# CMake build system

## Distribute your software easily

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# Outline

1. Motivations of a build system
2. CMake build system
3. Test integration
4. Packaging
5. Release engineering @ Inria

# 1

# Motivations of a build system

# What problems do build system solve?

- For a developer:
  - reduce the time spent in the cycle “edit / compile / test” cycle
  - compile only what is necessary in the source code
- For a development team:
  - generate packages
  - run tests
  - generate documentation
- For a user:
  - install software easily
  - have understandable error during install phase
  - tune installation

# Build a software: a lot of evil ways

Examples:

- “I will do a script to launch all my command and it will be ok”
  - system-dependent, all path dependent, etc.
  - high cost for developers and users
- “I will do a *makefile* with a *make.inc*, my software earns portability”
  - costly for the user: manual configuration
  - portable ≠ customizable
- Etc.

# Features of a build system (1)

- automatic dependency management  of source code
  - compile only the modified sources files and thiers dependencies

- software portability:
  - use native build environment
  - determine available OS/compiler features : foo.h, libbar, strndup, -Wall, etc.
  - name correctly the library: .so / .dylib / .dll

- adaptability according user environment:
  - auto-configuration of the project
  - determine the availability and location of libraries, commands, etc…

# Features of a build system (2)

- customize installation:
  - cross-compiling
  - give some information: --help
  - possibility to set information: --prefix, --libdir, --disable-shared, etc.
  - have some target: make all, make install…

- launch tests:
  - without installation: link with generated library
  - after an installation: link with installed library
  - give a report of the build

# 2

# CMake build system

# Introduction

- Open-source, cross-platform build system (New BSD Licence)
- Develop by Kitware since 2001
- Using compiler-independent method
- Can be used with native build environments (Eclipse, Xcode, Visual Studio…)
- Give some extensions to locate libraries, headers…
- Give some interfaces for generate a test suite and packaging
- Notable applications using CMake: KDE, Blender, LLVM, OGRE

# Get and install CMake

- Get and install from web:

  http://www.cmake.org/cmake/resources/software.html

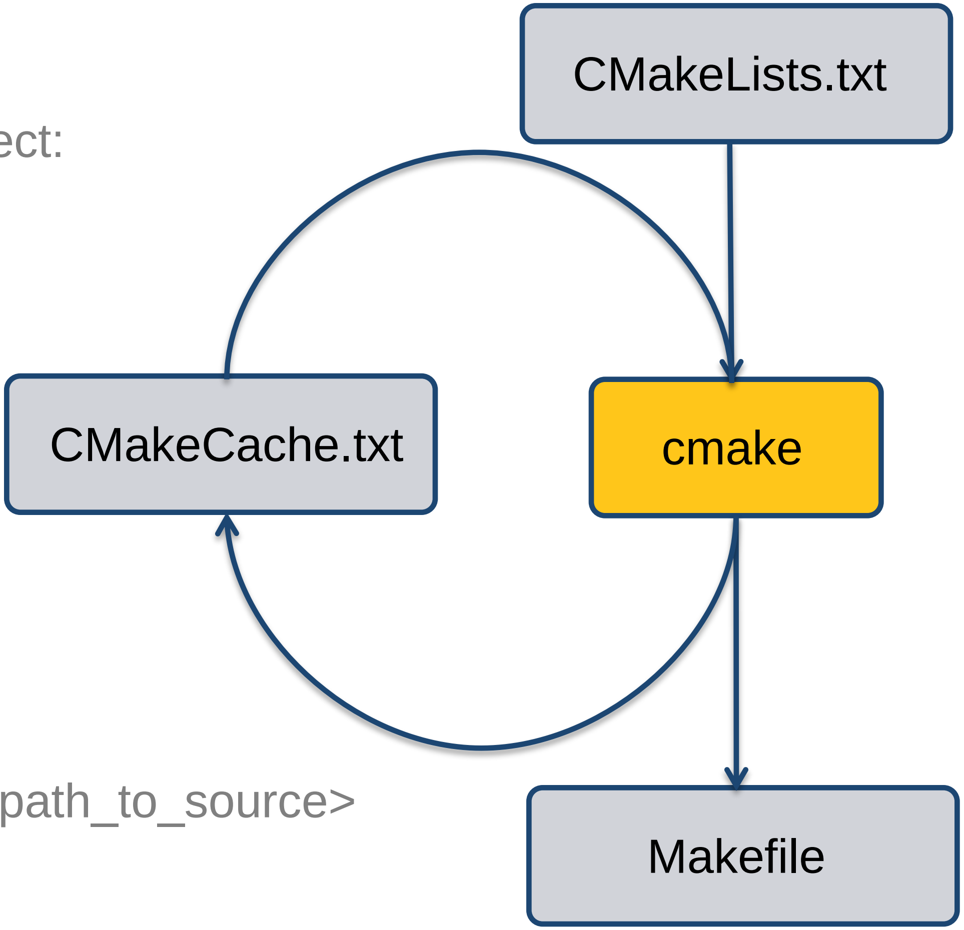
  ```
  >./configure --prefix=<path>
  > make
  > make install
  ```

