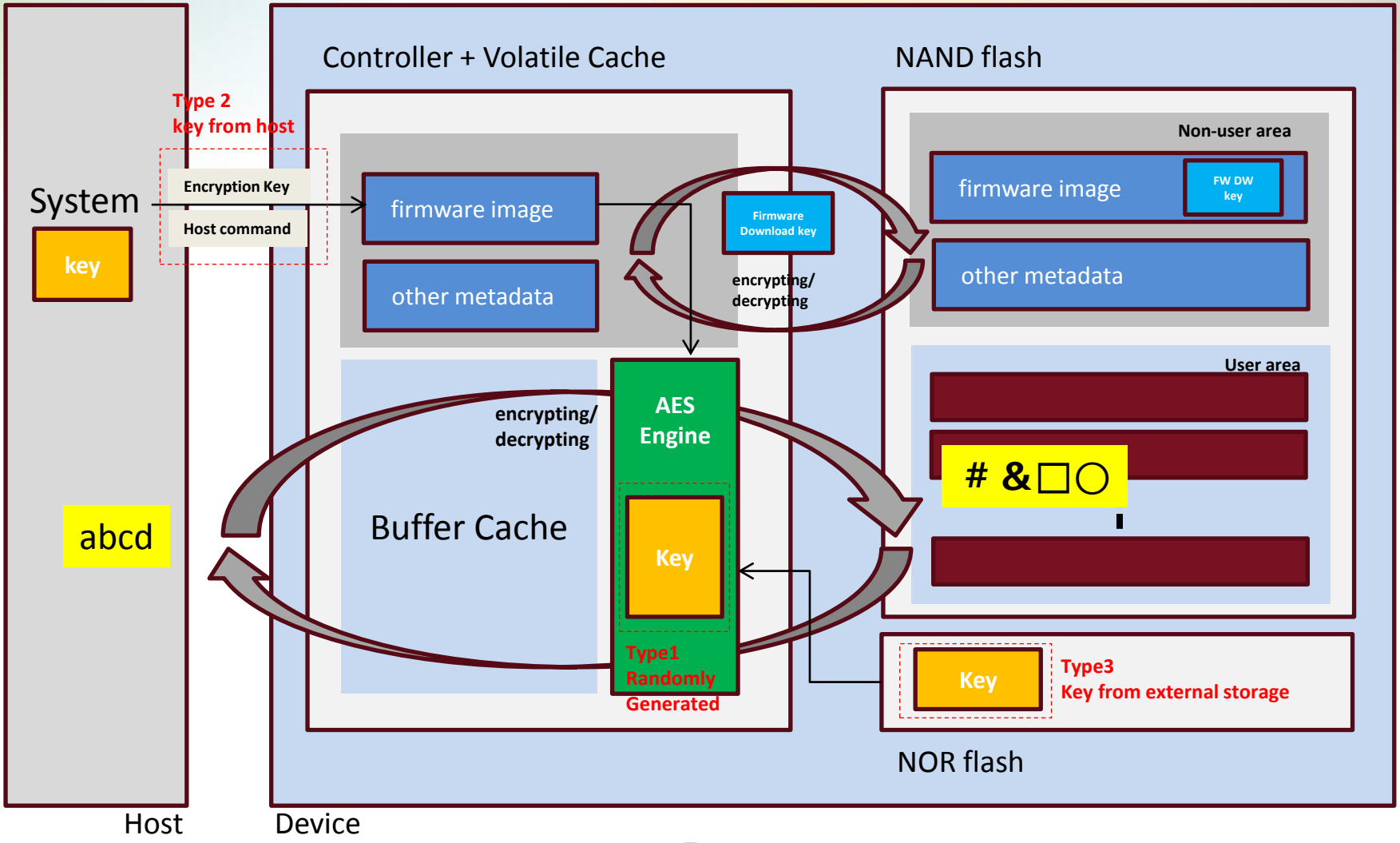
EXPRESS SERIES

- Interface: Native PCIe (NVMe), Gen2 x4
- Form Factor: 2.5”, 7mm/15mm Height - SFF-8639 Connector
- Capacity: 2TB/4TB (Single PCB) & 8TB (Dual PCB)
- Up to 1.8GB/s RW
- Up to 368K IOPS, 4K Random R/W

