How New Energy-Efficient SSD Controllers Can Dramatically Improve Data Center TCO

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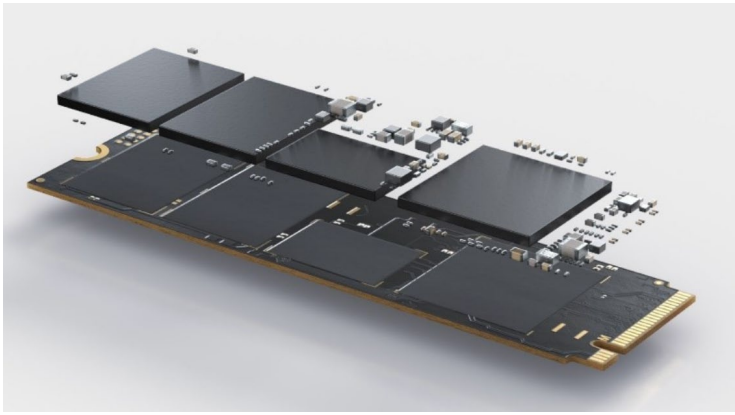
Agenda

- Power Efficiency Disparities: Data Center vs. Consumer SSDs
- Controller vs. NAND power
- Utilizing NVMe Power States
- Demo – Understanding Measured Results
- Drive Power Efficiency Impact to Server Power
- Drive Power Efficiency Impact to Rack Level TCO
- FDP Improves Write Bandwidth
- Quantifying the Impact: Sustainability vs Energy Efficiency

Power Efficiency Disparities: Data Center vs. Consumer SSDs



Data Center SSDs:

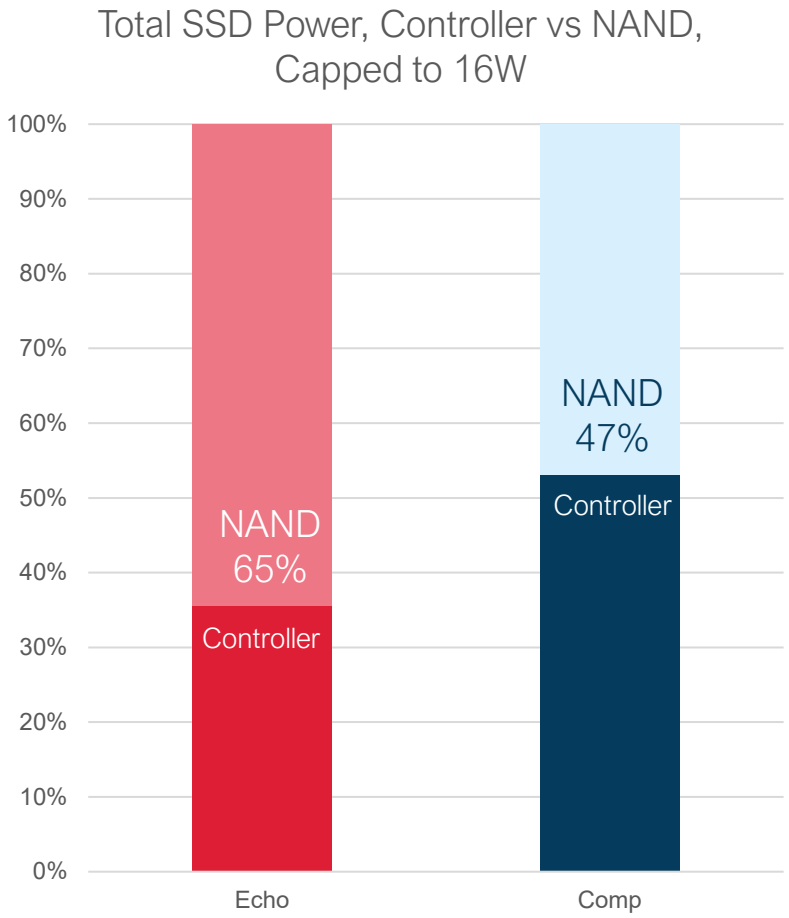
- Optimized for continuous workloads and steady-state performance
- Power can be efficiently managed by NVMe power states to cap the drive's TDP.
- The critical power efficiency metric is performance per watt in the active state and idle active (low latency resume).

