An Introduction to the SPEC High Performance Group and their HPC Benchmark Suites

Robert Henschel

Chair, High Performance Group (HPG)
Standard Performance Evaluation Corporation (SPEC)

Director, Research Software and Solutions
Indiana University

January 2019

RESEARCH TECHNOLOGIES
INDIANA UNIVERSITY
University Information Technology Services

PERVASIVE TECHNOLOGY INSTITUTE
INDIANA UNIVERSITY

spec

Content

- SPEC and SPEC HPG
- SPEC Benchmark Philosophy
- SPEC HPG Benchmarks
- Benchmark Use Cases
- How to Contribute

SPEC and SPEC HPG

SPEC is a non-profit corporation formed in 1988 to establish, maintain and endorse standardized benchmarks and tools to evaluate performance and energy efficiency for the newest generation of computing systems.

- **OSG: Open System Group**
- HPG: High Performance Group
- GWPG: Graphics & Workstation Performance Group
- RG: Research Group

Largest & Oldest Group
- Cloud
- CPU
- Java
- Power
- Virtual Machine
- File Server

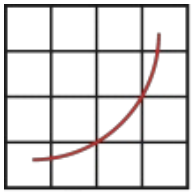
SPEC and SPEC HPG

SPEC is a non-profit corporation formed in 1988 to establish, maintain and endorse standardized benchmarks and tools to evaluate performance and energy efficiency for the newest generation of computing systems.

- OSG: Open System Group
- **HPG: High Performance Group**
- GWPG: Graphics & Workstation Performance Group
- RG: Research Group

HPC benchmarks
- MPI
- OpenMP
- Accelerator
  - OpenCL
  - OpenACC
  - OpenMP 4.5

SPEC and SPEC HPG



136 Organizations, including:

- 99 companies
- 37 academic institutions

spec®

spec

Standard Performance Evaluation Corporation

Home | Benchmarks | Tools | Results | Contact | Site Map | Search | Help

Benchmarks

- Cloud
- CPU
- Graphics/Workstations
- ACCEL/MPI/OMP
- Java Client/Server
- Mail Servers
- Storage
- Power
- Virtualization
- Web Servers

- Results Search

- Submitting Results
  - Cloud/CPU/Java/Power
  - SFS/Virtualization
  - ACCEL/MPI/OMP
  - SPECapc/SPECviewperf/SPECwpc

Tools

- SERT
- PTDaemon
- Chauffeur WDK

Order Benchmarks

- Order Form
- Downloads

SPEC

- About SPEC
  - GWPG
  - HPG
  - OSG
  - RG
- Membership
  - Member organizations

The SPEC Consortium: Members and Associates

SPEC Members:

*Acer Inc. * Action S.A. * Advanced Micro Devices * Amazon Web Services, Inc. * Apple Inc. * ARM * Avere Systems * Bull SAS * Cavium Inc. * Ciara Technologies Inc. * Cisco Systems, Inc. * Dell, Inc. * Digital Ocean * E4 Computer Engineering SPA * Fujitsu * Gartner, Inc. * Guizhou Huaxintong Semiconductor Technology Co. Ltd * Hitachi Data Systems * Hitachi Ltd. * Hewlett Packard Enterprise * HP Inc. * Huawei Technologies Co. Ltd. * IBM * Inspur Corporation * Intel * Lenovo * M Computers s.r.o. * Microsoft * NEC - Japan * NetApp * New H3C Technologies Co., Ltd. * NVIDIA * Oracle * OVH SAS * Primary Data * Principled Technologies * Pure Storage * Qualcomm Technologies Inc. * Quanta Computer Inc. * Red Hat * Samsung * SAP AG * Seagate * Sugon * Super Micro Computer, Inc. * SUSE * Taobao (China) Software Co. Ltd. * Unisys * Veritas Technologies * Via Technologies * VMware * WekaIO *

SPEC Associates:

*Acadamia Sinica, Institute of Information Science * Argonne National Laboratory * Charles University * China Academy of Telecommunication Research * Dresden University of Technology ZIH * fortiss GmbH * Helmholtz-Zentrum Dresden Rossendorf (HZDR) * Indiana University * JAIST * Karlsruhe Institute of Technology * Leibniz Rechenzentrum - Germany * Linaro Limited * 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 * Telecommunications Technology Association * Tsinghua University * University of Aizu - Japan * University of Basel * University of California - Berkeley * University of Cologne * University of Delaware * University of Illinois at Urbana-Champaign * University of Maryland * University of Miami * University of Texas at Austin * University of Tsukuba * University of Wuerzburg * Virginia Polytechnic Institute and State University *

SPEC Research Group:

*Advanced Strategic Technology LLC * Apple Inc. * ARM * bankmark UG * Barcelona Supercomputing Center * BEZNet * Charles University * Cisco Systems * Cloudera, Inc * Compilaflows * Delft University of Technology * Dell * Escuela Superior Politecnica del Litoral * fortiss GmbH * Friedrich-Alexander-University Erlangen-Nuremberg * Goethe University Frankfurt, Big Data Lab * Hewlett Packard Enterprise * Huawei * IBM * Imperial College London * Institute for Information Industry, Taiwan * Intel * Karlsruhe Institute of Technology * Kiel University * Linkoping University * Lund University * Microsoft * NICTA * NovaTec Consulting GmbH * Oracle * Purdue University * Queen's University * Red Hat * RETIT GmbH * RWTH Aachen University * SalesForce.com * San Diego Supercomputing Center * San Francisco State University * SAP AG * Stiftung University * SINTEF * Software Performance and Scalability Consulting * Tata Consultancy Services * Technica Corporation * Technische Universität Darmstadt * Technische Universität Dresden * The MITRE Corporation * Umea University * University of Alberta * University of Coimbra * University of Lugano * University of Minnesota * University of North Florida * University of Paderborn * University of Stuttgart * University of Texas at Austin * University of Wuerzburg * University Politehnica of Bucharest * VMware * York University *

To learn about SPEC Membership, please read the SPEC FAQ.

SPEC and SPEC HPG

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

31 Organizations
10 companies
21 academic

Lenovo

INDIANA UNIVERSITY

Content

- SPEC and SPEC HPG
- SPEC Benchmark Philosophy
- SPEC HPG Benchmarks
- Benchmark Use Cases
- How to Contribute

SPEC Benchmark Philosophy

- The result of a SPEC benchmark is one SPEC score.
  - Higher is better
  - Some benchmarks support power measurement
- This score is in relation to a reference machine.
  - Each benchmark has its own reference machine

- 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” and tampering

- Each benchmark suite has run rules and documentation requirements.