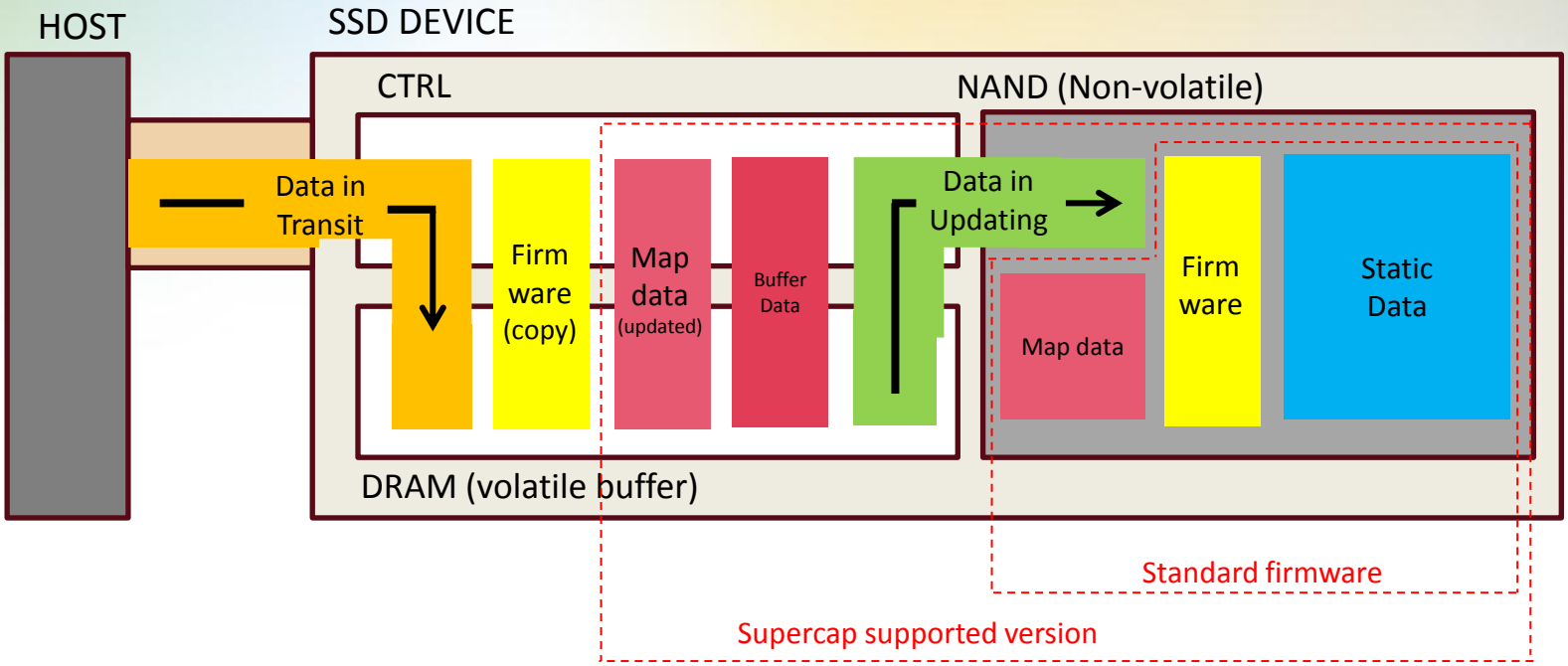
SCALAR SERIES

- Interface: SATA3
- Form Factor: 2.5”, 7mm/15mm Height
- Capacity: 2TB/4TB (Single PCB) & 8TB (Dual PCB)
- Up to 560MB/s RW
- Up to 100K IOPS, 4K Random R/W

Customized AES Encryption and key management model



Field-proven sudden power off recovery



Priority	Data Range	Standard firmware version	Supercap-supported version
Top	Firmware, Static Data, Map data	Secured	Secured
1st	Data in updating, Buffer Data, Map data (updated)	Loss	Secured
2nd	Data in Transit	Loss	Loss

