HL-LHC Computing Review summary

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Introduction: the HL-LHC computing review

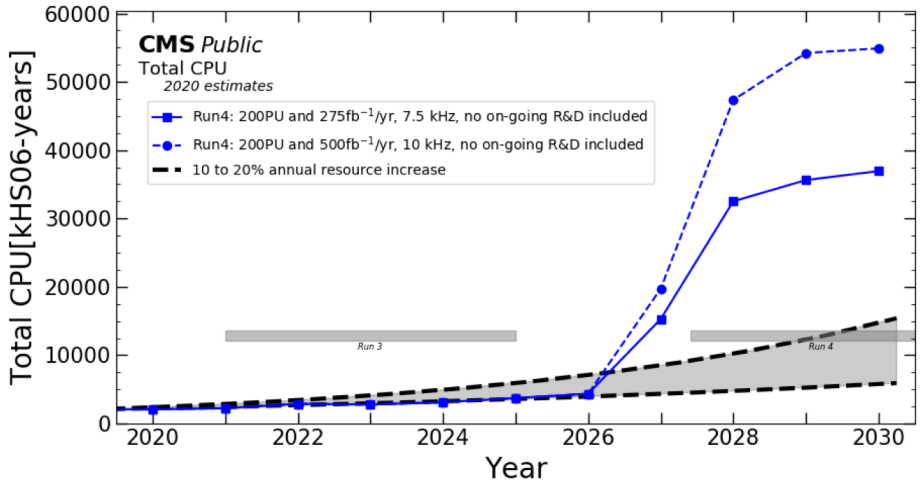
- First episode (May 19th 2020) of a process leading to the HL-LHC computing TDR(s) in ~2025. Owned by the LHCC.
- 5 documents submitted: ATLAS, CMS, WLCG, DOMA, software
- Focus on the R&D plans to:
  - address the resource needs in a flat budget scenario
  - ensure long term sustainability of tools, services and infrastructure for HL-LHC and beyond
- The review report is publicly available here:
  https://cds.cern.ch/record/2725487/files/LHCC-G-177.pdf

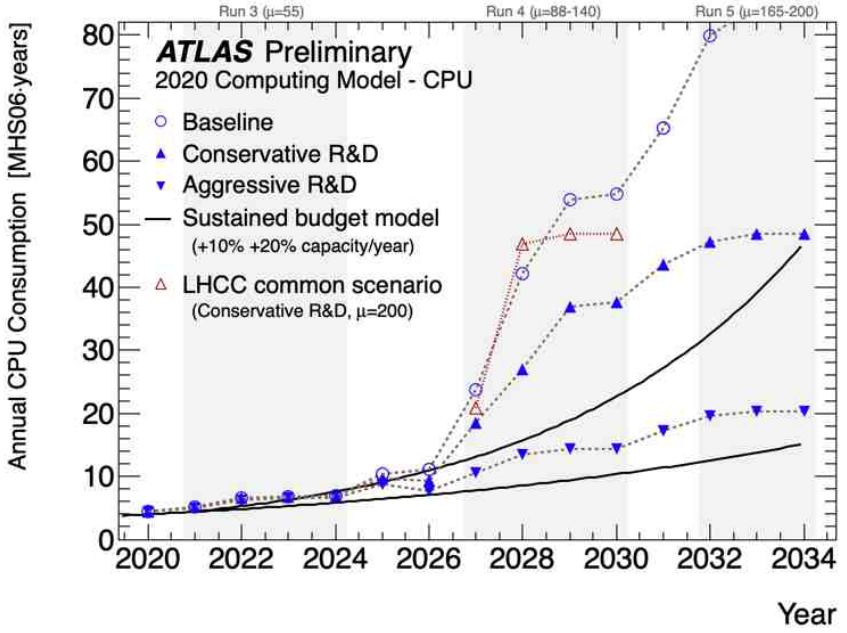
High Level Summary

- A promising and prioritized list of R&D activities was presented. For the next review a more formal assessment of the gains is expected.
- WLCG is the appropriate body for coordinating LHC specific efforts and to focus R&D on the most promising tasks. Special attention to common solutions.
- ATLAS and CMS have track record of computing innovation over many years, forming the foundation for the future R&D work. They presented a comprehensive list of activities.
- The HSF was congratulated for establishing a forum for discussions on common software, which plays an essential role in preparing for HL-LHC
- DOMA has shown promising results in proof-of-concept activities. Important progress also toward sustainability

