Heterogeneous Computing on Power:
From Multi-core and Accelerators (GPUs, FPGAs) to Quantum Computers

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Operating Systems and Middleware Group
19.04.2017

HPI Hasso Plattner Institut
IT Systems Engineering | Universität Potsdam

Seminar Outline

- Choose a project / topic (until May 3rd)
- Present your topic (~10 minutes) (May 10th/7th)
  - Background & goals of your project
- Project Phase (until July 5th)
  - No regular seminars, but occasional invited talks
  - Field trip to IBM Lab Böblingen?
  - Individual appointments for project consultation
- Final Presentation (~20-30 minutes) (July 12th/19th)
- Hand in a written report (4-6 pages IEEE) (Sept. 30th)
  - Provide biblography and presentation slide deck

HPI Future SOC Lab Day

HPI FUTURE SOC LAB DAY, FRÜHLING 2017

HPI Future SOC Lab Day - Frühling 2017

Der HPI Future SOC Lab Day findet am Dienstag, den **25. April 2017**, im Hauptgebäude des Hasso-Plattner-Instituts statt.

Im Rahmen des HPI Future SOC Lab Days stellen die Projekte der Vorperiode ihre Ergebnisse vor. Außerdem können ausgewählte Antragsteller ihre Vorschläge für Neuprojekte darstellen.

Registrierung

Die Registrierung für den Future SOC Lab Day erfolgt per Online-Formular:

› **Registrierung Future SOC Lab Day**

Agenda

Time	Title	Speaker
09:30	Registration	
10:00	Welcome	Prof. Dr. Christoph Meinel, Hasso Plattner Institute

FUTURE SOC LAB

› Ausstattung
› Projekte
› Projektablauf
› Veranstaltungen
› Veröffentlichungen
› Newsletter

CALL FOR PROJECTS

Verlängerung:
Ihren Projektantrag können Sie bis zum **10. April 2017** über dieses Formular einreichen. Weitere Informationen für den Antrag finden Sie hier:

› Call for Projects

TERMINE

25.04.2017 | HPI Future SOC Lab Day, Frühling 2017
Anfahrt. Der HPI Future SOC Lab Day findet statt im Hauptgebäude des Hasso-Plattner-Instituts, in ... > mehr

Heterogeneous Computing on Power

OSM Group,
April 19, 2017

Symposium on Future Trends in Service-Oriented Computing

Thursday, April 27, 2017 (Symposium with Industry & Academia)

HS 1, HS Foyer (Lecture Building)

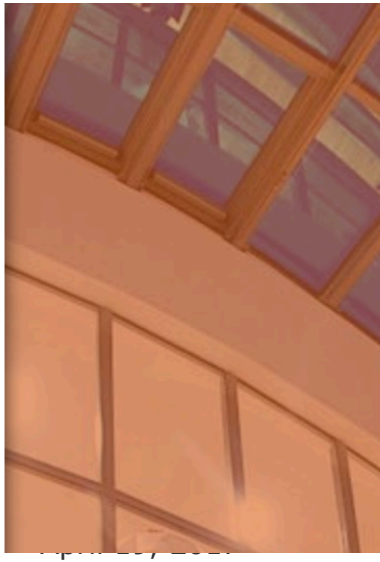
09:30 – 09:40 **Opening of the Symposium on Future Trends in Service-Oriented Computing**

10:00 – 10:40 **Keynote**

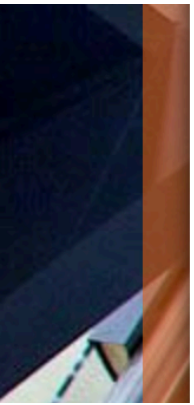
Dr. Wolfgang Maier, Dir. HW Development IBM R&D Boeblingen
Next Gen Computing - the IBM view

10:40 – 10:45 **Announcement of 2017 IBM Ph.D. Fellowship Award**

10:45 – 11:00 **Coffee Break**



Symposium on Future Trends in Service-Oriented Computing



Friday, April 28, 2017 (Keynote on Free Software)

HS 1 (Lecture Building)

