



Flash Memory Summit

Effective use of QLC flash in Hyperscale Datacenters



Prodigy Universal Processor
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10 Years of World-Class Innovation

SandForce™



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

skyera



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

Tachyum™



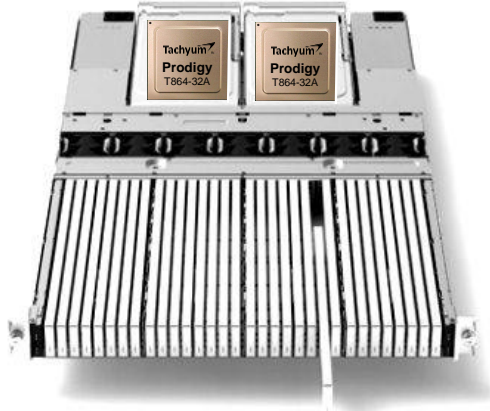
300x Flash Life
25¢ → 9¢ → **1¢ / GB**
TLC → QLC
Compression + Dedup.
Hyperscale-Out



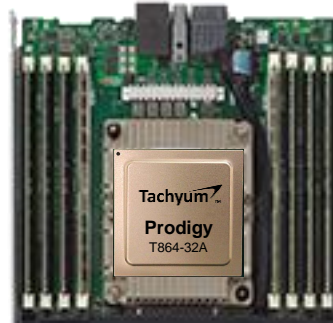
Low Cost Flash-Only Datacenter

