WLCG Update

HSF-OSG-WLCG workshop summary

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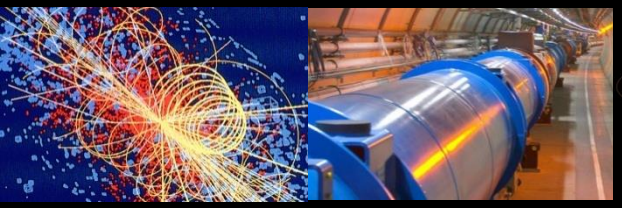


WLCG
Worldwide LHC Computing Grid

Overview

- HSF (HEP Software Foundation) and WLCG had a first combined workshop in Naples a year ago
  - Very successful, will be the standard now
- In 2019, at JLab, we were also joined by the OSG (Open Science Grid) all-hands meeting
- 246 registered participants
  - largest meeting JLab has hosted by some margin
- Excellent hospitality & enjoyable social events
  - The Mariner's Museum was a particular highlight

Scientific Program

https://indico.cern.ch/event/759388/timetable/#all.detailed

- Plenary sessions on Monday and Friday
- 2-5 parallel tracks at different times on the other days
  - WLCG
  - HSF
  - OSG
- Some overlap in interest between the tracks
  - Not possible to take it all in
  - This is a necessarily partial view

Monday plenary sessions

- Input from communities/experiments on current and future computing challenges
  - LHC experiments: ALICE, ATLAS, CMS, LHCb
  - DUNE, Belle II
  - Dark matter
  - Electron-Ion Collider
  - Photon/neutron sources
  - LSST
  - LIGO/VIRGO
  - IceCube
- Evolution of the WLCG collaboration

Tuesday parallel tracks

- WLCG (+ HSF)
  - Technology watch on computing, storage and networking
  - HPC centers, clouds
  - Expt. software frameworks on heterogenous resources
  - Authentication and Authorization Infrastructure evolution
  - Security operations
- HSF
  - GPU and other accelerator technologies
- OSG
  - OSG status
  - OSG communities

Wednesday parallel tracks

- WLCG
  - Resource and cost estimates
  - Benchmarking
  - Performance evaluation
  - Storage modeling and data popularity
  - DOMA (Data Organization, Management and Access)
    - WG topics: 3rd party copies; quality of service; access
    - Rucio, DIRAC
    - Data provisioning for HPCs and clouds
- HSF
  - Simulation, analysis, reconstruction, machine learning
- OSG
  - Infrastructure & resources

Thursday parallel tracks

- HSF
  - Present and future technologies for data analysis
  - Notebooks, Python, ROOT, vectorization, …
  - Training
  - Performance monitors/profilers, static analyzers
  - Packaging
- WLCG
  - Information system evolution
  - Operational intelligence
  - Long term future of the storage services at T2s
  - Lightweight sites
- OSG
  - USCMS Facilities
  - Researcher training

Friday plenary session

- Forward look and close out
  - DE Funding Initiative
  - UK IRIS Project
  - US IRIS-HEP Project
  - The Future of Scientific Computing

HSF Session Highlights

- Software on Accelerators
  - Significant work now archived in the community:
    - ALICE tracking in TPC; LHCb Allan project to port the whole of HLT1 to GPU
    - Event generation on GPU looks possible; Simulation looks very hard
  - General lesson: *data layout matters a lot – needs to be as simple and portable as possible*
  - General frustration: *no obvious toolkit exists for maintaining heterogeneous code*
- Simulation
  - Speed is of the essence – approximate methods are needed
  - Machine Learning is helping, but details are really tricky
  - Stochastic process – not easy to adapt to modern CPU architectures
- Reconstruction
  - Real Time Analysis (close to data taking) is driving fast calibration and high quality reconstruction to throw away raw data
    - Accelerators are finding use here