15:00–17:00 **Keynote**

Dr. Richard Stallman, Free Software Foundation

Ethical Principles for Service-Oriented Computing

Klassenfahrt zum Labor in Böblingen

Seminar Formalities

- Leistungserfassungsprozess
  - 2 Presentations (Kick-off & Final)
  - Project work (incl. consultations)
  - Written report (to be published as technical report)

- Seminar extent
  - 6 LP / 4 SWS
  - Modules: IST/ISAE, OSIS, SAMT

- https://www.dcl.hpi.uni-potsdam.de/teaching/hcompsem/

Projects / Topics

There are four major topic areas:

- Heterogeneous Computing
- Enterprise Lab
- Dependability
- Future Trends

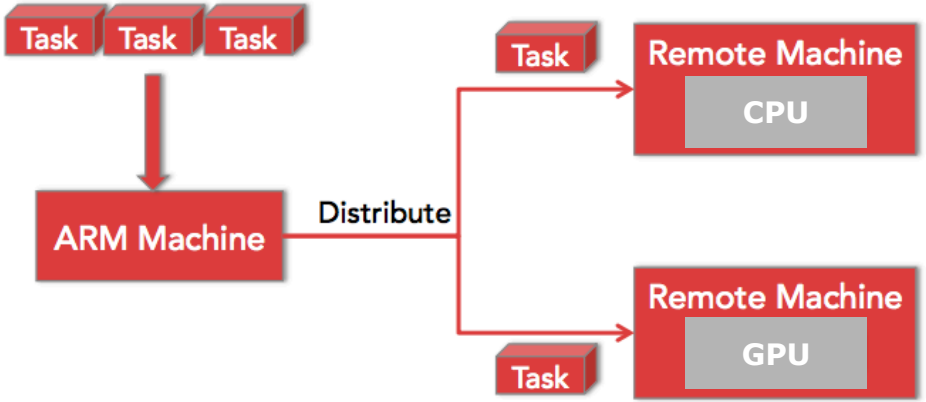
Heterogeneous Computing

- GPU Computing
  - Different Interconnects available on Power8+ (NVLink)
    - In the near future: cache coherent with CPU memory
  - Interaction with non-GPU accelerators (e.g. NX842 compression unit)
    - Hardware compression might be used to alleviate PCIe bottleneck

  - Accelerator support in high-level programming languages (IBM JDK 8)
    - Practical evaluation: what works, what doesn't and how fast is it?
    - Integration into Dynamic OpenCL framework?
  - …

Heterogeneous Computing: Dynamic OpenCL / Cloud-bursting for GPUs

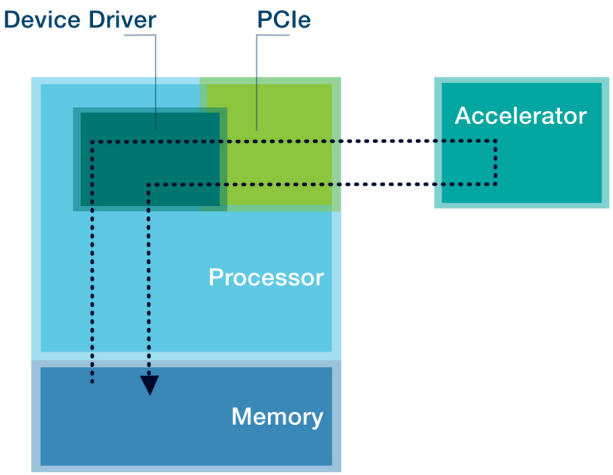
- Slow machines utilizing powerful remote resources
- Execution of large tasks in a burst scenario
- Minimized programming overhead