- 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**



**4 DDR5 200GB/s
500GB/s HBM**

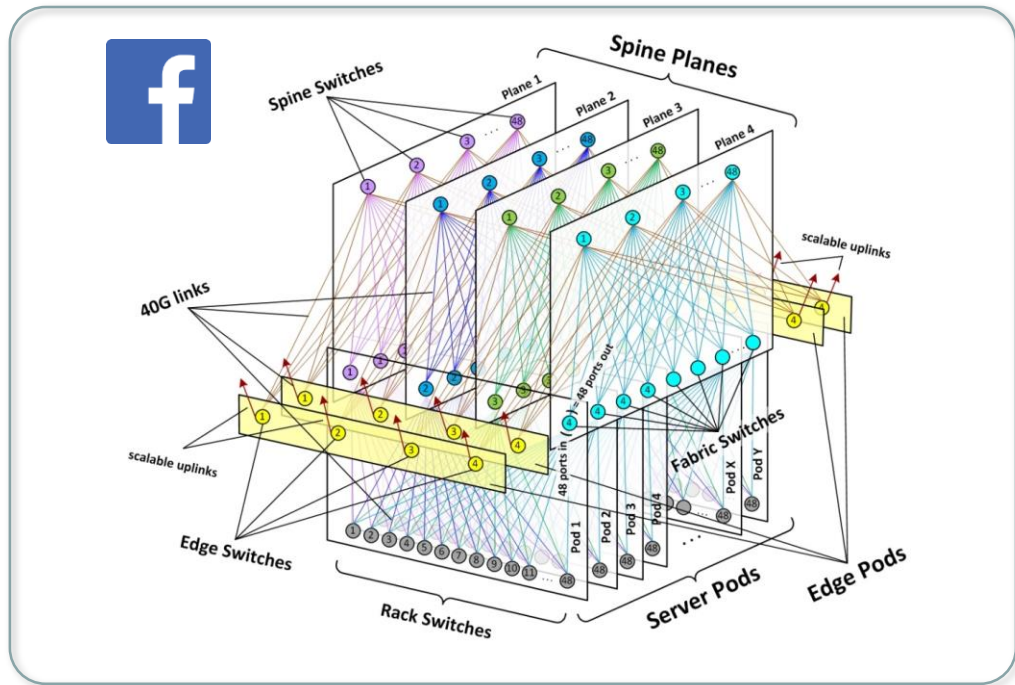
**32 x PCIe 5.0 x2
500GB/s SSDs**



10x Bandwidth at Same Cost

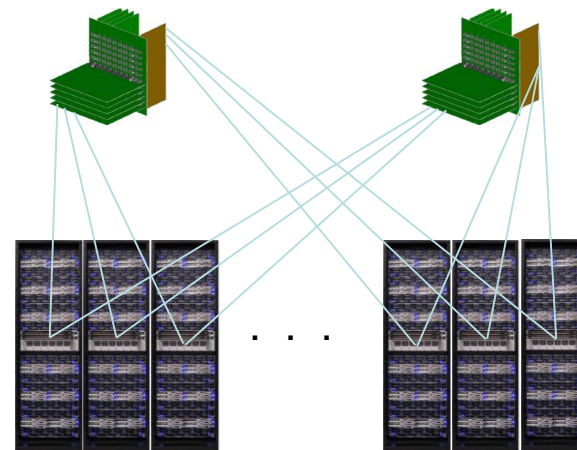
4096 x 200GE

Copper Rack → Edge → Fabric → Spine



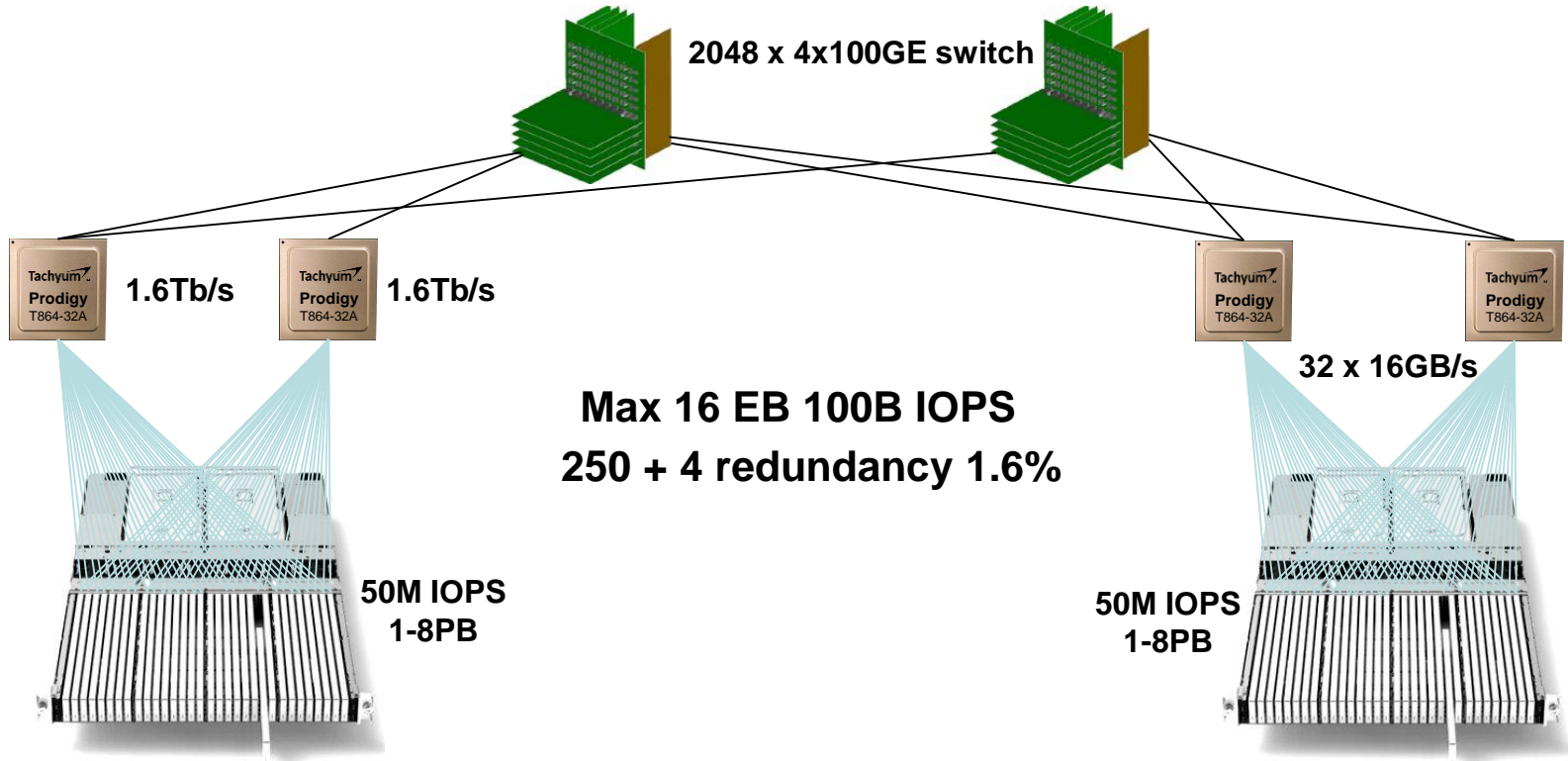
Copper Rack → Fiber Spine

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





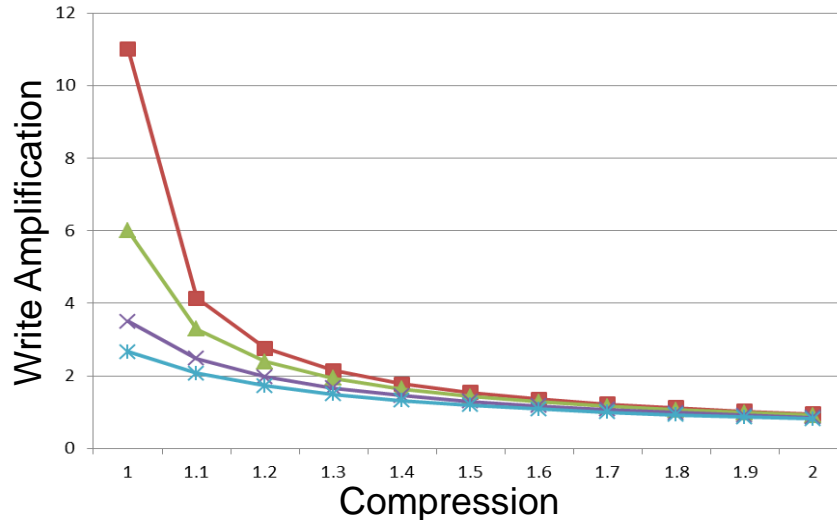
Private Cloud Architecture





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





100x Effective Life Amplification