HSF Session Highlights

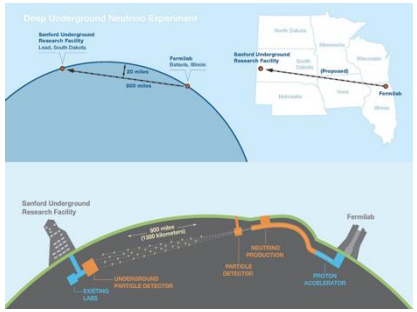
- Analysis and PyHEP
  - Very diverse landscape with huge dynamic range
    - Balance flexibility against costs of storage and (re)calculation
  - New ideas from data science are important, toolkit approach
  - Imperative and functional approaches look attractive – technology agnostic
- Education and Training
  - New initiatives needed to equip people with the right skills – better and wider training needed
  - LHCb StarterKit leads the way – being adopted across different experiments
    - Common training material within HEP, and even with Carpentries, looks possible
- Software Tools
  - Ripe area for collaboration in software profiling and analysis as well as packaging

HSF Perspectives

- Software covers a high range of tasks for HEP
  - Sharing ideas is profitable
  - Sharing code is much harder, but pays off in the long term
    - E.g. ACTS, DD4hep, VecGeom/VecCore
- New working groups put together great sessions during the meeting
  - Really generating community engagement
  - This is just the start of the process
    - Next HSF meeting will discuss future perspectives (11 April)
- CWP Roadmap was published in Computing and Software for Big Science – "The end of the beginning"
- HOW2019 took us to the next phase and was a really success

We are not alone …

- On the timescale of HL-LHC we will have many other large data volume HEP and astronomy/astroparticle experiments:

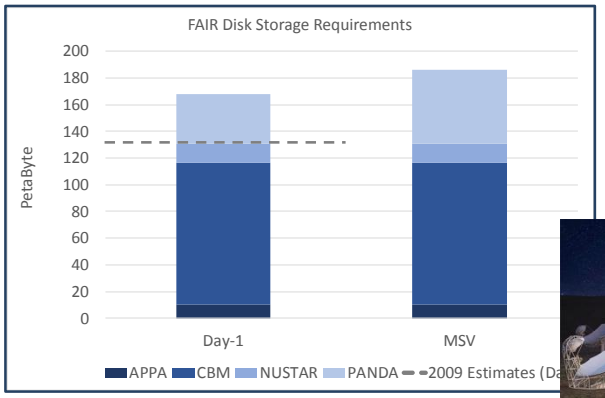


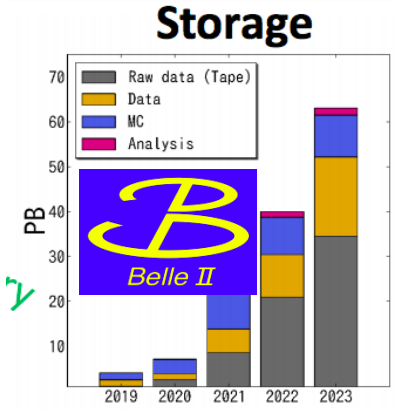
DUNE DEEP UNDERGROUND NEUTRINO EXPERIMENT

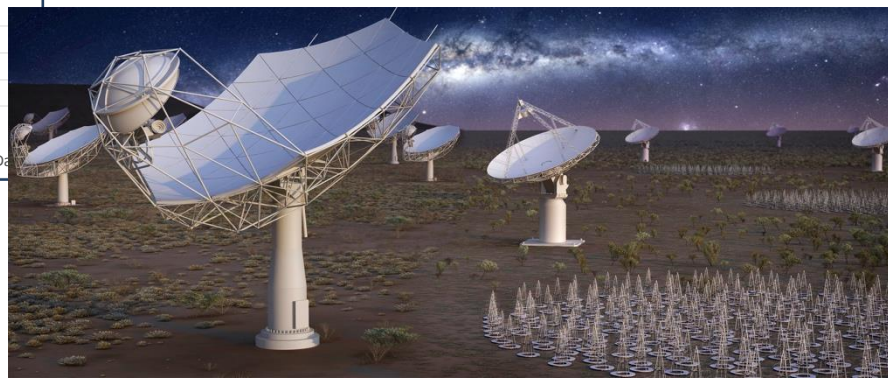
DUNE expects to produce ~70PB/year in the mid 2020s

