

## **Extending WLCG Tier-2 Resources using HPC and Cloud Solutions**

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Available computing resources limit data simulation and processing of LHC experiments. WLCG Tier centers connected via Grid provide majority of computing and storage capacities, which allow relatively fast and precise analyses of data. Requirements on the number of simulated events must be often reduced to meet installed capacities. Projection of requirements for future LHC runs shows a significant shortage of standard Grid resources if a flat budget is assumed. There are several activities exploring other sources of computing power for LHC projects. The most significant are big HPC centers (supercomputers) and Cloud resources provided both by commercial and academic institutions.

The Tier-2 center hosted by the Institute of Physics (IoP) in Prague provides resources for ALICE and ATLAS collaborations on behalf of all involved Czech institutions. Financial resources provided by funding agencies and resources provided by IoP do not allow to buy enough servers to meet demands of experiments. We extend storage resources by two distant sites with additional finance sources. Xrootd servers in the Institute of Nuclear Physics in Rez near Prague store files for the ALICE experiment. CESNET data storage group operates dCache instance with a tape backend for ATLAS (and Pierre Auger Observatory) collaboration. Relatively big computing capacities could be used in the national supercomputing center IT4I in Ostrava. Within the ATLAS collaboration, we explore two different solutions to overcome technical problems arising from different computing environment on the supercomputer. The main difference is that individual worker nodes do not have an external network connection and cannot directly download input and upload output data. One solution is already used for HPC centers in the USA, but until now requires significant adjustments of procedures used for standard ATLAS production. Another solution is based on ARC CE hosted by the Tier-2 center at IoP and resubmission of jobs remotely via ssh. We will also report on our experience with resource extensions via Open Nebula Cloud provided by CESNET.

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