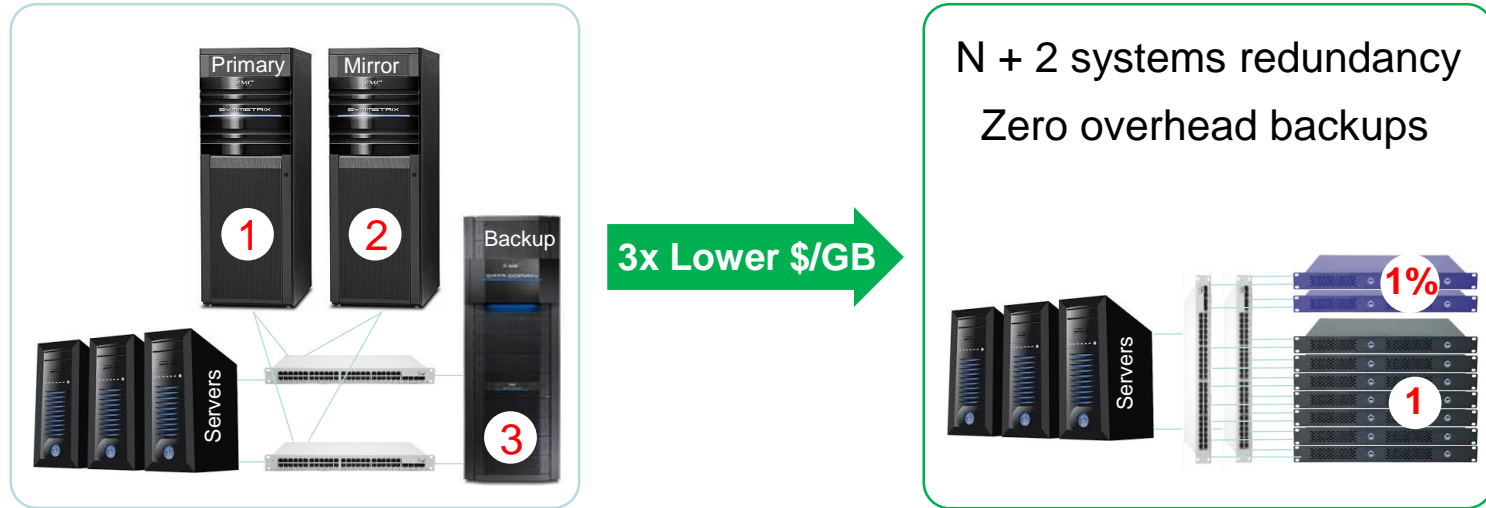
- 2.5x Deduplication and improved compression
 - From 2:1 compression to 5:1 compression and deduplication
- 3x One write instead of 3 writes for RAID6
 - Recycling and compression done on system - not SSD level
 - Data written sequentially; protection symbols are accumulated
- 1.33x Thin provisioning, zero overhead clones & snapshots
 - All above invented by Skyera and Pure Storage for flash storage
- $100 \times \text{life} = 2.5 \times 3 \times 1.33 \times 10x \text{ compression} + \text{recycling}$



