Persistent Memory & Energy Savings

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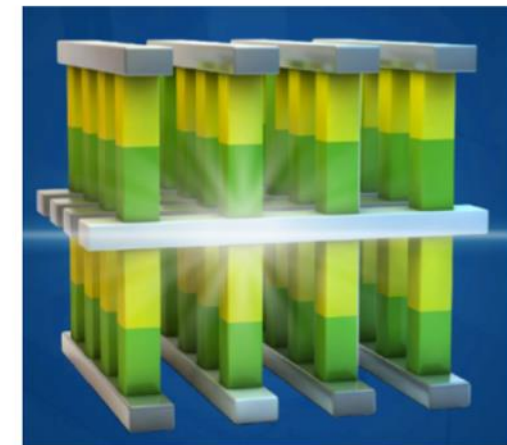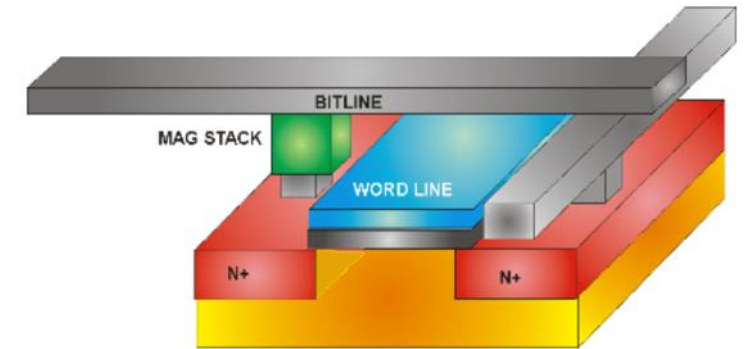
Emerging Memory Report

- Covers all major emerging memory technologies and companies

- Describes major driving applications

- Persistent memory forecasts (both embedded and stand-alone)

- Projections for capital investments

- **Now Available!**

https://tomcoughlin.com/tech-papers/

EMERGING MEMORIES RAMP UP

COUGHLIN ASSOCIATES
San Jose, California
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Green Data Centers

|	*Normal Data Center*	*Green Data Center*
Share of Total Data Centers	88%	12%
Relative Energy Consumption	100%	20%
Power Density/Rack	15kW	>25kW
Server Inlet Temperature	23.5° C	>26.5° C
Server Refresh Cycle	4.1 years	2-3 years

- Green Data Centers can:
  - Cut environmental impact by >80%
  - Save enough energy to keep the lights on in Las Vegas for 37 years
  - Annual savings as high as:
    - $38 million in energy costs
    - 350 tons of e-waste

