Performance Characterization

Lab 1

- Deploy and perform real HW evaluation with SpecCPU2006
  - 29 Applications
  - Compiler effect
- Study
  - ISA and optimization influence
  - Bottleneck analysis, Energy waste
- Deploy and evaluation with SpecWeb2005 and SpecJBB2005
  - 3 Applications: banking website, e-commerce website and a vendor support website
  - Appserver

CPU Benchmarks

- Designed to stress and compare processor/memory architecture
  - Little to none influence of other computer components (e.g. I/O)
  - “Supposedly” low OS impact
- Most widely use SpecCPU2006
  - Programs try to cover a ample aspect of use
  - Mostly single core (no multithreaded) although might be used to evaluate a multi-core in throughput computing environment
- Designed against bench-marketing
  - Every bit of it is designed to avoid “tampering” with the results

Everything is distilled down a number :the SPECmark

- Reference machine: Sun Ultra Enterprise II (1997/ 297 Mhz USII)
- Latency SPECmark (SPECint & SPECfp)
  - For each benchmark
    - Take odd number of samples: on both machines
    - Choose median
    - Take latency ratio (Sun Ultra Enterprise II / your machine)
  - Take GMEAN of ratios over all benchmarks
- Throughput SPECmark (SPECint_rate & SPECfp_rate)
  - Run multiple benchmarks in parallel on multiple-processor system
- Recent (latency) leaders
  - SPECint: Intel Xeon E5-2699 (63.6)
  - SPECfp: Intel Xeon E5-2699 (101)

Components of SPECcpu 2006

- Floating Point
  - http://www.spec.org/cpu2006/CFP2006/
  - 17 programs, C, C++ and Fortran.
  - Most cases physical phenomena, modeling
  - Quite regular, and “usually” memory bound

- Integer
  - http://www.spec.org/cpu2006/CINT2006/
  - 12 programs, C and C++
  - Most cases data processing or “logic” simulations
  - Quite irregular code, and “usually” CPU bound

- OS & Compiler agnostic
  - Via portability flags (conditional compilation)

Example Report

SPEC® CINT2006 Result

Hewlett-Packard Company

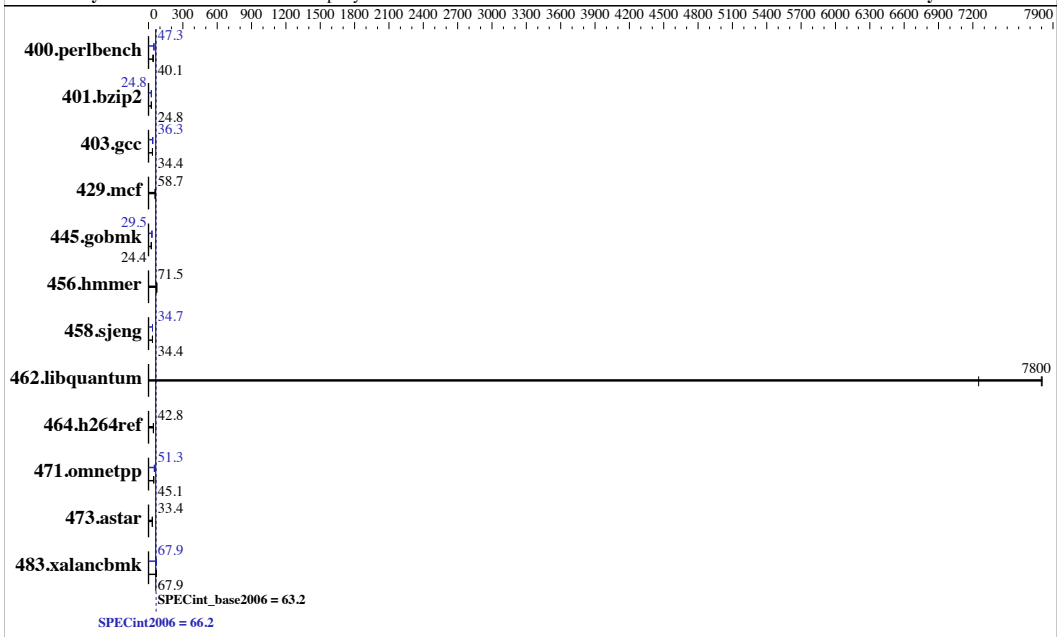
ProLiant DL380 Gen9
(2.30 GHz, Intel Xeon E5-2699 v3)