300x Effective Life Amplification

- 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





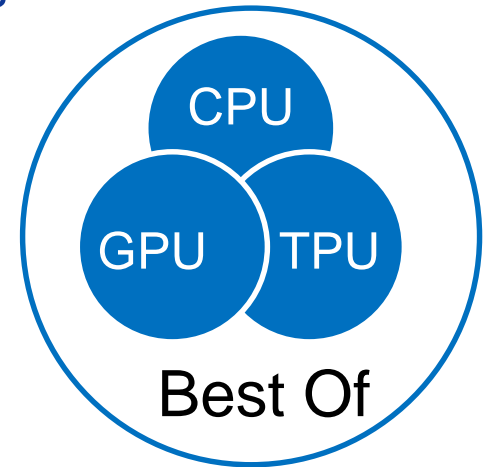
QLC Can Replace HDD in Datacenters

- 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

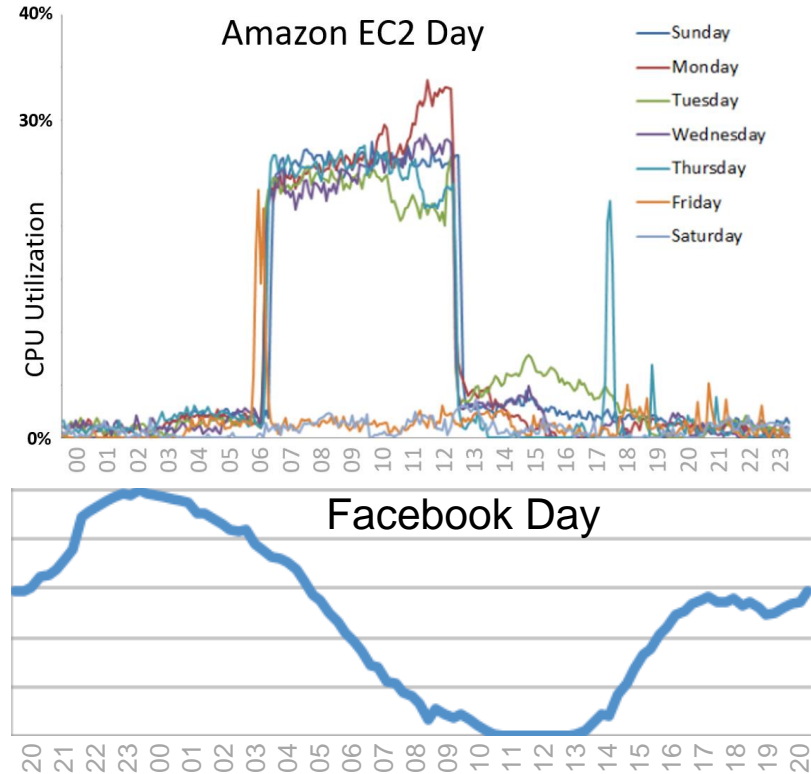
- Prodigy is a Server/AI/Supercomputer Chip
 - For hyperscale datacenters, HPC and AI markets
 - Ultra High performance / Ultra Low Power
- First time humanity can simulate human brain-sized neural networks in real-time
- Prodigy Outperforms CPU, GPU and TPU
 - CPU: easy to program, costly & power hungry
 - 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

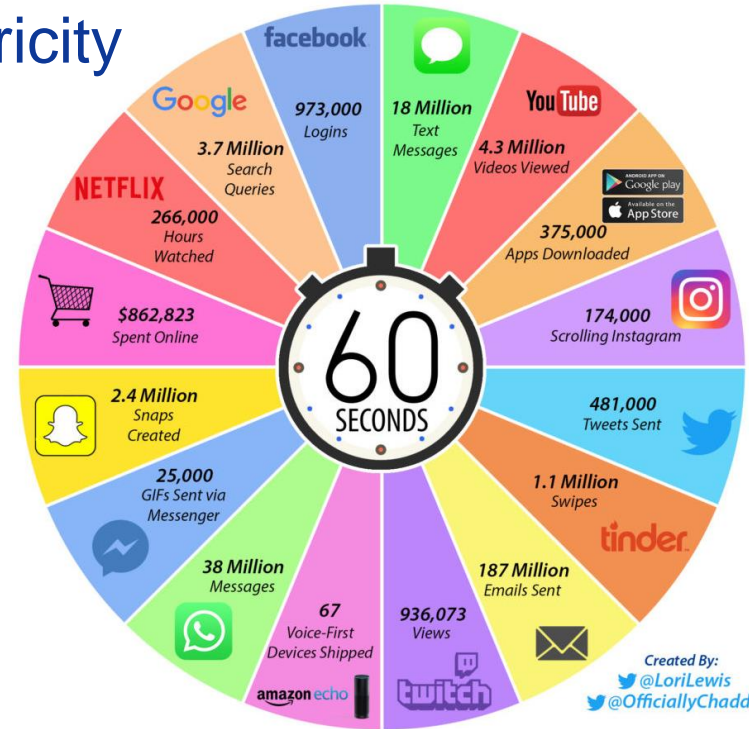
- SpiNNaker system 518,400 processors simulates rat brain
 - Human brain simulation requires 1,000x more performance
- 100+ brain-capable 100MW datacenters with 400K servers
 - 40% utilization means 265,420 idle servers
 - Use \$100B of underutilized equipment in the world





Prodigy: Low Power Flash Cloud

- 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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HPC wire silicon startup coming onto the HPC/hyperscale scene with some intriguing and bold claims

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

MICROPROCESSOR *report*
new 64-bit architecture that combines elements of RISC, CISC, and VLIW

\$24B market
10x less power

1st real-time human brain sized neural network sim

Hyperscale/AI/HPC
3x Lower Capex