ATLAS and CMS

Aggressive investment in R&D is needed to address the resource challenge





ATLAS and CMS

Storage still emerges as the main HL-LHC resource challenge. Many recommendations for ATLAs and CMS go in this direction

- Data carousel: implications on sites (so, engage them further) quantify savings, think about mitigations for potential risks (e.g. unclear future of tape)
- Full adoption of slim data formats (MiniAOD/DAOD_PHYS, NanoAOD/DAOD_PHYSLITE)
- Elaborate on the model of “data parking” to balance the cost over the years

For the next review, the experiments are asked to present quantitative measurements of the gains in CPU and storage from various R&Ds and develop a risk management plan

WLCG: define the Running Conditions for HL-LHC

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Common parameters: A continuous effort is needed to work on a common and realistic set of parameters across all experiments in the preparation of the TDR. These parameters can evolve in time, but need to be agreed upon by the LHC Machine Group, by WLCG and by the experiments.

HL-LHC Running Conditions for LHCC Computing Review including contingency

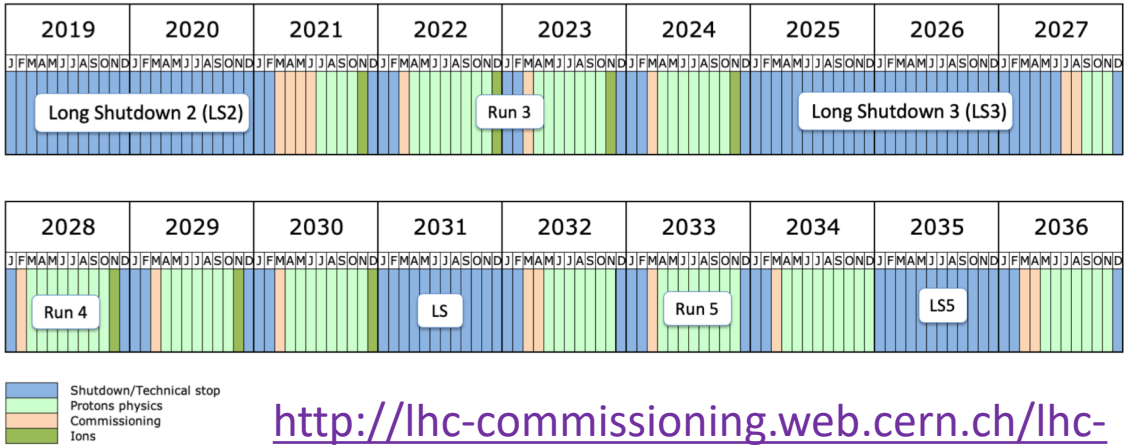
- ATLAS/CMS luminosity: <350/fb
- ATLAS/CMS average pile-up: ≤200
- LHCb luminosity: <15/fb
- ALICE luminosity: 90/pb
- Running time pp: 6×10^6 seconds
- Running time ions: 1.2×10^6 seconds

Numbers are more representative for later years in Run 4 and in Run 5
ALICE and LHCb assumed to run at same leveled luminosity as in Run 3

We agreed with the LPC on a set of conditions for HL-LHC based on the review feedback

- Applicable for Run-4 (2028-2030)
- Trigger rates and # of Monte Carlo events are experiment specific so not mentioned here

