WLCG Outlook to Run 3 and HL-LHC

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Scientific Computing Forum

CERN, 2nd October 2019

Run 3 guidance – June 2019

For 2021 the baseline assumption for the proton run is as presented in the March 6 LMC:

- bunch intensities ramping linearly up from 0 to 1.4e11ppb over the year with limited availability of the injectors/LHC resulting in **only 20% machine efficiency**.
- Note that LHCb is expected to be leveled at 1x10^33 for most of the time as the bunch intensity will not be sufficient to reach 2x10^33 for the duration of a full fill.
- For contingency planning, the machine efficiency can be assumed to reach the normal value of 50%. This results in the following luminosity envelope:

	Baseline	Upper limit
ATLAS/CMS	17/fb	42/fb
LHCb	3/fb	7/fb
ALICE	36/pb	90/pb

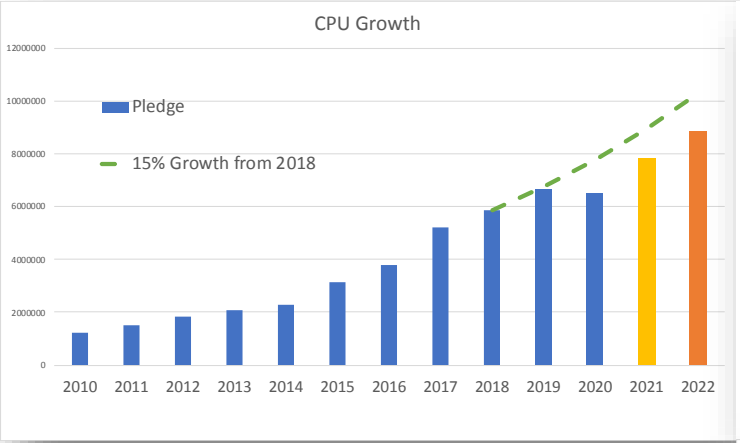
- We would like to emphasize that the upper limit is for **contingency planning only (i.e. raw data tape storage), not physics planning**.
- Furthermore the baseline numbers are likely to shift and should not be considered as luminosity targets yet. Updated numbers are likely to come towards the end of the year.
- For the PbPb period, it is assumed to be a full production year for now, which means more >2/nb for ATLAS, ALICE and CMS.

