THE 5TH ACM/SPEC
INTERNATIONAL CONFERENCE
ON PERFORMANCE ENGINEERING

CONFERENCE PROGRAM

ICPE 2014

MARCH 22-26, 2014
DUBLIN, IRELAND

Association for Computing Machinery

Standard Performance Evaluation Corporation

Welcome

Dear members of the ICPE community,

It is with great pleasure that we welcome you to the *5th International Conference on Performance Engineering - ICPE'14* in Dublin. We are delighted to bring together researchers and industry practitioners to share ideas, discuss challenges, and present results of both work-in-progress and state-of-the-art research on performance engineering of software and systems.

Following on from the successful inclusion of **workshops** last year, there are two co-located with the main conference: Hot Topics in Cloud Service Scalability (HotTopiCS 2014), and new this year to ICPE is the 3rd International Workshop on Large Scale Testing (LT 2014). Both workshops help broaden the ICPE community and furthermore inspire new directions.

We are also delighted to present three excellent **keynote speakers**: Toyotaro Suzumura, Petr Tůma, and Xiaoyun Zhu, whom we are sure you will enjoy.

The **Research track** of the conference attracted 56 submissions and after extensive deliberation, the Program Committee decided to accept 14 submissions as regular papers and 2 as short papers. The **Industry and Experience track** focuses on the application of research results to industrial performance engineering problems and received 22 papers, of which 7 were accepted. The accepted papers from both tracks cover several topics such as software, including evaluation-based papers as well as different concerns of Java performance. Distributed systems performance is also an important aspect, which in this edition addresses SOA, middleware, and Web issues. Papers devoted to performance aspects of self-adaptive systems and power consumption are also relevant.

As in previous editions, the **Vision/Work-in-Progress track** is a feature of ICPE that allows researchers to present and discuss ideas that they are still working on or that they are planning to work on in the near future. It is a great forum for learning about the direction of research in the area. This year we received 19 submissions to this track and we accommodated 6 short presentations in the conference program.

We would like to thank the members of the **Program Committee** for the many hours that they spent reviewing papers and participating actively in the discussions and the authors for their diligence in preparing their manuscripts and camera-ready papers.

Thanks also go to the **authors** of those papers who were not selected for presentation at the conference. We would like to encourage them to use the feedback received through the reviewing process and continue their work on performance engineering.

Much appreciation goes to the **Program Co-Chairs**, Walter Binder and José Merseguer, as well as the **Industrial Chair**, Raghunath Nambiar, for the enormous efforts they have put in, attracting an excellent Technical Program Committee and continuing the high quality of ICPE papers with an exciting research and industrial track.

The **Organizing Committee** has been invaluable in running a smooth process and in particular we acknowledge the efforts of Anja Bog for her dedicated job as **Finance Chair**; the **Tutorial Chair**, Alexandru Iosup, for his thoughtful efforts in assembling the tutorial program; Samuel Kounev and Meikel Poess, the conference **Award Chairs**, for proposing and running the award process; Kirk W. Cameron and Anthony Ventresque, the **Poster and Demo Chairs**, for their efforts in selecting and putting together the poster and demo exhibit; Kevin Casey for all the activity involved in gathering the proceedings as the **Publication Chair**; **Publicity Chairs**, Danilo Ansaloni and Bob Cramblitt, for broad and timely advertisements of the conference across many publicity channels; Nicola Stokes who successfully managed the job of **Registration Chair**; Cathy Sandifer, the **Webmaster**, for her continuous help and quick responses to our demands; and Patrick McDonagh for handling the multitude of **local arrangements**.

Special **thanks** go to the **General Chairs** as well as the **Program Chairs** of previous ICPE conferences for their valuable assistance in the organization of the conference program.