FAIR

Comparable data volume to LHC







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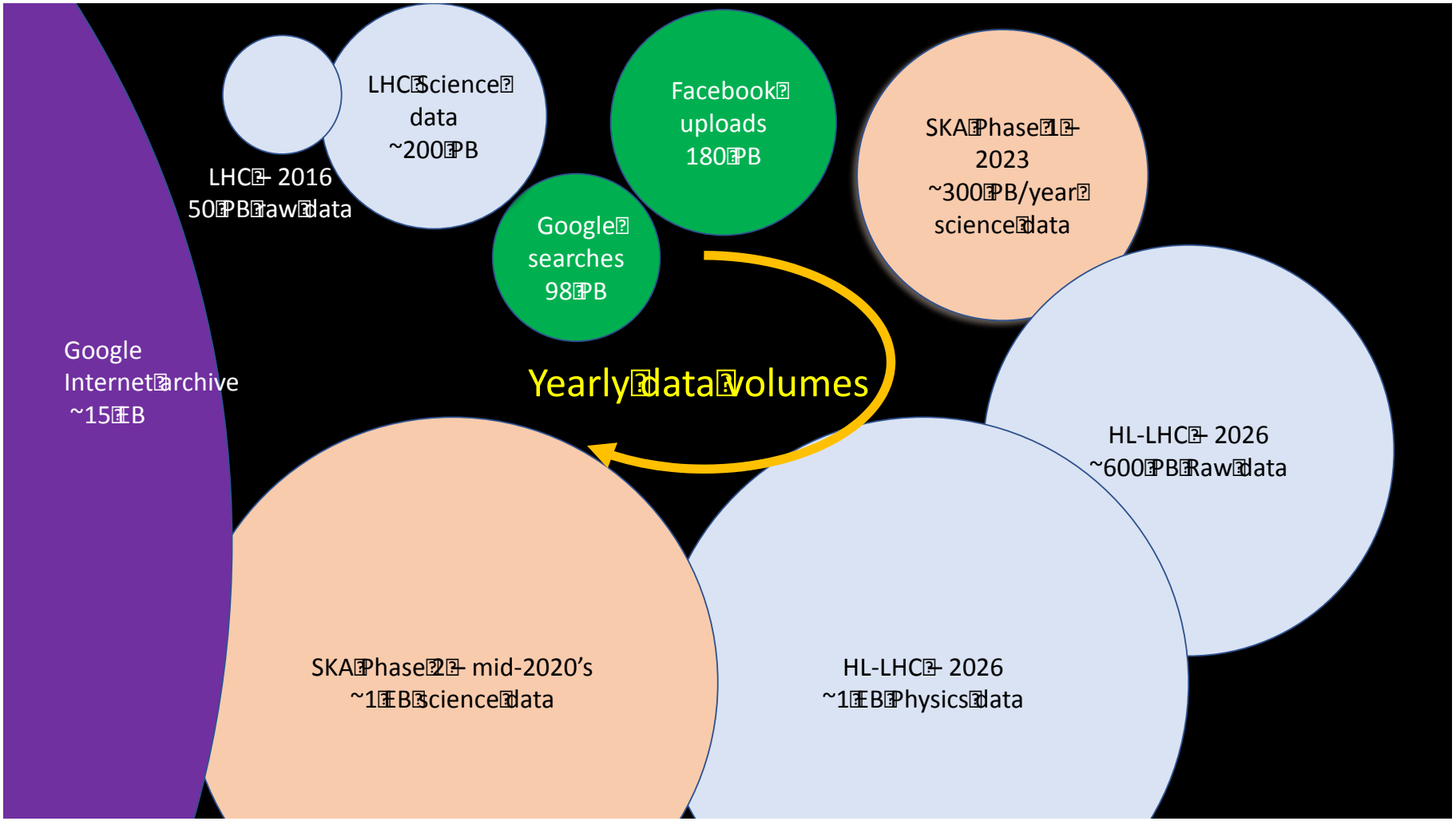
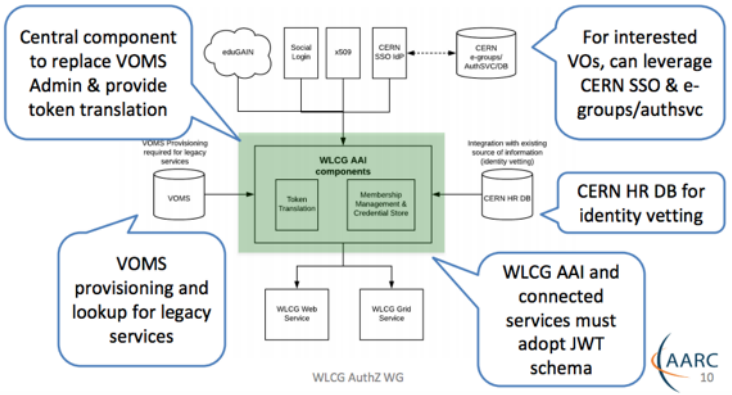
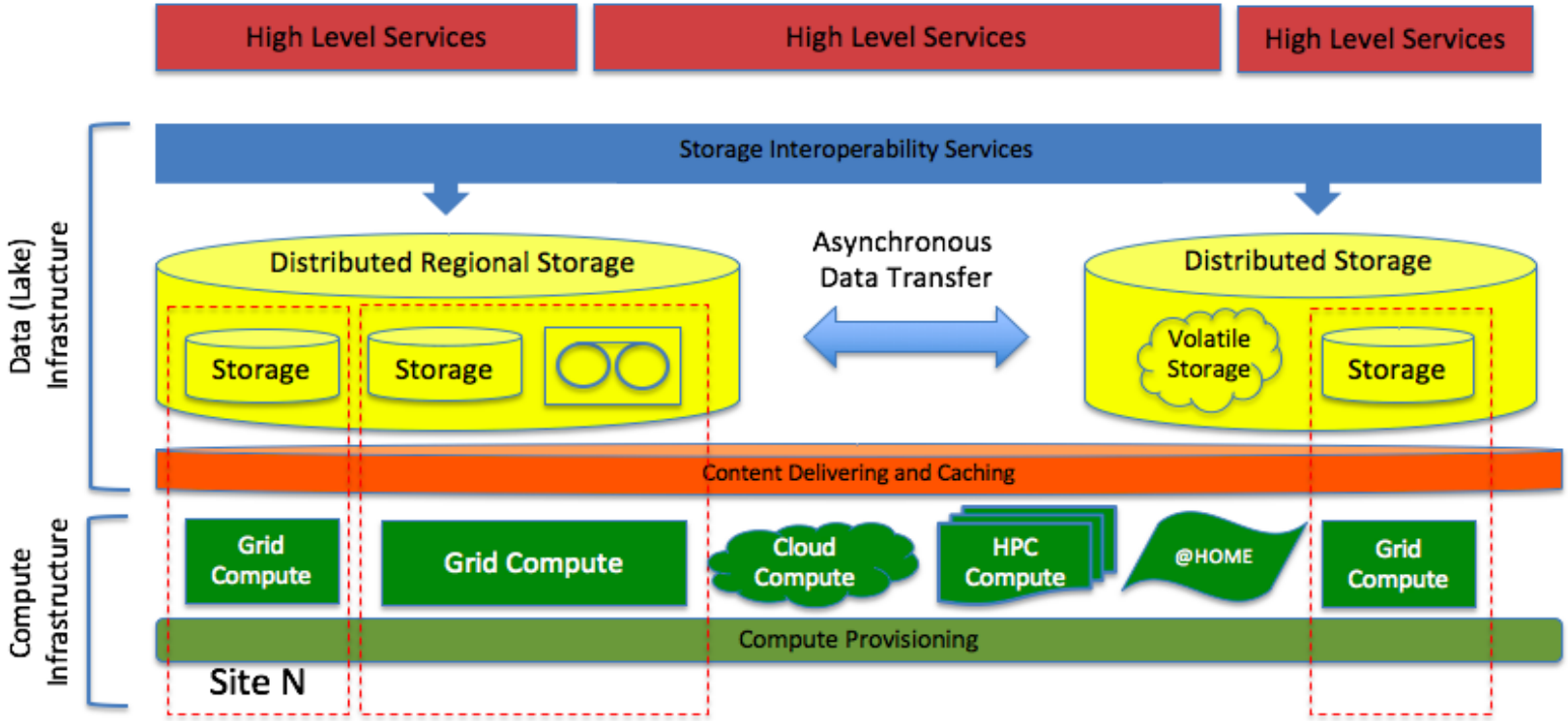