Military Secure Erase Protocol

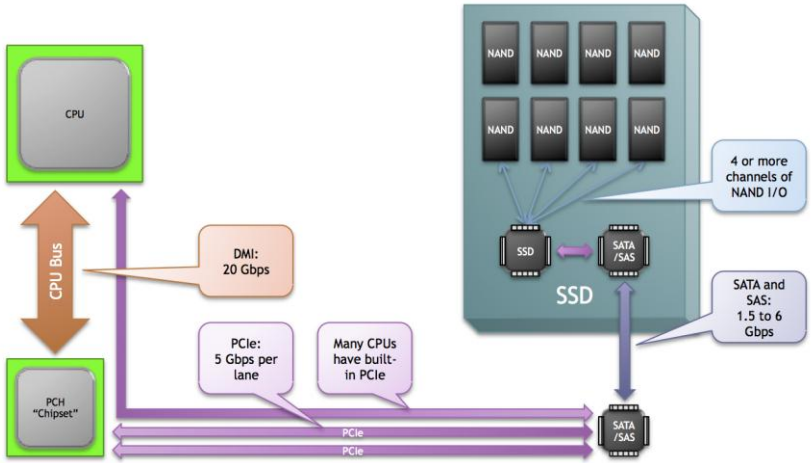
- Supports military secure erase via both software and hardware method.
  Software (Vendor-specific ATA command)
  Hardware (External GPIO switch)

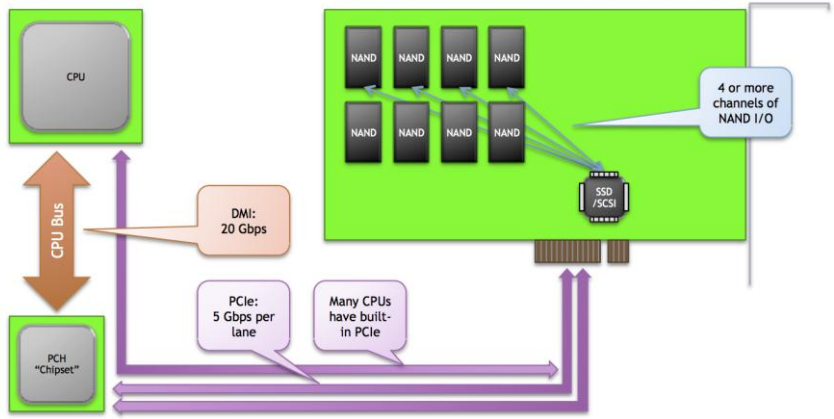
- Supports specified military secure erase protocol as below.
  Military Fast Erase (Erase and wring “FF” to all NAND flash)
  DoD 5220 22-M NISPOM
  DoD 5220 22-M NISPOM, Sup 1
  RCC-TG IRIG 106-07
  NSA/CSS 130-2
  NISPOMSUP Chap 8, Sect. 8-501
  Army AR 380-19
  Navy NAVSO P-5239-26
  Air Force AFSSI 5020
  NSA/CSS 9-12
  Gutmann method

- True verification tool after secure erase via directly accessing NAND flash.