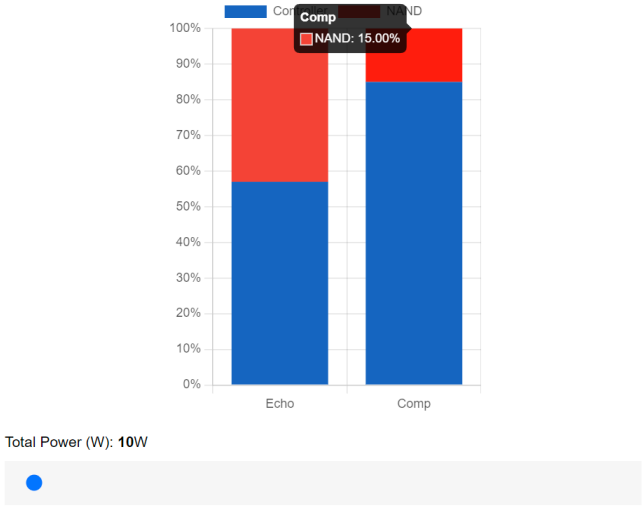
Performance per W in the active state is today's key metric for data center power efficiency.

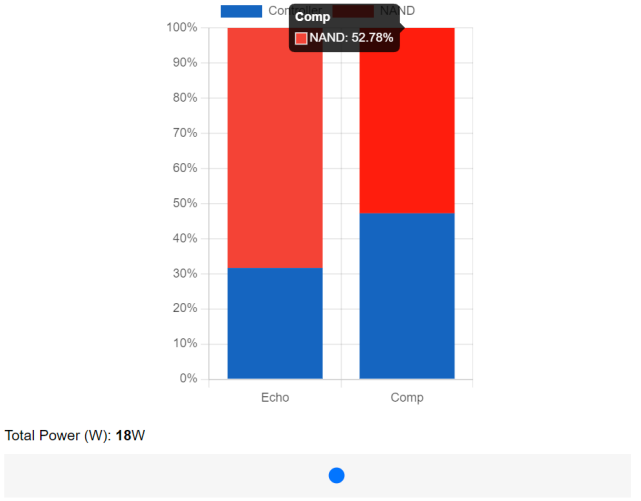
Consumer SSDs:

- typically experience bursty workloads followed by extended idle times (gaming, content creation, office productivity).
- This necessitates SSDs that can deliver responsive performance during active use while minimizing power consumption during idle periods.
- Consumer SSDs use technology like NVMe autonomous power state transitions and PCIe L1.2 to deliver near-zero idle power.

Controller vs. NAND power







The higher a controller's power consumption, the more performance loss and reduction in performance and power efficiency when the total power budget is capped

Utilizing NVMe Power States

- Discover available power states through NVMe identify controller
- Figure out what power state the drive is currently in

```
nvme get-feature /dev/nvme0 -f 2 -s 0
```

- Set a new power state that is saved and persistent across power cycles

```
nvme set-feature /dev/nvme0 -f 0x2 -v 0 -s
```