SPEC Benchmark Philosophy

Hierarchy within benchmark suits

- Benchmark suite
- Benchmark
- Dataset size
- Component

SPEC ACCEL
↳ OpenMP2012
↳ Medium
↳ 550.md

Benchmarks support “Base” and “Peak” configuration

- These yield separate SPEC scores, “Peak” runs allow for more freedom.

Base runs

- The same optimization compiler switches for all components
- The same level of parallelism
- Only portability switches allowed

SPEC Benchmark Philosophy

Result submission:

- Obtain and install the benchmark
- Perform a valid run and describe hardware and software configuration
- Submit result for review (and publication) to SPEC HPG – 2 week review process
- If needed, define embargo period
- Results are published on SPEC website

A curated result repository:

- Given appropriate hardware and software…. a published result should be reproducible 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.

SPEC Benchmark Philosophy

OpenACC (31):

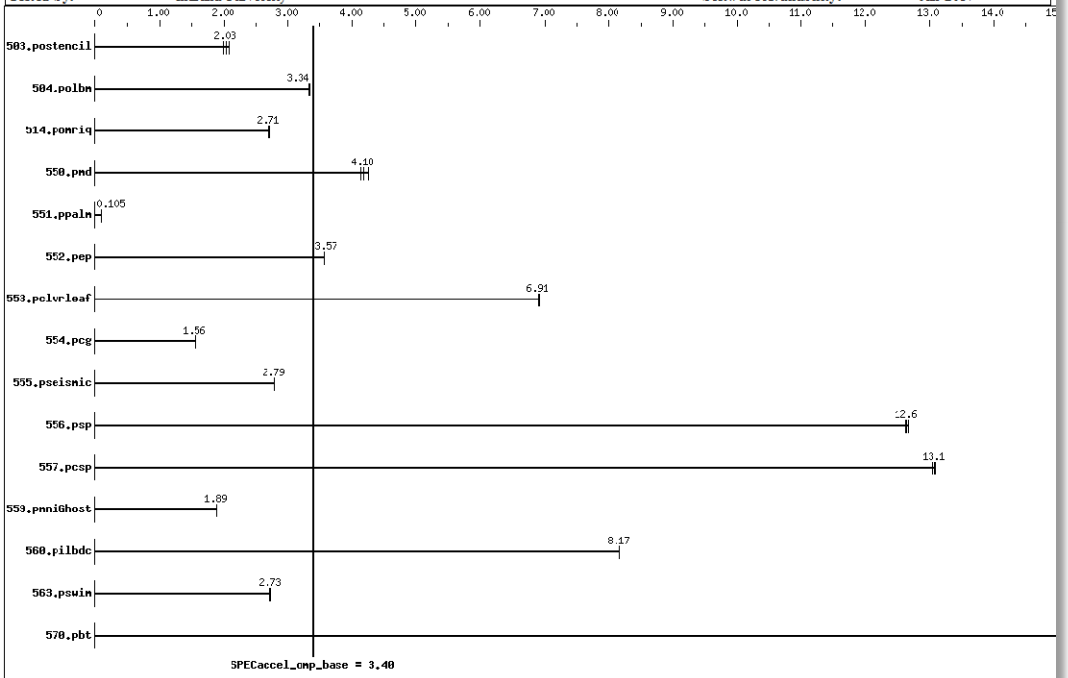
Test Sponsor	System Name	Accelerator Name	Results		Energy	
			Base	Peak	Base	Peak
Cirrascale Corporation	GIGABYTE MD70-HB0 Motherboard HTML | CSV | Text | PDF | PS | Config	FirePro s9150	2.89	2.99	--	--
Cirrascale Corporation	GIGABYTE MD70-HB0 Motherboard HTML | CSV | Text | PDF | PS | Config	FirePro s9150	3.10	3.21	--	--
Cirrascale Corporation	GIGABYTE MD70-HB0 Motherboard HTML | CSV | Text | PDF | PS | Config	FirePro s9150	3.60	Not Run	--	--
Indiana University	Cray XK7 HTML | CSV | Text | PDF | PS | Config	NVIDIA Tesla K20	1.74	Not Run	--	--
Indiana University	Cray XK7 HTML | CSV | Text | PDF | PS | Config	NVIDIA Tesla K20	1.27	Not Run	--	--
Indiana University	Cray XK7 HTML | CSV | Text | PDF | PS | Config	NVIDIA Tesla K20	1.31	Not Run	--	--
Indiana University	Cray XK7 HTML | CSV | Text | PDF | PS | Config	NVIDIA Tesla K20	1.77	Not Run	--	--
NVIDIA Corporation	ASUS P9X79 Motherboard HTML | CSV | Text | PDF | PS | Config	NVIDIA Tesla K40c	2.59	2.73	3.01	3.13
NVIDIA Corporation	ASUS P9X79 Motherboard HTML | CSV | Text | PDF | PS | Config	NVIDIA Tesla K40c	2.59	2.72	3.35	3.49
RWTH Aachen University	bullx R421-E3 HTML | CSV | Text | PDF | PS | Config	NVIDIA Tesla K20Xm	2.00	Not Run	--	--
RWTH Aachen University	bullx R425-E2 HTML | CSV | Text | PDF | PS | Config	NVIDIA Quadro 6000	1.05	Not Run	--	--

SPEC® ACCEL™ OMP Result

Colfax International (Test Sponsor: Indiana University)
Xeon Phi 7210
Ninja Developer Platform Pedestal: Liquid Cooled

SPECaccel_omp_base =	3.40
SPECaccel_omp_energy_base =	4.54
SPECaccel_omp_peak =	Not Run
SPECaccel_omp_energy_peak =	--

ACCEL license:	3440A	**Test date:**	May-2017
Test sponsor:	Indiana University	**Hardware Availability:**	Aug-2016
Tested by:	Indiana University	**Software Availability:**	Jan-2017



Hardware

CPU Name:	Intel Xeon Phi 7210
CPU Characteristics:	Simultaneous multithreading (SMT) on, Turbo off.
CPU MHz:	1300
CPU MHz Maximum:	1300
FPU:	Integrated
CPU(s) enabled:	64 cores, 1 chip, 64 cores/chip, 4 threads/core
CPU(s) orderable:	1 to 1 chip
Primary Cache:	32 KB I + 32 KB D on chip per core
Secondary Cache:	1 MB I+D on chip per tile (2 cores)
L3 Cache:	None
Other Cache:	None
Memory:	96 GB (6 x 16 GB 2Rx8 PC4-2400T-REB-11, ECC) + 16 GB MCDRAM
Disk Subsystem:	Intel S3510 SSD 800GB, SATA3
Other Hardware:	None