We assume 15% resource increase / year with flat budget (CPU/disk/tape), reviewed regularly in HEPIX



http://lhc-commissioning.web.cern.ch/lhc-commissioning/schedule/HL-LHC-plots.htm

A WLCG computing model in the political reality

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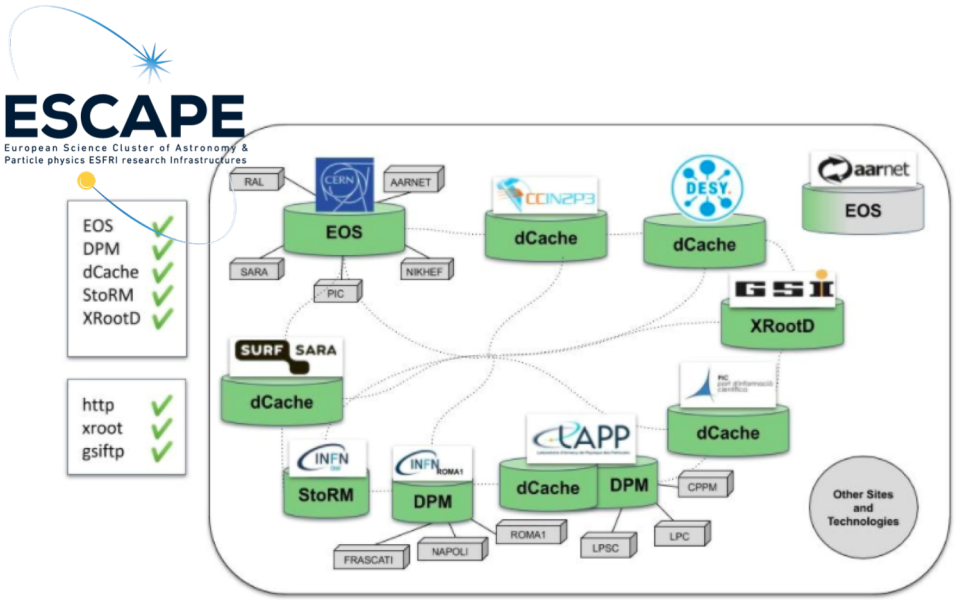
Implementing a computing model in the (political) reality: In view of strong preferences of some of the WLCG partners to invest in certain infrastructures or software developments, the solutions investigated cannot always follow the approach of using the best possible infrastructure/software for a given task. Thus, the approach to find a computing model for HL-LHC has to take into account road map decisions in the various partner countries. WLCG is thus encouraged to closely monitor the development of the computing landscape and political background in the participating countries in order to propose a computing model that can also be financed and implemented. Planning should also consider the evolution of the international computing landscape, such as the European Open Science Cloud (EOSC).



HPCs: CERN, SKA, PRACE and GEANT signed a collaboration agreement in July 2020. Complement the work done by the experiments

WLCG should leverage on the collaboration with EGI and OSG. Actively engage in the definition of the EOSC

Networks

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Network: The availability of a strong and reliable network as a backbone for the data lake model to work is of great importance. Close collaboration with LHC partners and with NRENs is required to ensure that the evolution of the networks is sufficient on the international, trans-atlantic, and national level.

ESnet
ENERGY SCIENCES NETWORK

U.S. DEPARTMENT OF ENERGY | Office of Science

ESNET REQUIREMENTS REVIEW
DOE Office of Science - High Energy Physics Program Office
June 2020 - February 2021

Review Purpose and Process
The primary purpose of an ESnet Requirements Review is to discuss and analyze current and planned science use cases and anticipated data output of a particular program, user facility, or project to inform ESnet's strategic planning, including network operations, capacity upgrades, and other service investments.