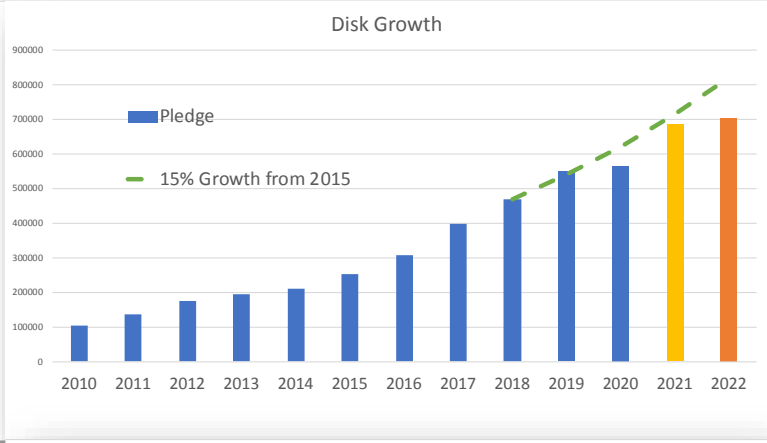
Run 3 : best guess

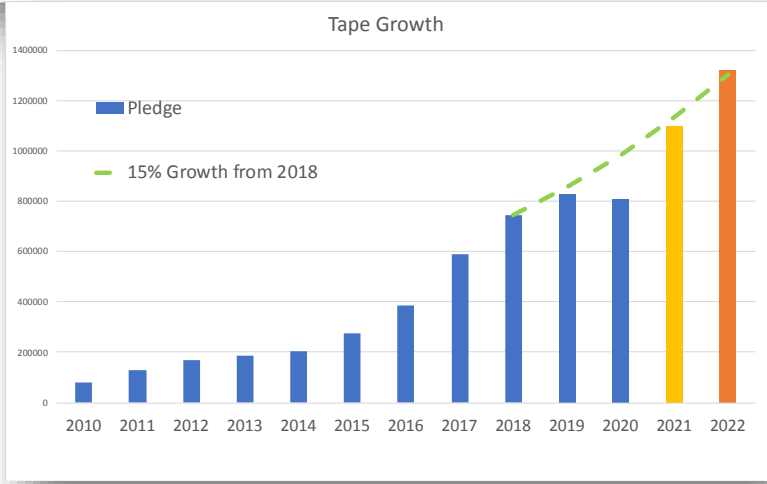
- Given information from LHC team, following June LHCC request:
  - Agree baseline for 2021 is 17 fb^{-1}
    - With contingency plan (for tape) is up to 42 fb^{-1}
  - No additional (needed!) input on likely conditions was given
    - So agreement is to assume levelling is for 4 hours per fill
  - Assume a full HI run
- Likely situation as far as we understand:
  - 2021 is a very low data test run, resources same as 2018 for pp;
    - However, full HI run is likely – will need some level additional resources
  - 2022 is a full year with a resource level of 1.5 x 2018
  - Moderate (20%) growth rates for 2023 (and 2024)

Resource evolution

- Actual installed
- 2021 request to C-RSG
- 2022 = 1.5*2018



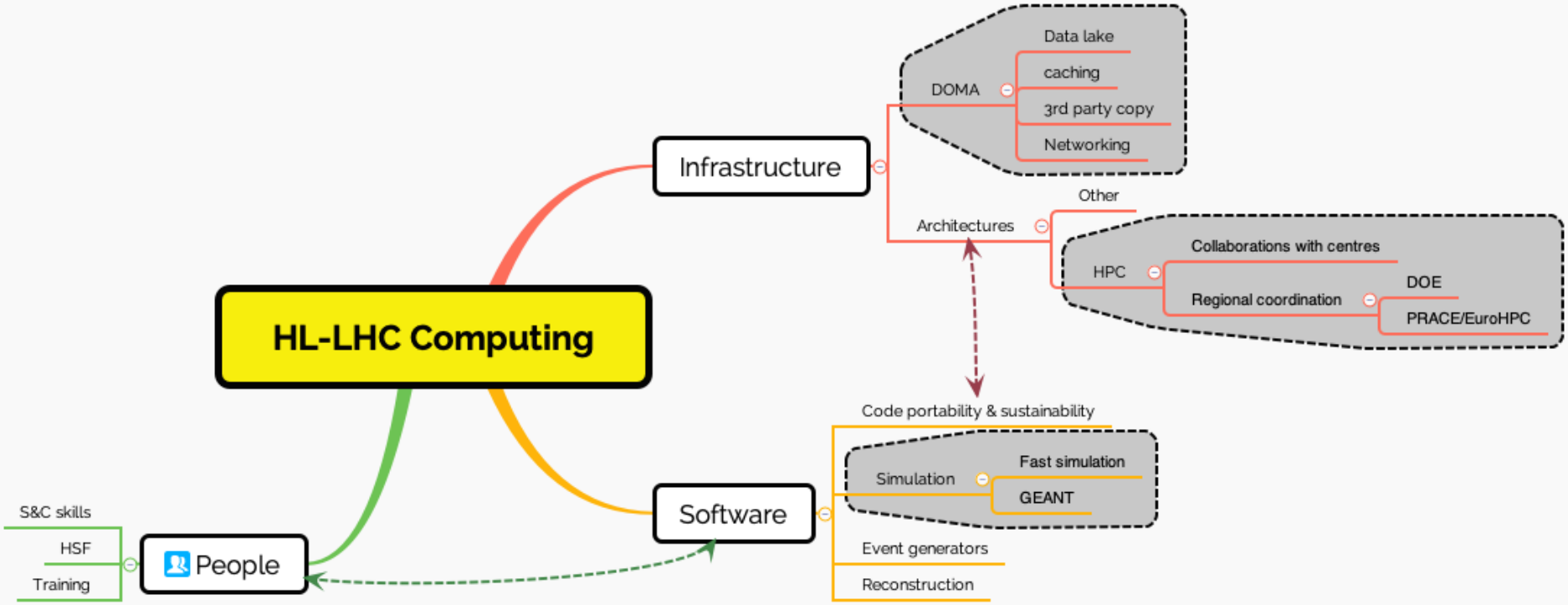




NB: Run 3 probably manageable overall, ***but*** constant budget growth until Run 4 is essential for HL-LHC