- Or install form your distribution

- Be careful:
  - about the version of CMake
  - CMake is needed to build and install your software

# Manage a project with CMake

- CMakeLists.txt describes the project:
  - *list of source files,*
  - *library to link with…*
- *CMakeLists.txt is:*
  - *machine-independent*
  - *common for all users*



- CMakeCache.txt is:
  - generated by calling: cmake <path_to_source>
  - GUI: ccmake or cmake-gui
  - machine-specific

# Configuration, build and install step

- Two way o configure the project:
  - In-source

```
> cd <path_to_source>
> cmake . -DOPTION=<VALUE>
```

  - Out-of-source

```
> cd <path_to_build>
> cmake <path-to_source>
  -DOPTION=<VALUE>
```

- Possibility to choose makefile generator during configuration

```
> cmake ../ -G “Unix Makefiles” or -G “Xcode” etc…
```

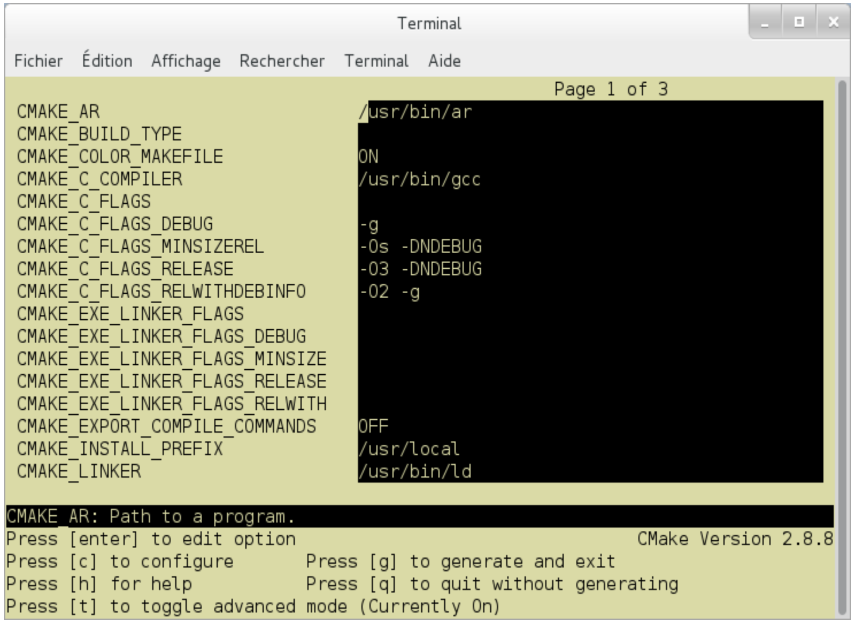
- After configuration, build and install step can be launch

```
> make
```

```
> make install
```