A CMS use case document has been submitted and will serve as baseline for the discussion

WLCG will take this opportunity to pave the road for similar discussions in other regions

DOMA data challenges will define metrics and targets, testing networks in real scenarios

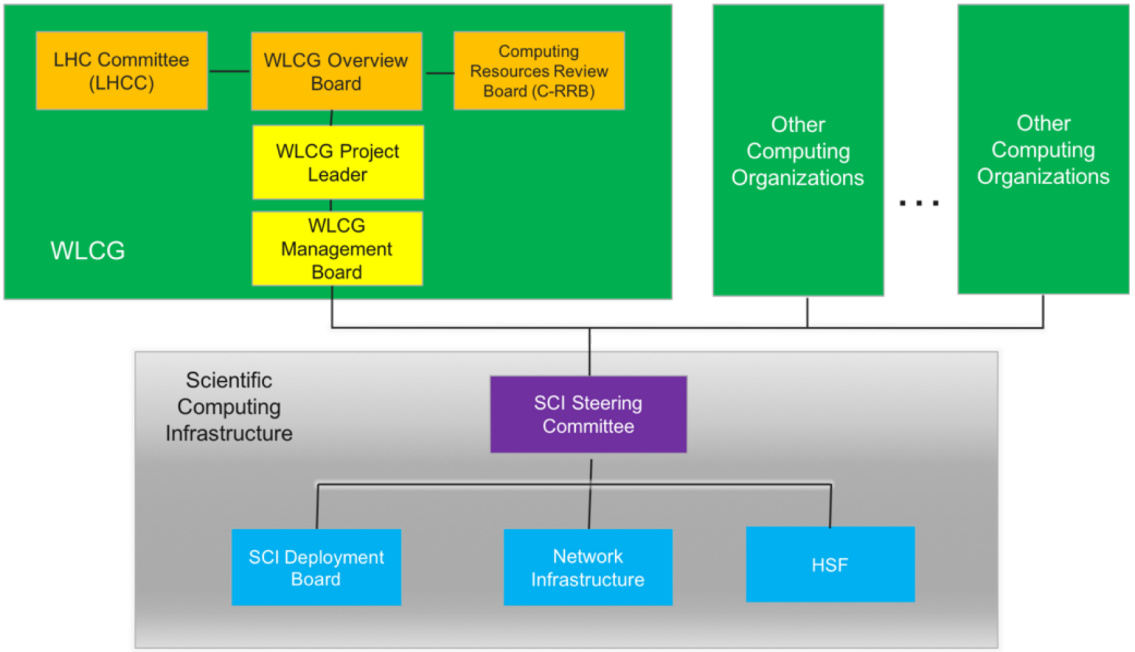
Coordination with other large experiments: Many WLCG facilities also support other large experiments, from the particle physics domain but also from other scientific fields. WLCG is encouraged to continue on the path of integrating other experiments in their discussion and converging on the same technical solutions when possible. These are, at the time being, Belle 2 and DUNE, but might include further experiments from other domains in the future.
The advantages and risks of a common "Scientific Computing Infrastructure" (as described in the Granada paper) should be further investigated.

A bottom up approach:

DUNE and Belle-2 experiments are participating to the GDB and the WLCG workshops and attending the MB. They are getting involved in common aspects of Scientific Computing (e.g. the recent task force on HEPSCORE)

Many astrophysics and astro-particle projects collaborate with WLCG in the ESCAPE European science cluster

From the Granada Open Symposium on the European Particle Physics Strategy



WLCG budgetary considerations

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Budgetary considerations: The flat budget approach in planning is certainly appreciated. However, there might be some possibility to on-board new partners into WLCG. In addition, we might be able to convince funding agencies to a slightly stronger commitment, if the arguments from the physics side are strong. Therefore, WLCG might also consider a scenario with a moderate budget increase of +10% particular if this can be shown to benefit a broader community.