NB2: 15% maybe an optimistic assumption – many indications that flat budget is much worse (~ 10%)

Towards HL-LHC



DOMA in a nutshell

DOMA project
(Data Organization, Management, Access)

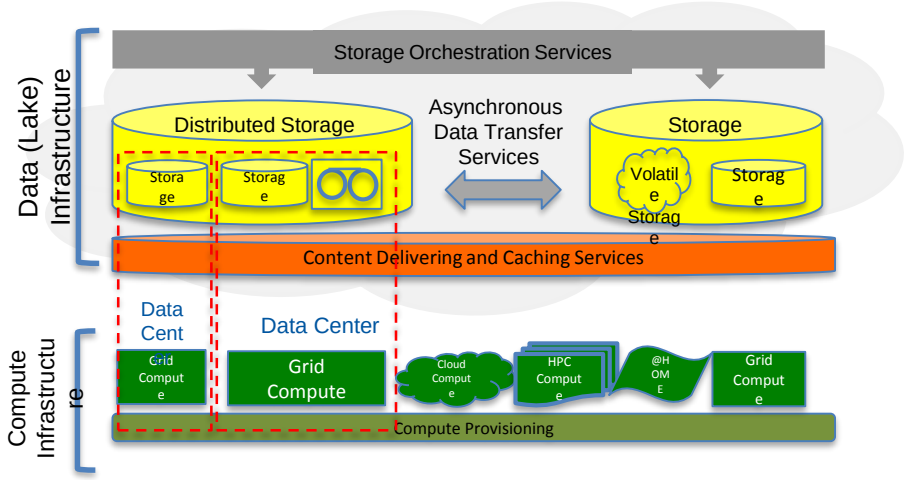
A set of R&D activities evaluating components and techniques to build a common HEP data cloud

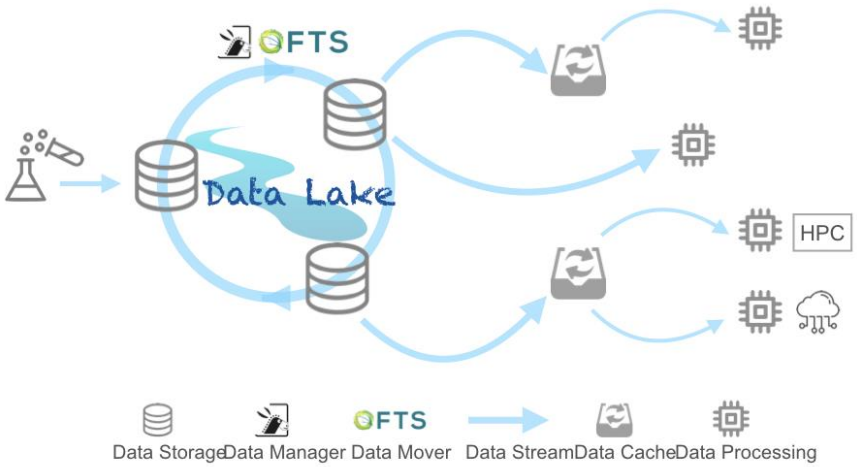
Three Working Groups

- ACCESS for Content Delivery and Caching
- TPC for Third Party Copy
- QoS for storage Quality of Service