Data management and storage

- Set of R&D projects to prototype such a data management infrastructure – and associated tools
- Aims:
  - Reduce the global cost of storage (hw and operations)
  - Enable a more effective use of existing storage
  - Be able to efficiently and scalably deliver data to large, remote, heterogenous, compute resources (LHC Tier centres or HPC, clouds, other opportunistic)
  - Build a common set of DM tools that can be used by a broad set of scientific experiments
    - Today LHC, DUNE, SKA, Belle-II, GW-3G, and others are all looking at a common set of identified tools
- Also collaboratively (LHC+SKA with GEANT) looking at underlying data transfer and network tools (replace gridftp, network protocols, etc.)
- Evolution of the AAI solutions from X.509 towards token-based systems
  - Following AARC, AARC2 models
  - In line with most modern network services



Data delivery “data lake (cloud)”



Idea is to localize bulk data in a cloud service (Tier 1’s ➔ data lake): minimize replication, assure availability

Serve data to remote (or local) compute – grid, cloud, HPC, ???

Simple caching is all that is needed at compute site

Works at national, regional, global scales

Data Organisation, Management and Access

- Quickly evolved to three DOMA working groups testing technologies to realise the ‘Data Lake’ idea
- Third Party Copy
  - https://indico.cern.ch/event/759388/contributions/3312485/attachments/1815438/2968872/DOMA-TPC-HOW2019-v4.pdf
- Quality of Service
  - https://indico.cern.ch/event/759388/contributions/3312486/attachments/1815441/2966872/QoSSession_v3.pdf
- Access
  - https://indico.cern.ch/event/759388/contributions/3312487/attachments/1815269/2966554/DOMA_ACCESS_JLAB_workshop-v3.pdf

Software

The real HL-LHC computing challenge is a software problem:

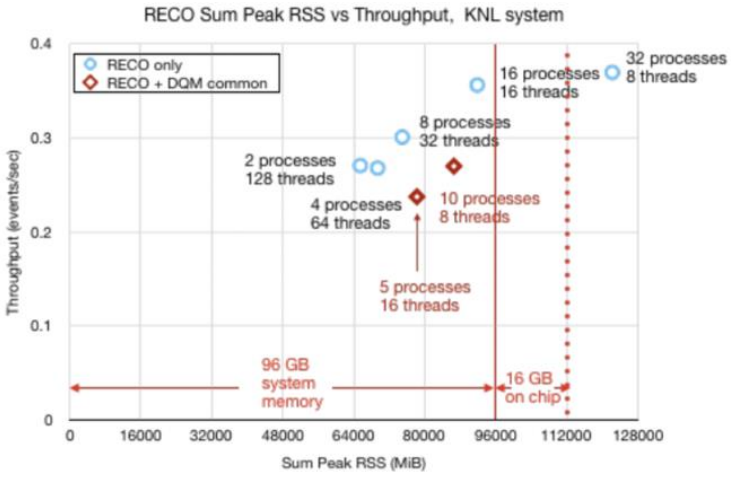
- Moore's law is still there in the number of transistors
  - But not in an easily usable form – many cores, specialized co-processors (e.g. vector units), GPUs, etc.
  - (Most of) Today's software is not efficient on these processors
- We need to be able to use all offered types of resources (HPC, GPU, other non-x86),
- Do we need to optimize on each architecture (& sub-type?)
  - Some types of machine may only be suited to certain workloads