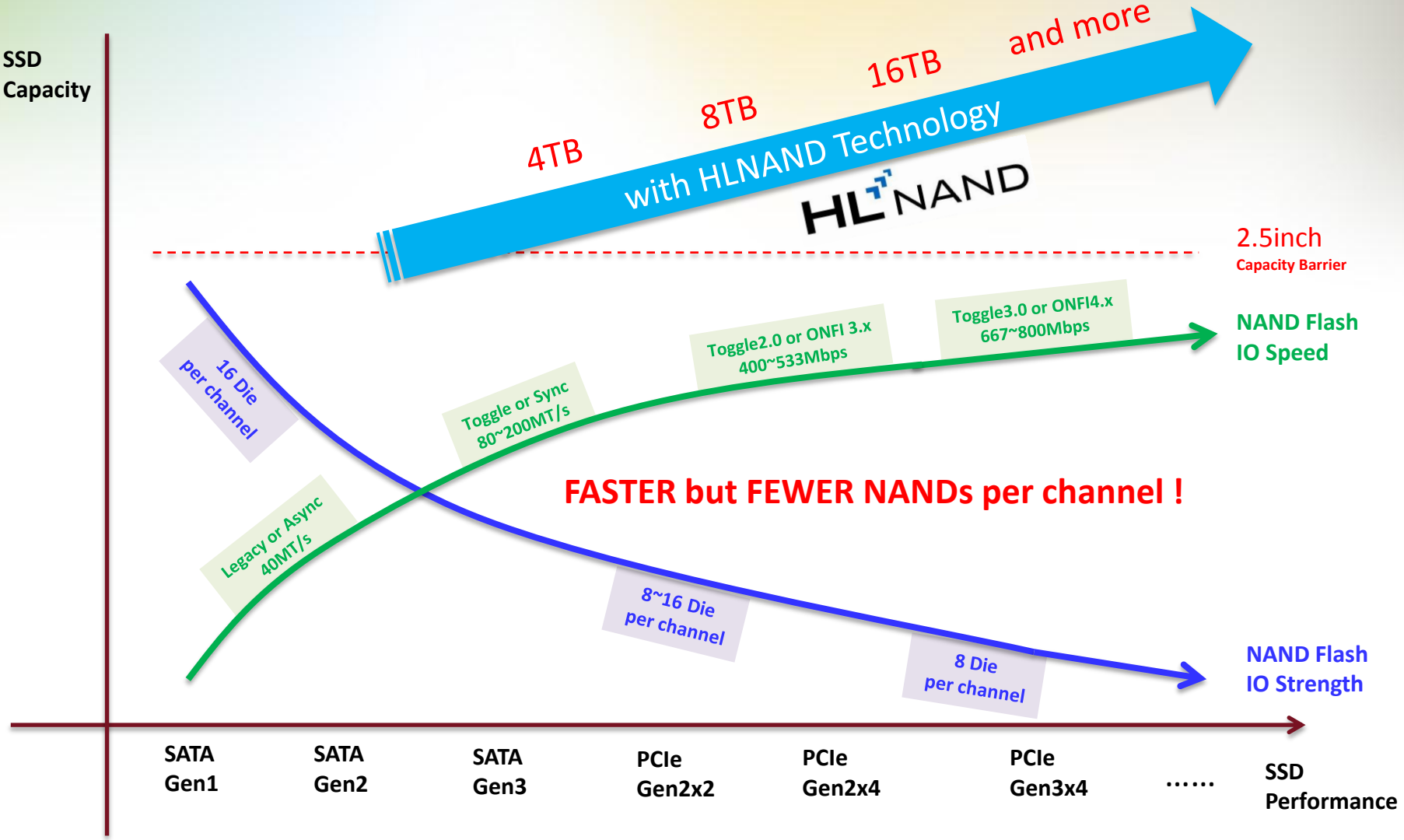
PCIe with NVMe vs. SATA with AHCI

SATA SSD with ATA Command sets		PCIe SSD with NVMe Command sets
Bandwidth Bottleneck at SATA	Sequential x 3~4	Bandwidth up to 2GB/s as full duplex
Inefficient single queue for 512B/4KB data	Random 4K x 4~8	127 Sub queue and 64K commands per queue
HBA latency overhead (20usec at best)	Latency 1/5	HBA overhead (3~4usec)





HLNAND Breaks SSD Capacity Barrier



Opportunity 1 : Cold Flash *

up to 80% of the data growth can be in cold storage — *storiant.com*

57% US electricity will be consumed by data centers by 2037. — ABB Data Center Infographic 2014

10% Data center footprint is increasing YoY — ABB Data Center Infographic 2014

Enterprise-grade
1.2TB 10K HDD

Cost-optimized
8TB SATA SSD
(based on 16nm-NAND)

SEAGATE ST1200MM0017	
Capacity	1.2T
Idle power	4.8W (4W/TB)
Latency	3,000 usec
Throughput	120MB/s