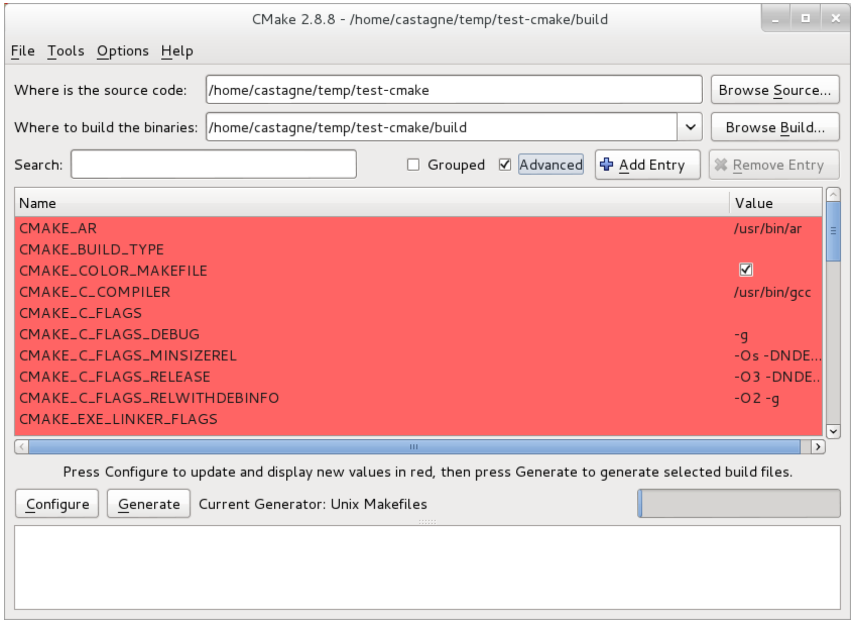
# Configuration with GUI

- ccmake <path_to_source>
- cmake-gui <path_to_source>



```
                                                 Page 1 of 3
 CMAKE_AR                         /usr/bin/ar
 CMAKE_BUILD_TYPE
 CMAKE_COLOR_MAKEFILE             ON
 CMAKE_C_COMPILER                 /usr/bin/gcc
 CMAKE_C_FLAGS
 CMAKE_C_FLAGS_DEBUG              -g
 CMAKE_C_FLAGS_MINSIZEREL         -Os -DNDEBUG
 CMAKE_C_FLAGS_RELEASE            -O3 -DNDEBUG
 CMAKE_C_FLAGS_RELWITHDEBINFO     -O2 -g
 CMAKE_EXE_LINKER_FLAGS
 CMAKE_EXE_LINKER_FLAGS_DEBUG
 CMAKE_EXE_LINKER_FLAGS_MINSIZE
 CMAKE_EXE_LINKER_FLAGS_RELEASE
 CMAKE_EXE_LINKER_FLAGS_RELWITH
 CMAKE_EXPORT_COMPILE_COMMANDS    OFF
 CMAKE_INSTALL_PREFIX             /usr/local
 CMAKE_LINKER                     /usr/bin/ld

CMAKE_AR: Path to a program.
Press [enter] to edit option                          CMake Version 2.8.8
Press [c] to configure       Press [g] to generate and exit
Press [h] for help           Press [q] to quit without generating
Press [t] to toggle advanced mode (Currently On)
```



Where is the source code: /home/castagne/temp/test-cmake

Where to build the binaries: /home/castagne/temp/test-cmake/build

Search: □ Grouped ☑ Advanced

| Name | Value |
|---|---|
| CMAKE_AR | /usr/bin/ar |
| CMAKE_BUILD_TYPE | |
| CMAKE_COLOR_MAKEFILE | ☑ |
| CMAKE_C_COMPILER | /usr/bin/gcc |
| CMAKE_C_FLAGS | |
| CMAKE_C_FLAGS_DEBUG | -g |
| CMAKE_C_FLAGS_MINSIZEREL | -Os -DNDE... |
| CMAKE_C_FLAGS_RELEASE | -O3 -DNDE.. |
| CMAKE_C_FLAGS_RELWITHDEBINFO | -O2 -g |
| CMAKE_EXE_LINKER_FLAGS | |

Press Configure to update and display new values in red, then press Generate to generate selected build files.

Current Generator: Unix Makefiles

# Build and install step

- Some important variables to:
  - control the build type:

```
CMAKE_BUILD_TYPE=[Debug, Release]
```

  - control the install directory

```
CMAKE_INSTALL_PREFIX=[/usr/local, home/toto/my_project]
```

  - activate the verbosity of makefiles

```
CMAKE_VERBOSE_MAKEFILE=ON
```

  - produce shared or static library

```
CMAKE_SHARED_LIBS=[OFF, ON]
```

  - etc…

# A simple syntax (1)

- Look like script language
  - note
  - variable
  - list
  - Command

```
# Describe what I have done
```

```
SET(VAR “toto”)
```

```
LIST(KEYWORD list iostream)
```

```
COMMAND(ARG1 ARG2)
```

- Control structure

```
IF(${VAR})
ENDIF()
```

```
FOREACH(VAR VAL1 VAL2)
ENDFOREACH()
```

- Dynamic configuration

```
CONFIGURE_FILE(config.h.in
               config.h)
```

```
#cmakedefine FOO_VER ${FOO_VER}
#cmakedefine @BUILD_SHARED_LIBS@
```

# A simple syntax (2)

- Library detection

```
FIND_LIBRARY(MY_LIB lib
             PATH path)
```

```
FIND_PACKAGE(CUDA
             REQUIRED)
```