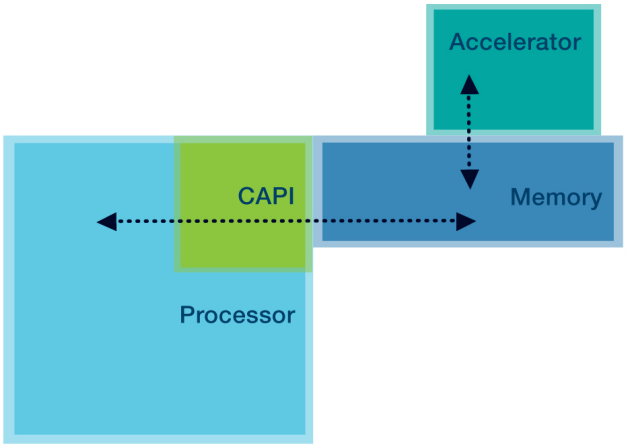
Heterogeneous Computing: The Coherent Accelerator Processor Interface (CAPI)

Hasso Plattner Institut

[Traditional Acceleration]

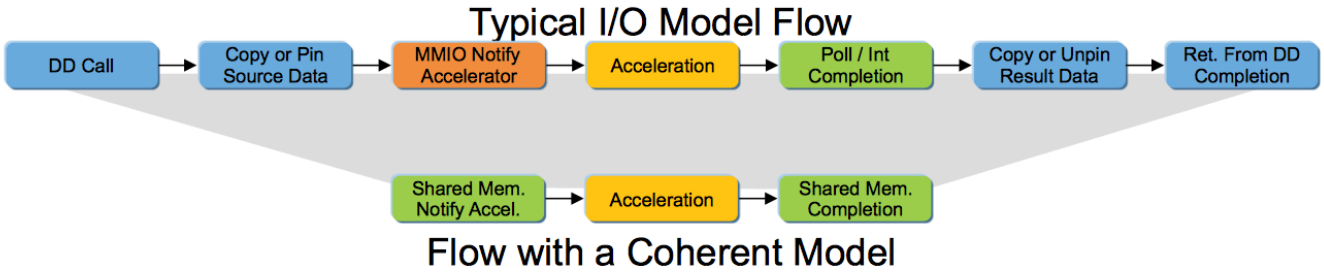


[CAPI]



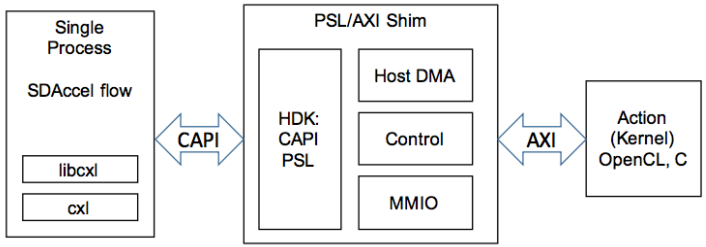
Heterogeneous Computing: What is going to change with CAPI?

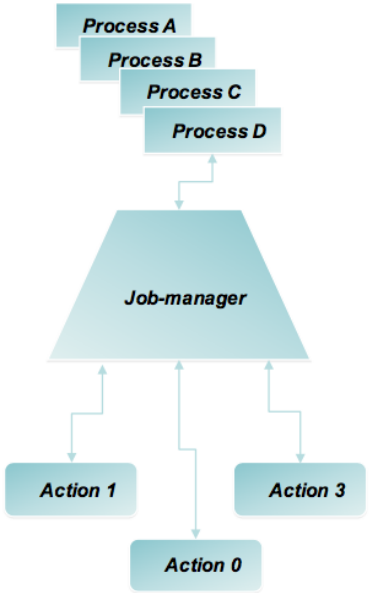
- Currently: Devices are still connected using PCI-Express Gen 3
- Reduced communication overhead through slimmed-down protocol
- Shared Memory model extends towards accelerators
  - No separate memory regions that have to be managed explicitly
  - Easier integratrion into existing applications
- In the near future: OpenCAPI via PCI-E Gen 4, NVLink, etc...



Heterogeneous Computing: The CAPI SNAP Framework

- Simplified integration of Field-Programmable Gate Arrays (FPGAs)
  - OpenCL/HLS instead of VeriLog/VHDL
  - Hardware initialization
  - Device communication
  - Memory alignment
  - Multiprocessing
  - ...