Our sincere gratitude goes to the **corporate supporters**, who at the time of writing include SPEC, LERO, Cisco, IBM, Intel, and SAP, which through their generous financial contributions have made this conference possible. We are also thankful to SPEC and ACM, through its SIGSOFT and SIGMETRICS special interest groups, for **continuing support** of the ICPE conference.

On behalf of the organizing committee, we welcome you to Dublin and look forward to several days of great presentations and stimulating discussions at ICPE'14.

Klaus-Dieter Lange
Hewlett-Packard Company, USA
ICPE'14 General Co-Chair

John Murphy
University College Dublin, Ireland
ICPE'14 General Co-Chair

Program at a Glance

Saturday, March 22, 2014

	HotTopiCS Workshop	LT 2014 Workshop
8:00 - 9:00	**Registration**	
9:00 - 12:45	**Morning Session**	**Morning Session**
12:45 - 13:30	Lunch	
13:30 - 17:00	**Afternoon Session**	
19:30 - 21:00	**Workshop Dinner**	

Sunday, March 23, 2014

	Tutorials	
8:00 - 9:00	**Registration**	
9:00 - 11:00	**Tutorial 1 – Part 1**	**Tutorial 2– Part 1**
11:00 - 11:15	Coffee Break	
11:15 - 13:00	**Tutorial 1 – Part 2**	**Tutorial 2– Part 2**
13:00 - 14:30	Lunch	
14:30 - 16:30	**Tutorial 3**	**Tutorial 4**
16:30 - 16:45	Coffee Break	
16:45 - 18:45	**Tutorial 5**	**Tutorial 6**
19:30 - 20:30	**ICPE Welcome Reception**	

Monday, March 24, 2014

	Main Conference
8:00 - 9:00	**Registration**
9:00 - 10:00	**Welcome Address and Keynote 1**
10:00 - 11:00	**Research Track: Best Paper Candidates**
11:00 - 11:30	Coffee Break
11:30 - 12:50	**Power and Performance**
12:50 - 14:10	Lunch
14:10 - 16:10	**Software and Performance**
16:10 - 16:40	Coffee Break
16:40 - 17:40	**Java and Performance**
18:00 - 19:30	**ICPE Steering Committee Meeting**

Tuesday, March 25, 2014

	Main Conference
9:00 - 10:00	**Keynote 2**
10:00 - 10:50	**Industry Track: Best Paper Candidates**
10:50 - 11:20	Coffee Break
11:20 - 12:40	**Distributed Systems Performance I**
12:40 - 14:00	Lunch
14:00 - 15:05	**Distributed Systems Performance II**
15:05 - 15:45	Coffee Break and Walk-in Poster Session
15:45 - 17:10	**Reports of Experience and Test**
19:00	**Meeting Point (Hotel Lobby for bus transfer) for ICPE Dinner**

Wednesday, March 26, 2014

	Main Conference
9:00 - 10:00	**Keynote 3**
10:00 - 10:45	**Work in Progress and Vision Papers I**
10:45 - 11:15	Coffee Break
11:15 - 12:00	**Work in Progress and Vision Papers II**
12:00 - 12:30	**SPEC Distinguished Dissertation Award**
12:30 - 12:50	**Best Research and Industry Paper Award**
12:50 - 13:00	**Closing Address**
14:00 - 17:30	**SPEC Research Group Annual Meeting**

Thursday, March 27, 2014

	SPEC Research Group Working Group Meetings
8:00 - 12:00	**Cloud Working Group**
13:00 - 17:00	**IDS Working Group**

International Workshop on Hot Topics in Cloud Service Scalability

This workshop provides a platform for academics and industrial practitioners to exchange novel research ideas and current problems from practice and to identify new and "hot" topics in the field of software service scalability, the mapping between a service's work and load and its resulting resource consumption.

Software services are increasingly both important and intertwined with our daily activities. With the growing complexity of software services and their unpredictably increasing workload, the scalability of these services is now critical. The benefit of a scalable service's implementation is that it can sustain increasing work (or load) by consuming more hardware resources, as well as releasing hardware resources with decreasing work (or load) while fulfilling the SLAs.