SPECint®2006 = 66.2

SPECint_base2006 = 63.2

CPU2006 license: 3
Test sponsor: Hewlett-Packard Company
Tested by: Hewlett-Packard Company

Test date: Aug-2014
Hardware Availability: Sep-2014
Software Availability: Jun-2014



Hardware

CPU Name:	Intel Xeon E5-2699 v3
CPU Characteristics:	Intel Turbo Boost Technology up to 3.60 GHz
CPU MHz:	2300
FPU:	Integrated
CPU(s) enabled:	36 cores, 2 chips, 18 cores/chip
CPU(s) orderable:	1,2 chips
Primary Cache:	32 KB I + 32 KB D on chip per core
Secondary Cache:	256 KB I+D on chip per core
L3 Cache:	45 MB I+D on chip per chip
Other Cache:	None
Memory:	256 GB (16 x 16 GB 2Rx4 PC4-2133P-R)
Disk Subsystem:	1 x 400 GB SAS SSD, RAID 0
Other Hardware:	None

Software

Operating System:	Red Hat Enterprise Linux Server release 7.0 (Maipo) Kernel 3.10.0-123.el7.x86_64
Compiler:	C/C++: Version 14.0.0.080 of Intel C++ Studio XE for Linux
Auto Parallel:	Yes
File System:	ext4
System State:	Run level 3 (multi-user)
Base Pointers:	32/64-bit
Peak Pointers:	32/64-bit
Other Software:	Microquill SmartHeap V10.0

Some notes

- Peak performance
  - Represents the results for “best” app-dependent compiler options
- Base
  - Represents the results for a “common” set of options across all the apps in the suite (using the same compiler)
- Modes
  - Default
    - Only affected by single core performance
    - Beware! Todays processors uses core independent DVFS (turbo boost)
      - **3.6Ghz versus 2.3Ghz**
  - Rate
    - Is usually used to compare performance in a throughput environment
    - Affected by the number of cores, threads per core, etc…
    - Interesting for servers in cloud-computing tasks

Task 1

- Download code
  - http://www.ce.unican.es/%7evpuente/SVS/SPECcpu2006.tar.gz
- Run the whole SPEC suite
  - Setup the environment for C/C++/Fortran
    - Use the provided scripts to produce the report of your hardware
  - Determine the influence of the ISA (from x86 to x86-64)
    - Compare a 32-bits and 64-bit compilation
  - Compare profile-guided compilation (runspec supports it and its called FDO)
- Choose one of benchmarks in each suite (both INT & FP)
  - Determine which benchmarks are memory bounded and which are CPU bounded
  - Determine how much energy is wasted due to speculation (i.e. the efficiency of the speculation)
- *Use "train" input for whole benchmark runs*
  - *Choose the most remarkable application for "ref." input*

Deployment of Complex Workloads

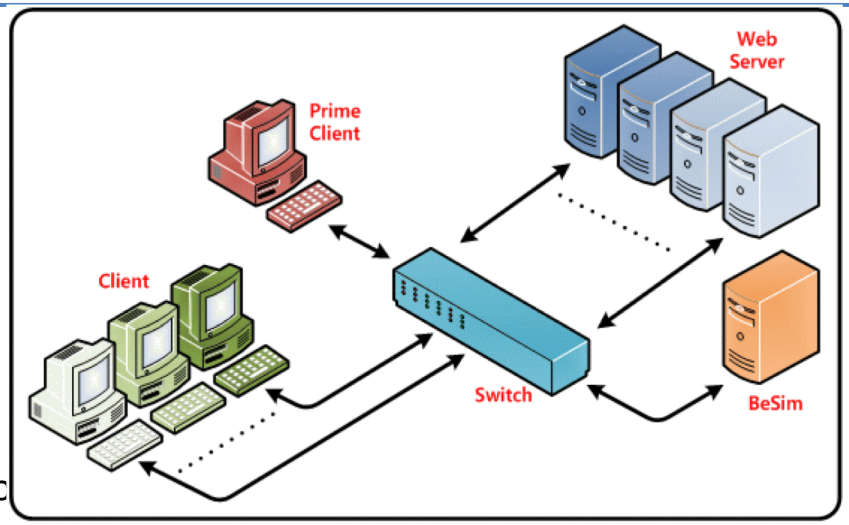
- Real life systems aren't simple cpu/mem bounded apps