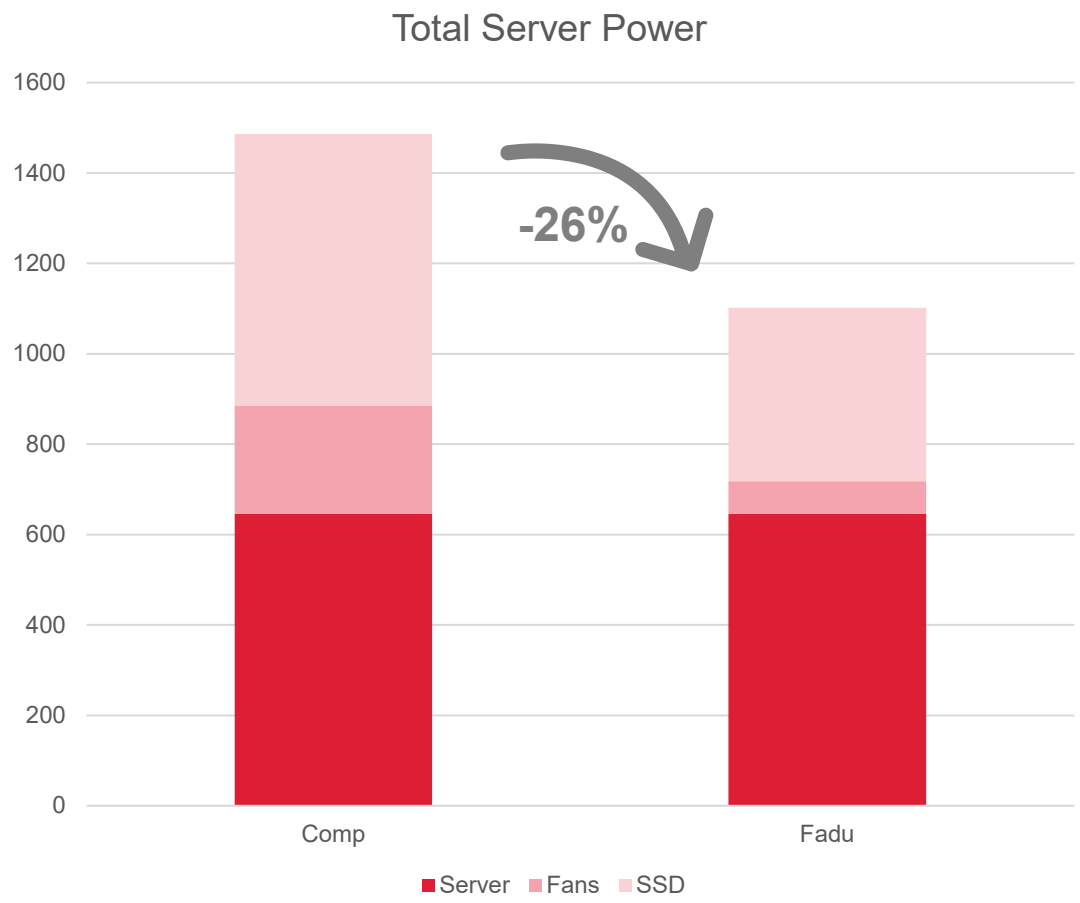

```
nvme id-ctrl /dev/nvme0n1 -H

ps      0 : mp:35.00W operational enlat:100000 exlat:100000 rrt:0 rrl:0
          rwt:0 rwl:0 idle_power:- active_power:-
          active_power_workload:-
ps      1 : mp:25.00W operational enlat:100000 exlat:100000 rrt:0 rrl:0
          rwt:0 rwl:0 idle_power:- active_power:-
          active_power_workload:-
ps      2 : mp:20.00W operational enlat:100000 exlat:100000 rrt:0 rrl:0
          rwt:0 rwl:0 idle_power:- active_power:-
          active_power_workload:-
ps      3 : mp:18.00W operational enlat:100000 exlat:100000 rrt:0 rrl:0
          rwt:0 rwl:0 idle_power:- active_power:-
          active_power_workload:-
ps      4 : mp:16.00W operational enlat:100000 exlat:100000 rrt:0 rrl:0
          rwt:0 rwl:0 idle_power:- active_power:-
          active_power_workload:-
ps      5 : mp:14.00W operational enlat:100000 exlat:100000 rrt:0 rrl:0
          rwt:0 rwl:0 idle_power:- active_power:-
          active_power_workload:-
ps      6 : mp:12.00W operational enlat:100000 exlat:100000 rrt:0 rrl:0
          rwt:0 rwl:0 idle_power:- active_power:-
          active_power_workload:-
ps      7 : mp:10.00W operational enlat:100000 exlat:100000 rrt:0 rrl:0
          rwt:0 rwl:0 idle_power:- active_power:-
          active_power_workload:-
ps      8 : mp:8.25W operational enlat:100000 exlat:100000 rrt:0 rrl:0
          rwt:0 rwl:0 idle_power:- active_power:-
          active_power_workload:-
```

