



Contribution ID: 197

Type: **Talk**

Building Scalable Analysis Infrastructure for ATLAS

Wednesday 23 October 2024 17:09 (18 minutes)

We explore the adoption of cloud-native tools and principles to forge flexible and scalable infrastructures, aimed at supporting analysis frameworks being developed for the ATLAS experiment in the High Luminosity Large Hadron Collider (HL-LHC) era. The project culminated in the creation of a federated platform, integrating Kubernetes clusters from various providers such as Tier-2 centers, Tier-3 centers, and from the IRIS-HEP Scalable Systems Laboratory, a National Science Foundation project. A unified interface was provided to streamline the management and scaling of containerized applications. Enhanced system scalability was achieved through integration with analysis facilities, enabling spillover of Jupyter/Binder notebooks and Dask workers to Tier-2 resources. We investigated flexible deployment options for a “stretched” (over the wide area network) cluster pattern, including a centralized “lights out management” model, remote administration of Kubernetes services, and a fully autonomous site-managed cluster approach, to accommodate varied operational and security requirements. The platform demonstrated its efficacy in multi-cluster demonstrators for low-latency analyses and advanced workflows with tools such as Coffea, ServiceX, Uproot and Dask, and RDataFrame, illustrating its ability to support various processing frameworks. The project also resulted in a robust user training infrastructure for ATLAS software and computing on-boarding events.

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Session Classification: Parallel (Track 9)

Track Classification: Track 9 - Analysis facilities and interactive computing