Size 1/6

Power 1/80

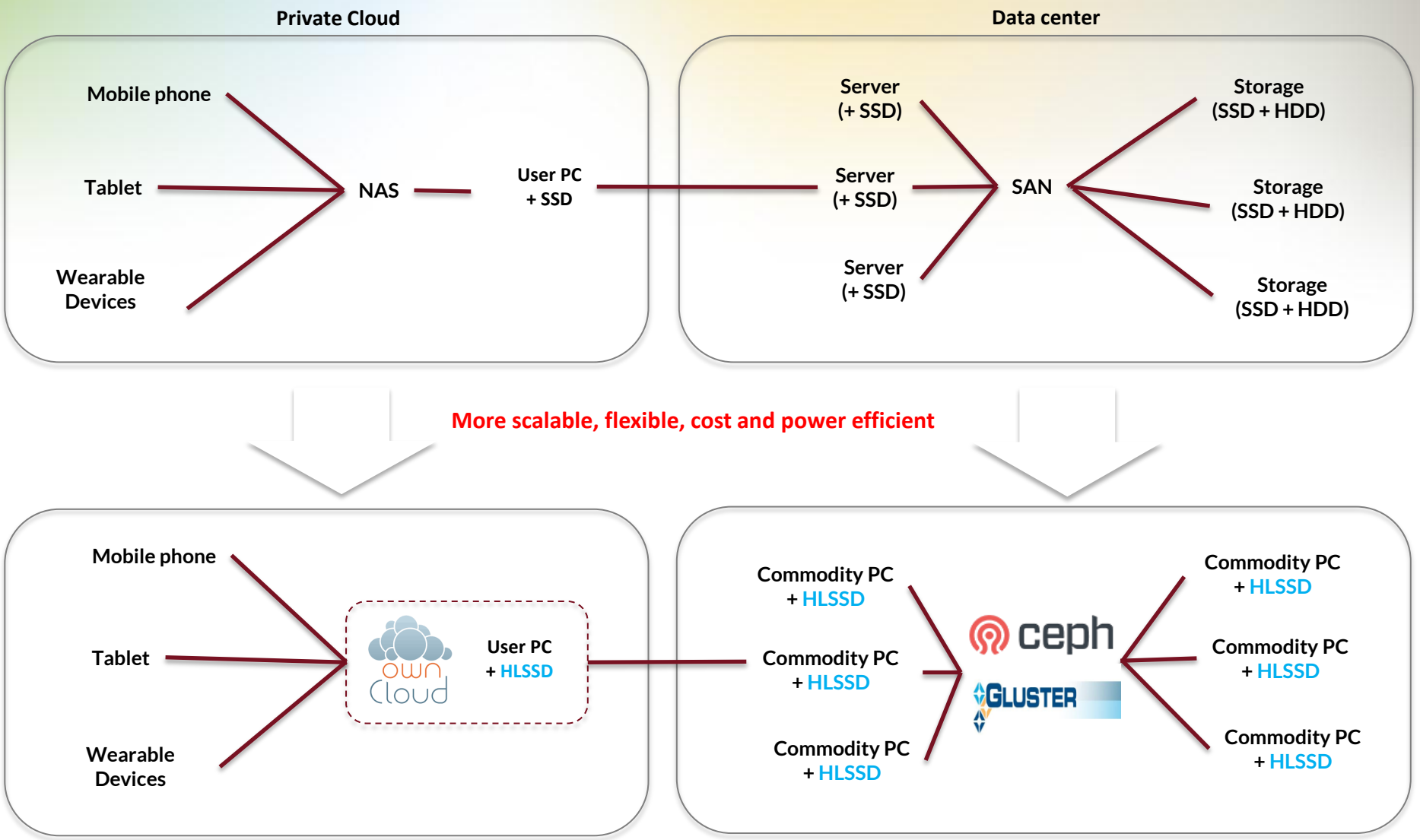
Latency 1/100

Throughput x4

SCALAR 8T	
8TB	Lower Footprint cost
0.4W (0.05W/TB)	Lower power/cooling cost
30usec	Better user experience
500MB/s	Better IOPS/$

* Using flash at cold data storage

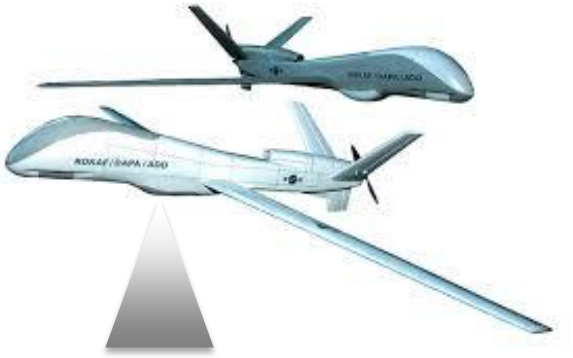
Opportunity 2 : Open source SW + HLSSD



Opportunity 3 : Mission-critical application

Various applications where requires super capacity, super performance, and super density.

High quality image



856MB, single image of 1800DPI photo

4K Video recording

72GB, one minutes of lossless 4K 60fps

3D Modeling and rendering

3,000TB NAS for rendering 3D movie Avatar

and more..