



Flash Memory Summit



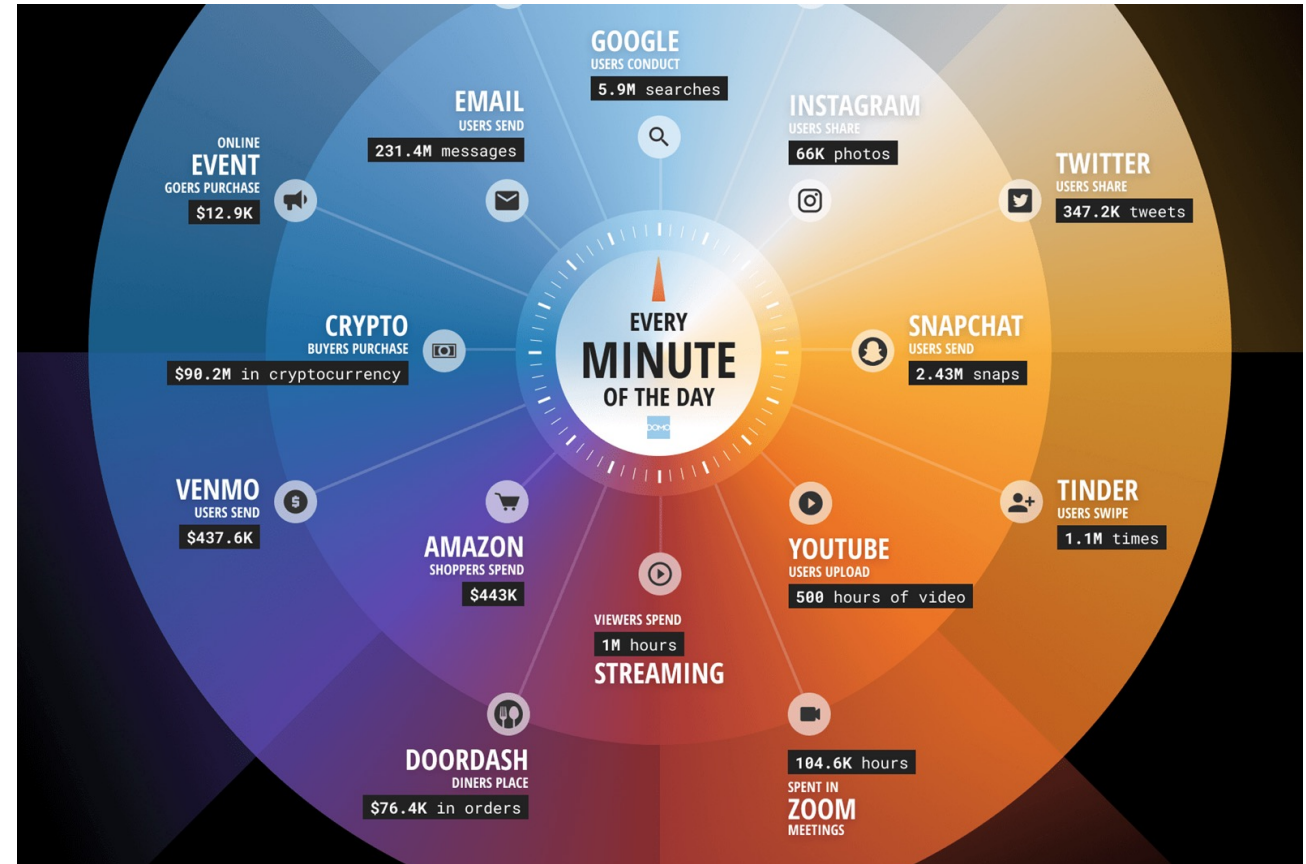
