NPPS Introduction Talk

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About Me

- Marcin Nowak, Software Engineer, Polish
- Joined BNL PAS group in 2006 to work on the ATLAS Offline Software
- Stationed full time at CERN (building 32-S-C10, PAS office shared now with Johannes and sometimes with Torre)
- I now work full time on the ATLAS Core Software in the Event Store group
  - with Peter Van Gemmeren (ANL) and recently Serhan Mete (ANL)

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ATLAS Offline Software Stack

- Based on the LCG project common software (LHC Computing Grid)
  - includes ROOT
- ATLAS Externals
  - Packages not developed by ATLAS and not common enough to be in LCG (some in external repositories, downloaded during release build process)
- ATLAS Online Software TDAQ layer
- Gaudi Framework (the LHCb software framework)
  - ATLAS maintain their own clone repository
- **Athena**
  - The offline production software framework for ATLAS
  - Open source since the beginning of this year
    https://gitlab.cern.ch/atlas/athena
  - Cite as:
    - ATLAS Collaboration. (2019, April 9). Athena (Version 22.0.1). Zenodo
   http://doi.org/10.5281/zenodo.2641997

Athena Software Infrastructure

- Athena source code is now managed in CERN hosted GitLab (before in CVS and SVN + custom Release Management tools e.g. TagCollector)

- The code is divided into over 2125 packages, but they are all in one big project

- 10 active branches - some diverging a lot, built nightly
  - Automatic migration of commits between branches, but also manual management

- Every developer has a private repository fork in GitLab where they can commit changes
  - Changes are submitted to the main repository branch as Merge Requests (via web interface)
  - MRs are reviewed by shifters and experts for compliance with ATLAS coding rules and for desirability of proposed changes
  - Continuous Integration (Jenkins) automatically compiles the entire project + MR and runs tests
  - Changes accepted by the release coordinator if everything OK

- This development model is relatively new in ATLAS and dramatically improved code quality in the master branch (even though introducing changes takes now longer and requires more manpower)

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Athena Software Development

- Athena: ~5 million lines of code - 80% C++, rest Python (mostly configuration)
  - 20 years old, hundreds of developers

- Compiled with gcc 8 – also Clang/LLVM (ROOT) on Scientific Linux 6/7
  - building takes 5-8h on 16 cores system
  - most branches compiled nightly, possibly in several flavors
  - one debug build takes over 100GB disk space

- Nightly builds are installed on CVMFS and kept for a month
  - developers can work against any of these builds (plus official numbered releases)
  - only need to compile selected packages (and dependencies!)
  - note: the private local git clone has to have the right branch/version checked out

- JIRA - issue and task tracking system
  - integrated with GitLab - tickets are updated when MRs addressing a given problem are merged into branches