- More like a combination of pieces working together to provide a results with substantial influence from I/O and other SW components (OS, DBMS, WebServer, JVM, etc…)
  - Hard to deploy and maintain
  - Hard to optimize

- Although, not widely used, there are also benchmarks
  - SpecVIRT (SpecWeb, SpecJbb)
  - TPC-XX,
  - BigBench,
  - …

Real “Life” use (Level 2)

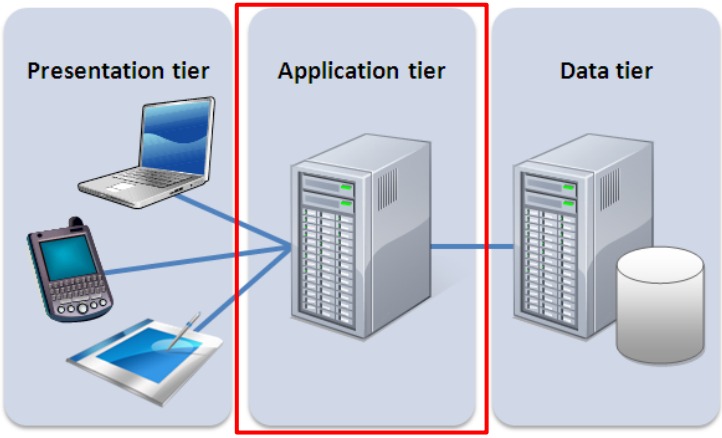
- Use SpecWeb2005 as guinea pig
  - Now is obsolete… but still useful
- Three mayor components
  - Banking Workload
    - Heavy dynamic content and fully secure
  - Ecommerce workload
    - Mixed static/dynamic content, some portic uses SSL
  - Support workload
    - Heavy static download, no SSL



- Performance measure is not easy (but not that hard either)
  - 3 pieces= Web server (jsp or php) + Back End Simulator + Clients
  - Although designed to run ins separate machines, we will use the same machine for the 3 pieces
- Hard to deploy
  - Many crosscutting issues: Apache, php, JSP, SSL, …

Real “Life” use (Level 1)

- Use SPECjbb2005
  - Representative benchmark for commercial servers
  - Evaluates the server side java in a three-tier client/server system (with emphasis in the middle tier)
  - Partially emulates an OLTP system
  - 1st degree approximation to other more complex approaches (TPC-C)



- Evaluates
  - Runtime: JVM, JIT, OS
  - CPU, Mem
  - Little I/O
- Much easier to deploy than SPECweb2005
  - Even easier than SPECCpu
  - The whole thing (setup and run) is encapsulated in a jar file

Task 2

- Download code
  - http://www.ce.unican.es/%7evpuente/SVS/SPECweb2005.tar.bz2
  - http://www.ce.unican.es/%7evpuente/SVS/SPECweb2005_ins.tar.bz2 (unpacked)
  - http://www.ce.unican.es/%7evpuente/SVS/SPECjbb2005.tar.gz