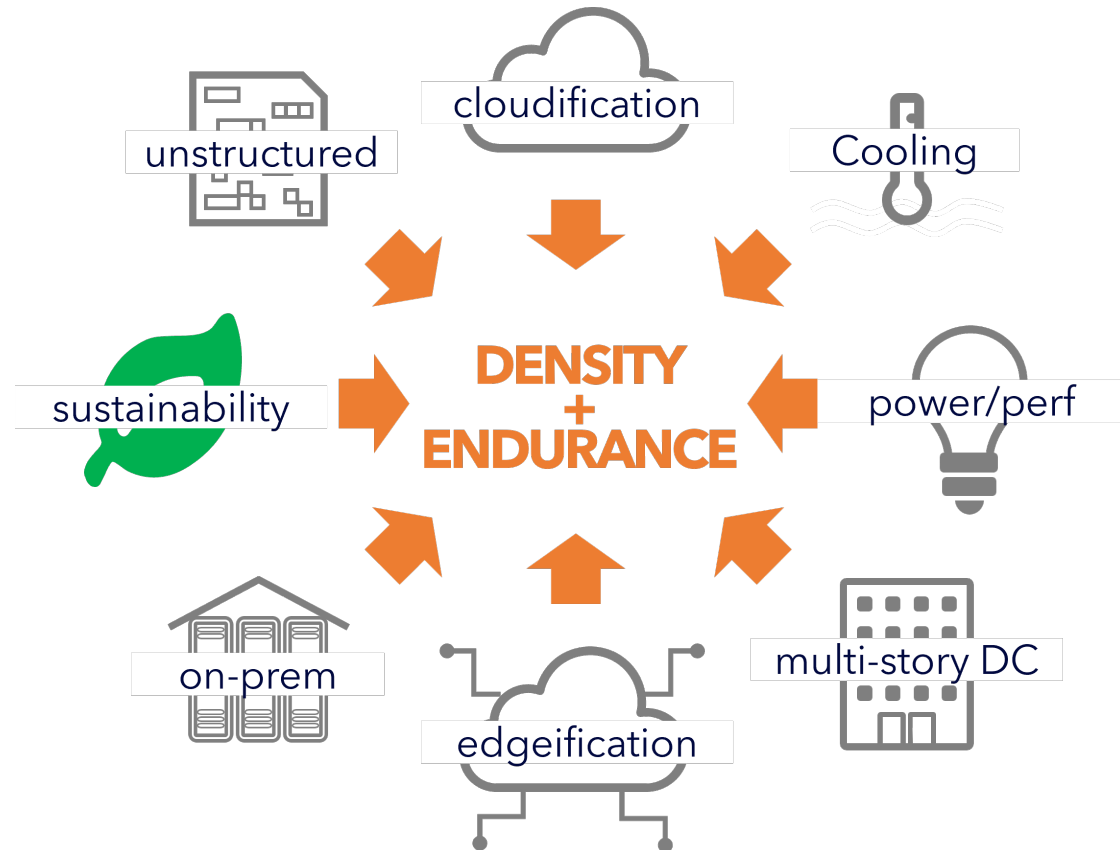
SSD Use Case Evolution