Accelerator

Accel Model Name:	Xeon Phi 7210
Accel Vendor:	Intel
Accel Name:	Xeon Phi 7210
Type of Accel:	CPU
Accel Connection:	N/A
Does Accel Use ECC:	Yes
Accel Description:	Second generation Xeon Phi self-bootable CPU, SMT on, Turbo off, flat DDR4+MCDRAM
Accel Driver:	N/A

Software

Operating System:	CentOS Linux release 7.2.1511 (Core) 3.10.0-327.13.1.el7.xppsl_1.3.3.151.x86_64
Compiler:	Intel Parallel Studio XE 2017 Update 1 for Linux, Version 17.0.1.132 Build 20161005
File System:	ext4
System State:	Run level 3 (multi-user with networking)
Other Software:	None

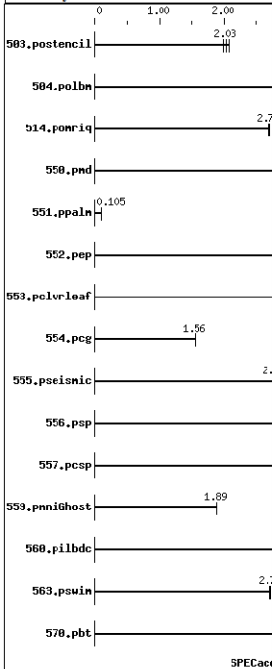
Power

Power Supply:	750W

spec

Colfax International (Test Spons
Xeon Phi 7210
Ninja Developer Platform Pe

ACCEL license:	3440A
Test sponsor:	Indiana Univers
Tested by:	Indiana Univers



Hard

CPU Name:	Intel Xeon Phi 7
CPU Characteristics:	Simultaneous mu
CPU MHz:	1300
CPU MHz Maximum:	1300
FPU:	Integrated
CPU(s) enabled:	64 cores, 1 chip,
CPU(s) orderable:	1 to 1 chip
Primary Cache:	32 KB I + 32 KE
Secondary Cache:	1 MB I+D on ch
L3 Cache:	None
Other Cache:	None
Memory:	96 GB (6 x 16 G + 16 GB MCDR
Disk Subsystem:	Intel S3510 SSD
Other Hardware:	None

Power Supply:

Power Supply Details:	Seasonic SSR-750RM Active PFC F3
Max. Power (W):	286.39
Idle Power (W):	91.01
Min. Temperature (C):	21.69

Power Analyzer

Power Analyzer:	156.56.179.146:8888
Hardware Vendor:	ZES Zimmer
Model:	ZES LMG450:4-Channel
Serial Number:	01001849
Input Connection:	RS232 USB adapter
Metrology Institute:	NIST (National Institute of Standards and Technology)
Calibration By:	ZES Zimmer
Calibration Label:	3783190001e
Calibration Date:	02.20.2017
PTDaemon Version:	1.8.1 (a497ea15; 2016-12-20)
Setup Description:	connected to the single power supply that powers the system
Current Ranges Used:	0.0A
Voltage Range Used:	130V

Temperature Meter

Temperature Meter:	156.56.179.146:8889
Hardware Vendor:	Digi
Model:	Watchport/H
Serial Number:	W40236768
Input Connection:	USB
PTDaemon Version:	1.8.1 (a497ea15; 2016-12-20)
Setup Description:	positioned in front of intake fan

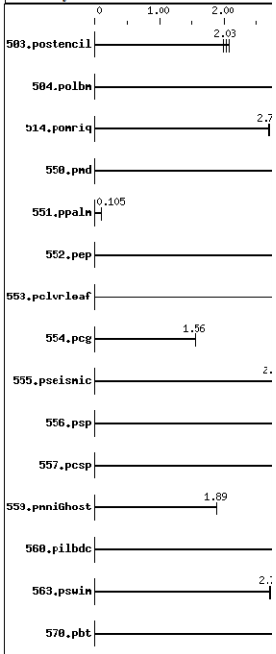
Base Results Table

Benchmark	Seconds	Ratio	--	--																

spec

Colfax International (Test Spons
Xeon Phi 7210
Ninja Developer Platform Pe

ACCEL license:	3440A
Test sponsor:	Indiana Univers
Tested by:	Indiana Univers



Hard

CPU Name:	Intel Xeon Phi 7
CPU Characteristics:	Simultaneous mu
CPU MHz:	1300
CPU MHz Maximum:	1300
FPU:	Integrated
CPU(s) enabled:	64 cores, 1 chip,
CPU(s) orderable:	1 to 1 chip
Primary Cache:	32 KB I + 32 KE
Secondary Cache:	1 MB I+D on ch
L3 Cache:	None
Other Cache:	None
Memory:	96 GB (6 x 16 G + 16 GB MCDR
Disk Subsystem:	Intel S3510 SSD
Other Hardware:	None

Power Supply:

Power Supply Details:	Sea
Max. Power (W):	286
Idle Power (W):	91.(
Min. Temperature (C):	21.(

Power Analyzer

Power Analyzer:	156.56.179.146:8888
Hardware Vendor:	ZES Zimmer
Model:	ZES LMG450:4-Channel
Serial Number:	01001849
Input Connection:	RS232 USB adapter
Metrology Institute:	NIST (National Institute of Standards and Technology)
Calibration By:	ZES Zimmer
Calibration Label:	3783190001e
Calibration Date:	02.20.2017
PTDaemon Version:	1.8.1 (a497ea15; 2016-12-20)
Setup Description:	connected to the single power supply that po the system
Current Ranges Used:	0.0A
Voltage Range Used:	130V

Benchmark	Seconds	Ratio	--	--				

```
      VERSION="7 (Core)"
      ID="centos"
      ID_LIKE="rhel fedora"
      VERSION_ID="7"
      PRETTY_NAME="CentOS Linux 7 (Core)"
      ANSI_COLOR="0;31"
      CPE_NAME="cpe:/o:centos:centos:7"
   redhat-release: CentOS Linux release 7.2.1511 (Core)
   system-release: CentOS Linux release 7.2.1511 (Core)
   system-release-cpe: cpe:/o:centos:centos:7

uname -a:
   Linux knl1.uits.indiana.edu 3.10.0-327.13.1.el7.xppsl_1.3.3.151.x86_64 #1 SMP
   Fri Jun 10 15:04:35 UTC 2016 x86_64 x86_64 x86_64 GNU/Linux

run-level 3 May 2 10:51

SPEC is set to: /home/lijunj/spec/accel-test/75
   Filesystem     Type  Size  Used Avail Use% Mounted on
   /dev/sda3      ext4  713G  174G  503G  26% /

Cannot run dmidecode; consider saying 'chmod +s /usr/sbin/dmidecode'

(End of data from sysinfo program)
```