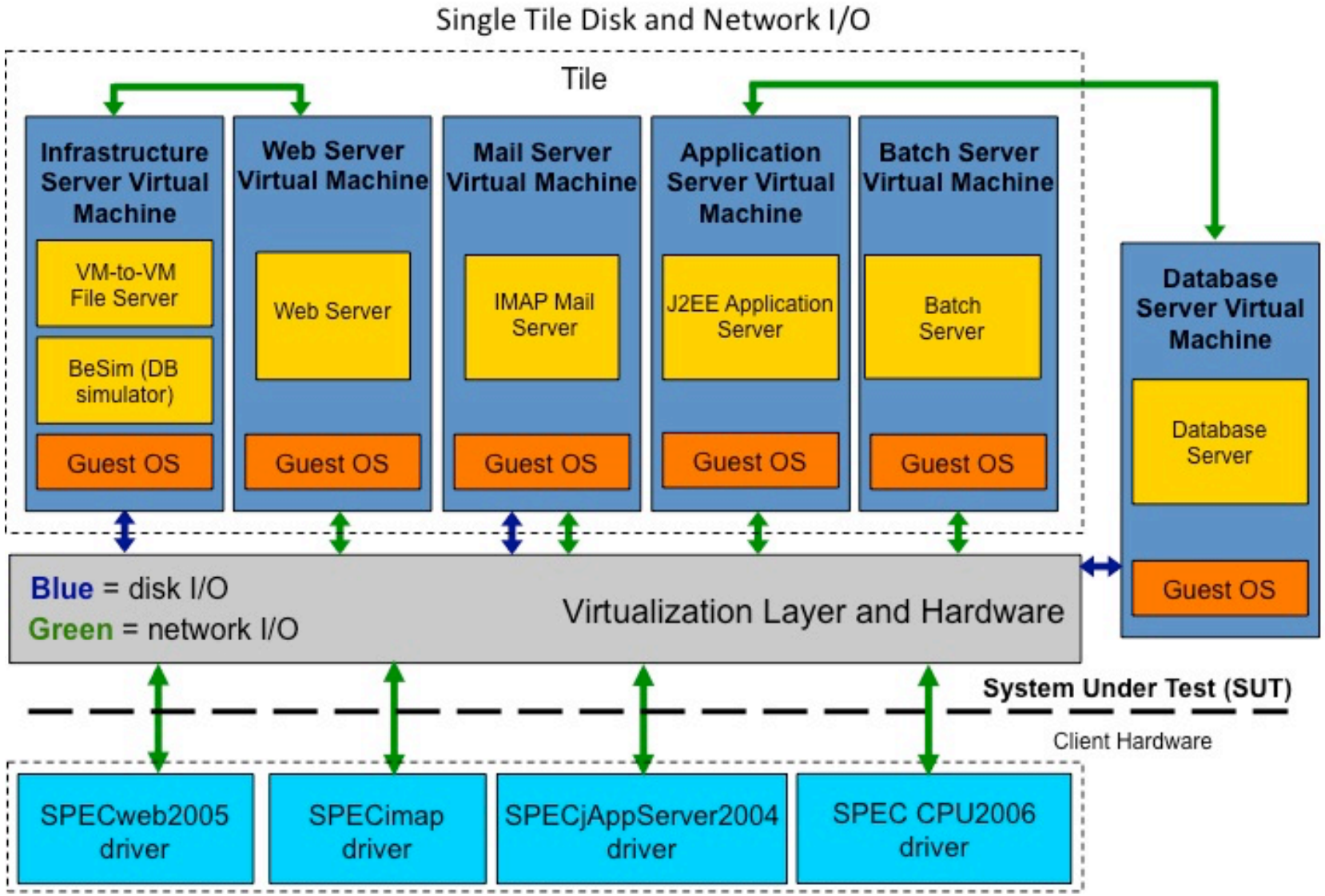
- Software stack influence in complex workloads:
  - Effects of web-server in SPECweb2005 (apache vs nginx)
  - Effects of JVM in SPECjbb2005(Oracle JVM vs *gpl* JVMs)

- Determine which component are the most limiting factor.

Grades

- Guide and presentation (25%)
- Content (75%)
  - Task 1 (25%)
    - Will require read documentation and “fix” some C/C++ code
    - Should be not hard. Might require some planning
  - Task 2
    - Level 1 (25%)
      - **Read more advanced documentation**
      - **Even easier to deploy than task 1**
    - Level 2 (25%)
      - **Hard, especially SSL portions**
      - **Will require configure apache/nginx (php, mod-cgi, SSL)**
- We will use this in next labs
  - Use profuse documentation, specially in task2.2

SPECVirt 2013



SPEC Cloud IaaS 2016

- YCSB
- K-Means