Advanced Analytics service to enhance workflow control at the ATLAS Production System

Mikhail Titov[1], Mikhail Borodin[2], Dmitry Golubkov[1,3], Alexei Klimentov[1,4]
on behalf of the ATLAS Collaboration

[1] National Research Centre «Kurchatov Institute» (RU), [2] University of Iowa (US), [3] Institute for High Energy Physics (RU), [4] Brookhaven National Laboratory (US)

CHEP 2018
9-13 July 2018
National Palace of Culture
Sofia, Bulgaria

Abstract

Modern workload management systems that are responsible for central data production and processing in High Energy and Nuclear Physics experiments have highly complex architectures and require a specialized control service for resource and processing components balancing. Such a service represents a comprehensive set of analytical tools, management utilities and monitoring views aimed at providing a deep understanding of internal processes, and is considered as an extension for situational awareness analytic service.

Key points of analytical and control service are:

- Analysis of task processing (e.g., selection and regulation of key task features that affect its processing the most);
- Modeling of processed data lifecycles for deep task analysis (e.g., generate guidelines for particular stage of data processing);
- Forecasting processes with focus on data and tasks states as well as on the management system itself (e.g., detect the source of any potential malfunction).

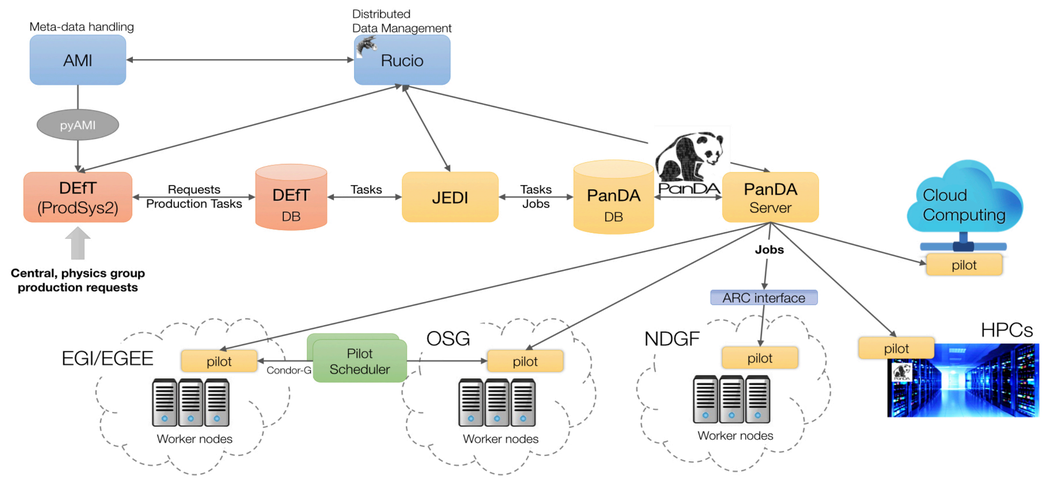


Figure 1. The ATLAS task processing workflow.

ProdSys2 / PanDA

The second generation of the **Prod**uction **Sys**tem (ProdSys2) [1] of the ATLAS experiment (LHC, CERN), in conjunction with the workload management system - **P**roduction **an**d **D**istributed **A**nalysis system (PanDA) [2], represents a complex set of computing components that are responsible for organizing, planning, starting and executing distributed computing tasks and jobs (figure 1).

ProdSys2/PanDA is responsible for all stages of (re)processing, analysis and modeling of raw and derived data, as well as simulating of physical processes and functioning of the detector using Monte Carlo methods. Using the ProdSys2/PanDA software, the ATLAS scientific community, individual physics groups and scientists have access to hundreds of **W**orldwide **L**HC **C**omputing **G**rid (WLCG) computing centers, supercomputers (HPC) and cloud computing resources.

Key sources of data for analytics processes are: i) **D**atabase **E**ngine **f**or **T**asks (DEfT), which is a main component of ProdSys2 that is responsible for forming computing tasks (task chains and group of tasks) based on the set of parameters and processing conditions; and ii) **J**ob **E**xecution and **D**efinition **I**nterface (JEDI), which is a part of ProdSys2/PanDA and is responsible for managing the payload at the task level and for the dynamic job definition and execution based on corresponding earlier defined tasks.