Demo – Understanding Measured Results

https://blogs.fadu.io/energy-efficient-controller/

Drive Power Efficiency Impact to Server Power

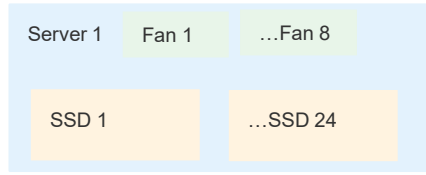


Fadu E1.S: 16W

Comp PCIe 5.0 E1.S: 25W

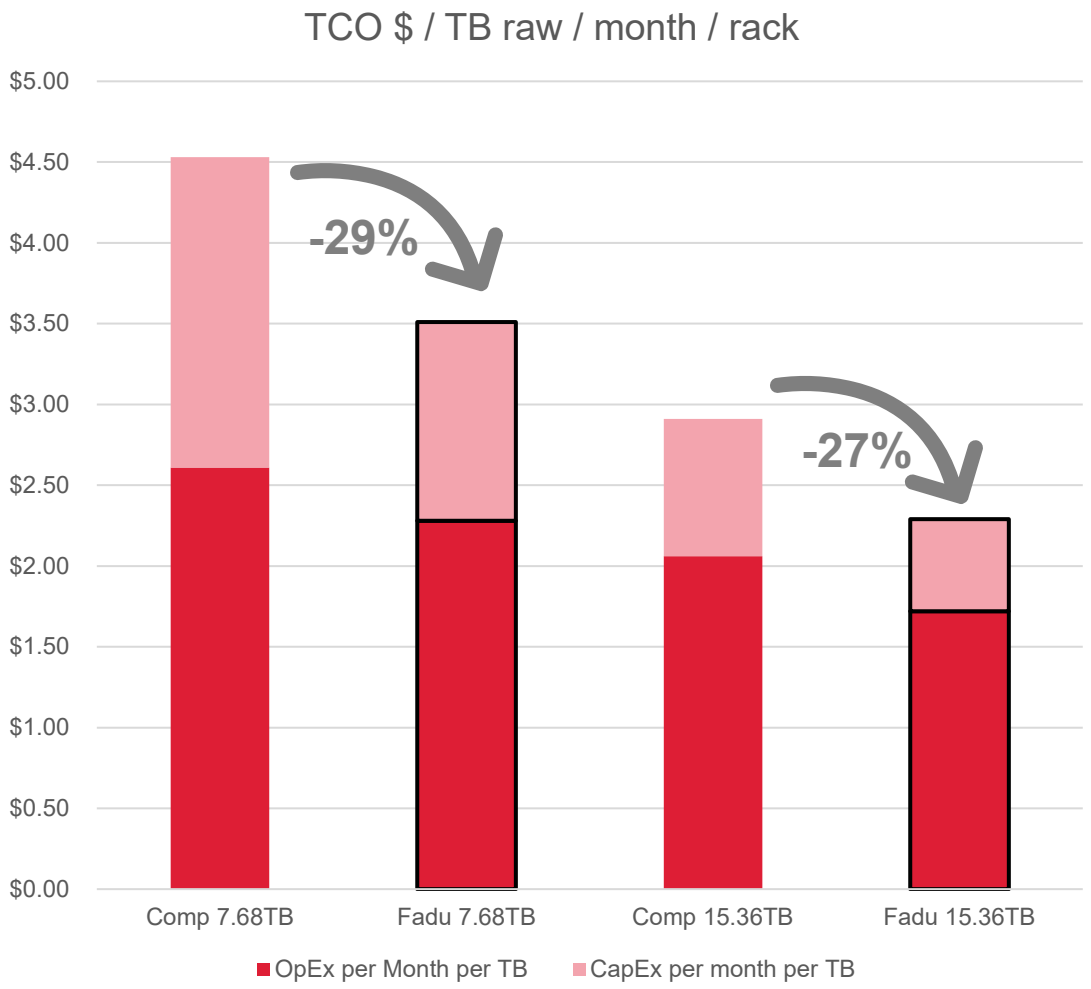
Server (CPU, DRAM, motherboard, NIC)