- Shorter refresh cycles improve energy efficiency

Source: SuperMicro Report

History:
What SSDs Did to Energy Savings

Intel 2008 PC Benchmark

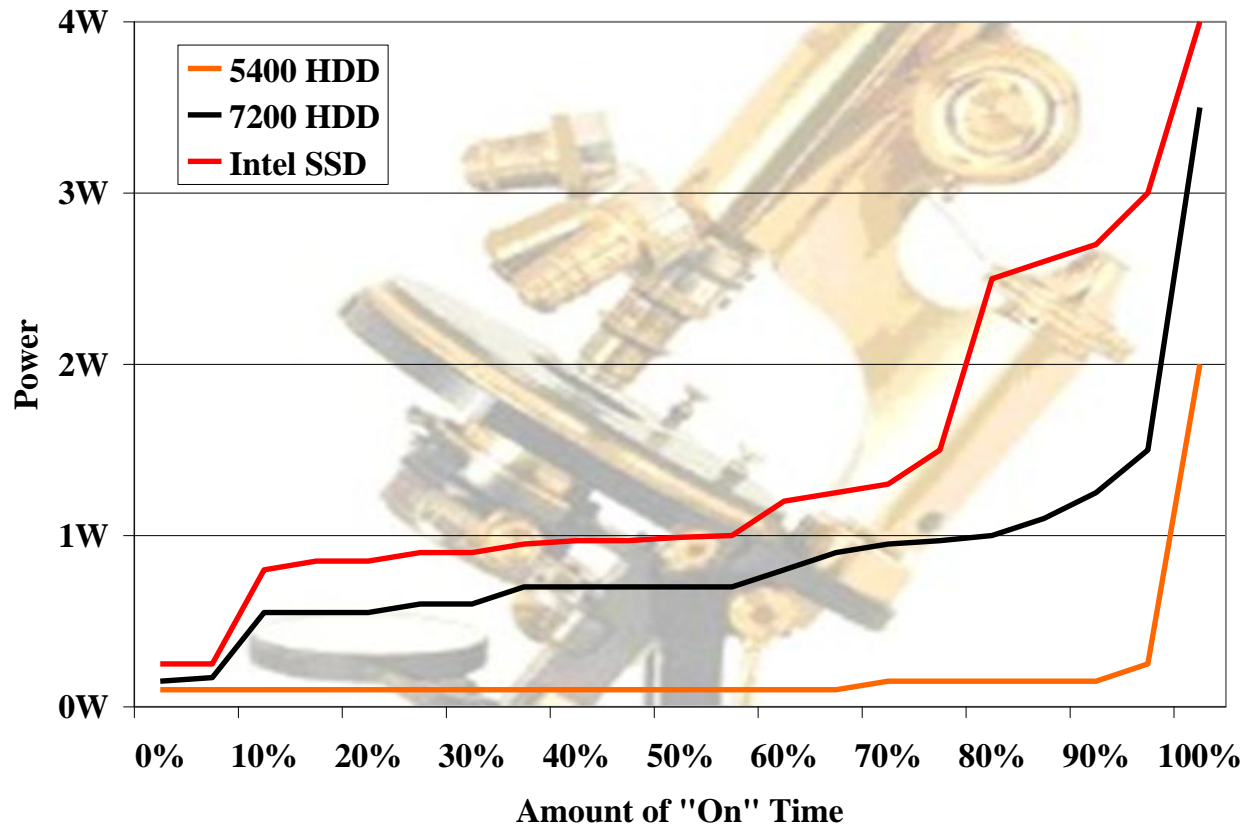|	*SSD*	*HDD*
Sustained Read	230MB/s	60MB/s
Sustained Write	130MB/s	50MB/s
Random Read IOPS	2,500	70
Random Write IOPS	25	115
Ave. File Access	0.12ms	19.0ms
Read latency	<1ms	15ms
Active Power – Read	0.5W	2.1W
Idle Power	0.1W	1.0W
Standby Power	0.06W	0.20W
Hibernate Resume	<5s	40s
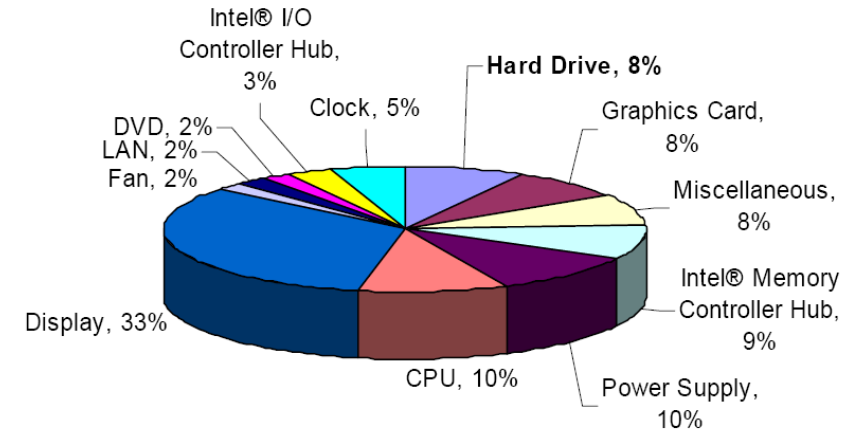
- 14% of total power went to HDD
- SSD's speed helped it power down more
  - HDD Powered down 10% of time
  - SSD powered down 96%
- Savings
  - Storage power 13%
  - Mother board power 2%

SNIA TCO Model 2010

	Power	Read IOPS	mW/IOPS
146GB 3.5: Enterprise Fibre Channel SSD	16.4W	10,000	1.6
64GB 2.5" Enterprise SATA SSD	6.5W	3,500	1.9
146GB 2.5" 15k RPM SAS HDD	11.0W	420	26.2
300GB 2.5" 10k RPM SAS HDD	10.2W	270	37.8
600GB 3.5" 15k RPM Fibre Channel HDD	24.3W	380	63.9
600GB 3.5" 10k RPM Fibre Channel HDD	18.1W	280	64.6
2TB 3.5" 7.2k RPM Enterprise SATA HDD	19.6W	133	147.4

From the perspective of mW/IOPS SSDs are a slam-dunk!
(Even WITHOUT) considering the savings elsewhere in the system.

Faster Performance Reduces Energy Use

- Allows other parts of the system to enter their own idle states sooner

- Further reduces overall power consumption

- HUGI: "Hurry Up, Go Idle."