ProdSys2 Predictive Analytics service

The prototype of the **P**rodSys**2** **P**redictive **A**nalytics (P2PA) is an essential part of the analytical service of the ProdSys2. P2PA uses such tools as **T**ime-**T**o-**C**omplete (TTC) estimation towards units of the processing (i.e., tasks and chains of tasks) to control the processing state and to be able to highlight abnormal operations and executions.

Key components:

- Predictive model handling is an independent package (prodsys-pa-model) that is adjusted and integrated into P2PA; it is responsible for predictive model creation and usage for the process of TTC predictions generation;
- Web application (prodsys-pa-web) is a central operation service (figure 4) that is responsible for the following procedures:
  - Monitor (e.g., exec processes that are historic data of runs, evaluation of estimated durations of task executions);
  - Control (e.g., selection parameters for training and input data collections, method / technology and set of features for prediction process).

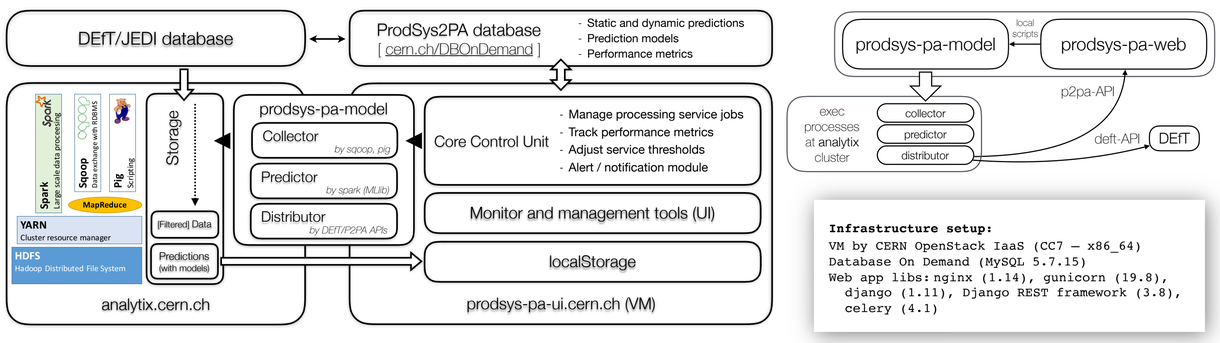
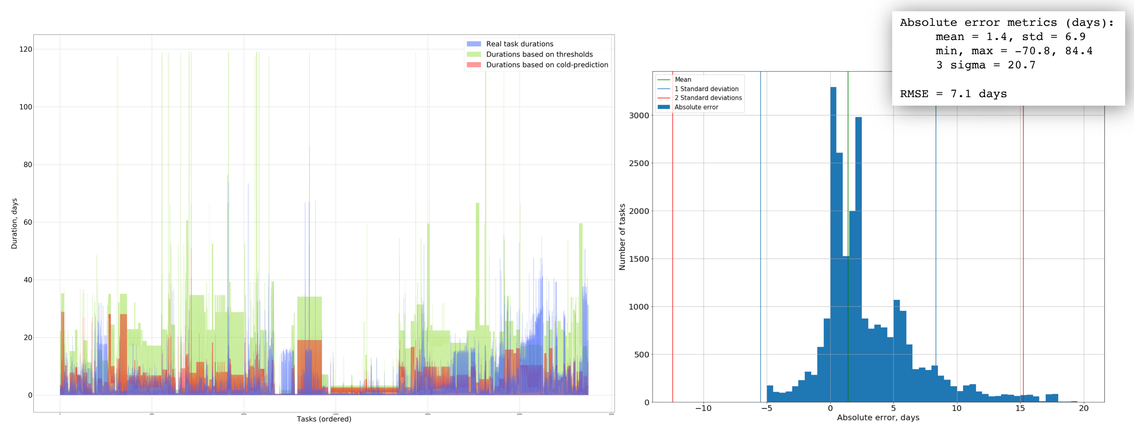


Figure 2. ProdSys2 PA architecture and its packages interaction.