And many activities, reporting regularly

https://twiki.cern.ch/twiki/bin/view/LCG/DomaActivities

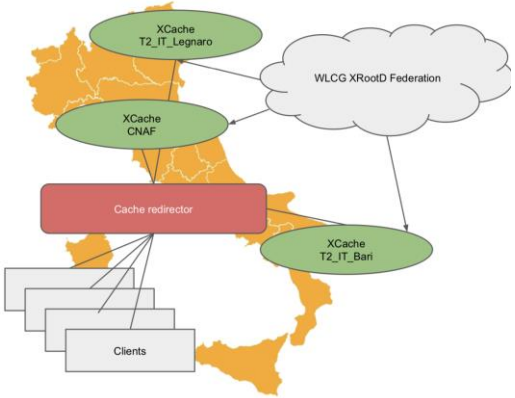


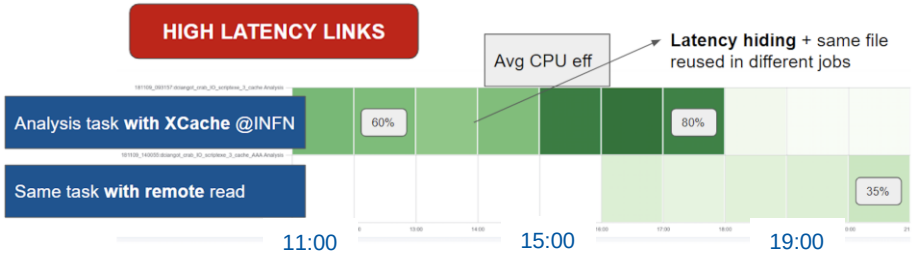


From Simone Campana @ LHCC 10/09/19

ACCESS: caching layer prototype

A distributed caching system in INFN



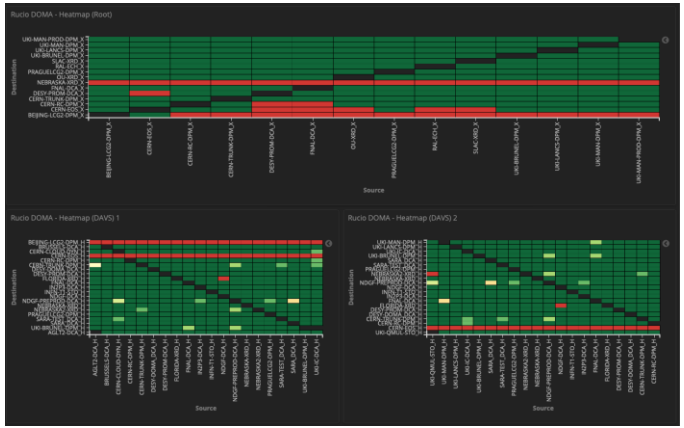


From Simone Campana @ LHCC 10/09/19

TPC

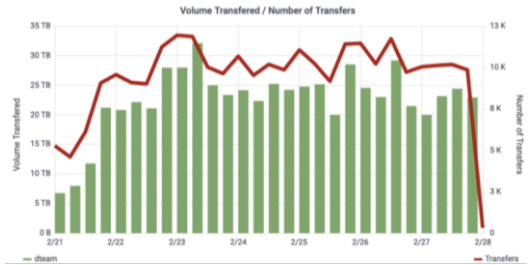
Goal: commission non-gridFTP protocols for asynchronous data transfer (Third Party Copy)

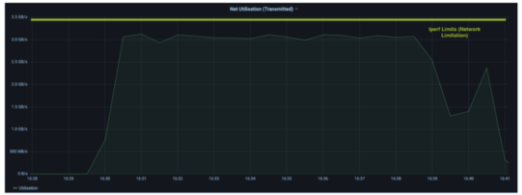
- Phase-2 (deadline June 2019): all sites providing > 3PB of storage to WLCG should provide a non-gridFTP endpoint in production



Point-point functional testing

Functional and Stress testing





Capable to fill available bandwidth

- Phase-3 (Dec 2019): all sites to have a non-gridFTP endpoint

NB: some features needed for TPC are available only in recent versions of storage

From Simone Campana @ LHCC 10/09/19

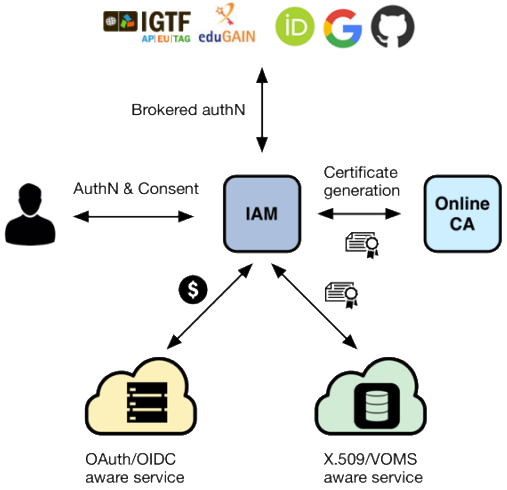
TPC and AAI

WLCG is planning to evolve AAI toward token based Auth/AuthZ and Federated Identities