Legend:
- 5400 HDD
- 7200 HDD
- Intel SSD

Y-axis: Power (0W, 1W, 2W, 3W, 4W)

X-axis: Amount of "On" Time (0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, 100%)

Source: Intel & Objective Analysis, July 2017

But There's More!
SSDs Save Energy In Other Parts of the System

- Fewer drives in high-performance RAID than for HDDs
  - No short-stroking
  - RAID itself became less interesting
- Reduced server count
  - Fewer wasted CPU cycles
  - One server can handle the workload of many
  - Fusion-io case study Wine.com: 7 servers replaced with 2
- Reduced network traffic
  - Local storage caches storage array data
- Additional energy savings from cooling

Future:
What PM Will Do to Energy Savings

PM Can Bring Similar Energy Savings

- Improve CPU Efficiency
  - Less time spent on data transfers
  - Persist without delay

- Reduce SSD accesses

- Reduce network traffic
  - Bigger memories need less calls to storage

- Improve HUGI
  - The hurrier I go, the idler I get
  - Power off when not using

Two Energy Benefits to PM

- Huge memory: fewer storage accesses
  - "Memory Mode"
  - Our uninformed guess: 10% energy savings
    - Faster performance
    - Fewer power-hungry I/O requests
- Fast persists
  - "App Direct Mode"
  - We guess 30% energy savings
    - Waaaaayyyyy fast persists
      - Energy = Power x Time
      - Time savings >>30%

PM Energy Savings

PM Energy Savings Projection
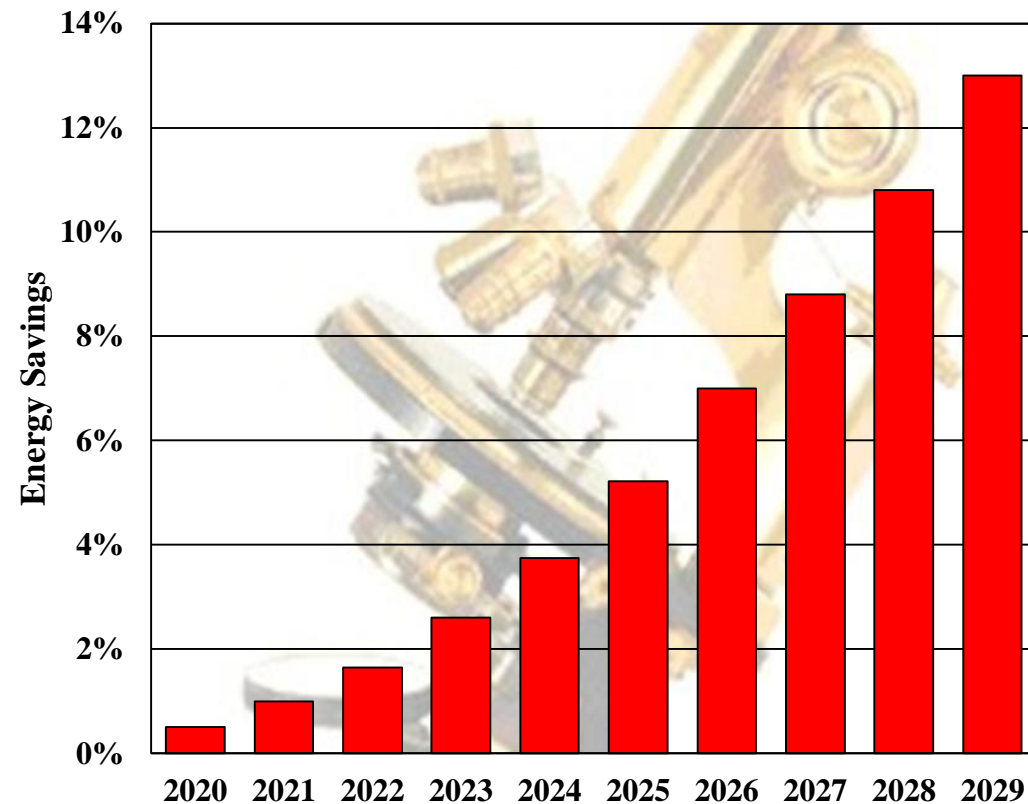
- Assumptions:
  - XPoint adoption follows Objective Analysis forecast
  - XPoint-based energy savings
    - 10% in Memory Mode
    - 30% in App Direct Mode
  - PM-Aware Software doesn't take off until 2023
  - Does not estimate reduced server requirements

Summary

- Green data centers are imperative

- SSDs reduced energy and accelerated speed

- Hurry Up, Go Idle – HUGI – multiplied those savings

- PM will do even more!