Scalability is deeply rooted in the service's architecture and high-level design. This workshop explores scalability from different angles in both conventional architectures and in cloud computing. The topics covered here include the modelling and analyses of scalability (and its related properties like elasticity or efficiency) as well as measurements to quantify scalability, elasticity, or efficiency.

Welcome and Invited Talk

9:30 - 09:40 Welcome
9:40 - 11:00 **Research Talks**
11:00 - 11:15 Coffee Break

Session 1:

11:15 - 12:45 **Research Talks**
12:45 - 13:45 Lunch

Session 2:

13:45 - 15:15 **Research Talks**
15:15 - 15:30 Coffee Break

Session 3: Discussion

15:30 - 17:00 **Discussion**

Workshop Dinner

19:30 Meeting Point for Workshop Dinner

International Workshop on Large-Scale Testing

Modern software systems, which range from e-commerce websites to telecommunication infrastructures, must serve millions of users. Many problems experienced `in the field' with these systems are due to their inability to scale to larger workloads, and not due to functional errors. In addition to conventional functional testing, these systems must be tested with large volumes of concurrent requests (termed the `load') to ensure the performance of these systems.

The theme of this year's workshop is Large-Scale Testing, which includes all different objectives and strategies of testing large-scale software systems under load. Examples of large-scale testing include live upgrade testing, load testing, high availability testing, operational profile testing, performance testing, reliability testing, stability testing and stress testing. Large-Scale testing is a difficult task, which requires extensive knowledge of the system under test. Practitioners face many challenges, such as those related to: tooling (choosing/implementing the testing tools), environments (software, hardware setup) and time constraints (limited time to design, test, and analyze). Yet, little research is done in the software engineering research.

This workshop aims to bring together software testing researchers, practitioners and tool developers to discuss the challenges and opportunities of conducting research on large-scale software testing. The keynote presentation titled "The Theory And Practice of Testing Software Applications For Cloud Computing" will be given by Dr. Grechanik (Assistant Professor at the Department of Computer Science of the University of Illinois at Chicago). The program also includes two research talks, an industrial talk and a panel discussion.

Program Outline

9:00 - 9:05 Welcome and Introduction
9:05 - 10:10 Keynote
10:10 - 10:25 Coffee Break
10:25 - 11:40 Research Talks
11:40 - 12:40 Panel Discussion on Large-Scale Testing
12:40 - 12:45 Workshop Wrap-up and LT 2015

This event is supported by Science Foundation Ireland.

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Sunday March 23 — Tutorial

09:00 - 11:00 *Tutorial 1 – Part 1*
Energy Efficiency Benchmark Framework (Chauffeur WDK)
Jeremy Arnold (IBM)
Tutorial 2 – Part 1
Pattern-Driven Performance Engineering for Multicore Systems
Jan Treibig (University of Erlangen-Nuremberg)

11:00 - 11:15 Coffee Break

11:15 - 13:00 *Tutorial 1 – Part 2*
Energy Efficiency Benchmark Framework (Chauffeur WDK)
Jeremy Arnold (IBM)
Tutorial 2 – Part 2
Pattern-Driven Performance Engineering for Multicore Systems
Jan Treibig (University of Erlangen-Nuremberg)

13:00 - 14:30 Lunch

14:30 - 16:30 *Tutorial 3*
Kieker Monitoring Framework.
Andre van Hoorn (University of Stuttgart) and Nils Ehmke (Kiel University)
Tutorial 4
Performance Unit Testing
Vojtěch Horký (Charles University)

16:30 - 16:45 Coffee Break

16.45 - 18:45 *Tutorial 5*
Network Performance Engineering.
Manoj Nambiar (TCS)

16.45 - 18:45 *Tutorial 6*
Glinda: a framework for performance tuning on heterogeneous platforms.
Ana Lucia Varbanescu (University of Amsterdam)

