SWaP
Space Watts and Power

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Outline

- Motivation for Introducing SWaP
- Overview and examples of SWaP benchmark
- SWaP in a power constrained environment
- Power Benchmarking
Motivation

**E10K**
- 1997
- 32 x US2
- 77.4 ft³
- 2000 lbs
- 13,456 W
- 52,000 BTUs/hr

**T2000**
- 2005
- 1 x US T1
- 0.85 ft³
- 37 lbs
- ~300 W
- 1,364 BTUs/hr

EPA Power Efficiency Forum
The New Metric for Server Evaluation: SWaP

Space, Watts, and Performance
SWaP Rating =

Performance

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Space*Watts
What Analysts Are Saying

“SWaP is an objective three-dimensional metric that provides a more comprehensive and realistic way to assess today’s servers.”

“Benchmarking the energy efficiency of IT systems can help customers make better purchasing decisions when considering the trade-off between the need for greater performance and the rising cost of energy and real estate.”
How Does SWaP Work?

Performance/(Space*Power) = SWaP Rating

19,000 Lotus iNotes Users

2RU * 325 Watts

= SWaP: 29.2

Sun Fire T2000

http://www.notesbench.org/r7report.nsf/ed670662098f24c68525687f006bf80e/e27efb1686cf746c852570ce007c0202?OpenDocument


EPA Power Efficiency Forum
SWaP is benchmark dependant: SpecJAppServer2004

Sun Fire T2000

\[
\frac{616 \text{ Jops}}{2\text{RU} \times 320 \text{ Watts}} = \text{SWaP: 0.96}
\]

Performance/(Space*Power) = SWaP Rating

http://www.notesbench.org/r7report.nsf/ed670662098f24c68525687f006bf80e/e27efb1686cf746c852570ce007c0202?OpenDocument

Best used as a relative measure for comparing servers

Sun Fire T2000

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<tbody>
<tr>
<td><strong>617 JOPS / 320 Watts</strong></td>
<td><strong>VS.</strong></td>
<td><strong>Competitor Box Here</strong></td>
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<tr>
<td><strong>Performance</strong></td>
<td>30%</td>
<td></td>
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<tr>
<td><strong>Power Usage</strong></td>
<td>-4.1X</td>
<td></td>
</tr>
<tr>
<td><strong>Space</strong></td>
<td>50%</td>
<td></td>
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<tr>
<td><strong>SWaP</strong></td>
<td>10.6X</td>
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See Legal Substantiation Slides
Legal Substantiation – Benchmarks

- Results as posted on [www.spec.org](http://www.spec.org): SPECjAppServer2004 BEA WebLogic Server 9.0 on Sun Fire T2000 615.64 Sun Fire T2000 (8 cores, 1 chip, 32GB)

- NotesBench* R7Notes* Sun Fire T2000 (1x1200 MHz UltraSPARC T1, 32GB), 4 partitions, Solaris [TM] 10, Lotus[R] Domino 7.0, 19,000 users, *$4.24 per user, 16,061 NotesMark tpm, 400 ms avg NotesBench R6iNotes IBM x346 (2 x 3.4 GHz Xeon processors, 8GB), 1 partition, SuSE Linux 8, Lotus[R] DominoR6.5.3, 6,050 users, $9.07 per user, 5,109 NotesMark tpm, 569 ms avg rt. *NotesBench R7 Notes HP DL580 (4 x 3.0 GHz Dual Core Xeon processors, 8GB), 4 partitions, Windows Server 2003, Lotus[R] Domino 7.0, 18,500 users, $4.29 per user, 15,953 NotesMark tpm, 434 ms avg rt.

- Sun Fire T2000 server power consumptions taken from measurements made during the benchmark run
Is this just marketing?

- Sun Engineers are finding this is useful too.
- We're using SWaP to evaluate future systems.
- One caveat is that in some cases data centers are limited by Watts/sq. ft.
SWaP in a power limited environment

• SWaP is still applicable
• Need to calculate SWaP with a set power limit per sq. ft. of floor space
  > Convenient to translate to a power/rack
• Space becomes the effective RU taken by the servers including white space
• If both servers in a comparison are limited by power and not by the size then SWaP just becomes a measure of

  Performance
  ---------------
  Watts
Example: SWaP for a system taking 10kW in a fully populated rack

Relative SWaP at Different Power Limits Per Rack

Power Limit per Rack in kW

Relative SWaP values

- Limited by Power
- Limited by Space
Methodology for Power-Performance

• Variation of Performance Benchmark Load
  > Typical benchmark has ramp-up, steady-state, ramp-down phases
  > Some benchmarks (i.e. SPECcpu2000, SPECweb2005) consist of a variety of sub tests with different subsystem loading.
  > Even monolithic benchmarks vary subsystem loading during steady-state
  > Variation in subsystem loading -> variation in power consumption

• Measure average power consumption during benchmark steady-state
  > Do not include power measurements during ramp up/down
  > This is a good enough definition to get started however need to make the start and stop points explicit points in the benchmark to make the rules unambiguous
Power Efficiency Benchmarking

- Avoid unnecessary complexity
  - Generally the power consumption doesn't vary too much by the exact workload
- We propose picking one widely used benchmark for each of the major type of computation
- Four key application areas
  - Web Tier Servers e.g. SPECweb2005
  - Application Tier Servers: e.g. SPECjbb2005
  - Database Tier Servers
  - High performance computing (HPC)
- Power efficiency defined as the average performance/watt over the steady state execution of the benchmark
The Standard Benchmark Rules

- Only published results on the benchmark organizations web site will be allowed.
- Power should be measured on the exact benchmark configuration.
- Power is only for the system under test and not associated hardware required for benchmarking.
- Power is the average server power consumption during the active part of the benchmark.
- Benchmarks that most closely resembles the customer workload should be used.
Conclusion

• SWaP is a useful metric for comparing power and space efficiency of servers
• Works in power constrained and unconstrained situations
• Need consistent standards for Watts & Performance
• Efforts are just starting in Spec.org & other industry forums to set rules for power benchmarking
THE END

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