40mm fan: 30W



Fans consume a lot of power in servers! Small component changes make a big difference

Drive Power Efficiency Impact to Rack Level TCO



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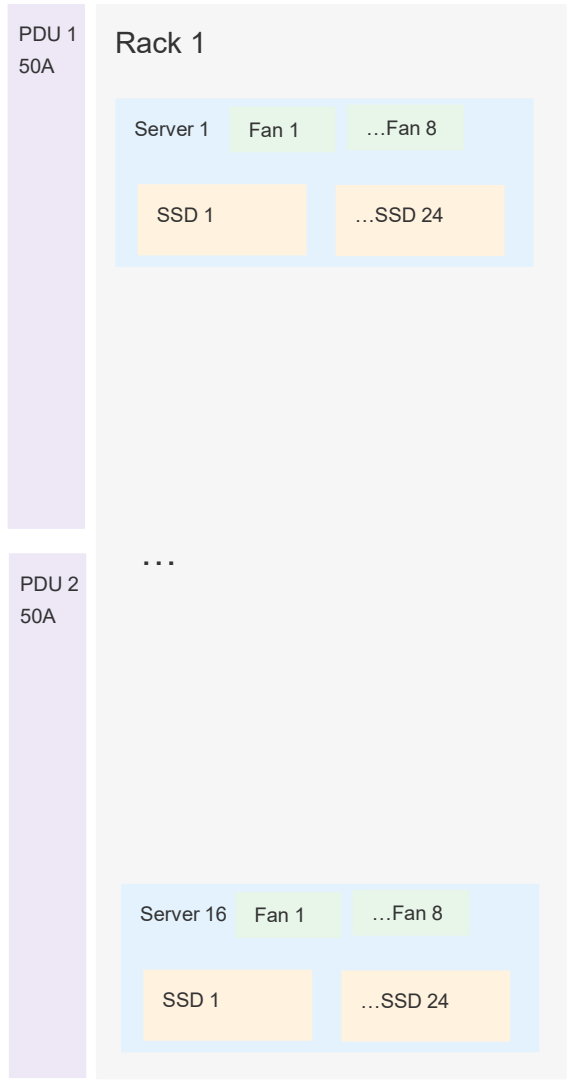
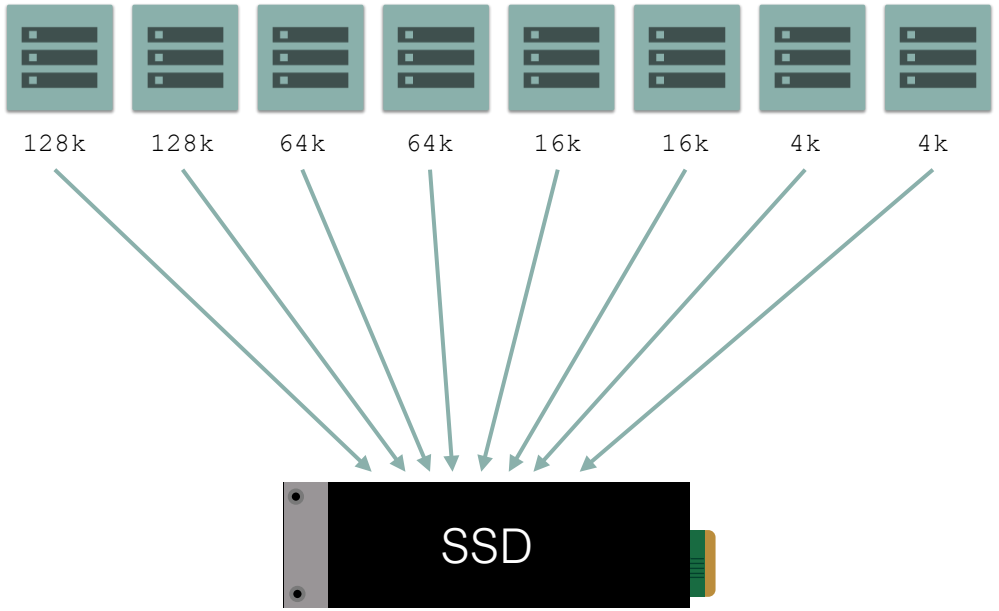
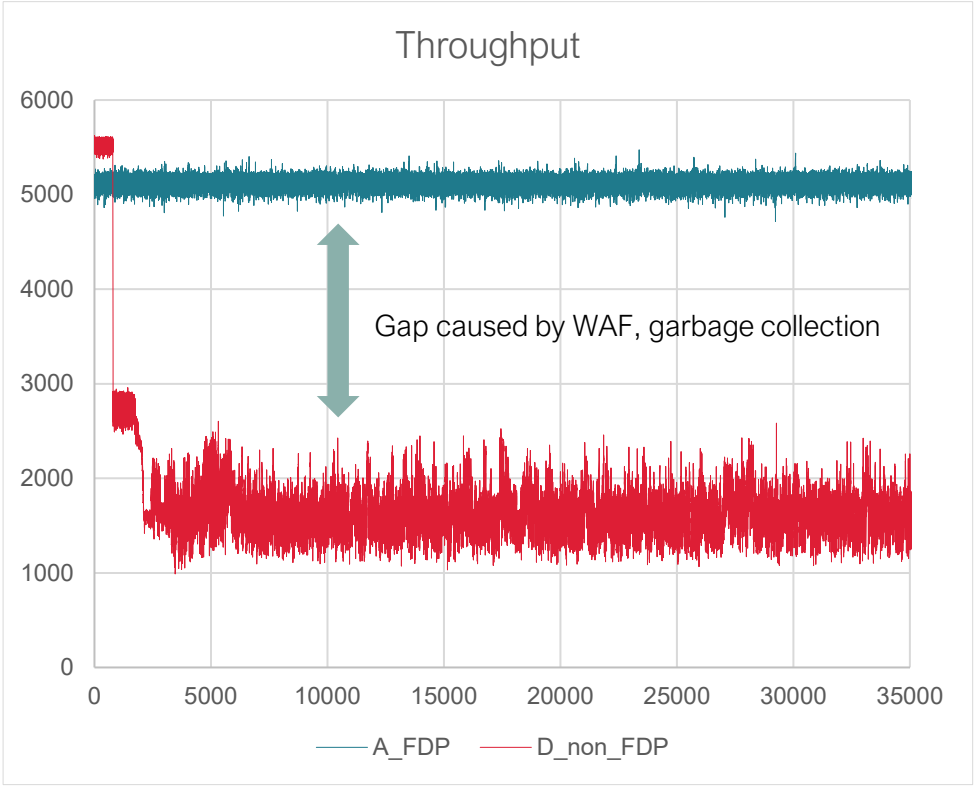