Cloud/Enterprise

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Data never sleeps!



Source: <https://www.domo.com/data-never-sleeps>

Density and endurance are critical from the core to the edge

"Density rules" in emerging use case examples



ADAS/AD¹

- Massive amount of data store and logging needs. Drive trays up to 320TB ([InoNet](#))
- High sequential write BW
- Very high fill rate/hr. Based on sensor density this can range between 1.4TB/hr to 19TB/hr
- However, vehicles are active @17,600 mins per year **resulting in 5PB/yr.**



SMART AG²

- Massive data collected via robotic systems/drones/satellite image analysis during tilling/planting/harvest/spraying
- Spraying e.g. - real-time compare 20 crop images/sec with a library of 1M images
- 36 cameras on John Deere "See and Spray" generating **6TB/day and 10 CPUs generating 14TB+/day**



OBJECT STORE³

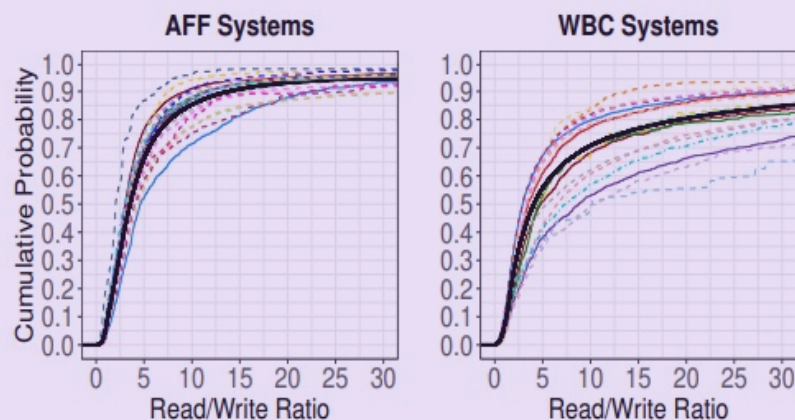
- F600/F900 246TB/737TB of unstructured data
- High read analytics transfer sizes require very little endurance – **projected 14 years of drive life with deployed QLC SSD**
- QLC w/in 5% of SPEC2020 perf suite vs incumbent TLC
- Move to QLC for **up to 17% TCO reduction on a 100PB deployment**

See appendix for footnotes

QLC endurance – time for the switch

Univ of Toronto Study⁴

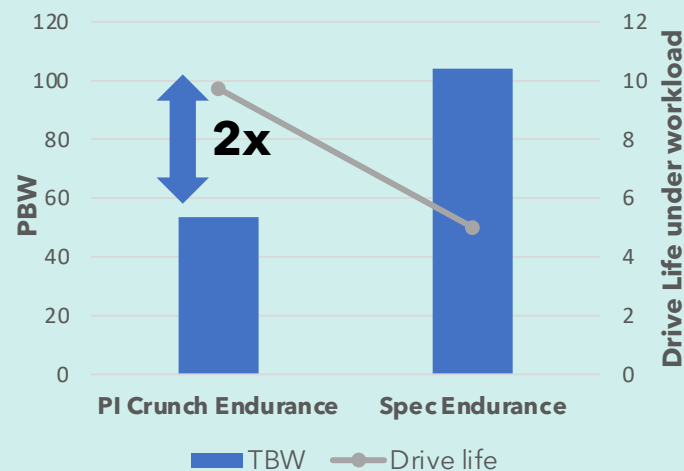
'94% experience more reads than writes. Median R/W ratio is **3.6:1**' (*HDD was reversed*)



Source <https://www.usenix.org/system/files/fast22-maneas.pdf>

StorageReview Endurance Study⁵

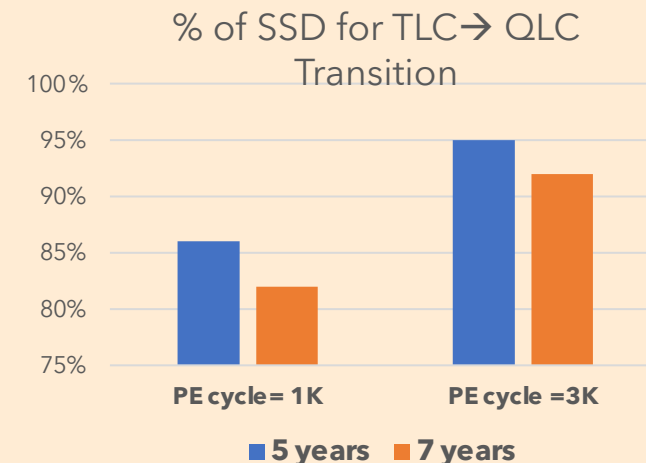
Crunched PI to the **100th trillion** digits for **54 days**, on **Solidigm™ D5-P5316**



<https://www.storagereview.com/review/storagereview-calculated-100-trillion-digits-of-pi-in-54-days-besting-google-cloud>