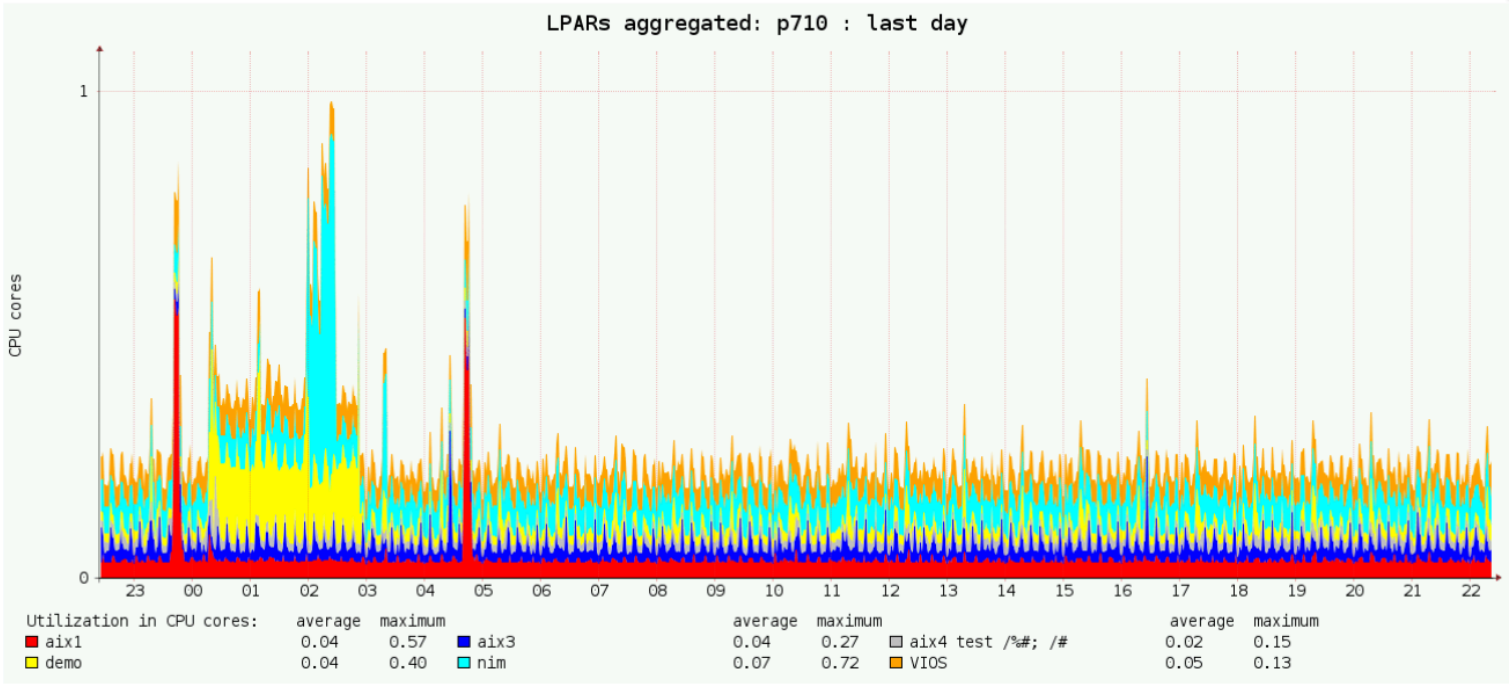


Heterogeneous Computing

- FPGAs / Coherent Accelerator Processor Interface (CAPI)
  - Multi-tenancy via Docker integration
  - Dynamic Reconfiguration: modifying FPGA functionality at runtime
  - Implications of coherent accelerators on programming models
  - Impact of CAPI on communication costs
  - Integration in existing applications: how hard is it?
  - …


8TB Hauptspeicher
IBM Power System E880
96 Kerne
768 logische Prozessoren

SLA-Überwachung



SLA-Überwachung

Experiment

- Hyrise-Instanz + Testquery
- Oszillierender Stream-Benchmark als zweiter Prozess
- Tool soll LPAR beobachten
- anhand Meßgrösse soll Verhältnis virtuelle/physische Prozessoren erhöht werden
- anhand Meßgrösse sollen Prozessoren hinzugefügt werden
  (cache misses, etc; weitere Meßgrößen?)

