intelligent Data Delivery Service (iDDS)

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HL-LHC R&D topics
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- **Summary**
iDDS (a joint project with IRIS-HEP and ATLAS)

- An intelligent service to transform and deliver needed data to consumers, to orchestrate of WFMS and DDMS with generalized workflows
  - Experiment agnostic based on the generalization
  - Extraction and abstraction of functions for orchestration
  - Maintainability and extensibility with plugin architecture
iDDS

- **Client/Server**
  - Rest server to handle requests from clients.
  - Employ different backends for transformation: PanDA, Rucio, Condor and so on.

- **Layered architecture of the server**
  - Every layer abstracts a group of functions, hidden the complexity of different logics on different layers.

- **Workflow-based task management**
  - A workflow is a group of work and their relationship.
  - Work is a transform task: For different experiment or use cases, different work can be defined or developed.
iDDS

- **DAG workflow management**
  - **Task Level DAG**
    - Relation description is among tasks.
    - When there are new outputs in a task, new jobs are generated for the dependent tasks.
    - When a task is terminated, dependent tasks are triggered.
  - **Job Level DAG**
    - Relation description is among pre-defined jobs.
    - Job grouping based on WFMS.
    - When a job is terminated, dependent jobs are triggered.
iDDS

- Monitors
  - iDDS publishes messages and many monitors are built based on these messages.
  - Processing status monitor:
    - Monitor task status
    - bigpanda, Grafana, Elastic Search
  - Service health monitor
    - Monitor whether iDDS is running in a good health
    - Elastic Search

- ToBeDone:
  - To construct an experiment-agnostic monitoring.
iDDS Achievements

- **Data Carousel**
  - In production since May, 2020
  - Solved the issues with the delayed start of processing data on tape

- **HPO (Hyper Parameter Optimization)**
  - To provide a fully-automated platform for hyper-parameter optimization on top of geographically distributed GPU resources on the grid, HPC, and clouds
  - Advertised to ATLAS ML users, not specific to ATLAS

- **Job level DAG based workflow management**
  - Using new DOMA PanDA instance used for Rubin Observatory (LSST) exercise
    - Cascade of chains for multi-step processing with thousands of jobs per step
    - Release jobs incrementally for different steps to avoid long waiting

- **Task level DAG based workflow management**
  - High-level workflows specified by DAGs driving workload scheduling.
  - Active Learning for ATLAS dynamic task management (New tasks are generated based on the analysis result of previous tasks).
iDDS Data Carousel

- **iDDS Fine-grained data carousel.**
  - Orchestrate Rucio to collect and digest file information, and lets JEDI/PanDA process only prestaged files with proper granualalities and grouping, instead of processing with dataset-level granualalities (not process data until the whole dataset is ready).
  - Trigger to process data based on messages from iDDS.
iDDS Data Carousel

- For ATLAS production since May, 2020
- Totally has processed about 21 PB data (Trillion).
- Reduced a lot of redundant job attempts.
iDDS HPO (HyperParameterOptimization)

- To provide a fully-automated platform for hyper-parameter optimization on top of geographically distributed GPU resources on the grid, HPC, and clouds.
- iDDS generates hyperparameters by iterations and collects results from hyperparameter evaluation.
- Leveraging scalability and resources integration, PanDA to evaluate hyperparameters.
- New hyperparameters are generated based on the results of previous iterations.
iDDS HPO (HyperParameterOptimization)

- Advertised to ATLAS ML users, not specific to ATLAS
- The usage is increasing.
- Advanced use cases
  - Segmented HPO, distributed training (See Rui Zhang’s presentation on Mar 03, https://indico.cern.ch/event/1004145/)

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iDDS Rubin Observatory (LSST)

- **LSST exercise (Job level DAG)**
  - Thousands of jobs and their dependencies are defined: cascade of chains for multiple-step processing.
  - Group jobs to tasks based on their dependencies, to adapt PanDA task management.
  - iDDS manages the dependencies and triggers to release jobs incrementally when all dependencies are ready, instead of blocking tasks until all previous tasks finish, to avoid long waiting.
iDDS Rubin Observatory (LSST)

- **LSST exercise**
  - Use the experiment-agnostic DOMA PanDA instance.
  - A new DOMA iDDS instance is deployed, to work with DOMA PanDA instance.
  - Various workflows with cascade of jobs are submitted.
  - Scale tests are ongoing.

A workflow with cascade of jobs:

Jobs are grouped to tasks.
iDDS ActiveLearning

- **ActiveLearning**
  - A simple DAG use case to chain processing and learning tasks.
  - To define the subsequent processing task based on the decision making in the learning task which analyze the results of the previous processing task.
  - Task templates to generate concrete tasks, and condition branches to control the workflow.
  - Under integration with PanDA.
Summary: iDDS Current Status

- **Main architecture**
  - iDDS database, core, REST API
  - Plugins
  - Agents
  - Watchdogs

- **Documents & monitors**
  - Home page: [https://idds.cern.ch](https://idds.cern.ch)
  - Codes: [https://github.com/HSF/iDDS](https://github.com/HSF/iDDS)
  - Documents: [https://idds.readthedocs.io](https://idds.readthedocs.io) (dev)
  - ATLAS monitor: [https://bigpanda.cern.ch/idds/](https://bigpanda.cern.ch/idds/)
  - Different monitors are being enriched.

- **Instances in production**
  - ATLAS, DOMA

- **Instance for dev**
  - Development and integration
  - New or not well-defined use cases.
Summary: iDDS Current Status

❖ **Use cases**
  ➢ Fine-grained data carousel
  ➢ Hyper Parameter Optimization (HPO)
  ➢ LSST exercise
  ➢ Decision making for active learning

❖ **future developments**
  ➢ Main Structure improvements
  ➢ Monitor improvements
  ➢ New use cases
    ■ ToyMC (Based on HPO, similar structure)
    ■ Dynamic transformation and placement on demand, for example Derivation on Demand
    ■ Fine-grained data transformation and delivery, such as Event Streaming Service