NetApp Enterprise SSD study⁶

2M SSDs, 3 vendors, 4+ years of data suggest, **1DWPD SSDs are overkill**



Source <https://www.usenix.org/system/files/fast22-maneas.pdf>

Need for dedicated swimlanes

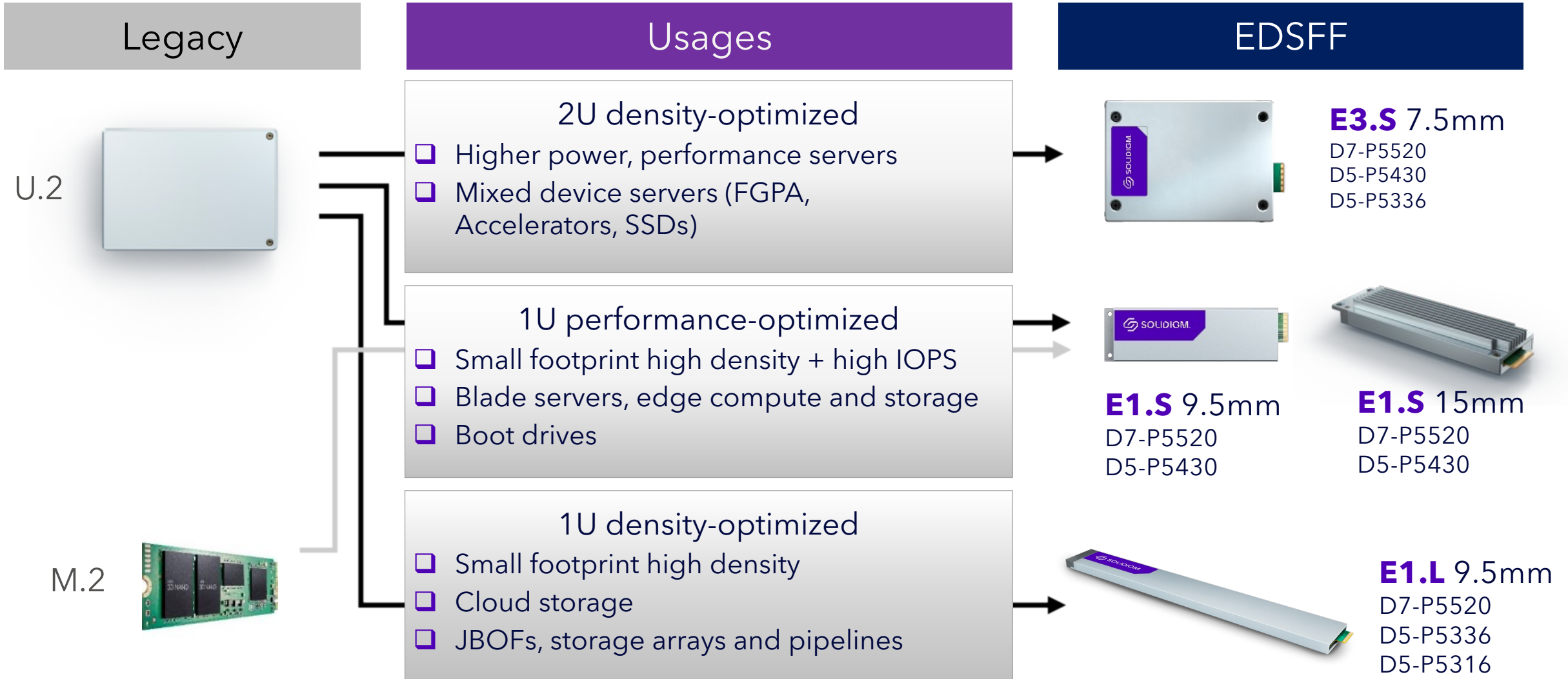
Endurance Swimlanes		Target Applications and Usages Examples			
65/134 PBW (Ran./Seq.) 3 DWPD	<u>D7-P5620</u> Write-centric and mixed	<ul style="list-style-type: none"> □Caching □High Freq. Trading □HPC 	<ul style="list-style-type: none"> □Cloud Compute 	<ul style="list-style-type: none"> □OLTP (small block, high duty cycle) 	
28/134 PBW (Ran./Seq.) 1 DWPD	<u>D7-P5520</u> Mixed and mainstream	<ul style="list-style-type: none"> □AI ingest □AI preparation 		<ul style="list-style-type: none"> □eCommerce □OLTP (variable block, low duty cycle) 	<ul style="list-style-type: none"> □Cloud Storage □Data Analytics □Email and UCC
32/105 PBW (Ran./Seq.) 0.5+ DWPD	<u>D5-P5430</u> Mainstream and read-intensive		<ul style="list-style-type: none"> □OLAP 		<ul style="list-style-type: none"> □General Purpose Server □Server-based Store □VDI
65/213 PBW (Ran./Seq.) 0.5+ DWPD	<u>D5-P5336</u> Read data-intensive	<ul style="list-style-type: none"> □Content Delivery Network 	<ul style="list-style-type: none"> □Adv. Driver Asst. Sys. □AI/ML data pipelines □Ceph □Object Storage 		