The WLCG task force is finalizing the token profile as last item

While this is has a much broader scope than DOMA, TPC offers a well confined use case to start with

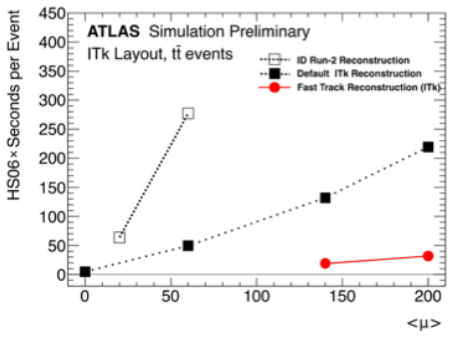
Rucio is integrating tokens. Storage is preparing to manage them.

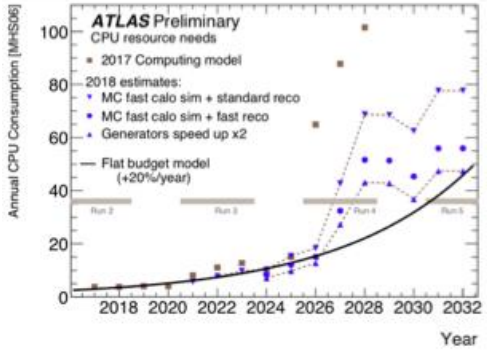


From Simone Campana @ LHCC 10/09/19

Software topics

- Several active HSF working groups
  - Event generators
    - Several workshops and meetings
  - Reconstruction and software triggers
    - Common topics: GPUs, real time analysis, links to other communities
  - Data Analysis working group
    - From DOMA to final analysis
    - Future analysis models, role of ML, etc.
  - Software frameworks
    - Just set up, conveners nominated
- Lots of work in experiments on software portability and performance
  - Use of HPC
  - Lots of work on tuning simulation; fast simulation (and where it is appropriate)
  - Performance and portability:
    - Adaptation of frameworks to accommodate heterogenous code (CPU+accelerators)
    - Portability libraries: Kokkos, Alpaka, SYCL, etc
      - Can there be one codebase for all architectures?





Simulation

- Is a major cost driver (~50% total computing cost)
- Long term supportability/portability/performance is essential
  - Lot of effort in the world on portability to new architectures
  - Not as one-off to e.g. GPU-version-x
    - but we need restructuring of GEANT4 *framework & data structures* to enable efficient and ongoing portability and tuning/optimization & offloading key parts to accelerators/co-processors
  - Need a major effort on simulation for the future to tie in all of these R&D efforts
  - This is going to be a many-year effort
  - Is it GEANT4 or is it a new framework?
- This is where we really need to invest effort in the future

