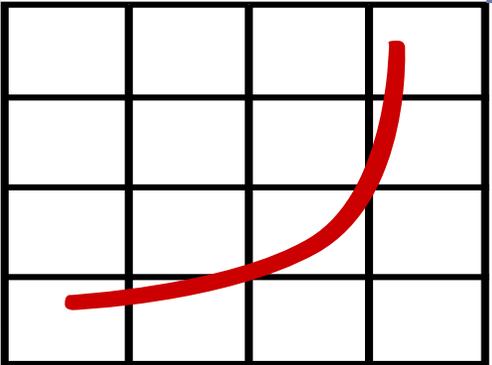


Overview of SPEC and the SPEC High Performance Group

Kalyan Kumaran, Argonne Leadership Computing Facility

Robert Henschel, Indiana University



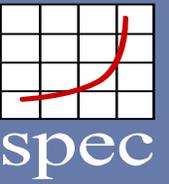
spec



<http://go.iu.edu/lp9>

- Tutorial Overview
- Intro to SPEC and SPEC HPG
- The SPEC Benchmark Philosophy
- SPEC HPG Benchmarks
- Users and Use Cases

Tutorial Overview

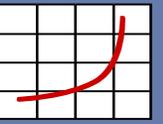


- Overview of SPEC and SPEC HPG
- SPEC Benchmarks
- Hands-On how to run SPEC Benchmarks
- Interpreting and Publishing Results
- Advances SPEC Benchmark Usage
- Wrap-Up

<http://go.iu.edu/lp9>



- **Intro to SPEC and SPEC HPG**
- The SPEC Benchmark Philosophy
- SPEC HPG Benchmarks
- Users and Use Cases



Standards Performance Evaluation Corporation (SPEC)_{spec}

- SPEC is a non-profit corporation formed to "establish, maintain and endorse a standardized set of relevant benchmarks that can be applied to the newest generation of high-performance computers"
- Composed of four groups
 - Graphics and Workstation Performance Group (GWPG)
 - High Performance Group (HPG)
 - Open Systems Group (OSG)
 - Research Group (RG)
- <https://www.spec.org>

The SPEC Consortium: Members and Associates

SPEC Members:

*Acer Inc. * Action S.A. * Advanced Micro Devices * Amazon Web Services, Inc. * Apple Inc. * ARM * ASUSTeK Computer Inc. * Avere Systems * Bull S.A. * Cavium Inc. * Cisco Systems, Inc. * Dell, Inc. * E4 Computer Engineering SPA * EMC * Fujitsu * Gartner, Inc. * Hitachi Data Systems * Hitachi Ltd. * HP * Huawei Technologies Co. Ltd. * IBM * Inspur Corporation * Intel * Lenovo * Micron Technology, Inc. * Microsoft * NEC - Japan * NetApp * NVIDIA * Oracle * Panasas * Primary Data * Principled Technologies * Qualcomm Technologies Inc. * Quanta Computer Inc. * Red Hat * Samsung * SAP AG * Seagate * SGI * Sugon * Super Micro Computer, Inc. * SUSE * Symantec Corporation * Twitter, Inc. * Unisys * Via Technologies * VMware * Wipro Ltd. * ZTE Corporation **

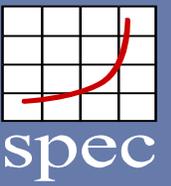
SPEC Associates:

*Academia Sinica, Institute of Information Science * Argonne National Laboratory * Charles University * China Academy of Telecommunication Research * Department of Veterans Affairs - Corporate Data Center Operations * Dresden University of Technology ZIH * fortiss GmbH * Indiana University * Institute for Information Industry Taiwan * JAIST * Karlsruhe Institute of Technology * Leibniz Rechenzentrum - Germany * National University of Singapore * Oak Ridge National Laboratory * Ohio State University * Pennsylvania State University * Purdue University * RWTH Aachen University * Technische Universität Darmstadt * Technische Universität Dresden * Tsinghua University * University of Aizu - Japan * University of California - Berkeley * University of Cologne * University of Houston * University of Illinois at Urbana-Champaign * University of Maryland * University of Miami * University of Pavia * University of Texas at Austin * University of Tsukuba * University of Wuerzburg * Virginia Polytechnic Institute and State University **

SPEC Research Group:

*Advanced Strategic Technology LLC * bankmark UG * Barcelona Supercomputing Center * Charles University * Cisco Systems * Cloudera, Inc * Compilaflores * Delft University of Technology * Dell * fortiss GmbH * Friedrich-Alexander-University Erlangen-Nuremberg * Goethe University Frankfurt, Big Data Lab * Hewlett-Packard * Huawei * IBM * Imperial College London * Indian Institute of Technology, Bombay * Institute for Information Industry, Taiwan * Institute of Communication and Computer Systems/NTUA * Intel * Karlsruhe Institute of Technology * Kiel University * MIOsoft Corporation * Mitre Corporation * NICTA * Nova-Tec Consulting GmbH * Oracle * Purdue University * Red Hat * RWTH Aachen University * Salesforce.com * San Diego Supercomputing Center * San Francisco State University * SAP AG * Siemens Corporation * Technische Universität Darmstadt * Technische Universität Dresden * The MITRE Corporation * Umea University * University of Alberta * University of Coimbra * University of Florence * University of Lugano * University of Minnesota * University of North Florida * University of Paderborn * University of Pavia * University of Stuttgart * University of Texas at Austin * University of Wuerzburg * VMware **

SPEC High Performance Group (HPG)



- Develops benchmarks to represent high-performance computing applications for standardized, cross-platform performance evaluation.

- Benchmarks

- SPEC OMP2012
- SPEC MPI2007
- SPEC ACCEL



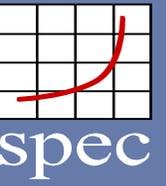
UNIVERSITY OF HOUSTON



INDIANA UNIVERSITY



- Intro to SPEC and SPEC HPG
- **The SPEC Benchmark Philosophy**
- SPEC HPG Benchmarks
- Users and Use Cases



SPEC Benchmark Philosophy

- The result of a SPEC benchmark is always a SPEC score.
 - Higher is better

- This score is always in relation to a reference machine.
 - Each benchmark has its own reference machine

SPEC Benchmark Philosophy cont'd

- SPEC (HPG) benchmarks are full applications.
 - Including all the overhead of a real application
- SPEC harness ensures correctness of results.
 - To detect “overly aggressive optimization”
 - To guard against tampering
- Each benchmark suite has a set of run rules.

SPEC Benchmark Philosophy cont'd

- Hierarchy within benchmark suits
 - Benchmark suite i.e. SPEC ACCEL
 - Benchmark i.e. OpenACC
 - Dataset size i.e. Medium
 - Component i.e. 350.md

