CMake

ATLAS's (Not So New) Software Build Tool

Attila Krasznahorkay

CMake

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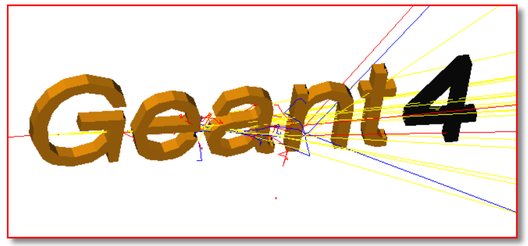
Cross-platform Make

NETFLIX



XRootD

- ATLAS decided years ago to replace CMT (and RootCore) with a more modern build system
  - Mainly to stop using systems that nobody else was using…
  - The final choice was CMake
- Adopted by many prominent projects as their build system by now
  - Including an ever growing number inside HEP as well
- A general build system, **not** specifically designed for ATLAS
  - Prompting the examination of some of our workflows

Code Compilation

- For the simplest setup, like a `helloWorld.cxx` source file, you don't need any help for the compilation

```
g++ -o helloWorld helloWorld.cxx
```

- Once you have multiple source files, you don't want to execute such commands one by one anymore
  - This is where GNU Make comes in, allowing you to describe the build procedure of your files in a very low level way

```
myExecutable: source1.o source2.o
    g++ -o $@ $^
.SUFFIXES: .cxx .o
.cxx.o:
    g++ -c -o $@ $<
```

- As your project grows, you start depending on more exotic "externals", GNU Make doesn't scale anymore
  - You need a higher level build system at that point

Build System Generator

- CMake doesn't actually perform the build itself
  - It generates a configuration for some underlying build system to do it
    - On UNIX in most cases it is GNU Make
      - However Ninja is becoming more and more powerful/popular, and is also capable of building the full ATLAS offline software
    - But it can be an IDE as well. Like Xcode on MacOS X, or Visual Studio on Windows
- Once the build system's configuration is generated, you just interact with that build system to perform the build

Config - Build - Install

- Like all autoconf / automake projects, CMake projects also follow these 3 steps during the build
  - Configure
    - Either in-source

```
cd project-1.2.3
cmake -DCMAKE_INSTALL_PREFIX=/usr/local
```

    - Or out-of-source

```
mkdir build; cd build/
cmake -DCMAKE_INSTALL_PREFIX=/usr/local ../project-1.2.3
```