General Notes

```
BIOS settings:
  Intel Simultaneous Multithreading (SMT): on
  Intel Turbo Boost Technology (Turbo)  : off
  Cluster Mode: quadrant
  Memory Mode: flat
  (MCDRAM is partitioned to the second NUMA node)

Current range for power measurement is 2.5A.
```

Base Compiler Invocation

C benchmarks:

icc

Fortran benchmarks:

ifort

Benchmarks using both Fortran and C:

icc ifort

Base Portability Flags

503.postencil: -DSPEC_USE_INNER_SIMD
504.polbm: -DSPEC_USE_INNER_SIMD
514.pomriq: -DSPEC_USE_INNER_SIMD
550.pmd: -DSPEC_USE_INNER_SIMD -80
551.ppalm: -DSPEC_USE_INNER_SIMD
552.pep: -DSPEC_USE_INNER_SIMD
553.pclvrleaf: -DSPEC_USE_INNER_SIMD
554.pcg: -DSPEC_USE_INNER_SIMD
555.pseismic: -DSPEC_USE_INNER_SIMD
556.psp: -DSPEC_USE_INNER_SIMD
557.pcsp: -DSPEC_USE_INNER_SIMD
559.pmniGhost: -DSPEC_USE_INNER_SIMD -nofor-main
560.pilbdc: -DSPEC_USE_INNER_SIMD
563.pswim: -DSPEC_USE_INNER_SIMD
570.pbt: -DSPEC_USE_INNER_SIMD

Base Optimization Flags

C benchmarks:

-O3 -qopenmp -qopenmp-offload=host -xMIC-AVX512

Fortran benchmarks:

-O3 -qopenmp -qopenmp-offload=host -xMIC-AVX512

Benchmarks using both Fortran and C:

-O3 -qopenmp -qopenmp-offload=host -xMIC-AVX512

The flags files that were used to format this result can be browsed at
https://www.spec.org/accel/flags/Intel-ic17.0-linux64.html,
https://www.spec.org/accel/flags/colfax-knl.html.

You can also download the XML flags sources by saving the following links:
https://www.spec.org/accel/flags/Intel-ic17.0-linux64.xml,
https://www.spec.org/accel/flags/colfax-knl.xml.

Content

- SPEC and SPEC HPG
- SPEC Benchmark Philosophy
- SPEC HPG Benchmarks
- Benchmark Use Cases
- How to Contribute

SPEC HPG Benchmarks - Pricing

- Different groups in SPEC have different policies on the sale of benchmarks.
- **Since March 2018, SPEC HPG benchmarks are available free of charge to non-profit organizations, including universities and research labs.**
- SPEC HPG hopes that this will encourage even more organizations to actively participate.

SPEC HPG Benchmarks - ACCEL

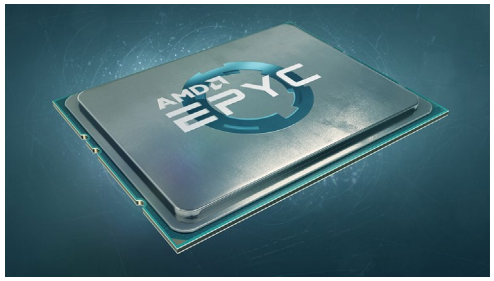
- SPEC Accel provides a comparative performance measure of
  - Hardware accelerator devices (GPU, Co-processors, etc.)
  - Supporting software tool chains (Compilers, Drivers, etc.)
  - Host systems and accelerator interface (CPU, PCIe, etc.)
- Computationally-intensive parallel HPC applications and mini-apps
- Portable across multiple accelerators
- Three distinct benchmarks, initially released in 2014, updated in 2017:
  - OpenCL v1.1 19 C/C++ applications
  - OpenACCv 1.0 15 Fortran/C applications
  - OpenMP v4.5, 15 Fortran/C applications
- Support for power measurement

SPEC HPG Benchmarks - ACCEL

Accel score: 3.02
Dual 20-core Power 9 @3.4 GHz
IBM AC922

Accel score: 11.9
Tesla V100, IBM
AC922

OpenACC: portable across different platforms (PGI compiler)