Dynamic Topolgies

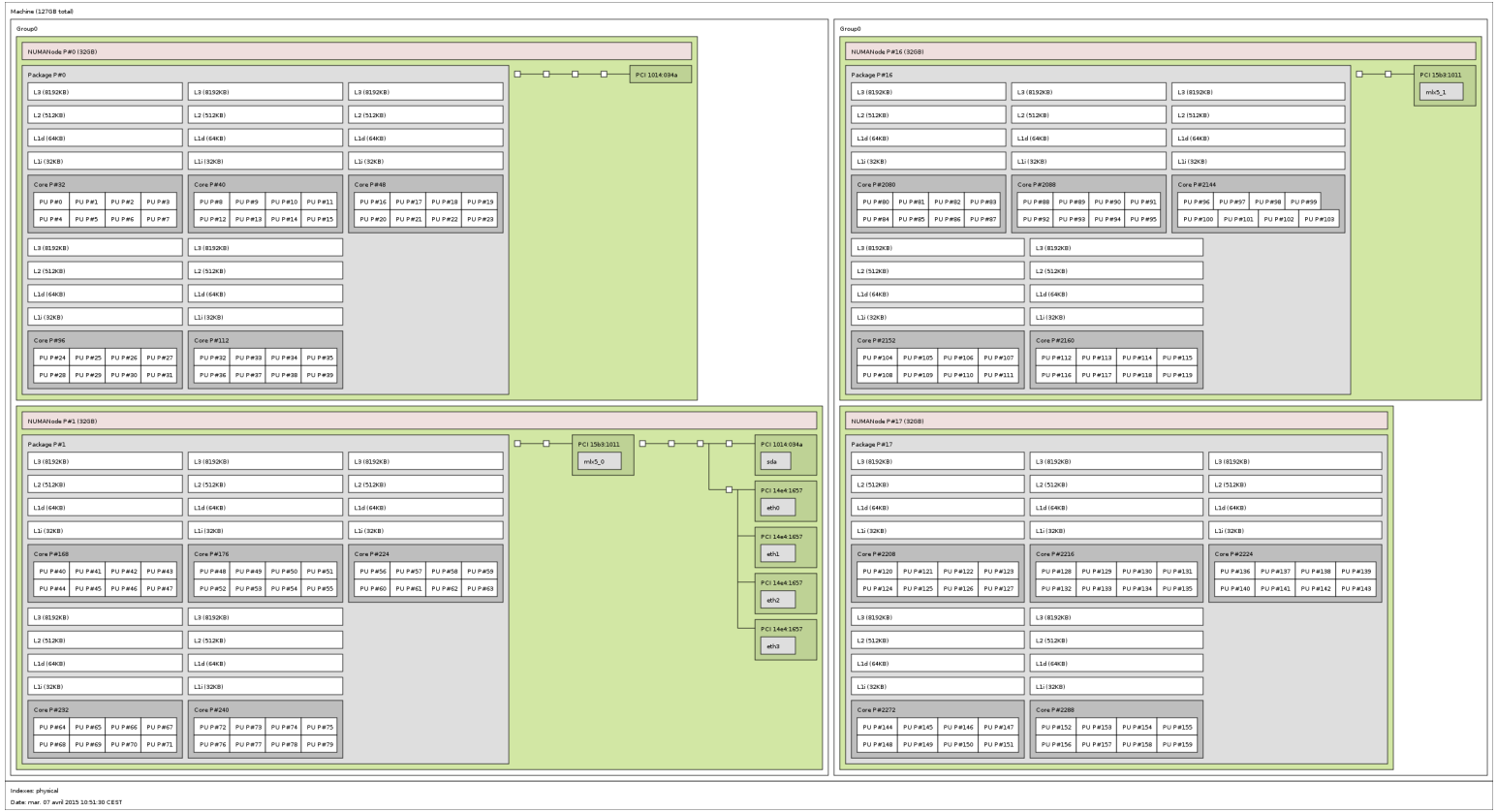


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Chart **18**

Dynamische Tolopogien

Experiment

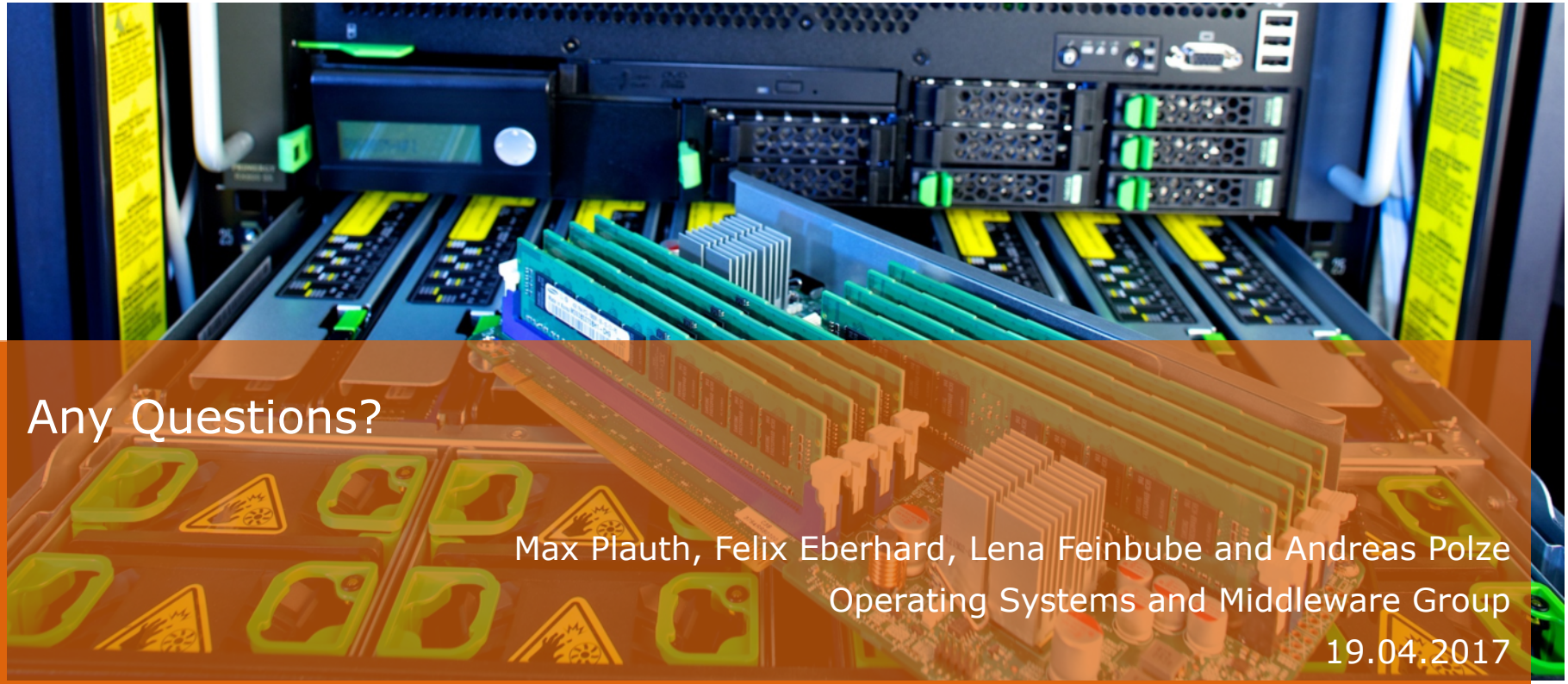
- Hwloc und libudev studieren
- Plugin für hwloc/Linux kernel programmieren
- Dynamische TaskQueues implementieren
- (OpenMP-Anpassung)

Dependability aspects of Power systems

- Fault injection on Power platforms
  - Modify LD_LIBRARY_PATH
  - Replace standard libraries with fault-injecting libraries
  - Harden application to tollerate faults
- N-version computation
  - Use SIMD operations for redundant computations on scalar values
- Stress and resiliency testing
  - ...

Future Trends

- Quantum Computing
  - IBM-q / Quantum Experience: http://research.ibm.com/ibm-q/



Any Questions?

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