Effective use of QLC flash in Hyperscale Datacenters

Prodigy Universal Processor

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10 Yeas of World-Class Innovation

10x Flash Life
$20 → $3 / GB
SLC → MLC

100x Flash Life
$20 → $3 → $1 / GB
eMLC → MLC → TLC
Compression + Dedup.

300x Flash Life
25ȼ → 9ȼ → 1ȼ / GB
TLC → QLC
Compression + Dedup.
Hyperscale-Out
Flash is cheaper than 10TB HDD for hyperscale

- Disk 11¢/GB: 3 copies 10TB $320 = 9.6¢/GB + 1.4¢/GB system
- Flash 9¢/GB: 32GB USB $2.5 = 7.8¢/GB + 1.2¢/GB system

1¢/GB effective achievable for flash

- 5:1 compress+dedup., 2:1 thin provisioning + snapshots + clones

3 copies vs. RAID6 used to avoid 4x slowdown

- RAID6 3 reads + 3 writes reduces 2x performance at 4:1 R/W
- If drive is failed then additional 2x slow down during rebuild
Solution for Flash-Only Datacenter

8 x 64-256GB RDIMM

2 x 400G Ethernet

4 DDR5 200GB/s
500GB/s HBM

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500GB/s HBM

32 x PCIE 5.0 x2
500GB/s SSDs
10x Bandwidth at Same Cost

Copper Rack → Edge → Fabric → Spine

4096 x 200GE

Copper Rack → Fiber Spine

128 x 2x100GE PAM4 switch chip
12U 4K ports x 200GE switch
front-connector-back cards
Private Cloud Architecture

Max 16 EB 100B IOPS
250 + 4 redundancy 1.6%
10x Effective Life Amplification

- 10x life amplification from compression
  - 2:1 compression & 5% free space => 10x life amplification
  - SandForce with IBM proved 10x life in real life applications

![Graph showing the relationship between compression and write amplification. The graph shows a decrease in write amplification as the compression ratio increases, indicating improved life amplification.]
100x Effective Life Amplification

- 2.5x Deduplication and improved compression
  - From 2:1 compression to 5:1 compression and deduplication

- 3x One write instead of 3 writes for RAID6
  - Recycling and compression done on system - not SSD level
  - Data written sequentially; protection symbols are accumulated

- 1.33x Thin provisioning, zero overhead clones & snapshots
  - All above invented by Skyera and Pure Storage for flash storage

- $100 \times \text{life} = 2.5 \times 3 \times 1.33 \times 10\times \text{compression} + \text{recycling}$
Enterprise storage & cloud storage both use 3-copy system
  - RAID6: useless when rack fails or part of the building get damaged
  - Primary system has hot mirror system and also backup system

3x From system level failure tolerance without 3 copies
  - Write data & metadata sequentially across flash in different systems
  - Allows for 2-4 complete system failures without data unavailability
300x Effective Life Amplification

N + 2 systems redundancy
Zero overhead backups

3x Lower $/GB
QLC Can Replace HDD in Datacenters

- Assume 300 P/E (Program/Erase) cycles for QLC flash
  - 90,000 effective cycles = 300 x life amplification x 300 P/E cycles
    - If existing RAID6, snapshots, cloned and thick provisioning
    - If we make 3 copies for protecting against system failures

- Seagate 1 HAMR head laser writes 2PB during lifetime
  - 2PB/head/1TB = 2K full writes → equivalent to flash 2K P/E cycles

- QLC endurance is sufficient with Tachyum Prodigy chips
  - 300 P/E cycle QLC has similar effective endurance as conventional datacenters using SSDs with flash endurance 90,000 P/E cycles
Prodigy: Universal Processor / AI Chip

- Prodigy is a Server/AI/Supercomputer Chip
  - For hyperscale datacenters, HPC and AI markets
  - Ultra High performance / Ultra Low Power

- First time humanity can simulate human brain-sized neural networks in real-time

- Prodigy Outperforms CPU, GPU and TPU
  - CPU: easy to program, costly & power hungry
  - GPU: much faster but very hard to program
  - TPU: faster but more limited apps than GPU
Prodigy: AI for Datacenters CAPEX Free

- Universal Processor / AI chip
  - 10x more AI using idle servers
- Avg. over 24 hours: 60-80% of servers are idle
  - <5% of servers have AI GPUs
  - Prodigy idle servers to be re-configured to HPC/AI systems
- Existing Processors too slow for AI; GPU/TPUs are used
Brain Simulation In Hyperscale Datacenters

- SpiNNaker system 518,400 processors simulates rat brain
  - Human brain simulation requires 1,000x more performance

- 100+ brain-capable 100MW datacenters with 400K servers
  - 40% utilization means 265,420 idle servers
  - Use $100B of underutilized equipment in the world
Datacenters consume 2% total electricity
• Consume 40% more power than UK
• Emit more CO2 than world’s airliners

10% of planet energy by 2030
• 15% growth: is 2x every 5 years
• 40% of planet energy by 2040

New Technology is needed
• 10x lower power to continue growth
Flash only datacenters below HDD cost

Prodigy
Faster & 10x more efficient processor than Xeon

Status
Tape-out 2019, production 2020

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2018 Winner
new 64-bit architecture that combines elements of RISC, CISC, and VLIW

$24B market
10x less power

451 Research attractive proposition for hyperscale cloud providers, which could potentially build a single architecture that could be repurposed

1st real-time human brain sized neural network sim

Hyperscale/AI/HPC
3x Lower Capex