- Feature validation

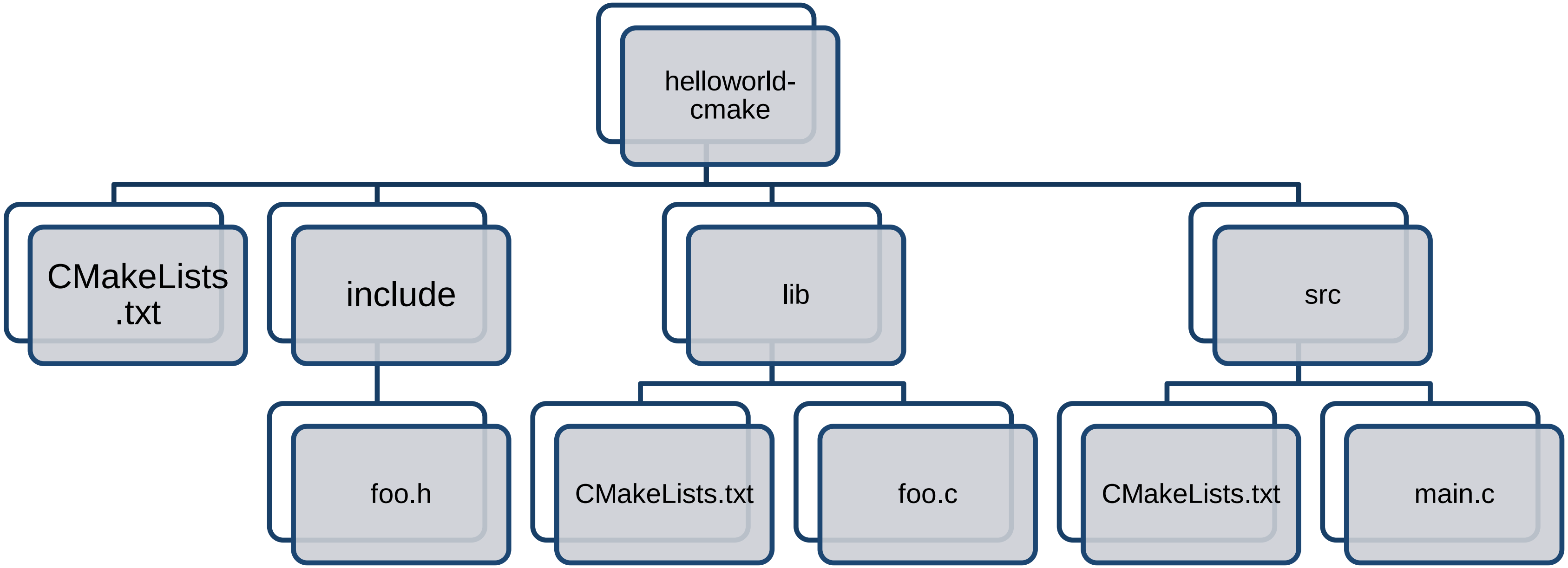
```
INCLUDE(CheckCCompilerFlag)
CHECK_C_COMPILER_FLAG(flag
                      HAVE_FLAG)
```

```
INCLUDE(CheckFunctionExists)
CHECK_FUNCTION_EXISTS(func
                      HAVE_FUNC)
```

```
INCLUDE(CheckSourceCompiles)
CHECK_C_SOURCE_COMPILES(code
                           VAR)
```

```
INCLUDE(CheckIncludeFile)
CHECK_INCLUDE_FILE(header
                HAVE_HEADER)
```

# Exercise: helloworld-cmake (1)



helloworld-cmake

CMakeLists.txt

include

lib

src

foo.h

CMakeLists.txt

foo.c

CMakeLists.txt

main.c

# Exercise: helloworld-cmake (2)

```
#include <foo.h>
int main(int ac, char *av[])
{
  print_message();
  return 0;
}
```

```
#include <stdio.h>
void print_message(void);
```

```
#include <foo.h>
void print_message(void) {
  printf("Hello World!\n");
}
```

- The quickest way to compile the project
- Feature test are not here !
- “install” phase not defined…

```
CMAKE_MINIMUM_REQUIRED(VERSION 2.6)
PROJECT(helloworld C)
SET(SRC
    src/main.c
    include/foo.h
    lib/foo.c
    )
ADD_EXECUTABLE(test ${SRC})
```