18:45 - 18:55 **Tutorial - Closing Remarks.**

19:30 - 20:30 **ICPE Welcome Reception**

Welcome Session

9:00 - 9:10 **Welcome note.**

Keynote Session A:

Chair: Raffaela Mirandola (Politecnico di Milano)

9:10 - 10:00 **Keynote: Extreme Big Data Processing in Large-Scale Graph Analytics and Billion-Scale Social Simulation.**
Toyotaro Suzumura (IBM Research/University College Dublin)

Session 1: Research Track Best Paper Candidates

Chair: Samuel Kounev (KIT)

10:00 - 10:30 **Uncertainties in the Modeling of Self-Adaptive Systems: a taxonomy and an example of availability evaluation.**
Diego Pérez-Palacin, and Raffaela Mirandola

10:30 - 11:00 **On The Limits of Modeling Generational Garbage Collector Performance.**
Peter Libič, Lubomír Bulej, Vojtěch Horký, and Petr Tůma

11:00 - 11:30 Coffee Break

Session 2: Power and Performance

Chair: Hansfried Block (Fujitsu)

11:30 - 11:50 **Speeding Up Processing Data From Millions of Smart Meters.**
Jiang Zheng, Zhao Li, and Aldo Dagnino

11:50 - 12:20 **Automated Analysis of Performance and Energy Consumption for Cloud Applications.**
Feifei Chen, John Grundy, Jean-Guy Schneider, Yun Yang and Qiang He

12:20 - 12:50 **An Experimental Methodology to Evaluate Energy Efficiency and Performance in an Enterprise Virtualized Environment.**
Jesus Omana Iglesias, Liam Murphy, Philip Perry, Teodora Sandra Buda, and James Thorburn

12:50 - 14:10 Lunch

Session 3: Software and Performance

Chair: Murray Woodside (Carleton University)

14:10 - 14:40 **Efficient Optimization of Software Performance Models via Parameter-Space Pruning.**
Mirco Tribastone

14:40 - 15:10 **Exploring Synergies between Bottleneck Analysis and Performance Antipatterns.**
Catia Trubiani, Antinisca Di Marco, Vittorio Cortellessa, Nariman Mani, and Dorina Petriu

15:10 - 15:40 **Adaptive Model Learning for Continual Verification of Non-Functional Properties.**
Radu Calinescu, Yasmin Rafiq, Kenneth Johnson and Mehmet Bakır

15:40 - 16:10 **Performance Queries for Architecture-Level Performance Models.**
Fabian Gorsler, Fabian Brosig and Samuel Kounev

16:10 - 16:40 Coffee Break

Session 4: Java and Performance

Chair: Lubomír Bulej (Charles University)

16:40 - 17:10 **The Taming of the Shrew: Increasing Performance by Automatic Parameter Tuning for Java Garbage Collectors.**
Philipp Lengauer and Hanspeter Mössenböck

17:10 - 17:40 **Constructing Performance Model of JMS Middleware Platform.**
Tomáš Martinec, Lukáš Marek, Antonín Steinhauser, Petr Tůma, Qais Noorshams, Andreas Rentschler, and Ralf Reussner

17:40 - 17:50 **Day 1 - Closing Remarks.**

18:00 - 19:30 **ICPE Steering Committee Meeting.**

Keynote Session B:

Chair: Maria Carla Calzarossa (University of Pavia)

9:00 - 10:00 **Keynote: Performance Awareness.**
Petr Tůma (Department of Distributed and Dependable Systems, Charles University)

Session 5: Industry Track Best Paper Candidates

Chair: Meikel Poess (Oracle)

10:00 - 10:20 **Test-Driving Intel Xeon Phi.**
Jianbin Fang, Henk Sips, Lilun Zhang, Chuanfu Xu, Yonggang Che, and Ana Lucia Varbanescu

