Automatized Compilation of Large Packages Example of mpdroot

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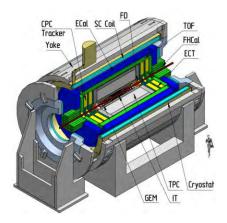
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Multi-Purpose Detector

- part of Nuclotron-based Ion Collider fAcility
- Multi Purpose Detector main detector under costruction
- mpdroot library for reconstruction of tracks and physical analysis (http://mpdroot.jinr.ru/)



Just Install FairRoot and Build mpdroot...

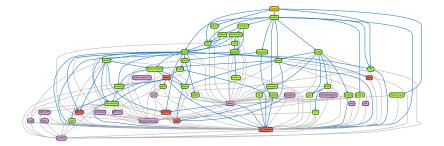
How to install MPDroot (each user had to build own version):

- install all basic packages (about 70);
- download, patch, and build FairRoot;
- download and build mpdroot from sources. In-source build highly recomended.

It's really "easy":

- basic packages are often not available in compatible versions
- patching FairRoot can be tedious (during last major version change more than 100 lines of code)
- building FairRoot takes about 2-4 hours on a regular computer
- in-source build guides users to use improper paths when linking own code
- users tend to use same version of mpdroot for long time

The mpdroot Dependencies



Centralized Build of MPDroot

Requirements:

- we want to deliver latest version of MPDroot to the users
- all dependencies have to be statisfied and no version clashes are allowed
- results need to be repeatable

Solution:

- CVMFS robust distribution of software not only between clusters/supercomuters
- aliBuild set of tools for building software together with its dependencies
- toolbox rootless wrapper for podman (docker). Supported on most linux-based systems. On MacOS and Windows one can use docker
- EnvironmentModules environment enabling loading multiple versions of the same software with its dependencies

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- CMVMFS is a read-only file system
- anyone can mount the shared directories to its computer
- extensively uses caching of the files on local computer
- only used (accessed) files are downloaded. That makes first load slow but following are as fast as local usage
- since it is centralized, changes on server are directly available to all users

- wrapper for podman (rootless docker alternative) ordinary user can use it
- allows user to "work" inside virtual machine no connection to the users system
- we support CentOS7, but to test our software we build also CentOS Stream 8 and 9 versions
- basic system image is fixed without any updates and therefore all results are reproducible

Environment Modules https://modules.readthedocs.io/

- started as a project to separate various versions of same software
- simple "module files" contain paths to the software together with list of dependencies
- to use some software one has to load it first via command module add mpdroot/latest. Paths to executables as well as libraries is than added in the commandline. All necessary dependencies are loaded as well.

```
Example of module file (excerpt):
```

```
module load BASE/1.0 GEANT4/$GEANT4_VERSION-$GEANT4_REVISION
module load ROOT/$ROOT_VERSION-$ROOT_REVISION
setenv MPDROOT \$PKG_ROOT
prepend-path ROOT_INCLUDE_PATH \$PKG_ROOT/include
prepend-path LD_LIBRARY_PATH \$PKG_ROOT/include
```

- created as a solution to the ALICE experiment software distribution problem
- automatic build of software and all its dependencies
- reusing already built packages
- if some package was changed, all dependants are rebuild
- apropriate modules are created and numbered automatically
- can get messy if packages change frequently and are not cleared
- based on recipes guides how to build some package

mpdroot Recipe

```
package: mpdroot
version: "%(commit_hash)s"
tag: "dev"
source: https://git.jinr.ru/nica/mpdroot.git
requires:
  - FairRoot
 - eigen3
 - nlohmann ison
  - VMC
  - GSL
unset SIMPATH
export MPDROOT=$INSTALLROOT
cmake $SOURCEDIR
      ${BOOST_ROOT:+-DBOOST_ROOT=$BOOST_ROOT}
                                                                                      ١
      ${EIGEN3 ROOT:+-DEIGEN3 ROOT=$EIGEN3 ROOT}
      ${LIBXML2_ROOT:+-DPC_LIBXML_LIBDIR=$LIBXML2_ROOT/lib}
      ${NLOHMANN_JSON_ROOT:+-DNLOHMANN_JSON_ROOT=$NLOHMANN_JSON_ROOT}
      -DCMAKE INSTALL PREFIX=$MPDROOT
cmake --build . -j$JOBS install
# Modulefile
MODULEDIR="$INSTALLROOT/etc/modulefiles"
MODULEFILE="$MODULEDTR/$PKGNAME"
mkdir -p "$MODULEDIR"
alibuild-generate-module --bin --lib > $MODULEFILE
cat >> "$MODULEFILE" << EoF
setenv MPDROOT \$PKG ROOT
setenv MPDROOT MACROS \$PKG ROOT/macros
prepend-path ROOT_INCLUDE PATH $::env(BASEDIR)/GSL/$GSL_VERSION-$GSL REVISION/include
EoF
```

Changing Defaults

default: - &MPDROOT TAG v22.09.22 - &GCC_TOOLCHAIN_TAG v10.2.0-alice2 package: defaults-release version: v1 disable: - arrow env: CMAKE BUILD TYPE: RELWITHDEBINFO CXXFLAGS: -fPIC -02 --std=c++17 ENABLE VMC: 'ON' overrides: mpdroot: tag: *MPDROOT_TAG version: *MPDROOT TAG ROOT: tag: "v6-26-08" requires: - GSL - libxml2 GCC-Toolchain: tag: *GCC TOOLCHAIN TAG version: *GCC TOOLCHAIN TAG

Wrapping Up

Our view:

- software is stored in git
- on each push to master or creation of tag, command aliBuild --build --no-deps --defaults releaseName is called and built package is placed into CVMFS. Software is available no later than 1h after being successfully built.

Developer's view:

- toolbox enter c7-nica
- source /cvmfs/nica.jinr.ru/sw/login/login.sh
- module add mpddev/latest
- export MPDROOT=/path/to/install
- git clone path_to_mpdroot && mkdir build && cd build && cmake .. && make install

User's view:

- toolbox enter c7-nica
- source /cvmfs/nica.jinr.ru/sw/login/login.sh
- module add mpdroot/latest

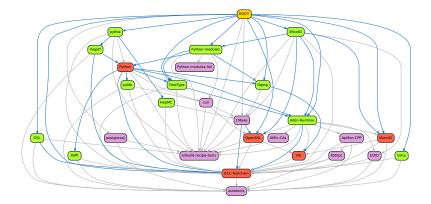
or concrete version

• module add mpdroot/v22.09.22-1

Conclusions

- for ordinary users build of mpdroot takes no time
- latest version of software is instantly available to everyone
- it is easy to return to previous versions (including dependencies)
- all results are repeatable since we store basic system image as well as all recipes
- most of the packages we build from scratch (including low level, s.a., CMake, GCC, OpenSSL)
- with recipes new dependencies are distributed among developers without necessity for them to install anything (it is done automatically)

All Great Except...



It can't be that bad, can it?

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- (semi)automatic cleaning of obsolete packages needs to be added
- GUI for cleaning of packages would be nice to have
- accounting which packages were used and what is the distribution of their usage in time
- distribution of mpdroot (and dependencies) via rpms
- protection of closed-source software
- sometimes even new recipes are not easy to add

What I need to know:

nothing – kind of

What will I get:

diploma

What will I learn (part of/maybe all):

- git (not only for storing files)
- bash, CMake, aliBuild/aliDist
- Docker/Toolboxes, RHEL based packaging
- creating web-based application

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