We need to start this discussion with the Funding Agencies. It is important to demonstrate that there is a benefit for a broader set of communities: evolve further toward a non-HEP specific infrastructure (services, protocols, …)

DOMA

As for the experiments: focus in defining milestones, quantifying the potential reductions in cost (equipment and manpower), mitigate risk

- Quantify the potential gains and evaluate risks of the datalake model: implications of the specialized role of sites, impact of content delivery networks on cost and efficiency, person-power needs for operations

Therefore, the DOMA data challenges (network, datalakes) will be the key in the next couple of years

Sites and experiments are expected continue remaining fully engaged in those activities, in preparation for the next phase of the HL-LHC computing review

Software

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We congratulate the HSF for establishing a forum where common software developments and techniques are discussed. The value of this is recognized by the experiments and the community. Common software has played an essential role for the community in the past and will do so, perhaps even more, in the future. The cornerstone of the common projects are ROOT, Geant4 and the event generators.

A strong focus on heterogeneous architectures and accelerators as common strategy across experiments.

The review panel identified Generators and Event Simulation as the areas where the community should invest with a highest priority. We are asked to identify structures that would allow institutes and Funding Agencies to make formal commitments

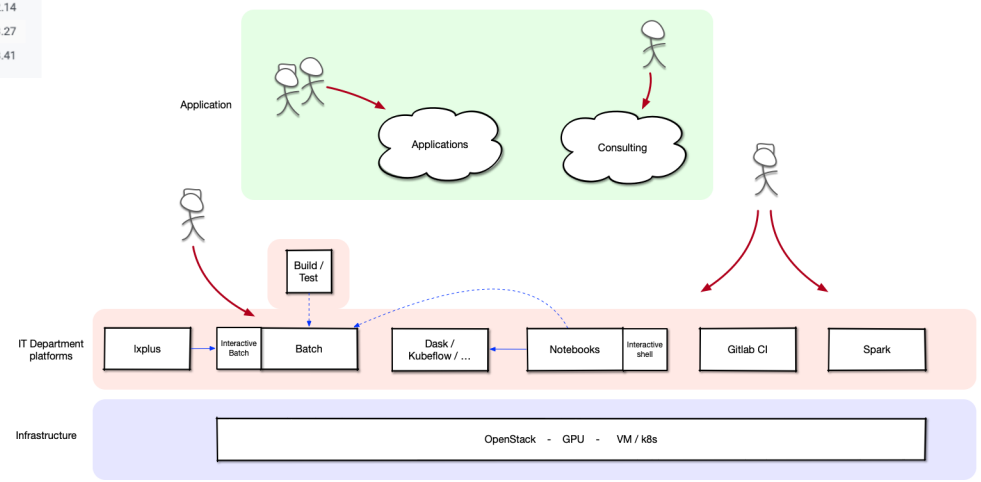
This review was a touch-base on common software. The next review, in Fall 2021 will focus on that (charge being prepared)

Heterogeneous Architectures and Accelerators

The work on the software side needs to be supported at the level of the infrastructure

CERN GPU service at CERN

Make GPUs available to a variety of use cases
A common infrastructure to flexibly assign resources
Consultancy on GPU usage



GPU enabled queues on WLCG

Used mostly for Machine Learning at the moment

GPU provisioning and accounting will be a future challenge in WLCG. Discussion started.

Conclusions

One area of concern shared by the experiments and WLCG is finding means to ensure that the highly skilled personnel essential for R&D in computing and storage have meaningful career paths within the LHC community to provide for sustainability and the need for continual evolution over the lifetime of HL-LHC.

We note particularly that effort on generators is needed as one of the components to solve the HL-LHC computing challenge, however the required work does not fit into the established funding schemes.

Special attention should be devoted to keep the effort needed for the software development sub-projects (e.g. RUCIO, FTS, AAI, XRootD & Xcache, dCache, etc.) at the right level to reach the DOMA goals within the time constraints.

The lack of career perspectives is identified as a risk for attracting and keeping people with the necessary skills and guaranteeing sustainability. Training and education are an important part of the strategy.

Person-power and the lack of career perspective remain an issue. The LH-LHC challenge presents an opportunity to improve on this. Requires prioritization and planning of the high priority tasks