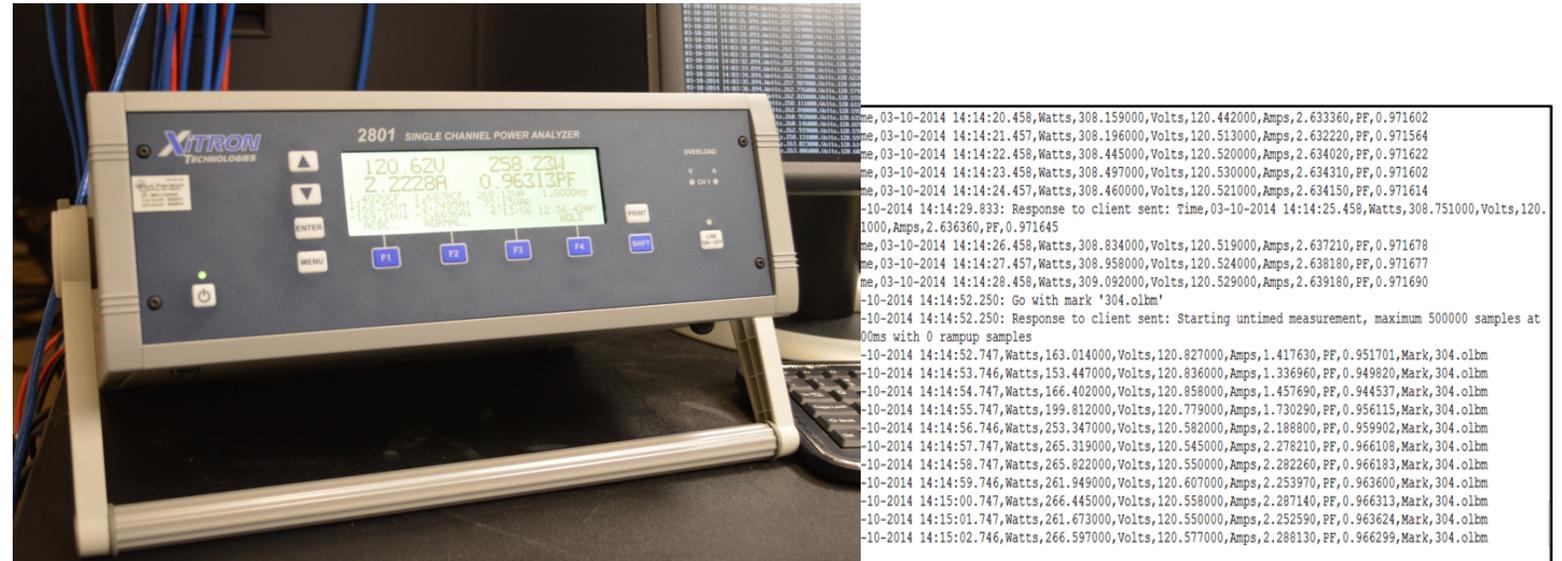
SPEC Benchmark Philosophy cont'd

- Benchmarks support “Base” and “Peak” configuration
 - These yield separate SPEC scores.
 - Peak” runs allow for more freedom.

- Base runs
 - The same compiler switches for all components
 - The same parallelism
 - Only portability switches allowed

SPEC Power

- SPEC provides a standard methodology to measure and report power usage which can be incorporated into a SPEC benchmark.
- Normalizes the power usage across the full run of the suite



Benchmark Development Process

- Group effort, with lots of discussions
- Final decisions are by vote, even though we strive for consensus
- Technical and managerial parts
 - Find benchmark components and define run rules
- Using SPEC provided tools
 - SVN, harness, “common rules”
 - Websites, mailing lists, meeting venues

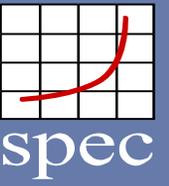
Result Submission Process

- Obtain and install the benchmark
- Perform a valid run
- Supply hardware and software description
- Submit result for review (and publication) to SPEC HPG
 - 2 week review process
 - (Define embargo period)
- Use the result as you would like (within fair use policy)

The Value of a Curated Result Repository

- Given appropriate hardware.... a published result should be reproducible just with the information available in the submission.
- Peer reviewed results are so much better than “everyone can upload a result”!
- The value of a benchmark suite lies in public results, their correctness and the ability to compare them.

Contents



- Intro to SPEC and SPEC HPG
- The SPEC Benchmark Philosophy
- **SPEC HPG Benchmarks**
- Users and Use Cases

- SPEC Accel provides a comparative performance measure of
 - Hardware accelerator devices (GPU, Co-processors, etc.)
 - Supporting software tool chains (Compilers, Drivers, etc.)
 - Host systems and accelerator interface (CPU, PCIe, etc.)
- Computationally-intensive parallel HPC applications and mini-apps
- Portable across multiple accelerators
- Two distinct benchmarks
 - OpenACC v1.0
 - OpenCL v1.1
- Support for power measurement

- Follow on to SPEC OMP2001
- 14 applications
- Scales up to 512 threads
- Support for power measurement

- Large and medium data set
- 13 applications
- Scales to 2048 MPI processes
- Power not supported

Under Development

- SPEC MPI2007 XXL dataset
 - Scalability target 8K cores
- SPEC ACCEL version 1.1
 - Minor tweaks
- SPEC ACCEL OpenMP 4.0 benchmark
 - This is hard... given the state of OpenMP 4.0 compilers

- Intro to SPEC and SPEC HPG
- The SPEC Benchmark Philosophy
- SPEC HPG Benchmarks
- **Users and Use Cases**

- System vendors
- Accelerator vendors
- Software vendors
- Users looking for objective comparison
- Researchers

Vendors

- Marketing
- Drive benchmark development
 - To utilize state of the art hardware/software features
- Internal validation suite
 - Compiler
 - OMP / MPI runtime libraries
- Prepare for RFPs

Application Developers

- Include their application in the benchmark suite
- Compare hardware and software stack
 - Compilers
 - Parallel runtimes
 - Different versions of processors
 - Different interconnects