10:20 - 10:40 **A Power-Measurement Methodology for Large-Scale, High-Performance Computing.**
Thomas R. W. Scogland, Craig P. Steffen, Torsten Wilde, Florent Parent, Susan Coghlan, Natalie Bates, Wu-chun Feng, and Erich Strohmaier

10:40 - 11:20 Coffee Break

Session 6: Distributed Systems Performance I

Chair: Connie U. Smith (L&S Computer Technology)

11:20 - 11:40 **Engineering Resource Management Middleware for Optimizing the Performance of Clouds Processing MapReduce Jobs with Deadlines.**
Norman Lim, Shikharesh Majumdar, and Peter Ashwood-Smith

11:40 - 12:10 **A Meta-Controller Method for Improving Run-Time Self-Architecting in SOA Systems.**
John M. Ewing and Daniel A. Menascé

12:10 - 12:40 **Agile Middleware for Scheduling: Meeting Competing Performance Requirements of Diverse Tasks.**
Feng Yan, Shannon Hughes, Alma Riska, and Evgenia Smirni

12:40 - 14:00 Lunch

Session 7: Distributed Systems Performance II

Chair: Vittorio Cortellessa (University of L'Aquila)

14:00 - 14:30 **Understanding, Modelling and Improving the Performance of Web Applications in Multi-core Virtualised Environments.**
Xi Chen, Chin Pang Ho, Rasha Osman, Peter Harrison, and William Knottenbelt

14:30 - 14:50 **An Evaluation of ZooKeeper For High Availability in System S.**
Cuong Pham, Zbigniew Kalbarczyk, RavishankarIyer, Victor Dogaru, Rohit Wagle, and Chitra Venkatramani

14:50 - 15:05 **Scalable Hybrid Stream and Hadoop Network Analysis System.**
Cody Bumgardner and Victor Marek

Session 8: Poster Session

Chairs: Anthony Ventresque (University College Dublin)

15:05 - 15:45 **Posters & Demos Exhibit** with Coffee Break

Session 9: Reports of Experience and Test

Chair: Raghunath Nambiar (Cisco)

15:45 - 16:00 **System Performance Analyses through Object-oriented Fault and Coupling Prisms.**
Alessandro Murgia, Roberto Tonelli, Michele Marchesi, Giulio Concas, Steve Counsell, Stephen Swift

16:00 - 16:20 **Run-Time Performance Optimization of a BigData Query Language.**
Yanbin Liu, Parijat Dube and Scott Gray

16:20 - 16:40 **Model-driven Engineering in Practice: Integrated Performance Decision Support for Process-centric Business Impact Analysis.**
David Redlich, Ulrich Winkler, Thomas Molka and Wasif Gilani

16:40 - 17:10 **Continuous Validation of Load Test Suites.**
Mark D. Syer, Zhen Ming Jiang, Meiyappan Nagappan, Ahmed E. Hassan, Mohamed Nasser, and Parminder Flora

17:10 - 17:20 **Day 2 - Closing Remarks.**

Keynote Session C:

Chair: Nicola Stokes (University College Dublin)

9:00 - 10:00 **Keynote: Application Performance Management using Learning, Optimization, and Control.**
Xiaoyun Zhu (VMware)

Session 10: Work in Progress and Vision Papers I

Chair: Diego Perez-Palacin (Politecnico di Milano)

10:00 - 10:15 **Software Contention Aware Queueing Network Model of Three-Tier Web Systems.**
Shadi Ghaith, Miao Wang, Philip Perry, and Liam Murphy

10:15 - 10:30 **Efficient and Accurate Stack Trace Sampling in the Java Hotspot Virtual Machine.**
Peter Hofer and Hanspeter Mössenböck

10:30 - 10:45 **PowerPerfCenter: A Power and Performance Prediction Tool For Multi-Tier Applications.**
Bhavin Doshi and Varsha Apte