Accel score: 2.59
Dual EPYC 7451

Accel score: 3.7
Dual Xeon Gold 6148

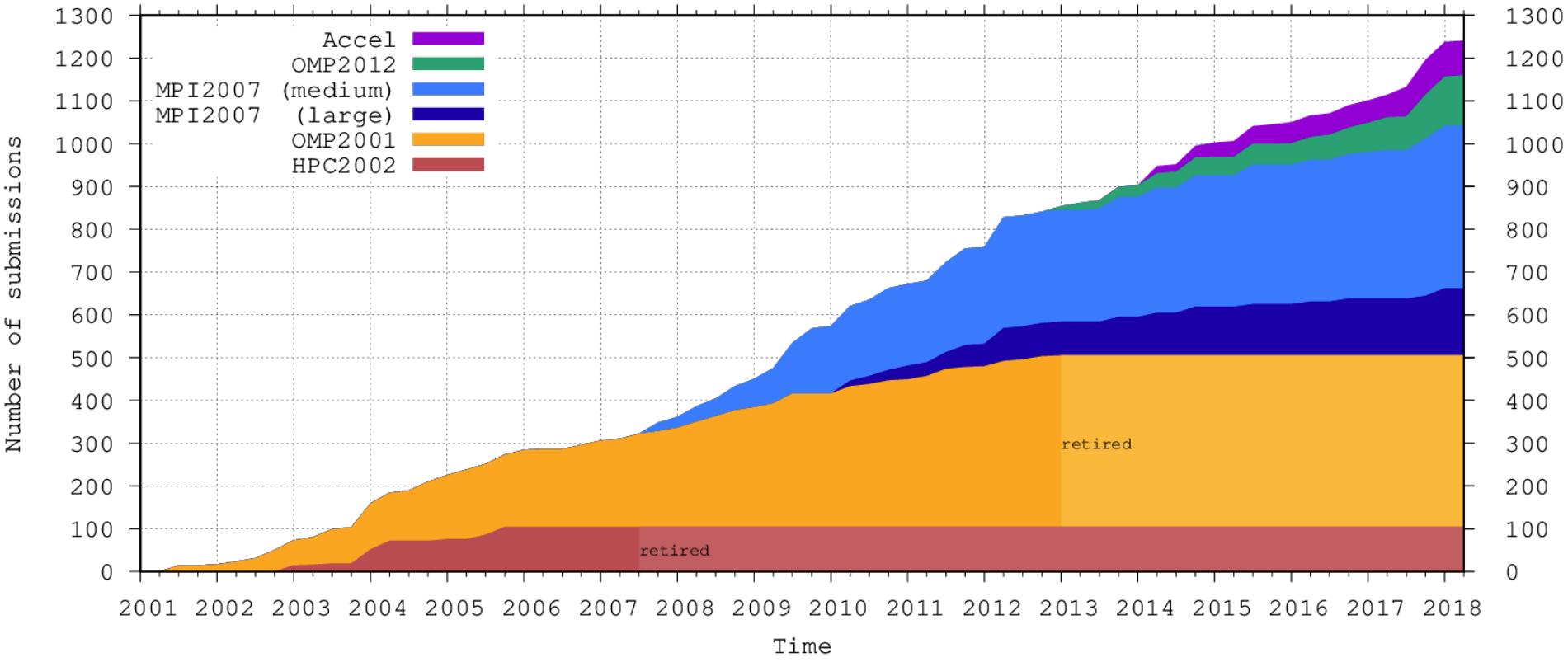
SPEC HPG Benchmarks – OMP2012

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

SPEC HPG Benchmarks – MPI2007

- Large and medium data set
- 13 applications in Fortran/C/C++
- Scales to 2048 MPI processes
- Power not supported

Published Results



Future SPEC HPG Benchmarks – MPI+X

- First hybrid benchmark, posing lots of challenges for run rules and metrics
  - "+X" can be anything, including, OpenMP, OpenACC, CUDA, TBB, Kokkos, PTHREADS, …
- Search program in 2017 and 2018, benchmark creation in 2018 and 2019
- More than a dozen candidates submitted from 3 continents and 6 different countries and more to come.

Content

- SPEC and SPEC HPG
- SPEC Benchmark Philosophy
- SPEC HPG Benchmarks
- Benchmark Use Cases
- How to Contribute

Use Cases

- System, accelerator and software vendors
- Application developers
- Users and HPC centers
- Researchers
- Examples

Use Cases – 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

Use Cases – Application Developers

- Include their application in the benchmark suite
  - See results on a lot of different systems.
- Compare hardware and software stack
  - Compilers
  - Parallel runtimes
  - Different versions of processors
  - Different interconnects

