

Performance Analysis

CSE 410 - Computer Systems
November 5, 2001

Readings and References

- Reading
 - Chapter 2, *Computer Organization & Design*, Patterson and Hennessy
- Other References

5-Nov-2001

CSE 410 - Performance

2

Performance Analysis - When?

- Evaluation prior to system purchase
 - deciding which system is right for the need
 - very speculative and uncertain
 - unknown future workload, future capability
- Tuning prior to product release
 - product must meet expectations or it won't sell
 - very speculative and uncertain
 - sensitive to configuration, workload

5-Nov-2001

CSE 410 - Performance

3

Understand your Environment

- The question is “what system to buy?”
 - or design to select, or vendor to hire, etc
- Performance analysis is fun
 - you get to look at all sorts of machines and their inner workings
- It's very easy to analyze the wrong things ...
 - ... and then your analysis will lead you to a wrong answer

5-Nov-2001

CSE 410 - Performance

4

Time to complete task

- The best metric is time to complete the task, as perceived by the user
- Total performance is the sum of many individual factors and perceptions
- Understand the task and the expectations
 - write down the tasks to be accomplished
 - write down the user expectations for performance

5-Nov-2001

CSE 410 - Performance

5

Evaluation tools

- Simulation
 - necessary if there is no system in place yet
 - accuracy of the simulation is critical
 - how is accuracy defined?
- Prototypes
 - accuracy is critical - it looks real, but you don't have the real product in hand yet
 - where are the simplifications, are they important?

5-Nov-2001

CSE 410 - Performance

6

Benchmarks

- High potential for misleading results
- May not reflect actual operation at all
 - reading from disk controller cache, not disk
 - product vendor tweaked system for benchmark
- Simplified representation of the workload may completely miss critical factors
 - eg, operating system performance under heavy user load

5-Nov-2001

CSE 410 - Performance

7

Better benchmarks

- Benchmarks derived from real applications
 - Standard Performance Evaluation Corp (SPEC)
- Test hardware
 - simulated users at simulated keyboards
- Prototype deployment
 - actually build an initial version of the application and deploy it on a limited scale

5-Nov-2001

CSE 410 - Performance

8

Validate!

- Your users do not think of the system the same way you do - guaranteed!
- Document your assumptions
- Use several different types of benchmarks
- Keep an open mind
 - pay attention to business issues too, or you will be surprised when your choice is not selected

5-Nov-2001

CSE 410 - Performance

9

SPEC Benchmarks

- “Establish, maintain, and endorse standardized set of relevant benchmarks and metrics for performance evaluation of computer systems”
 - numeric computing
 - web servers
 - graphic subsystems
- Test the CPU, memory hierarchy, compilers
 - Fortran, C, C++
 - Integer and Floating Point sections

5-Nov-2001

CSE 410 - Performance

10

CPU 2000

Compression	Quantum physics
FPGA circuit placement	Shallow water model
C compiler	Multi-grid field
Combinatorial Optimizer	Partial Dif. Equations
Chess	3D Graphics
Word Processing	Fluid Dynamics
Visualization	Image recognition
Perl	Seismic wave simulation
Group Theory	Image processing
OO Database	Chemistry, Meteorology
Place and route simulator	Number theory

5-Nov-2001

CSE 410 - Performance

11

More SPEC Benchmarks

- Java Virtual Machines
- server-side Java
- shared-memory parallel programming
- SMTP and POP3 mail servers
- NFS (network file server) computers
- World Wide Web Servers
- System MultiTasking performance
- high-end industrial-style applications
- graphics performance

5-Nov-2001

CSE 410 - Performance

12

Tuning - Design for speed

- Think about performance early and often
- Good algorithms first
 - throw faster hardware at it only when you can't think of anything else
- Product is almost ready, but ...
 - particular data models cause problems
 - many concurrent users cause problems
 - etc

5-Nov-2001

CSE 410 - Performance

13

Tuning - The product is slow

- Let the numbers tell you what to work on
- Don't assume anything!
 - I/O bottlenecks, memory thrashing, unusual data sets, unexpected usage patterns, ...
 - the problems can be anywhere
 - the solutions can be anywhere
- Make sure you are solving real performance issues as perceived by the real users

5-Nov-2001

CSE 410 - Performance

14

Tuning Tools

- Clock on the wall
 - Remember your customer - web user with modem, corporate end user, sysadmin
- High level statistics from the program
 - functions performed and time elapsed
- Profiling
 - detailed information about instruction history
 - logic analyzer tracing for embedded systems

5-Nov-2001

CSE 410 - Performance

15

Profiling

- Continuously sample CPU state
 - built-in performance counters (eg I-cache miss)
 - sample program counter and context
- Procedure level
 - Where are we spending the most time?
- Instruction level
 - What are we doing there?
 - Why is it taking so long?

5-Nov-2001

CSE 410 - Performance

16