10:45 - 11:15 Coffee Break

Session 11: Work in Progress and Vision Papers II

Chair: Sanjay Sharma (Intel)

11:15 - 11:30 **Modelling Database Lock-Connection in Architecture-level Performance Simulation.**
Philipp Merkle and Christian Stier

11:30 - 11:45 **Benchmarking Graph-Processing Platforms: A Vision.**
Yong Guo, Ana Lucia Varbanescu, Alexandru Iosup, Claudio Martella, and Theodore L. Willke

11:45 - 12:00 **Real-Time Multi-Cloud Management Needs Application Awareness.**
John Chinneck, Marin Litoiu, and Murray Woodside

Session 12: Awards

Chair: Walter Bays (SPEC President)

12:00 - 12:30 **SPEC Distinguished Dissertation Award 2013: Dynamic Management of Caching Tiers.**
Anshul Gandhi (IBM)

12:30 - 12:40 **Best Research Paper Award.**
Samuel Kounev (ICPE 2014 - Award Co-Chair)

12:40 - 12:50 **Best Industrial Paper Award.**
Meikel Poess (ICPE 2014 - Award Co-Chair)

Closing Address

12:50 - 13:00 **Day 3 - Closing Remarks.**

About SIGSOFT

The ACM Special Interest Group on Software Engineering (SIGSOFT) focuses on issues related to all aspects of software development and maintenance. Areas of special interest include: requirements, specification and design, software architecture, validation, verification, debugging, software safety, software processes, software management, measurement, user interfaces, configuration management, software engineering environments, and CASE tools. SIGSOFT is run by a volunteer Executive Committee composed of officers elected every three years, and assisted by a professional program director employed by the ACM.

Newsletter

Software Engineering Notes is the bi-monthly ACM SIGSOFT newsletter. For further information, see http://www.acm.org/sigsoft/SEN/.

About SIGMETRICS

SIGMETRICS is the ACM Special Interest Group (SIG) for the computer systems performance evaluation community.

SIGMETRICS promotes research in performance analysis techniques as well as the advanced and innovative use of known methods and tools. It sponsors conferences, such as its own annual conference (SIGMETRICS), publishes a newsletter (Performance Evaluation Review), and operates a mailing list linking researchers, students, and practitioners interested in performance evaluation.

Target areas of performance analysis include file and memory systems, database systems, computer networks, operating systems, architecture, distributed systems, fault tolerant systems, and real-time systems. In addition, members are interested in developing new performance methodologies including mathematical modeling, analysis, instrumentation techniques, model verification and validation, workload characterization, simulation, statistical analysis, stochastic modeling, experimental design, reliability analysis, optimization, and queuing theory.

For further information, please visit http://www.sigmetrics.org/.

Call for Papers

The 6th International Conference on Performance Engineering (ICPE) sponsored by ACM SIGMETRICS and ACM SIGSOFT in cooperation with SPEC will be held in Austin, Texas, USA, during January 31 to February 4, 2015. The goal of the ICPE is to integrate theory and practice in the field of performance engineering. ICPE brings together researchers and industry practitioners to share and present their experience, to discuss challenges, and to report state-of-the-art and in-progress research on performance engineering. (ACM approval pending)

Important Submission Dates (abstract/paper)

Research Papers	**13 Jul / 20 Jul 2014**
Industrial / Experience Papers	**31 Aug / 7 Sep 2014**
Tutorial Proposals	**14 Oct 2014**
Poster and Demo Papers	**14 Oct 2014**
Work-in-Progress and Vision Papers	**16 Nov 2014**
PhD Workshop	**16 Nov 2014**

General Chairs

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Collocated with the SPEC Annual Meeting

OSG, HPG, WGPG and RG	**02-06 Feb 2014**

Submission Guidelines

Authors are invited to submit original, unpublished papers that are not being simultaneously considered in another forum. A variety of contribution styles for papers are solicited including: basic and applied research, industrial and experience reports, and work-in-progress/vision papers. Different acceptance criteria apply for each category; please visit: http://icpe2015.ipd.kit.edu/ for details. At least one author of each accepted paper is required to register at the full rate, attend the conference and present the paper. Presented papers will be published in the ICPE 2015 conference proceedings that will be published by ACM and included in the ACM Digital Library.