(a) (b)

Figure 3. (a) Real vs. estimated durations of tasks execution (group of tasks for 1 month);
(b) Distribution of absolute errors for cold-prediction process.

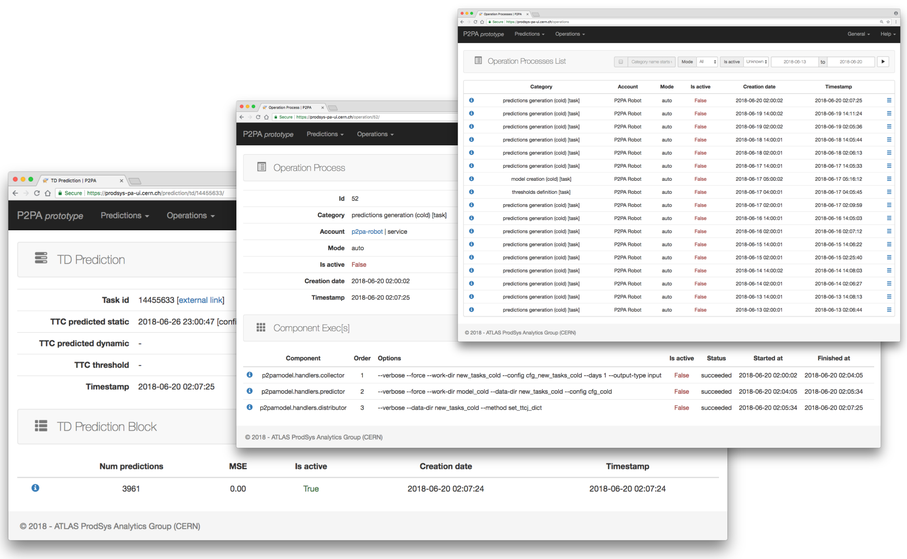


Figure 4. ProdSys2 PA Web application (UI) screenshots.

P2PA analysis processes

The P2PA analysis processes are responsible for estimations and calculations of corresponding analytic metrics, and basic processes are presented below.

Threshold definition

It calculates the upper limit of the duration of tasks execution process in such a way that 95% of all tasks of the corresponding type (i.e., represented by the set of task parameters: *project*, *productionStep*, *workingGroup*) and for the defined time period (the last 180 days) are executed not longer than the calculated value. It uses statistical analysis.

Cold-prediction generation

It estimates task duration (i.e., prediction generation) during the task formation process. There is also a prior step - creation of predictive model, which is used for prediction generation process. It is based on task definition parameters that categorize the average execution process for the defined task type (with particular conditions). It represents an initial prediction and uses descriptive data. The current implementation is built using Spark.MLlib Random Forests regression method.

Conclusions

ProdSys2 Predictive Analytics service is designed to enhance workflow control at the ATLAS Production System and to be able to detect and highlight abnormal operations and executions. Obtained metrics are used in decision making processes to regulate the system behaviour and resources consumption. Techniques and methods of predictive analytics would benefit the monitoring and control processes. The advanced analytics service (based on predictive analytics techniques) would also optimize the whole management process.

National Research Centre Kurchatov Institute

The University of Iowa

ИФВЭ IHEP

BROOKHAVEN NATIONAL LABORATORY

Acknowledgements

This work has been carried out using computing resources of the federal collective usage center Complex for Simulation and Data Processing for Mega-science Facilities at NRC "Kurchatov Institute", http://ckp.nrcki.ru/. Also, this work was funded in part by the Russian Ministry of Science and Education under contract No. 14.Z50.31.0024.

References

1. M Borodin et al. The ATLAS Production System Evolution: New Data Processing and Analysis Paradigm for the LHC Run2 and High-Luminosity // Journal of Physics: Conference Series, vol. 898, no. 5, 2017.
2. F H Barreiro et al. PanDA: Exascale Federation of Resources for the ATLAS Experiment at the LHC // EPJ Web of Conferences, vol. 108, 2016.