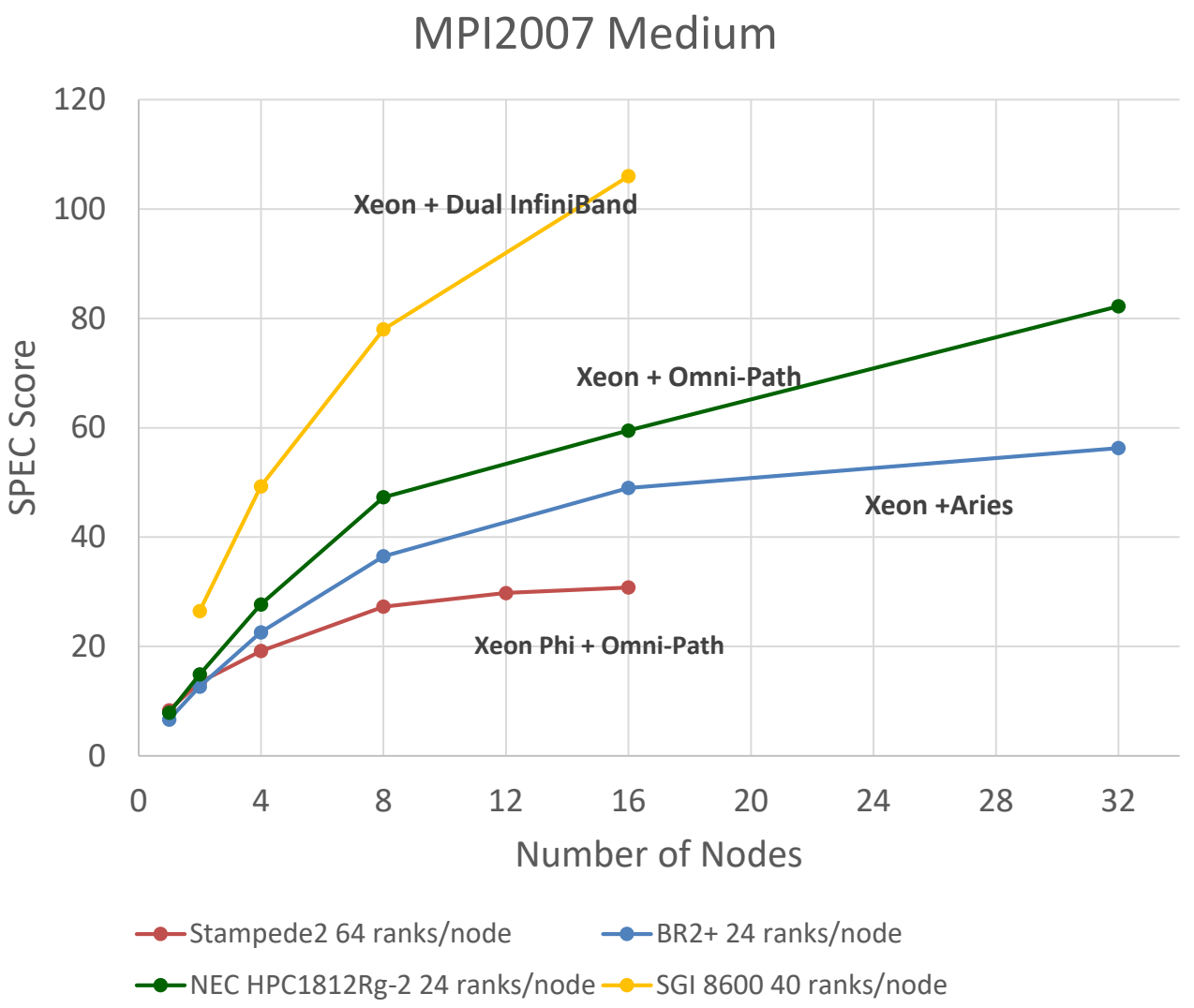
Use Cases – HPC Centers

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

Use Cases – Researchers

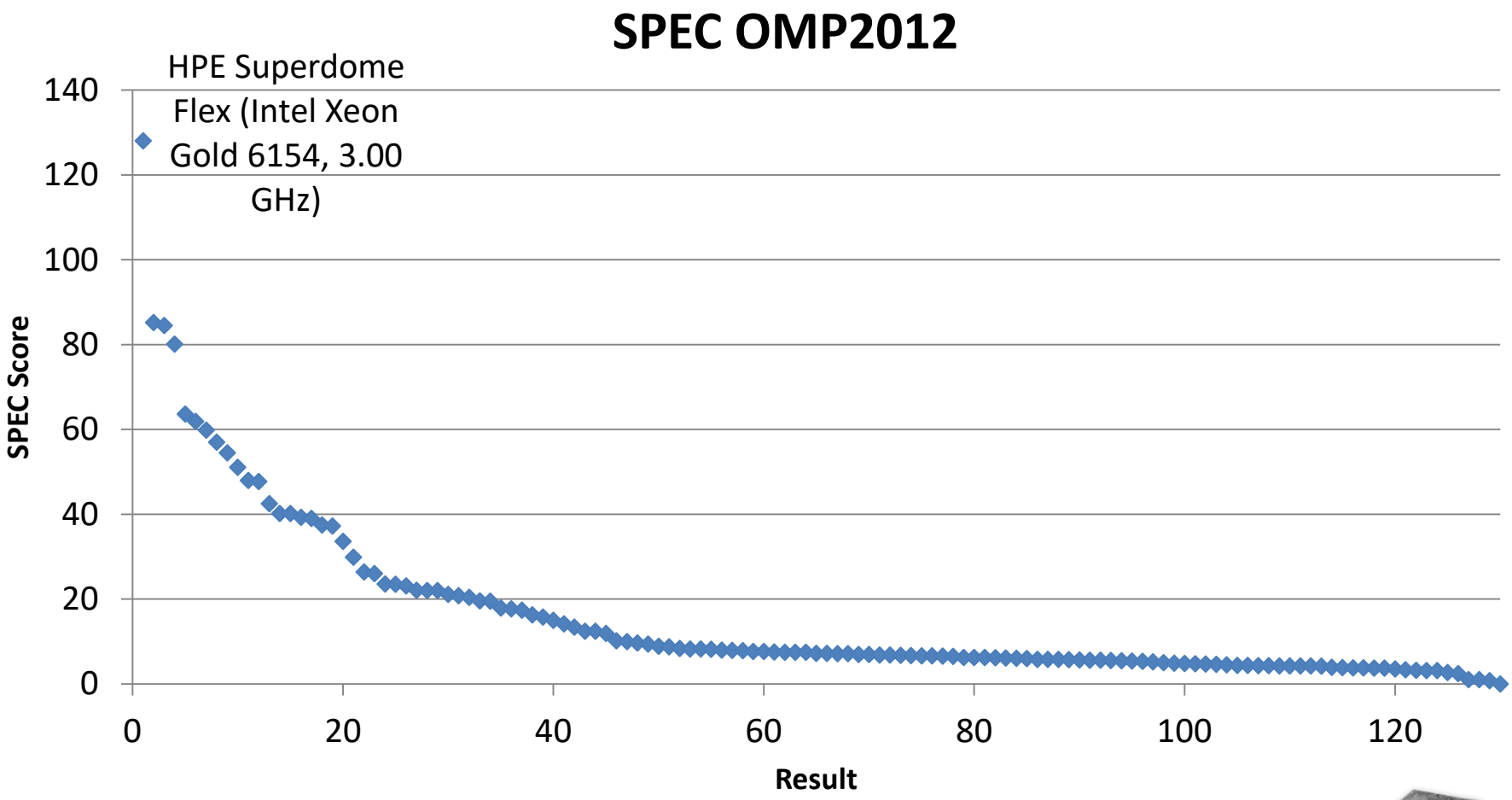
- Scalability studies
- Novel implementations of parallel runtime libraries
- Detailed power consumption studies
- Comparison of parallel programming paradigms

