

# SWaP

# Space Watts and Power

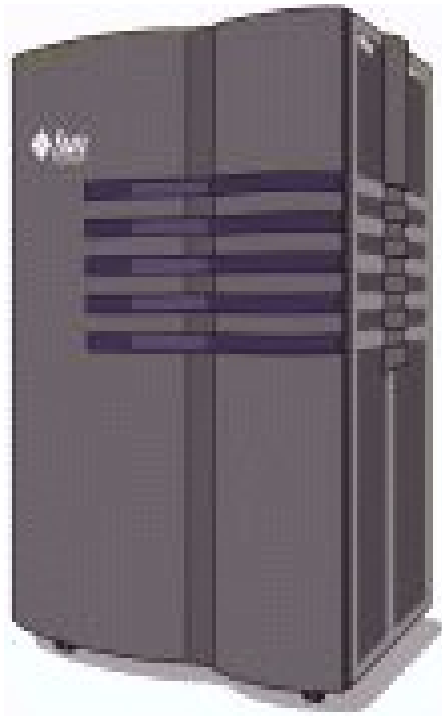
**David Greenhill**  
**Distinguished Engineer**  
**Chief Engineer Horizontal Systems**  
david.greenhill@sun.com

# 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 ft<sup>3</sup>  
2000 lbs  
13,456 W  
52,000 BTUs/hr



## T2000



2005  
1 x US T1  
0.85 ft<sup>3</sup>  
37 lbs  
~300 W  
1,364 BTUs/hr

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?

## Sun Fire T2000



$$\frac{19,000 \text{ Lotus iNotes Users}}{2\text{RU} * 325 \text{ Watts}} = \text{SWaP: } 29.2$$

Performance/(Space\*Power) = SWaP Rating

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

<http://www.sun.com/servers/coolthreads/t2000/specifications.jsp>

# SWaP is benchmark dependant: SpecJAppServer2004

## Sun Fire T2000



$$\frac{616 \text{ Jops}}{2\text{RU} * 320 \text{ Watts}} = \text{SWaP: } 0.96$$

Performance/(Space\*Power) = SWaP Rating

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

<http://www.sun.com/servers/coolthreads/t2000/specifications.jsp>



# Best used as a relative measure for comparing servers

Sun Fire T2000



VS.