Implies significant re-engineering & re-writing of core application software

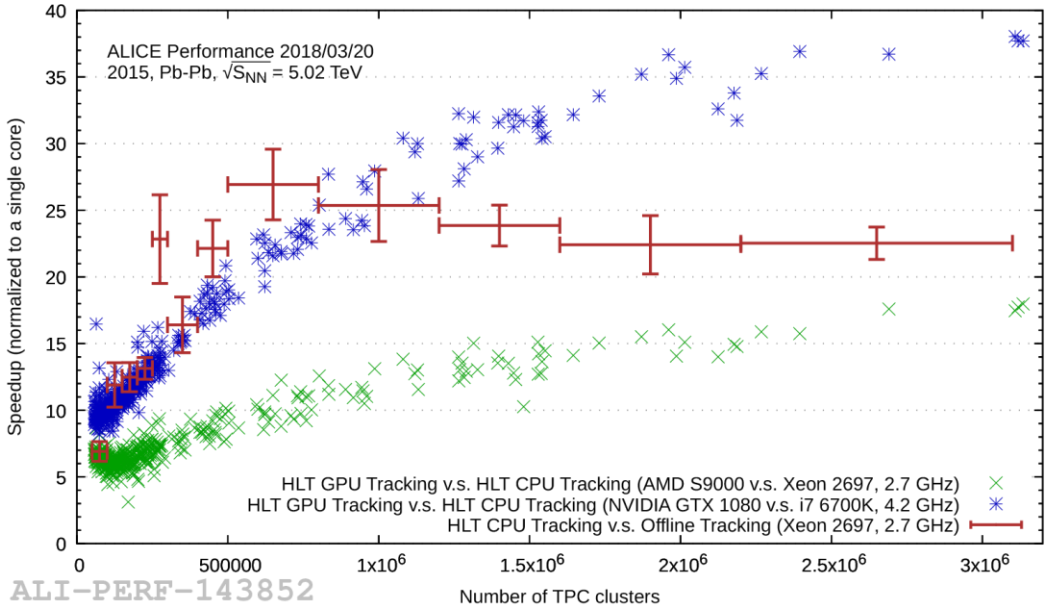
- This is a non-trivial and long-term proposition
- Not just a problem for HEP – requires sustained and significant investment in software skills & capabilities from Funding Agencies
  - This is currently largely missing!

Software challenges

- We have seen significant successes with improved performance
  - Reducing the overall scale of the HL-LHC problem
  - But these need long term skills development & career recognition for scientists



CMS reconstruction – multithreading – trade performance for memory



ALICE: speed up from GPU use + algorithmic improvements + tuning on CPUs

Selected observations (1)

- Can no longer assume increases in performance/capacity
  - 20% yearly increase “for free” has not held in recent years
- ATLAS and CMS Run 4 requirements are driving a lot of the activities
  - With benefits already planned for Run 3 and for other experiments and communities, e.g. through Rucio
- Other experiments and communities have requirements at least comparable scale
  - WLCG will evolve toward more explicit forms of collaboration with related communities
    - Profit better from shared efforts and investments
    - Speak to funding agencies with a common voice
- Funding agencies have finally started recognizing the importance of sustainable SW development for big science (CWP played a big role.)

Selected observations (2)

- Use of HPC centers and clouds will increase
  - Should become easier to use – more organisation on our side will help
- Use of GPUs, other accelerators and machine learning will become more significant
- Authentication and authorization becoming easier
  - Federated identities instead of certificates
  - More work to be done
- The organization, management and access of big data will shift toward *data lakes*
  - WLCG will probably be a hybrid infrastructure for many years to come
- Sites will be able to choose between several ways to make their service deployment and operations more lightweight

We have an interesting decade ahead of us! ☺

Questions?