System and Interconnect Comparison

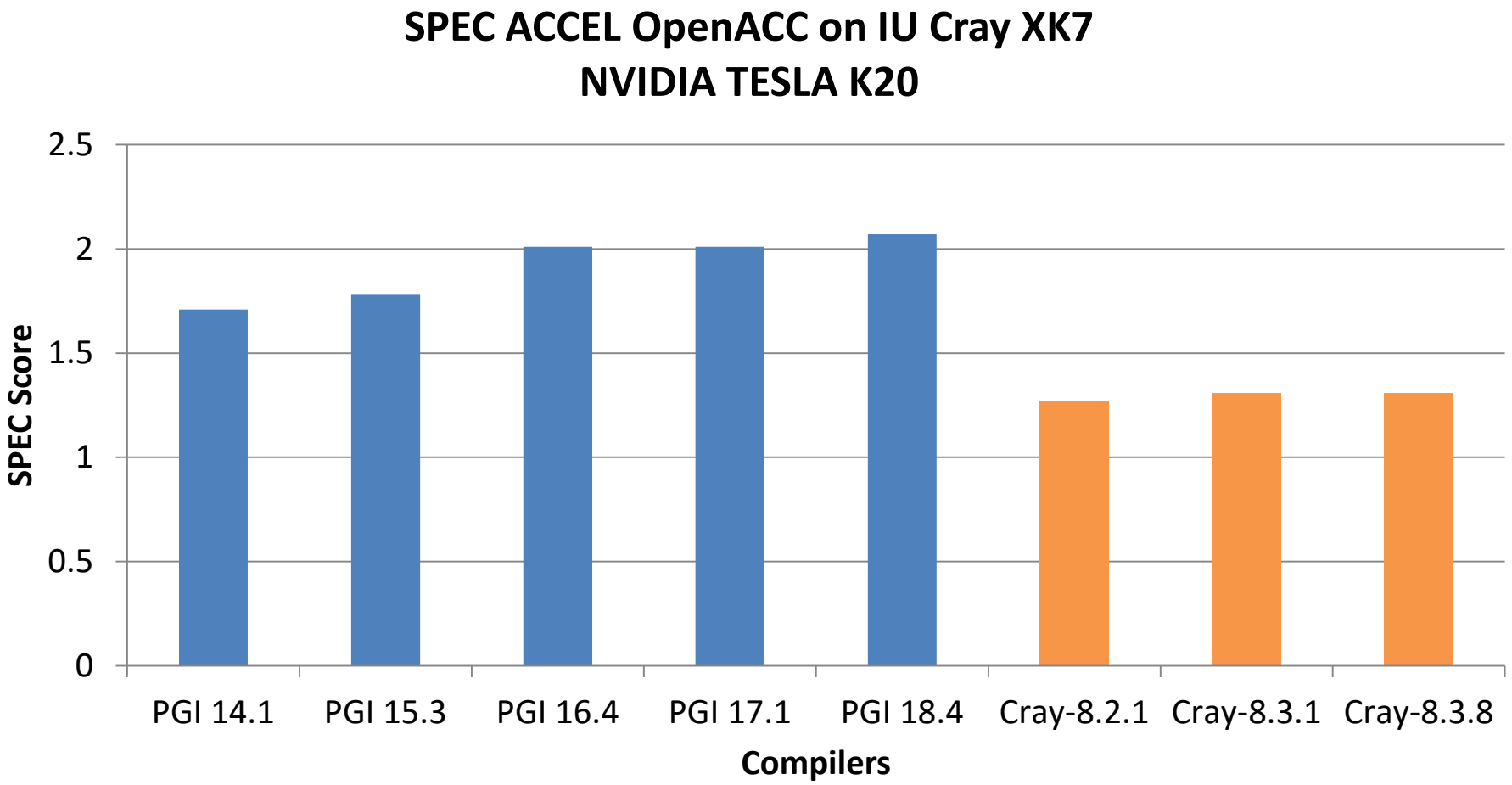


- BR2+ node:
  - 2x Xeon E5-2697 v2 (24C)
  - Cray Aries interconnect
  - Cray MPI
  - Dragonfly
- Stampede2 node:
  - Xeon Phi 7250 (68C)
  - Intel Omni-Path interconnect
  - Intel MPI
  - Fat tree
- NEC HPC1812Rg-2 node:
  - 2x Xeon E5-2650 v4 (24C)
  - Intel Omni-Path interconnect
  - Intel MPI
  - Fat tree
- HPE SGI 8600 node:
  - 2x Xeon Gold 6148 (40C)
  - Dual-rail InfiniBand 4X EDR
  - HPE SGI MPI
  - Enhanced hypercube

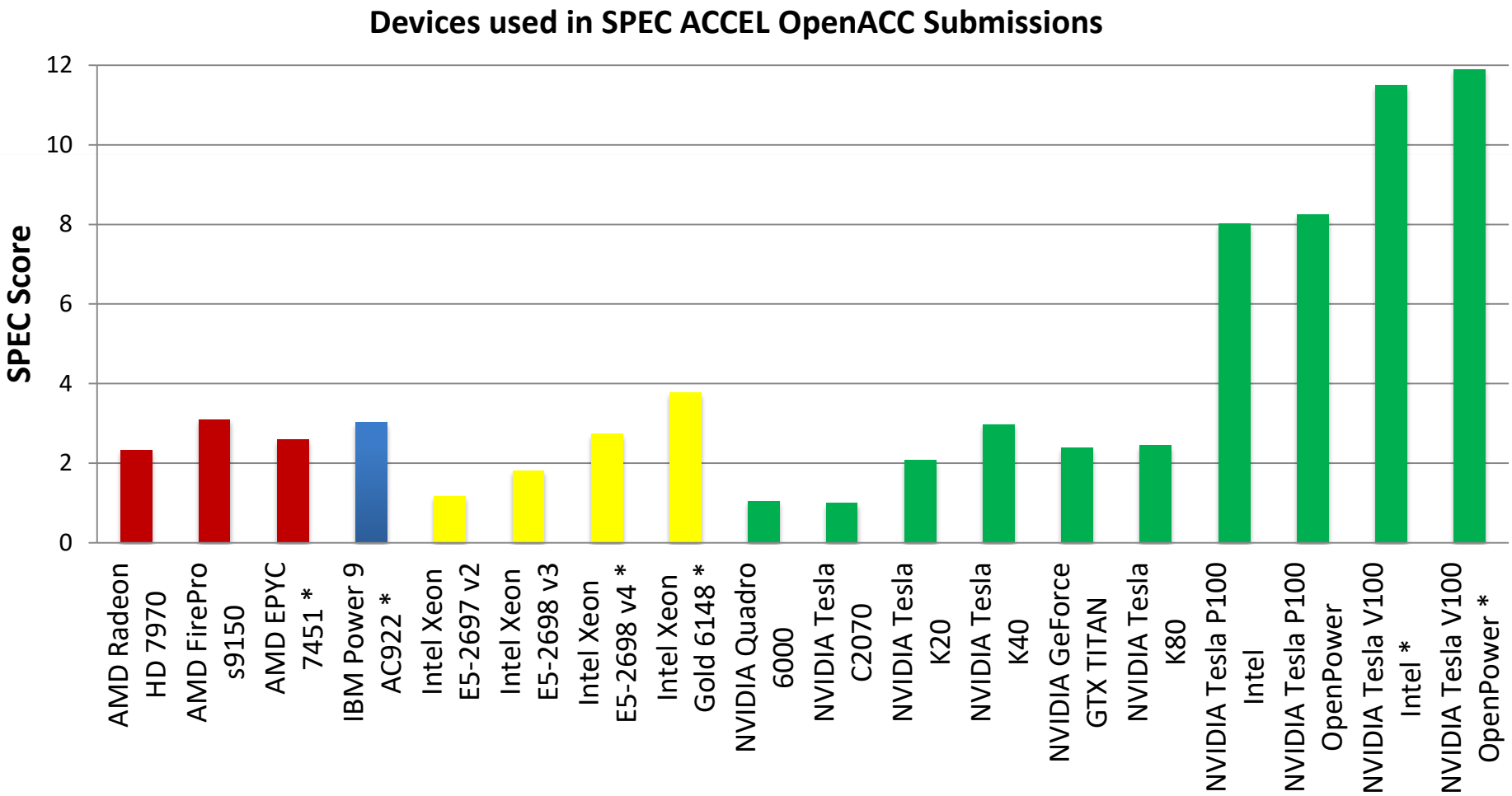
OpenMP Performance Over Time



Compiler Performance Over Time



OpenACC on CPUs and GPUs



* Results from Version 1.2 of the SPEC ACCEL benchmark while all other results are from version 1.1.

