

FairRoot, FairMQ and DDS

Facility for Antiproton and Ion Research GmbH

GSI Helmholtzzentrum für Schwerionenforschung GmbH

E-OSSR Onboarding Presentation

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ESFRI/RI

Partner



Introduction

Facility for Antiproton and Ion Research

Helmholtz Center for Heavy Ion Research

- Super heavy elements
- Astro- and nuclear physics
- Biophysics
- Hadron physics
- Heavy ion collisions
- Plasma physics







Introduction

Demands of GSI / FAIR experiments

- Complex detectors need to be designed and optimized detailed simulations
- Framework for online and offline data analysis
- Understand experimental results with help of simulations
- Parallel data processing
- Dynamic controlling of large scale data analysis on a super computer









Purpose

- FairRoot: simulation, reconstruction and data analysis
- FairMQ: framework for high throughput distributed data analysis
- Dynamic Deployment System (DDS): management and controlling of distributed workflows

10.5281/zenodo.3896282 10.5281/zenodo.1689985 10.5281/zenodo.3854975 https://fairroot.gsi.de https://github.com/FairRootGroup/FairMQ http://dds.gsi.de





- Provides building blocks
 - for experiment-specific algorithms
 - distributed data analysis on small to very large data scale
 - in heterogeneous hardware
 - multiple languages environment
- DDS is used on computing cluster to start, initialize and manage large amount of user processes
- Each process is a separated reconstruction/analysis step
 - communicate over network or shared memory via message passing



ESCAPE



A. Rybalchenko

X 🕐 O2 Framework debug GUI \sim \sim \times Show grid Center Hide tree Show metrics Hide inspector Comm Workflows 8 Device Inspector its-entropy-encoder ▼ o2-raw-file-reader-workflc Name: itstpc-track-matcher internal-dpl-clock Executable: o2-tpcits-match-workflow Pid: 24457 raw-file-reader toc-residuals-wr tpc-tracker_t0 Rank: 0/1%0/1 tpc-tracker_t1 Attach debugger Profile 30s 🝷 itstpc-track-matcher 🛕 tpc-tracker_t2 ▼ Inputs: toc-tracker_t3 0: <matcher query: (and origin:TPC (toc-tracker t4 its-tracker 🥼 1: TPC/TRACKS/0 tpc-tracker_t5 2: TPC/CLUSREFS/0 tpc-tracker_t6 3: ITS/TRACKCLSID/0 tpc-tracker_t7 ╶┼┼┼┼┼┼┼ 4: ITS/ITSTrackROF/0 internal-dpl-global-bina internal-dpl-clock 5: ITS/TRACKS/0 o2-itsmft-stf-decoder-work 6: ITS/COMPCLUSTERS/0 its-stf-decoder 7: ITS/PATTERNS/0 🕈 internal-dpl-global-binary-file-sink o2-its-reco-workflow 8: ITS/CLUSTERSROF/0 its-entropy-encoder tof-compressed-decoder material-lut-path: • o2-tpc-reco-workflow 🛴 raw-file-reader tpc-entropy-encoder o2-tpcits-match-workflow Name Value its-dictionary-pa (fairmq) o2-tof-compressor tof-compressor-0 ▼ Workflow Options o2-tof-reco-workflow TOFClusterer 🛕 Name Driver information disable-mc disable-root-inpu 🔵 Play 💿 Pause 💿 Step its-stf-decoder disable-root-outp configKeyValues Input parsing cost (latency): 0.0(20.0)ms readers State stack (depth 0) tof-compressor-0 --disable-root-input --disable-root-output

ALICE EPN workflow

D. Rohr, G. Eulisse





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Integration in workflow

- Concrete experiment software is derived from FairRoot and FairMQ
- DDS is used as a service to steer the experiment software
- Provides ready-to-use tools
 - Event filtering
 - Interfaces to HEP event generators
 - Tools for full and fast MC simulations
 - Propagation in non-homogeneous magnetic field





AliceO2 http://alice-o2.web.cern.ch/		https://fa	CbmRoot https://fair-center.eu/for-users/experiments/cbm.html			PandaRoot https://panda.gsi.de/			R3BRoot https://www.gsi.de/r3b	
Fa http://ship.v	irShip veb.cern.ch/ship/		SofiaRoot			AsyEosRoot			MPDRoot http://mpd.jinr.ru	
ExpertRoot http://er.jinr.ru/		http://ig	EnsarRoot http://igfae.usc.es/satnurse/ensarroot.html			ATTPCRootv2 https://github.com/ATTPC/ATTPCROOTv2			BNMRoot http://mpd.jinr.ru	
ALFA								FairR	oot	
:	FairMQ	Topology Editor	DDS (Dynamic Deployment)	Testing	Parameter/ Condition	Geometry	Detector Response	Magnetic Field	Event Generators	
Software Stack										
ROOT	Boost	Simulation Engines	VGM		CMake	Network (ZeroMQ, nanomsg, OFI libtabric)	Serialization (Protocol Buffers, msgpack, FlatBuffers, ROOT)	Google Test	:	

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Software Development

- License: LGPL 3.0
- Projects are on Github
- Use GitHub tools: tickets / issues / projects / milestones
- Review using Pull Requests
- Release Management: project specific





Software Development

- Git Workflow
- Test-suites for the major use cases
- CI as integral part of development. Jenkins and others to control the CI flow
- Part of our CI runs on cluster

Talk by C. Tacke in the Workshop on Open-Source Software Lifecycles





Software Requirements

Operating system and Compilation environment

- Linux or macOS
- gcc or clang, cmake
- Hardware requirements
 - FairRoot is a single node application. Scalable on event basis
 - Geant4 multithreaded transport use all cores on a single machine
 - RAM requirement is experiment specific
 - FairMQ and DDS are aimed for a large cluster (online / offline)
 - High network throughput





Software Requirements

Containerization requirements

- Large dependencies (ROOT, Geant4) -> size of a container
 ~ 5 GB
- •Workflow / Interface requirements to other software
 - FairRoot supports: macro workflow (C++ interpreter) compiled code Python
 - FairMQ applications are built out of independent processes different programming languages: C/C++, Python, Go ... data exchange can be internode (Ethernet/InfiniBand) or intranode (shared memory and named pipes)





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OSSR Integration

•What is available?

- Source code, examples, documentation, containers, shared installation (Cern-VM FS)
- •What will be onboarded?
 - Source code, container with installed software + dependencies







OSSR Integration - User story

- Generate skeleton of an experiment specific framework using our automated template
- Run examples of Monte Carlo simulation + reconstruction + visualization
- Run examples of parallel data processing

 FairRoot is a software framework – analysis of concrete experimental data will not be provided





Time for a short demo

Preliminary version of the container

https://hub.docker.com/repository/docker/gsisde/escape

D. Kresan Onboarding of FAIR software