About SPEC

The **Standard Performance Evaluation Corporation (SPEC)** was formed in 1988 to establish industry standards for measuring computer performance. Since then, SPEC has become the largest and most influential benchmark consortium in the world.

SPEC currently offers more than 20 industry-standard benchmarks and tools for system performance evaluation in a variety of application areas. Thousands of SPEC benchmark licenses have been issued to companies, resource centers, and educational institutions globally. Organizations using these benchmarks have published more than 30,000 peer-reviewed performance reports.

Benchmarks

SPEC offers a range of computer benchmarks and performance evaluation tools. The latest releases include SPECviewperf 12, SPECwpc V1.0, SPECapc for Siemens NX 8.5, SPECvirt_sc2013, Server Efficiency Rating Tool (SERT) 1.0.2, and SPECjbb2013.

Besides working on updating of many existing SPEC benchmarks and performance evaluation tools, several new projects are in development:

- Service Oriented Architecture (SOA) benchmark suite - measuring performance for typical middleware, database, and hardware deployments.
- A benchmark for measuring compute-intensive performance of handheld devices.
- SPECsip_Application benchmark suite, a system-level benchmark for application servers, HTTP, and SIP load generators.
- SPECsfs, an update to file server throughput and response time benchmark.
- A Worklet Development Kit (WDK) for to simplify the development of workloads for measuring both performance and energy efficiency.

Research Group (RG)

The SPEC RG serves as a platform for collaborative research efforts in the area of quantitative system evaluation and analysis, fostering interactions between industry and academia.

Membership

SPEC's membership comprises more than 100 leading computer hardware and software vendors, educational institutions, research organizations, and government agencies worldwide.

Full membership provides a wide range of benefits, including free access to benchmark suites, participation in developing new benchmarks and tools, and publication of benchmark results on SPEC's web site.

SPEC welcomes interested conference attendees.

Tuesday, March 25

08:30 - 17:00 SPEC OSG **CPU** Subcommittee
08:30 - 17:00 SPEC OSG **Power** Subcommittee
08:30 - 17:00 SPEC OSG **SFS** Subcommittee

Wednesday, March 26

08:30 - 17:00 SPEC OSG **Cloud** Subcommittee
08:30 - 17:00 SPEC OSG **CPU** Subcommittee
08:30 - 17:00 SPEC OSG **Power** Subcommittee
08:30 - 17:00 SPEC OSG **SFS** Subcommittee
14:00 - 17:30 SPEC **Research Group** Annual Meeting

Thursday, March 27

08:30 - 17:00 SPEC OSG **Cloud** Subcommittee
08:30 - 17:00 SPEC OSG **CPU** Subcommittee
08:30 - 17:00 SPEC OSG **Power** Subcommittee
08:30 - 17:00 SPEC OSG **SFS** Subcommittee
08:30 - 17:00 SPEC OSG **Virtualization** Subcommittee
08:00 - 12:00 SPEC **Research Cloud** Working Group
13:00 - 17:00 SPEC **Research IDS** Working Group
18:00 - 20:00 SPEC **Board of Directors**

Friday, March 28

08:00 - 10:00 SPEC **OSG Steering Committee**
10:30 - 16:00 SPEC OSG **CPU** Subcommittee
08:30 - 17:00 SPEC OSG **Power** Subcommittee
08:30 - 17:00 SPEC OSG **SFS** Subcommittee
08:30 - 17:00 SPEC OSG **Virtualization** Subcommittee

For further information, please visit www.spec.org or contact SPEC at info@spec.org.

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