WLCG Risk Register

ID	Risk	Risk: Likelihood	Risk: Impact	Risk: Severity	Owner	Effect	Mitigation
Funding							
1	CERN Tier 0 budget insufficient	3	4	12	CERN	Cannot fulfill CERN commitments; knock-on effect to other Funding Agencies	Reduce scope of Tier 0 responsibility
2	Flexibility of CERN project budget lost	2	4	8	CERN	Cannot adapt spending to often changing LHC parameters and requirements	Work with RPC to retain project flexibility
3	No PCC for Run 4	3	4	12	CERN	Unable to deliver Tier 0 commitment; Lack of flexibility between online/offline at CERN	Significantly reduce scope of Tier 0 responsibility
4	WLCG Funding Agencies lack funding	4	3	12	Funding Agencies	Cannot provide required resources to experiments;	Prioritise physics programme of the experiments, via the LHCC and experiment managements
5	Physics request for resources not affordable	3	3	9	Experiments	Not all physics programmes can be done, or will be delayed	
Technology							
6	Evolution of current technology insufficient	4	4	16	WLCG	Unpredictability of costs; Unable to provide required resources with constrained budgets	Ensure software as efficient as possible; Prioritise physics programme of the experiments Ensure flexibility in software and hardware - adaptable software, optimize between CPU, storage, networks
7	Offered resources not matched to requirements (e.g. HPC, GPS, etc)	3	3	9	WLCG	Inefficient usage	Ensure software as efficient & portable as possible; Prioritise physics programme of the experiments
8	Resources fragmented by types (HPC, GPU etc	3	3	9	WLCG	Inefficient usage; some resources may only support certain workflows; loss of general flexibility	
9	Tape market shrinks/fails	2	4	8	WLCG	Major rethink of value of data vs re-run of experiment, Need new data models; Drastic reduction in overall storage capacity	Content delivery models with relatively few data repositories; Rethink of value of multiple data copies; Assess alternative archiving solutions
10	HDD technology changes - expensive, hard to use	2	4	8	WLCG	Storage costs become too high	
11	Inadequate WAN; or competition with other sciences, or complex landscape	3	3	9	WLCG/GEANT/NRENs	Lack of sufficient bandwidth to support data delivery model	Work with NRENs, GEANT, etc.; Concepts like LHCONE to prioritise and shape network traffic
Software							
12	Lack of investment in software skills	3	3	9	WLCG/HSF	Inability to sufficiently improve performance of core software	Training, education, hackathon programmes with HSF; projects such as IRIS-HEP, & other initiatives
13	Geant4 does not invest in long term strategy for performance improvement (x5-10)	2	4	8	EP/SFT	Cannot afford sufficient simulation; physics analysis suffers	Start major R&D program to devise strategies for fast MC, as well as better use of compute architectures
14	ROOT does not invest & prioritise I/O performance and data formats	2	4	8	EP/SFT	Significant bottleneck in data performance, streaming, access - starves CPU resources; this is also key for content delivery models required to address storage costs and concerns	Start R&D program on I/O and data management in ROOT, prioritse above other functions; has major cost impact
15	Event generators for higher order not optimised	2	4	8	HSF/Generators	Event generation too slow, becomes significant additional cost	HSF working group with generator community. Ensure progress is made
16	Experiments do not improve computing model performance	2	4	8	Experiments	Lack of investment of effort to reduce reconstruction time, decrease storage needs, etc.	Experiment working groups on all aspects of computing and storage: nanaAOD, reduce reconstruction time, fast simulation, etc. Must include work on data models.
17	Collaboration between experiments diverges	2	3	6	WLCG	Multiple solutions & duplication of effort too expensive to support in constrained budgets	Ensure common solutions deliver and adapt to majority of use cases
18	3rd party software no longer supported	3	1	3	WLCG	gridftp, OSS tools; would need to replace or support in the community	Remain flexible to ongoing changes at all levels
Other							
19	Licensing limitations	3	1	3	CERN/Experiments	Costs rise too high	Only limited Oracle use today?
20	EC (& other e.g. EOSC) diverges from WLCG needs	2	2	4	WLCG	Contradictory requirements on collaborating sites	Engage early enough and steer, guide, advise; e.g. ESCAPE etc.
21	Long term reliance on short term funding (e.g. EGI, OSG)	2	2	4	WLCG	Risk that services lose support	Enure key services have independent support commitments within WLCG
22	Security environment changes and breaks federation/trust model	2	4	8	WLCG	Disruptive to operation; would require significant investment in changing fundamental sharing model	Ensure our trust networks, policies, awareness are proactively adapting to the changing landscape
23	Lack of operational support at sites	3	3	9	WLCG DOMA	Unreliability of services and resources	Focus storage and data services at large sites; serve data to smaller sites
24	GDPR not fully complied with	3	2	6	WLCG	Impact on services and collaboration in particular if some sites cannot run services.	Due diligence and clear policy frameworks.

Likelihood:
1: never expected to happen
2: could happen but very unlikely
3: could well happen
4: will probably happen

Impact:
1: we can deal with it, no problem
2: a bit of a hassle but not too bad
3: can be managed, but with significant effort
4: crisis

https://wlcg-docs.web.cern.ch/wlcg-docs/boards/MB/Risks/RiskRegister.html

Conclusions

- Overall Run 3 will probably fit within cost expectations
- Preparations for HL-LHC ongoing
  - Significant efforts underway, bearing fruit
    - Infrastructure, software
  - Still some way to go
  - Long term software performance and adaptability is going to be a key area to address
- Skills retention for sw & computing remains a concern