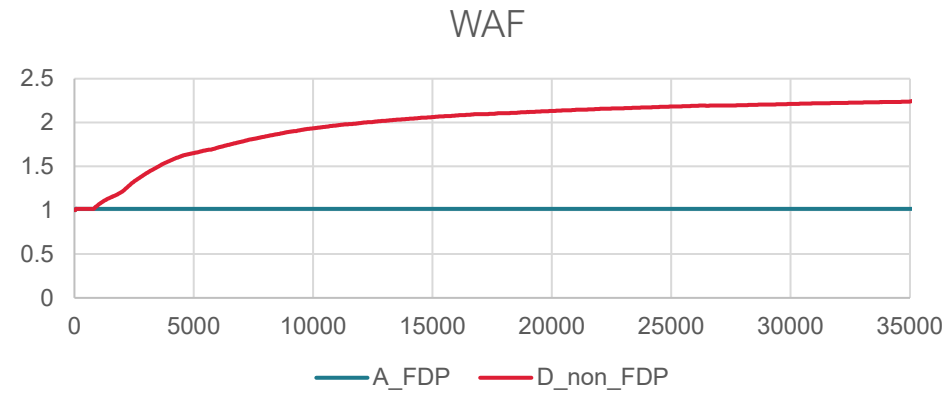
45% more servers per rack (PDU limit at ~15kW)

FDP Improves Write Bandwidth – and perf/W!



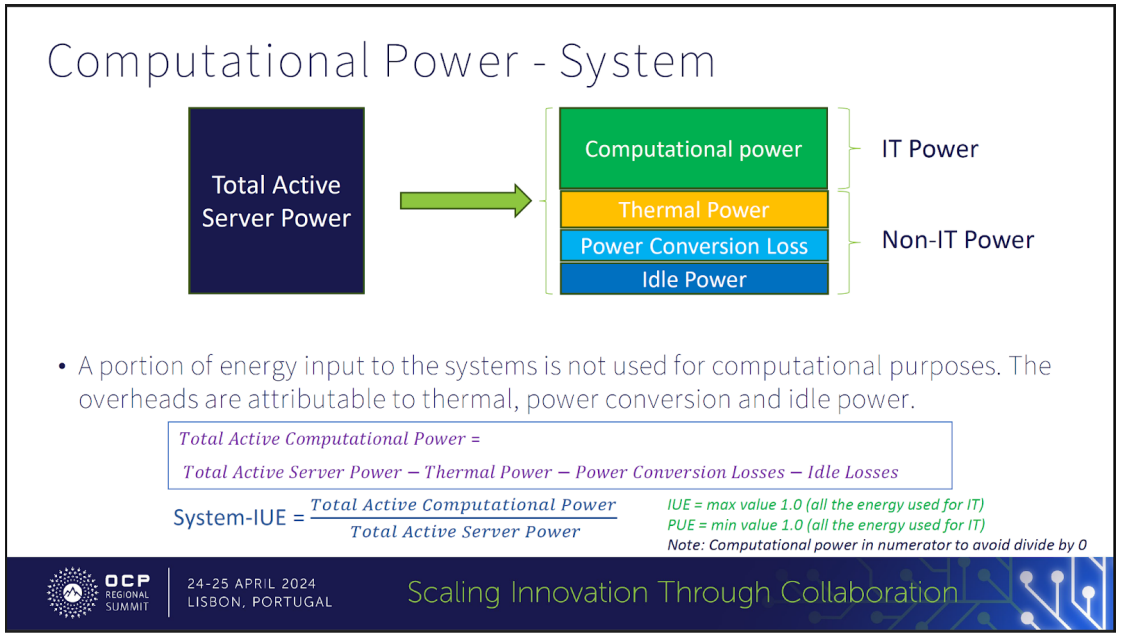
8 different write threads of different block sizes
Achieve WAF=1, full NAND bandwidth with FDP





Quantifying the Impact: Sustainability vs Energy Efficiency

- Most people confused energy efficiency and sustainability
- OCP sustainability has published whitepaper on sustainability in ICT
- New metrics, Infrastructure Utilization Efficiency (IUE) metric to classify energy consumed at system and rack level that distinguishes between compute vs non-compute power
- Life Cycle Assessments (LCAs) offer a comprehensive way to document energy efficiency



Energy efficiency is a key sustainability driver of the use phase!

Creating Future