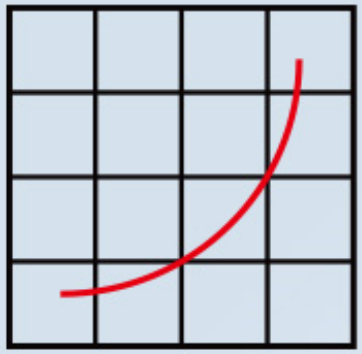

SPEC 2016亚洲峰会
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Trends in Server Efficiency and Power Usage in Data Centers

Sanjay Sharma

SPECpower Committee Vice-Chair

Agenda

Components of a typical Data Center

For each key component, we will briefly discuss:

- Deployed units in the US
- Power consumed in recent years & future outlook
- Opportunities/mechanisms of conserving energy

Overall Data Center Efficiency Opportunities

Q & A

Components of a Data Center

Servers

External Storage

Networking

Environmental Infrastructure

Server Power Consumption Trends (1)

Total deployed units today is ~14 million in the US

- Projected to be ~18 million units by 2020

Average service life of a server is ~4.4 years

Server energy efficiency increased 17x[1] since 2007

Peak power has held steady in recent years[1]

- 1S & 2S+ volume server avg. peak power is ~330 Watts[2]

Average power consumed by servers in US today is ~32 billion kWh/year

By 2020, it is expected to be ~38 billion kWh/year

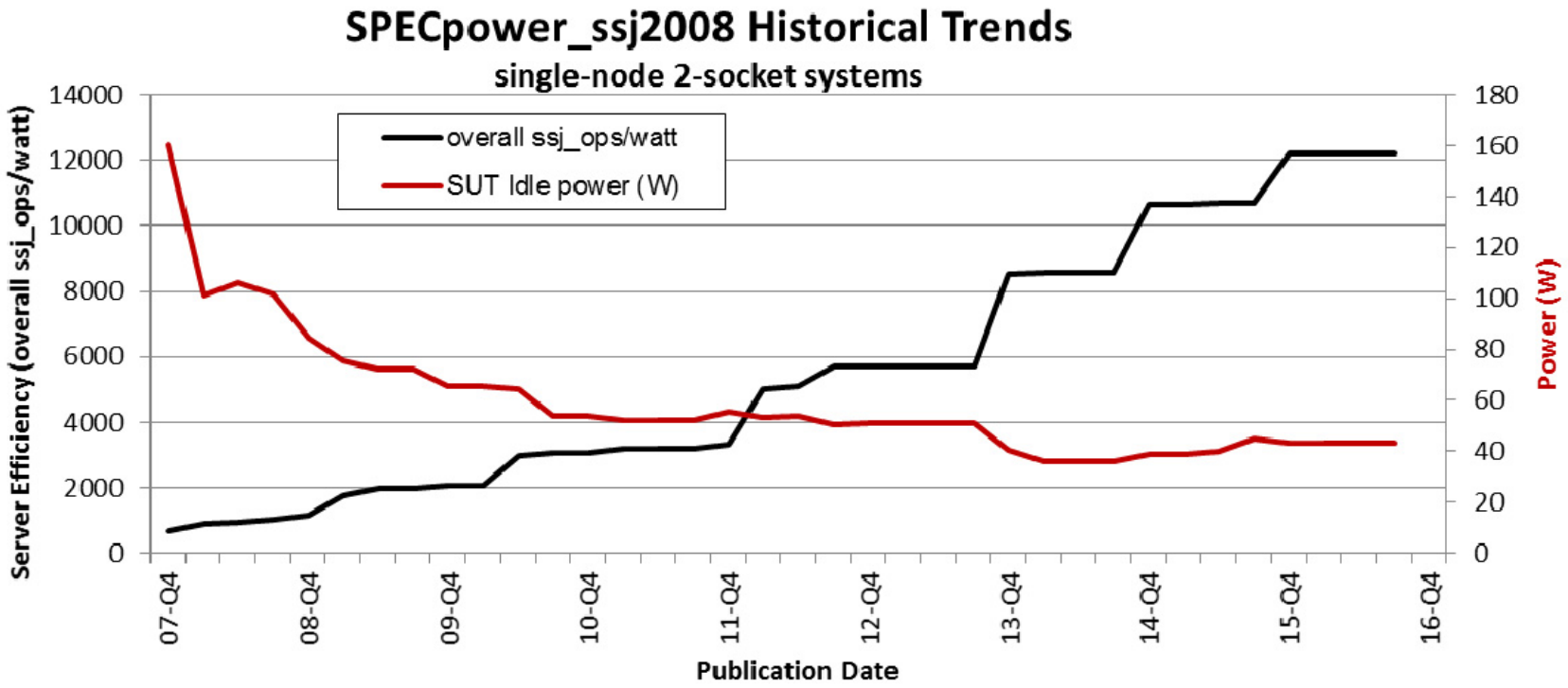
[1] Per SPECpower_ssj2008 historical published results
[2] Per 2013 SPEC SERT database

Server Power Consumption Trends (2)

SPECpower_ssj2008

17x server efficiency gain since release (Q4-2007)