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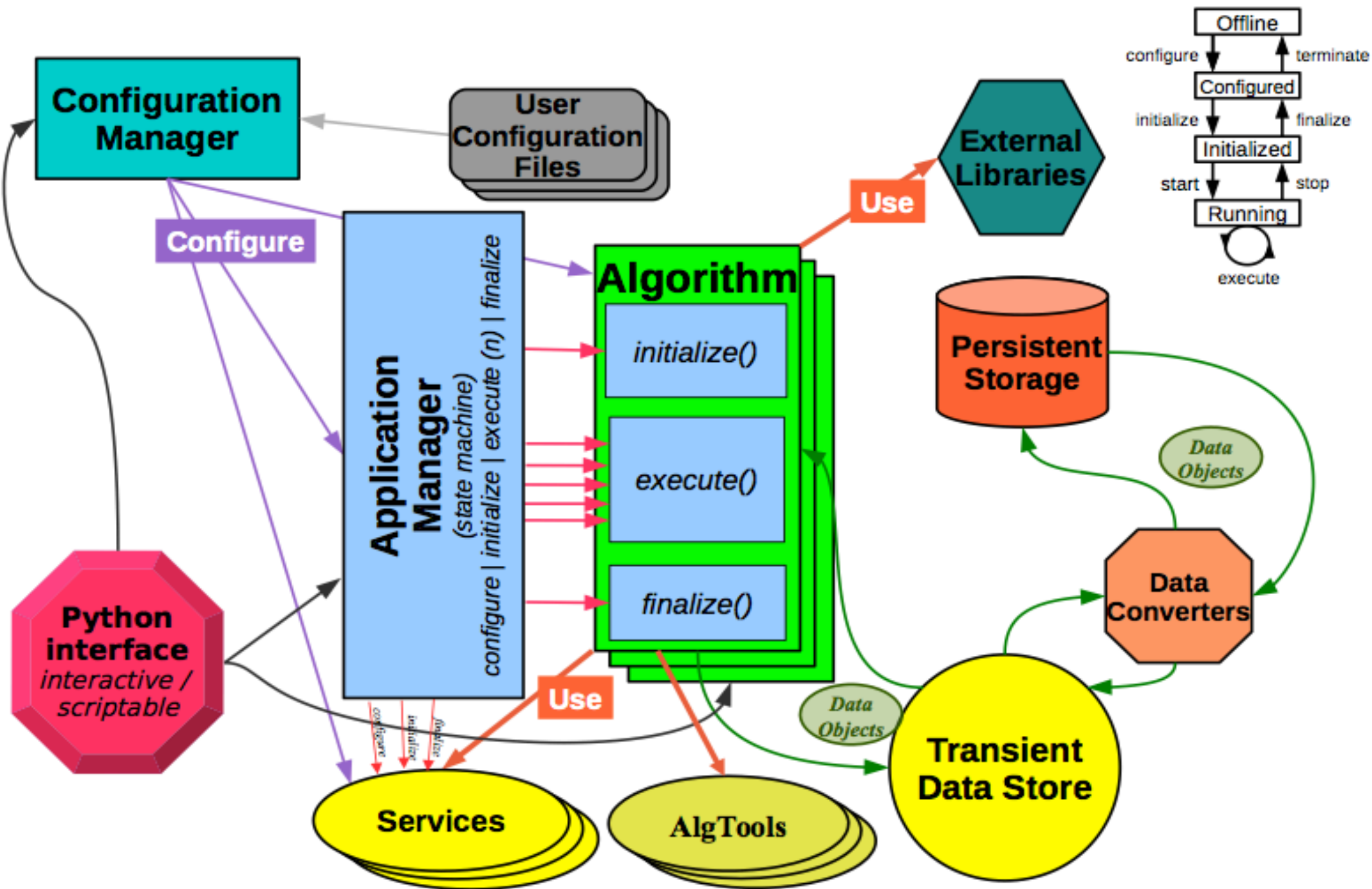
What Do We Do in the Event Storage Group

- General mandate is to provide mechanisms to store transient Event Data that can be found in the application memory and to retrieve it later.
  - Support for really complex C++ types (~3000 types)
  - Support for data model changes over time (schema evolution)
  - Ensuring storage size efficiency
  - and I/O performance
- Navigation (identification and retrieval of single objects (subevent level)
- Storage technology independence (mostly)
- Recently: parallel processing (AthenaMP output merging)
- New: multi-threading support

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My Past Projects (for ATLAS)

- Schema Evolution support for Run1 Event Data (T/P separation/conversion layer)
  - to make sure we can "always" read old data
  - implemented by introducing separate independent persistent EDM with versioned classes and converters
  - mostly replaced now by the new Run2 EDM (xAOD) but still existing for some classes. Allows Athena to read Run1 data still.
  - good mechanism for reducing storage size and increasing I/O performance
    - Data selection, compression and reordering

- Event TAG Database
  - first implementation of an information system containing summary information of all Events for different processing stages RAW/ESD/AOD
  - Now replaced by Event Index

- I/O implementation for ATLAS Run2 EDM (xAOD types)
  - xAOD (C++ objects) can be extended with arbitrary new data members at runtime and ATLAS had no I/O infrastructure to handle such dynamically defined objects

- Athena migration from ROOT5 to ROOT6
  - Athena uses selection.xml files to tell ROOT which C++ types need dictionaries for I/O
  - CINT, Reflex and Cintex gone with ROOT5, code parsing with Clang in ROOT6

- Panda monitoring database migration from BNL (MySQL) to CERN (Oracle)

My Current Activities

- AthenaMT - multi-threading Athena that is able to process multiple Events concurrently
  - Big and important project for the entire Core Software and other groups
    - all components must be MT-safe
  - Well advanced – simplified production jobs can be executed
    - Physics validation planned for beginning of 2020
  - I/O components are MT-safe in typical workflows
    - we are working on increasing concurrency
    - fixing problems with unusual workflows when discovered (e.g. Event Service)

- Athena I/O layer review
  - Activity initiated by Torre 2 years ago to identify steps required to prepare for Run3 and Run4 increased data rates
  - Ongoing work to improve I/O code quality and performance