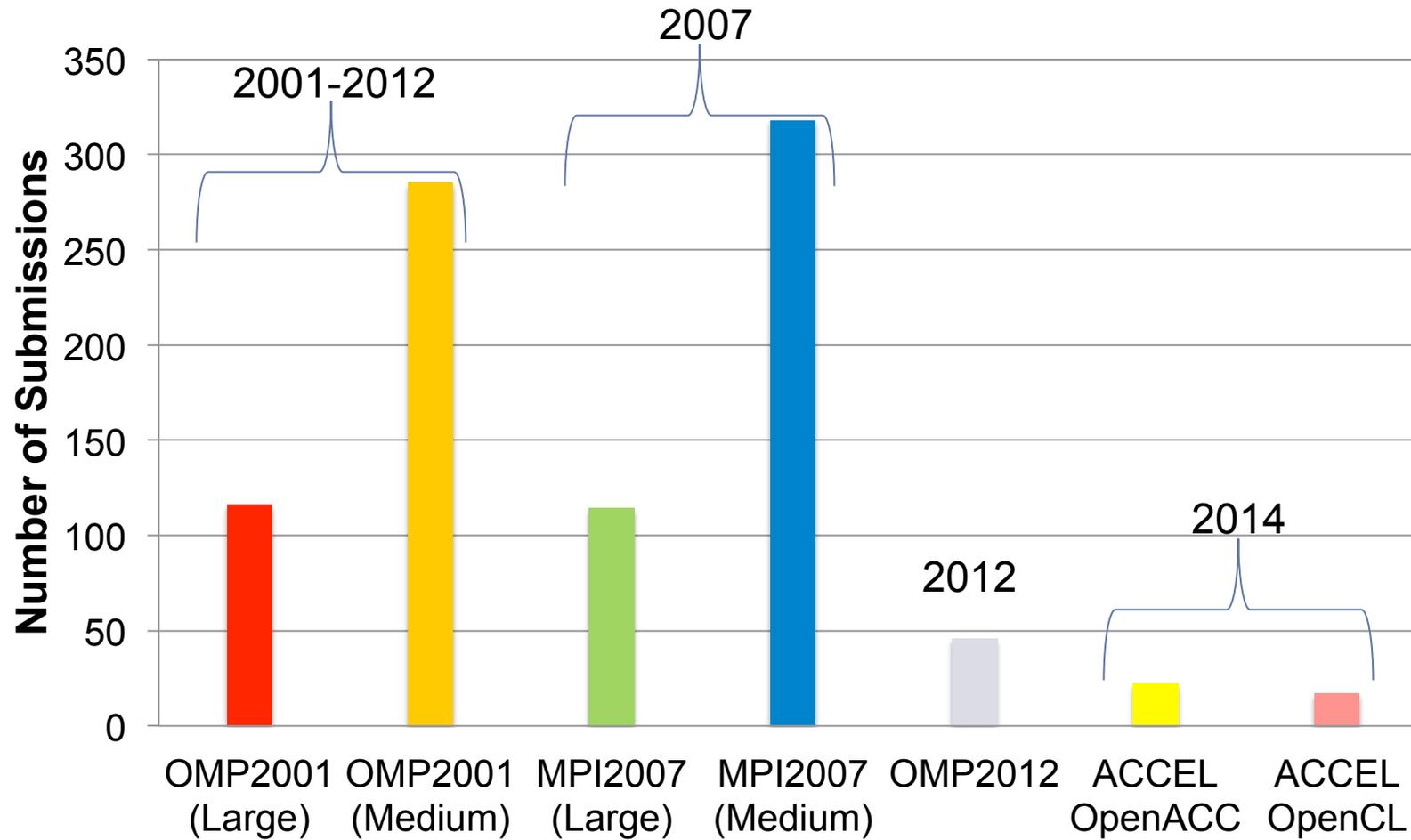
- Include the benchmarks in the RFP process
- Use them for performance regression testing
 - Hardware
 - Software
- System configuration and tuning
- Power consumption

- Scalability studies
- Novel implementations of parallel runtime libraries
- Detailed power consumption studies
- Comparison of parallel programming paradigms

Join and Contribute

- Submit results
- Full members vs. associate members
- Contribute benchmark components
- Help with benchmark suite development
- Test release candidates

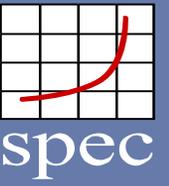
Result Submissions by Benchmark



Sample Use Cases

- Comparing performance and energy
- Comparing performance of hypervisors
- Comparing HPC systems at a specific center
- Compare compiler performance over time
- Compare performance of different compilers
- Scalability study for different interconnects
- System setup questions like to use HT or not, which OS to use
- Compare accelerator performance

Thank you!



Questions?