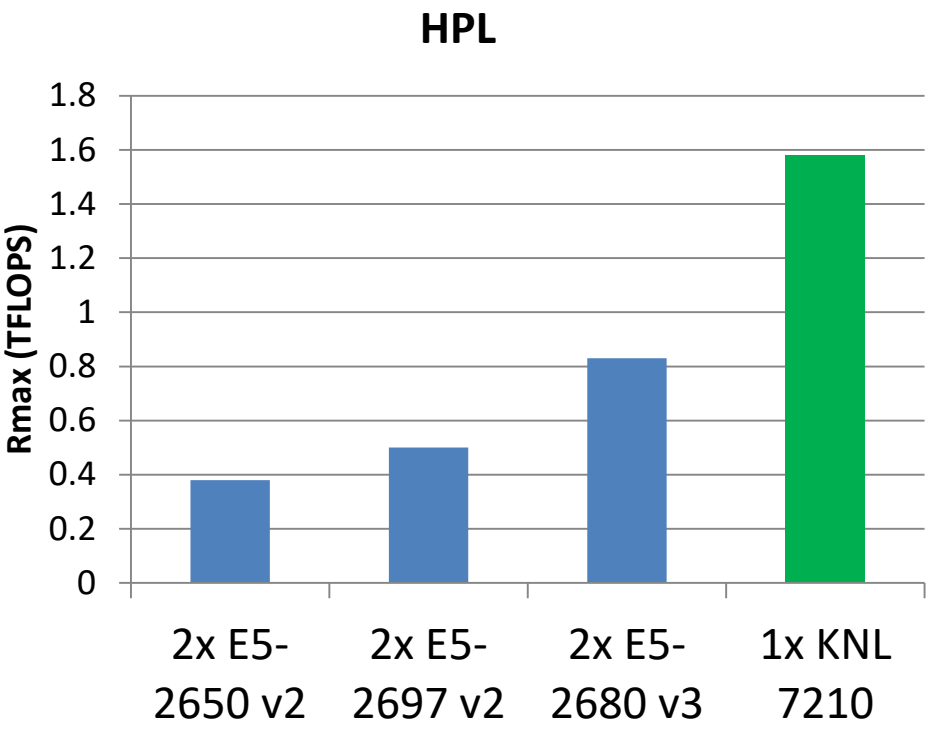
Experimental Results OpenMP Offload

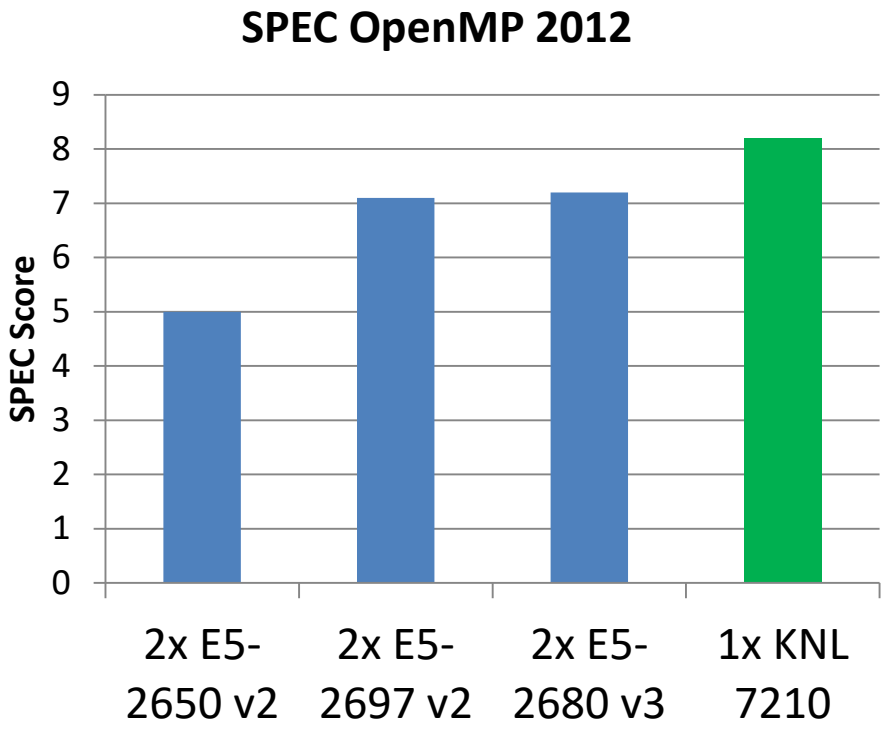
- Cray and IBM compilers support OpenMP 4.5 offload to GPUs. We only had access to the Cray compiler and currently only 6 of 15 benchmarks work!
- RPeak: KNL-7210 2.60 TFlops
  K20 1.17 TFlops Ratio: 2.2x

	SPEC Score (Estimate)			Speedup	
Benchmarks	KNL(MCDRAM) intel	KNL(DDR4) intel	K20 cray	**KNL(MCDRAM) vs K20**	**KNL(DDR4) vs K20**
503.postencil	1.99	0.70	1.26	1.6x	0.6x
504.polbm	3.42	0.75	0.90	3.8x	0.8x
514.pomriq	2.71	2.72	1.11	2.4x	2.4x
555.pseismic	2.83	1.06	1.43	2.0x	0.7x
560.pilbdc	8.43	1.97	4.61	1.8x	0.4x
570.pbt	27.4	20.2	18.2	1.5x	1.1x
Geometric Avg				**2.1x**	**0.8x**

HPL vs. SPEC OpenMP 2012

- HPL vs. SPEC OpenMP 2012





Content

- SPEC and SPEC HPG
- SPEC Benchmark Philosophy
- SPEC HPG Benchmarks
- Benchmark Use Cases
- How to Contribute

How to Contribute to SPEC HPG

- Submit results
- Join SPEC HPG
- Result review
- Test new benchmark kits on your hardware
- Help with benchmark development

Benchmark Development Process

- Group effort, with lots of discussions
- Working with experts that are developing the programming model.
- Final decisions are by vote, we strive for consensus
- Technical and infrastructure work
  - Find benchmark components and define run rules
- Using SPEC provided tools
  - GIT, SPEC harness, “common rules”
  - Websites, mailing lists, meeting venues

Conclusion

- SPEC has been around for a long time.
- SPEC benchmarks are created and maintained by a broad mix of industry and academia.
- There is great value in peer reviewed results and a public searchable result repository.
- SPEC HPG is working on the next benchmark, targeting hybrid parallelism.
- Please consider joining and contributing to benchmark development and submitting results.

Thank You!

Questions?