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AthenaMT I/O Layer Overview
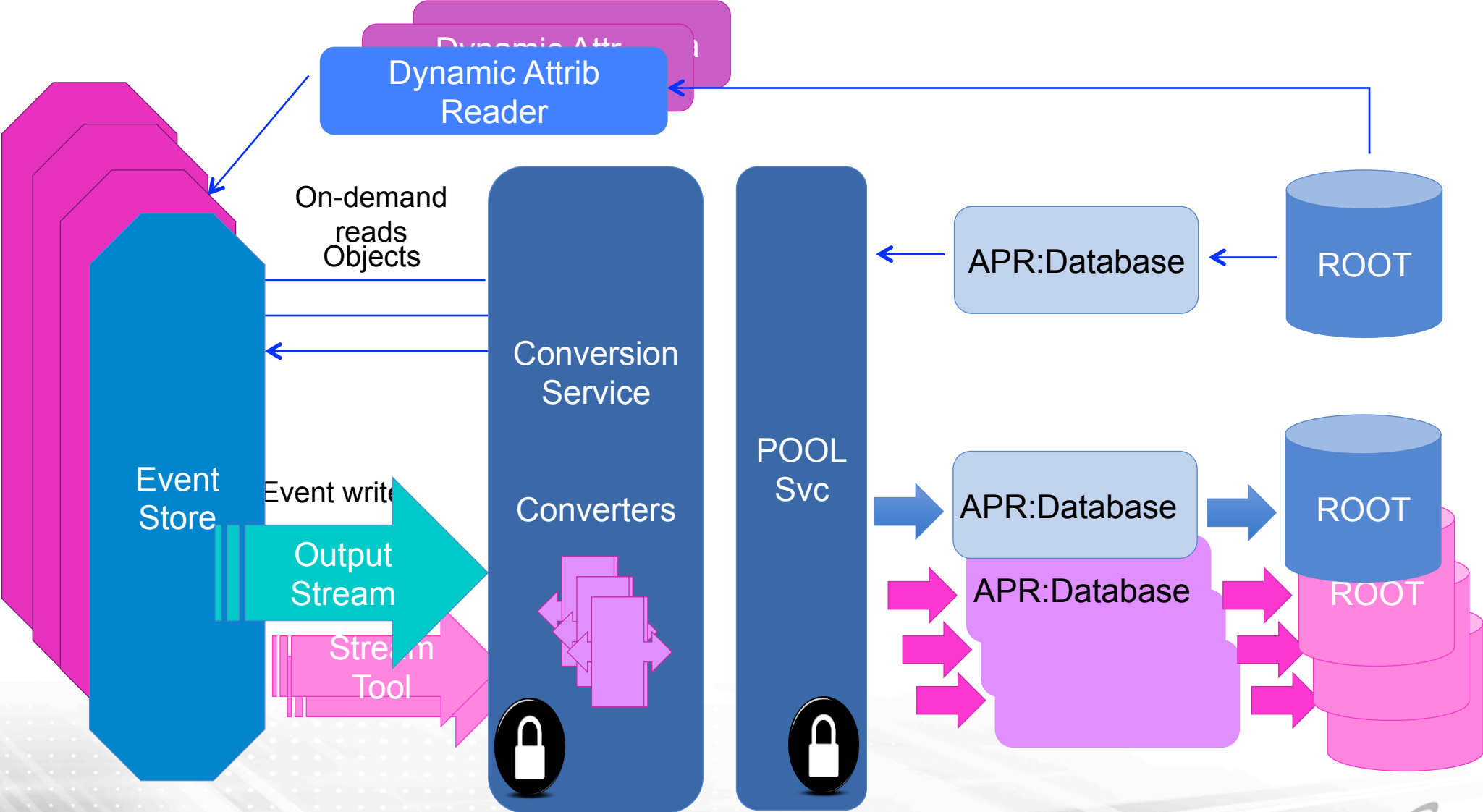
Current Activities (2)

- EventInfo – related changes
  - Migration to xAOD::EventInfo
  - Introduction of mini-EventInfo
    - Low level ROOT attributes independent of Event Data for fast file content scanning

- Event indexing (modified version of TTree Storage Technology)
  - Indirection layer for navigation (TTreeIndex)
  - Needed for fast (pure ROOT) file merging and concurrent writing to the same TFile

- SharedWriter – output merging for AthenaMP
  - Helping Peter van Gemmeren

New Projects

- **Event Service**
  - Adapting AthenaMT to continuous processing of short event ranges
    - Main challenge – handling multiple overlapping output streams
    - Implemented for Event Data, tested with mock examples
    - Working on a solution for in-file Metadata
      - Starting analysis of Simulation jobs metadata processing

- **Event Streaming Service**
  - Data serialization and streaming
  - Event I/O and persistency that are long range or are directed at exascale platforms

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