698 -> 12,212 overall ssj_ops/watt



Server Efficiency Improvement Opportunities

Ability of hardware components to be selectively powered down at lower utilization levels

- Micro processor
- Power Supplies
- Memory modules

Software/firmware/OS features monitor utilization and adjust power consumed

Both of the above help improve the Dynamic Range[2] (DR) of servers

- $DR = P_{idle} / P_{peak}$
- Today, it is 0.67, projected to be 0.44 by 2020

[2] Measure of how closely power consumption increase tracks with increase in resource utilization

External Storage Power Consumption Trends

Total deployed units today is ~110 million in the US

- Projected to be ~125 million units by 2020
- In 2012, 8% drives were SSD, projected to be ~27% by 2017, and 47% by 2020

Average service life of a storage devices is ~4.4 years

25% of external storage energy is consumed by storage infrastructure

HDD power is constant regardless of capacity, is dropping 5% annually. 2020 projection is ~6.5 W/disk

SSD are expected to maintain power consumption steady at 6 W/disk. Capacity per watt for SSDs will increase 3x-4x by 2020

Average power consumed by external storage in US is ~8.5 billion kWh/year today

- It is expected to remain the same by 2020

External Storage Efficiency Improvement Opportunities

More efficient drive components

Better idle power management

Use of capacity optimization methods

- Larger capacity drives means less number of units deployed

Network Equipment Power Consumption Trends

Total deployed ports today is ~70 million in the US

- Projected to be ~85 million ports by 2020

Average service life of a storage devices is ~4.4 years

As NIC speeds increase, so does their power consumption

NIC Speed	Power Consumption
100 MB	1.4
1000 MB	2.3
10 GB	3.6
40 GB	6.1

By 2020, it is expected that 1 GB ports will consume 1 W

Power consumption of all deployed ports today is ~1.4 billion kWh/y

- Network components have minimal effect on the overall data center power consumption

Network Equipment Efficiency Improvement Opportunities

More efficient implementations resulting in power savings.

Availability of larger bandwidth ports (40 GB) would allow for using less number of ports to achieve same throughput.

Environmental Improvement Opportunities

Environmental factors play a big role in Data Center efficiency

- Not always controllable, as it depends largely on weather conditions at the facility

Energy efficient cooling, or primarily air-cooled designs, result in lower Power Usage Effectiveness (PUE)

Energy efficient lighting can help lower PUE.

By 2020, US data centers are projected to consume 660 billion gallons of water.

- 2 gallons per kWh for generation, and 0.46 per kWh of data center capacity for cooling.

Overall Data Center Power Consumption

Adding it all up

- Collating the power consumed by the different components of the data center discussed so far
- And adding the infrastructure cost to run a data center

Total power consumed by US data centers is ~70 billion kWh/year

2020 projection is ~73 billion kWh/year

Overall Data Center Efficiency Improvement Opportunities

Server virtualization and consolidation

Higher server utilization results in better efficiency

Larger data centers are more efficient, both in terms of utilization as well as PUE[1]

Server Type	Utilization 2000-2010	Utilization by 2020
In-House	10%	15%
Service Providers	20%	25%
Hyperscale Servers	45%	50%

Improved efficiency of server components

CPU, cooling fans (or replace with liquid cooling), power supplies, memory

Price drop of more efficient components; SSDs

[1] Power Usage Effectiveness (Sum of Equipment Power x Data Center PUE = Total power needed to operate the data center)

Overall Data Center Efficiency Improvement Opportunities (2)

PUE[1] of data centers have trended linearly since 2014 – going from 2.5 to 1.13

Increase in PUE[1] of the data center by:

- Reducing infrastructure (cooling, lighting) costs
- Improving thermal management by hot/cold aisle isolation and reducing set point temperatures
- Removing un-utilized servers from the data center

Servers support higher ambient operating temperatures

- Allowing for lower cooling costs, or even predominantly air cooled data centers

Use Software solutions to cap power consumption

[1] Power Usage Effectiveness

References

United States Data Center Energy Usage Report

https://datacenters.lbl.gov/resources/united-states-data-center-energy-usage

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Jonathan Koomey, *Steyer-Taylor Center for Energy Policy and Finance, Stanford University*

Eric Masanet, *McCormick School of Engineering, Northwestern University*

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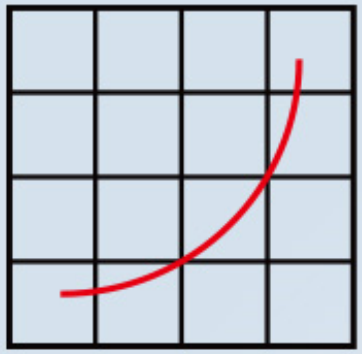
Report utilized data, guidance and projections from IDC, SPECpower database, SERT database, ITIc, TGG, and other industry experts.



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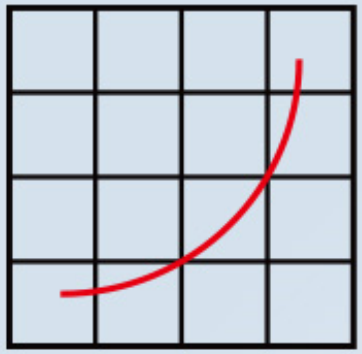

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info@spec.org
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