Ein Blick nach vorn

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GridKa – An International User Facility

- Data and analysis center for particle and astroparticle physics
- A cornerstone of the Worldwide LHC Computing Grid (WLCG)
- Integral part of the LHC data processing chain

~12,000 physicists worldwide
~1,300 from Germany

Global Effort → Global Success
Results today only possible due to extraordinary performance of accelerators – experiments – Grid computing
Observation of a new particle consistent with a Higgs Boson (but which one...?)
Historic Milestone but only the beginning
Global Implications for the future

Data transfers from GridKa to WLCG centers

- RAW data processing
  - e.g. event (re-)reconstruction
  - Event selection
  - Physics and detector simulation
  - Analysis

Disk
Tape Archive
Analysis and simulation jobs

RAW Data
GridKa Today

- Resources available for 2022/2023
  - ~61,000 CPU logical cores
  - 56 NVIDIA GPUs V100 & A100
  - 99 PB Online Storage installed
    - Chip/logistics crisis hitting hard
    - Deployment delayed until summer 2022
  - 135 PB Offline Storage capacity
    - Migration TSM ➔ HPSS in full swing
  - 400 G Wide Area Network connection
    - 2x100G to CERN + 2x100G to DFN
- Check the performance of GridKa live: [https://s.kit.edu/gridka-monitoring](https://s.kit.edu/gridka-monitoring)
GridKa Preparations for LHC Run 3

- Increased tape performance requirements
- Migration to HPSS tape system
  - Long term team effort started in 2020
  - Data Migration (70 PB) + new software stack
  - CMS & LHCb use HPSS since 3/2022
  - ATLAS, ALICE are next
  - Experience shared with community
- Successful Tape Challenge 3/2022
Immediate Future – LHC Run 3

Satisfy increased computing and storage requirements at highest possible reliability!

Ready for LHC Run 3
Mid-term Future
Preparing for HL-LHC
Upgrade TIER-Centers for HL-LHC

- HL-LHC generates **new challenges** for data management and analytics – addressing them properly enables new scientific discovery
- Without alternatives, **Germany needs** powerful data and analysis centers so that the German physics community can participate in the scientific discovery at HL-LHC

➔ “Upgrade TIER-Centers for HL-LHC”
joint proposal of KIT, DESY, GSI and part of the Helmholtz FIS roadmap 2021, page 53

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R&D on Opportunistic Resource Usage

- Research and Development to provide third-party compute resources via established entry points
  - Combine expertise of Grid centers with capacities of HPC, Cloud, …

- Domain agnostic software suite COBalD/TARDIS developed at KIT (jointly with computing group at ETP)
  - Regional resource pool across HEP University- & HPC-resources coordinated at KIT/GridKa

- Cooperation/integration with PUNCH4NFDI
Cooperation with NHR

- SDL Astroparticle and Particle Physics
  - Goal: software and consulting to use NHR@KIT; coordinated by GridKa experts
  - Enable **knowledge and technology transfer** with other compute driven scientific communities
- Opportunity to shape NHR/HPC usage for physics
  - Close cooperation of experts for both HPC and Grid
  - Establishing **tooling and policies** for HPC usage by large-scale, distributed scientific communities
  - Support other sites to use HPC for physics communities e.g., HEP@CLAIX at RWTH Aachen
Expected Changes

- **Centrally accessible but distributed and dynamic resources**
  - GridKa as gateway to both static and opportunistic on- and off-site resources

- **Data Lake**
  - GridKa Online and Offline Storage need to serve dynamic remote caches
  - WAN bandwidth ever more important

- New architectures for offline computing
  - Algorithms optimized for CPU usage and Accelerators (GPUs)

- Changing security concepts, incl. retirement of GridKa CA
GridKa 2030
Starting Point

ATLAS

CMS
Side Notes…

- Scenarios not equal between ATLAS & CMS
  - Use for ATLAS & CMS
- Assume T1 requests scale with total requests
- Already +1 year old
- 10 years is a long time in IT
- Work with what we have & have learned
- Many uncertainties, large error bars (not shown), slipping schedules …

Disclaimer: calculations from 11/2021
GridKa CPU Pledge

- Prediction based on x86 CPUs
- Experiment strategy w.r.t. large scale accelerator (GPU) use and better CPU feature utilization unclear
  ➞ important topic for the experiments to work on
- Other architectures: ARM? Power?

3.5M HS06 @ 2022
~ 350k log. cores
~ 1400 nodes
GridKa Disk Pledge

- Spinning disk ≠ spinning rust yet
- Affordable flash-based large volume storage not in sight yet
- Higher density, less power

350 PB @ 2022
~ 22k 18 TB HDDs
~ 30 racks
GridKa Tape Pledge

- **Tape is not dead!**
- Monopoly, but clear path forward
- A lot more than just media – performance at scale is not cheap
  - Libraries
  - Drives
  - Disk (flash) buffers

| 1 EB @ 2022 |
| ~ 50k 20TB cartridges |
| ~ 5x 10k slot libraries |

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Graph showing the increase in data storage over time from 2021 to 2030.
Power/Heat

- New purchases and retirements are taken into account
- Current building 441/442
  - limited to ~1.2 MW power and cooling
  - Other users besides GridKa
- GridKa is not limited to 441/442
  - CPUs can be “anywhere” with good network connectivity
- ~500 kW UPS power required for storage
  - Currently ~230 kW for all users in 441/442
Funding

- FIS roadmap entry “Upgrade TIER centers for HL-LHC” by (DESY/GSI/KIT)

- Full support of the German community

„Ohne diese Ausbauinvestitionen werden die Helmholtz-Zentren nicht in der Lage sein, ihre herausragende Rolle im WLCG-Computing in Deutschland weiter wahrzunehmen. Der deutsche Beitrag zum LHC-Computing wäre dann insgesamt dramatisch gefährdet.“
sagt “Danke”