# Exercise: helloworld-cmake (3)

```
CMAKE_MINIMUM_REQUIRED(VERSION 3.6)
PROJECT(helloworld C)
INCLUDE(CheckIncludeFile)
CHECK_INCLUDE_FILE(stdio.h
                   HAVE_STDIO)
IF(NOT HAVE_STDIO)
    MESSAGE(FATAL_ERROR "Looking
         for stdio.h - not found")
ENDIF()
INCLUDE(CheckFunctionExists)
CHECK_FUNCTION_EXISTS(printf
                      HAVE_PRINTF)
IF(NOT HAVE_PRINTF)
    MESSAGE(FATAL_ERROR "Looking
          for printf - not found")
ENDIF()
INCLUDE_DIRECTORIES(include)
ADD_SUBDIRECTORY(lib)
ADD_SUBDIRECTORY(src)
```

```
CMAKE_MINIMUM_REQUIRED(VERSION 2.6)
ADD_LIBRARY(foo foo.c)
INSTALL(TARGETS foo
        DESTINATION lib)
```

```
CMAKE_MINIMUM_REQUIRED(VERSION 2.6)
ADD_EXECUTABLE(my_helloworld main.c)
TARGET_LINK_LIBRARIES(my_helloworld
foo)
INSTALL(TARGETS foo
        DESTINATION bin)
```

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# Test integration

# About CTest

- CTest comes with CMake
- It can be use without CMake
- It allows to:
  - automate updating form a repository
  - configuration and build
  - execute unit or regression tests
  - execute advanced tests (coverage, purify, valgrind…)
- Results can be submit to a CDash server

# Introduction to CTest

- Modify *CMakeLists.txt* in the top directory:

```
PROJECT(FOO)
INCLUDE(CTest)
INCLUDE_DIRECTORIES(tests)
ENABLE_TESTING()
```

- tests/CMakeLists.txt looks like:

```
ADD_EXECUTABLE(example example.cpp)
ADD_TEST(test1 example)
```

# Using CTest

- Get the list of tests

```
> ctest -N
```

- Launch tests

```
> make test
```

```
> ctest
```

```
> ctest -I Start,End,Stride
```

- Get log files

```
LastTest.log
```

```
LastTestsFailed.log
```

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# Packaging

# about CPack

- CPack comes with CMake
- It can be use without CMake
- It allows to:
  - generate a source distribution
  - generate different binary package

# Introduction to CPack without CMake

- Write a file named CPackConfig.cmake or CPackSourceConfig.cmake that looks like:

```
SET(CPACK_GENERATOR                    “TGZ")
SET(CPACK_PACKAGE_NAME                 “MY_SOFT”)
SET(CPACK_PACKAGE_VERSION_MAJOR        “1")
SET(CPACK_PACKAGE_VERSION_MINOR        “2")
SET(CPACK_PACKAGE_VERSION_PATCH        “0")
SET(CPACK_PACKAGE_DESCRIPTION_FILE     “${SOURCE_DIRECTORY}/COPYRIGHT")
SET(CPACK_PACKAGE_DESCRIPTION_SUMMARY  “Summary”)
SET(CPACK_INSTALLED_DIRECTORIES        “${SOURCE_DIRECTORY};/")
SET(CPACK_INSTALL_CMAKE_PROJECTS       “”)
SET(CPACK_PACKAGE_FILE_NAME            “my-soft")
SET(CPACK_PACKAGE_VENDOR               “Inria”)
```

- Generate package :

```
> cpack -D OPTION=VALUE
```

# Introduction to CPack with CMake

- Add in your CMakeLists.txt

```
INCLUDE(InstallRequiredSystemLibraries)
SET(CPACK_GENERATOR                              “TGZ")
…
SET(CPACK_PACKAGE_VENDOR                         “Inria”)
INCLUDE(Cpack)
```

- Generate package :

```
> make && cpack
```

```
> make && make package
```

```
> make && make package_source
```

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# Release engineering @ Inria

# Some platform to help you

- Continuous integration:
  - Hydra: local platform | status: OK
    contact: sed-bordeaux@inria.fr
  - CI@Inria: national platform | status: standby
    contact: sed-lille@inria.fr
  - CDash: national platform | status: OK
    contact: http://cdash.inria.fr/CDash/

- Porting:
  - PIPOL: national platform | status: ON (OFF soon???)
    contact: http://pipol.inria.fr/

# 6

# To conclude

# Some conclusions

- About build system
  - manage the relationship: developer(s) / user(s)

- About CMake / CTest / CPack
  - easy-to-develop
  - multi-platform
  - warning: reinventing the wheel, and making it square

# Thank you

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http://sed.bordeaux.inria.fr