Modern QLC excels in read-dominant workloads

Product	Capacity	Content Delivery Network Total BW	General Purpose Server Total BW	Object Storage Total BW	OLAP Total BW	Write Pressure Test Lower is Better
Comp M7	15.36TB	0.84x	0.76x	0.92x	0.97x	1.59x
Comp M6	30.72TB	0.85x	0.75x	0.92x	1.06x	2.11x
Comp K	15.36TB	0.76x	0.65x	0.89x	0.94x	1.59x
Solidigm D5-P5430™	15.36TB	0.89x	0.89x	1x	0.88x	1.12x
Solidigm D5-P5336 (baseline)	30.72TB	1x	1x	1x	1x	1x
Solidigm D5-P5336	61.44TB	1x	0.94x	1x	1.05x	1.05x

Source: Solidigm

Edgification/Cloudification demands new Form Factors



Use cases are dictating SSDs of the future

Key Parameters	First Gen.	Standardization	Future
Density, Endurance and retention	~ 20 DWPD Non-Standard Workload	85% of SSDs shipped <1DWPD JESD219 Workload	Declining DWPD/increasing density Need for IU-aligned "JESD219"
Performance with Impact	Find-as-you-go	Industry targets IOPS consistency Post TRIM performance	Data placement mode Multi-tenancy Co-existence of compute/storage
Form Factor	2.5" 7mm, m.2	U.2, EDSFF E1.L, E1.S	EDSFF E3.X XT , E1.X
Data-Centric features	Power loss protection End to end data path protection	Standardized MI Telemetry Silent Data Corruption Fool proof	Serviceability at the edge , AI/ML powered predictive failure analysis

Call to action

65/134 PBW
28/134 PBW
32/105 PBW
65/213 PBW

Embrace **new tiers of endurance** as density grows and workloads evolve towards more read-intensive



Design for performance that accelerates **real-life applications**



Think beyond 2.5", **newer FFs** have efficiency to scale, making them future interface speed-proof

At the core, care for **design, data integrity, and reliability**

Thank you.





Footnotes

Emerging use cases

1. ADAS/AD: <https://www.solidigm.com/products/technology/inonet-used-solidigm-qlc-drives-for-duration-cost-accuracy-of-test-drive-results.html> and <https://www.visualcapitalist.com/network-overload/>
2. Smart agriculture: 36 cameras on John Deere “See and Spray” – 1080p is ~ 8.4GB/min or 505GB/hour x 36 cameras = 18TB per hour per tractor and <https://eos.com/blog/smart-farming/>
3. Object Store: <https://www.storagereview.com/review/dell-powerscale-benefitting-from-qlc-ssd-economics-and-performance>

QLC Endurance

4. University of Toronto Study: <https://www.usenix.org/conference/fast22/presentation/maneas>
5. PI crunch workload: <https://www.storagereview.com/review/storagereview-calculated-100-trillion-digits-of-pi-in-54-days-besting-google-cloud>
6. Netapp SSDs: https://www.usenix.org/system/files/fast22_slides_maneas.pdf