  - Build

```
make -jX
```

  - Install

```
[sudo] make install [DESTDIR=/some/location]
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In “local builds” usually not necessary

AtlasCMake / AtlasLCG

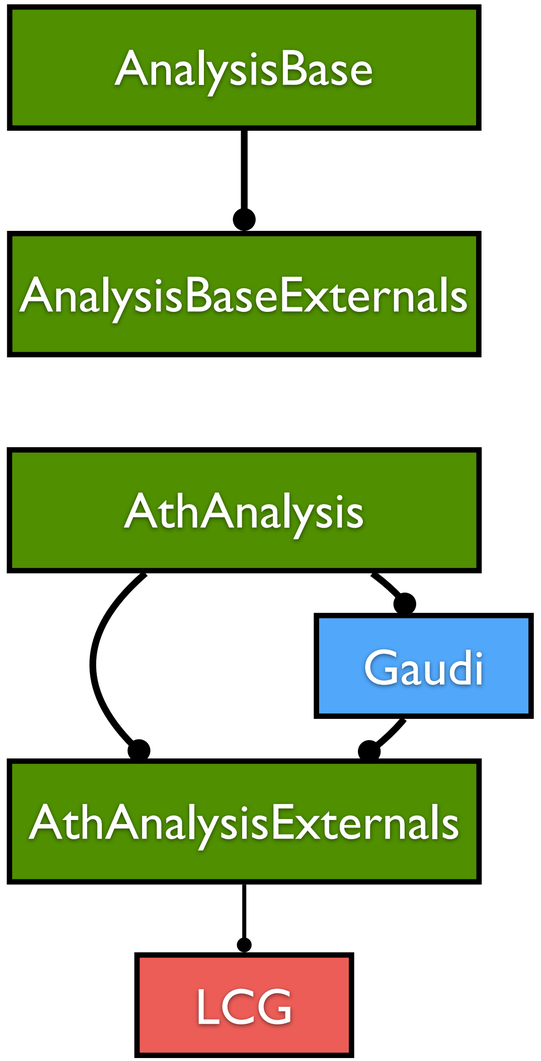
- As said, CMake itself is a very general language for describing the build of some software
- ATLAS does have very concrete conventions on how it builds its code though
  - All of the helper code for building ATLAS packages is held by the atlas/atlasexternals repository
  - Most of the CMake logic is in the AtlasCMake and AtlasLCG subdirectories of the repository…
  - You can find some useful information about the code just by browsing the Git repository
- For a reference documentation of AtlasCMake's features, see: https://twiki.cern.ch/twiki/bin/viewauth/AtlasComputing/SoftwareDevelopmentWorkBookCMakeInAtlas

Packages

- Historically ATLAS code is organised into “packages”
  - Distinct build units that have their own configuration for how they should be built
- With CMake this is not the most natural organisation, but we kept it not to change too many things at once
- The layout of any ATLAS project is hence:
  - A `CMakeLists.txt` project configuration either at the root directory of the source tree, or in a subdirectory of the `Projects/` folder
  - Many sub-directories with a `CMakeLists.txt` file of their own
    - Note that package configuration files are not functional on their own! They only work correctly when a project configuration file includes them “in the right way”.

Projects

- In order to provide external software for our builds in a well controlled way, every ATLAS CMake project starts from a base project
  - These are defined in atlasexternals/Projects
- For regular code development you should not worry about these externals projects
  - But if you want to introduce the usage of some new external library for instance, then you need to know about them



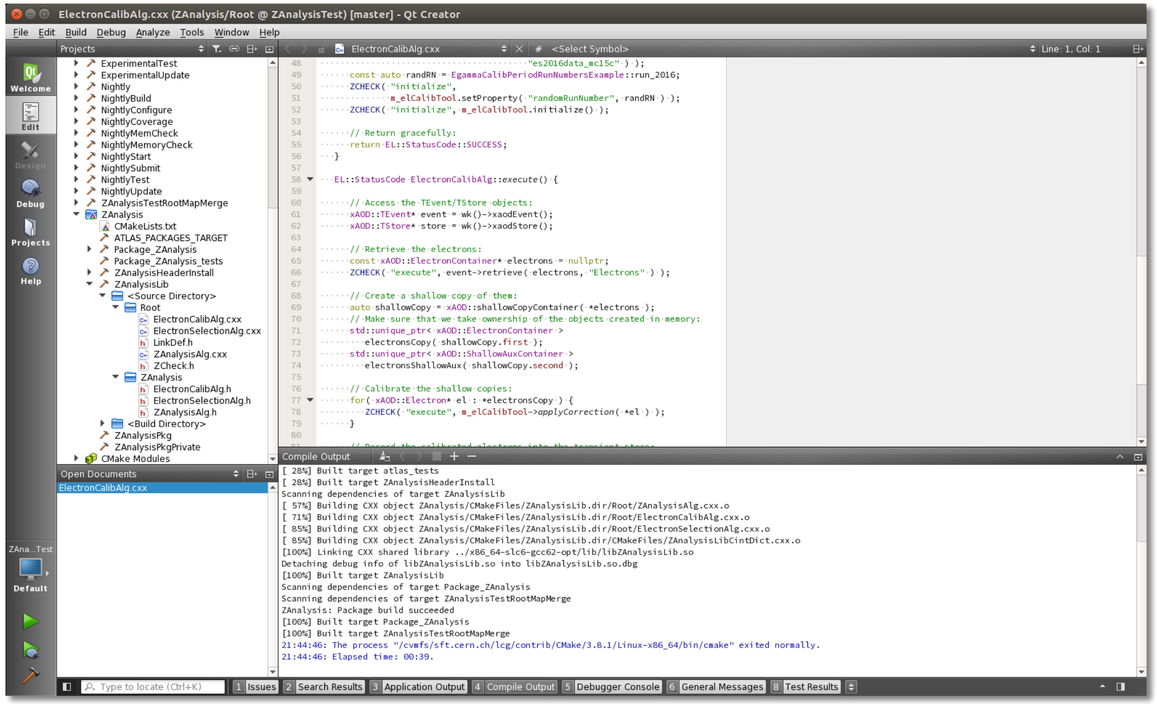
Building Projects

- Covered in good detail on https://atlassoftwaredocs.web.cern.ch
- The main points:
  - ATLAS repositories can all build multiple projects. So you don't point CMake at the repository's root directory, but at one of the directories in the Projects/ folder.
  - When working with the athena repository, use the Projects/WorkDir project to build a selected number of packages against a release/nightly.
  - You can build entire projects from scratch using the build scripts in their project directories. Instructions for the scripts can be found in the individual project directories.
    - For instance AnalysisBase can be built from the 21.2 branch of atlas/athena with:

```
git clone ...
./athena/Projects/AnalysisBase/build_externals.sh
./athena/Projects/AnalysisBase/build.sh
```

Summary

- CMake is the build system for all ATLAS projects
- Whatever you learn in this tutorial is directly applicable in offline/trigger software development as well
- For further instructions on good code layout with CMake and Git, see the upcoming talks



Extra Material

PUBLIC / PRIVATE

- Often a source of confusion…
- In the end it's only relevant for shared libraries
  - Interface libraries only have public dependencies
  - Component libraries only have private ones
  - The "package dependencies" will go away at one point…
- When a shared library need an include path or a library as a public dependency, they will be used while compiling/linking the sources of the shared library, and also while compiling/linking any component linking against this shared library.
  - If an include is made to a package/shared library in a public header of this library, that's a public dependency.
- Any include paths or libraries that a shared library depends on privately will only be used while compiling/linking the shared library. They are ignored when building components linking against it.
  - If an include is only made to another shared library in a private source file, that's a private dependency.
- CMake even defines a 3rd dependency type, but we don't use that explicitly in the ATLAS code…

Library Types

- Shared library
  - Created by atlas_add_library(…)
  - Can be linked against, symbols defined in it can be used by other components
  - Has to define public headers
- Component/module library
  - Created by atlas_add_component(…)
  - Can not be linked against
  - Provides no public headers
  - Houses the Gaudi components of the software
- Interface library
  - Created by atlas_add_library(…) when using the `INTERFACE` argument with it
  - Provides an interface to headers. Very useful for header-only packages, and when a package provides both a component library and some public (interface) headers.
- Some other types for T/P, POOL and BS converter libraries that you'll learn about if/when needed
  - See: https://twiki.cern.ch/twiki/bin/viewauth/AtlasComputing/SoftwareDevelopmentWorkBookCMakeInAtlas#Generic_build_target_declaration

Using an IDE

- Two types of IDEs exist:
  - Ones interacting directly with CMake;
    - You can usually just open the project `CMakeLists.txt` file of your source area, and the IDE sets up itself correctly
    - Includes: KDevelop, QtCreator, CLion, etc.
  - Ones not doing that.
    - You need to instruct CMake to generate a native project configuration for the IDE
    - Includes: Eclipse, Xcode, Visual Studio, Visual Studio Code, etc.
- On SLC6/lxplus I had the most success with QtCreator
  - If you want to give it a try, after setting up your build environment (from which you could call CMake to set up your build directory), execute:

```
/afs/cern.ch/work/k/krasznaa/public/QtCreator/4.6.2/x86_64-slc6-gcc62-opt/bin/qtcreator
```

  - …and point the application to the “main” `CMakeLists.txt` file of your code
    - I.e. File → Open…

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Though in recent months I'm using Visual Studio Code more and more…

Example Package Configuration

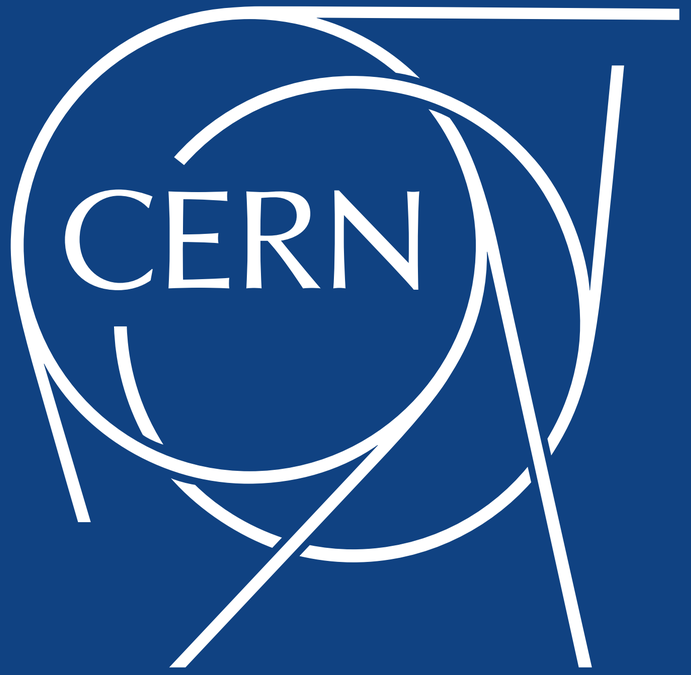
```
# Set the name of the package:
atlas_subdir( MyPackage )

# Set which other packages it depends on:
atlas_depends_on_subdirs(
   PRIVATE GaudiKernel Event/xAOD/xAODEgamma
   Control/AthenaBaseComps )

# Make use of TBB directly in the code:
find_package( TBB )

# Build a component library from the package's code:
atlas_add_component( MyPackage
   src/*.h src/*.cxx src/components/*.cxx
   INCLUDE_DIRS ${TBB_INCLUDE_DIRS}
   LINK_LIBRARIES ${TBB_LIBRARIES} GaudiKernel xAODEgamma AthenaBaseComps )

# Install extra files from the package:
atlas_install_python_modules( python/*.py )
atlas_install_joboptions( share/*.py )
```



http://home.cern