Competitor Box Here

617 JOPS / 320 Watts

Performance

30%

Power Usage

- 4.1X

Space

50%

SWaP

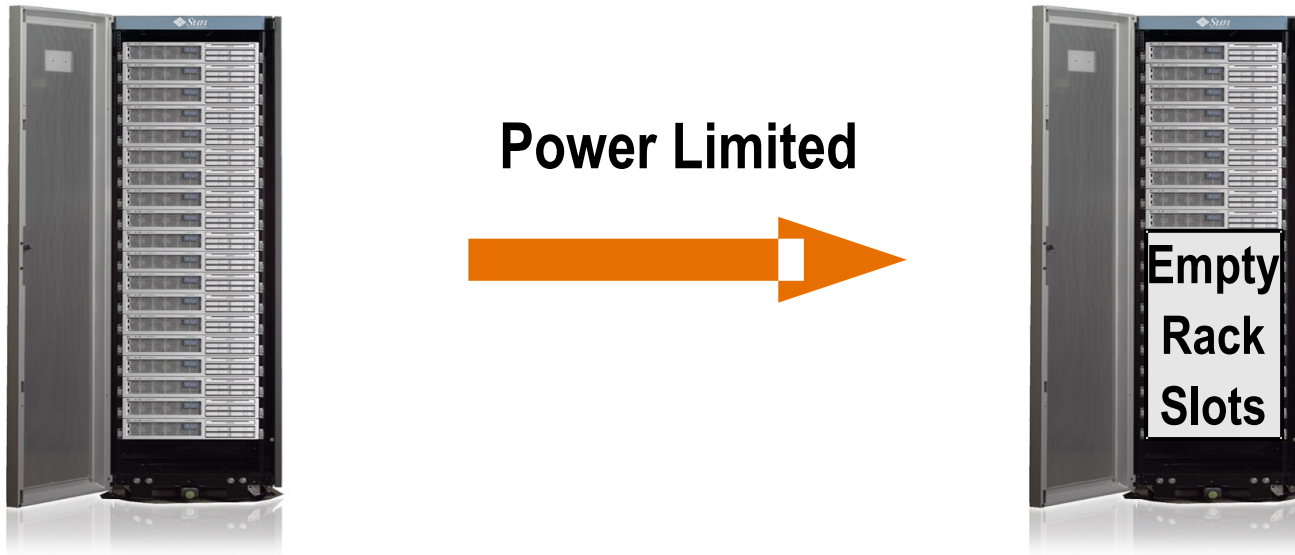
10.6X

# 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

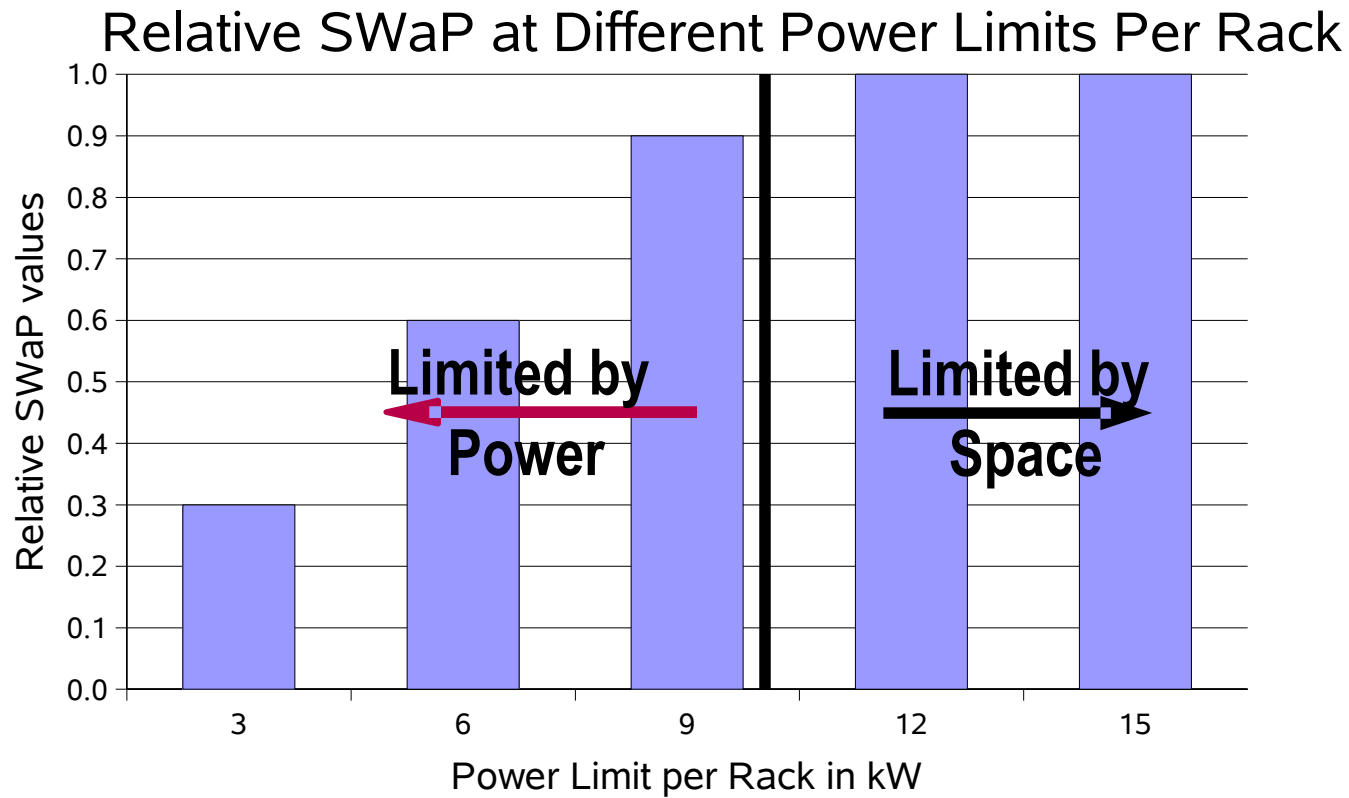
- SWaP is still applicable
- Need to calculate SWaP with a set power limit per sq. ft. of floor space
  - > Convenient to translate to a power/rack
- Space becomes the effective RU taken by the servers including white space
- If both servers in a comparison are limited by power and not by the size then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

**Performance**

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**Watts**

# Example: SWaP for a system taking 10kW in a fully populated rack



# 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**

**David Greenhill**

david.greenhill@sun.com