CMake tutorial

and its friends CPack, CTest and CDash

Your NAME - your.name@whatever.com

CMake

Cross-platform Make

http://www.cmake.org

DRAFT compiled on April 18, 2016

https://github.com/TheErk/CMake-tutorial

Initially given by Eric Noulard for Toulibre on February, 8^{th} 2012.

Thanks to...

- Kitware for making a really nice set of tools and making them open-source
- the CMake mailing list for its friendliness and its more than valuable source of information
- CMake developers for their tolerance when I break the dashboard or mess-up with the Git workflow,
- CPack users for their patience when things don't work as they ~~should~~ expect
- Alan, Alex, Bill, Brad, Clint, David, Eike, Julien, Mathieu, Michael & Michael, and many more...
- My son Louis for the nice CPack 3D logo done with Blender.
- and...Toulibre for hosting this presention in Toulouse, France.

And thanks to contributors as well...

History

This presentation was initially made by Eric Noulard for a Toulibre (http://www.toulibre.fr) given in Toulouse (France) on February, 8^{th} 2012. After that, the source of the presentation has been release under CC-BY-SA, http://creativecommons.org/licenses/by-sa/3.0/us/ and put on https://github.com/TheErk/CMake-tutorial then contributors stepped-in.

Many thanks to all contributors (alphabetical order):

Contributors

Sébastien Dinot, Andreas Mohr.

CMake tool sets

CMake

CMake is a cross-platform build systems generator which makes it easier to build software in a unified manner on a broad set of platforms:



, Windows, Mac OS, AIX, IRIX, , iOS $\cdots$

CMake has friends softwares that may be used on their own or together:

- CMake: build system generator
- CPack: package generator
- CTest: systematic test driver
- CDash: a dashboard collector

Outline of Part I: CMake

Outline of Part II: CPack

Outline of Part III: CTest and CDash

Build what?

Software build system

A software build system is the usage of a [set of] tool[s] for building software applications.

Why do we need that?

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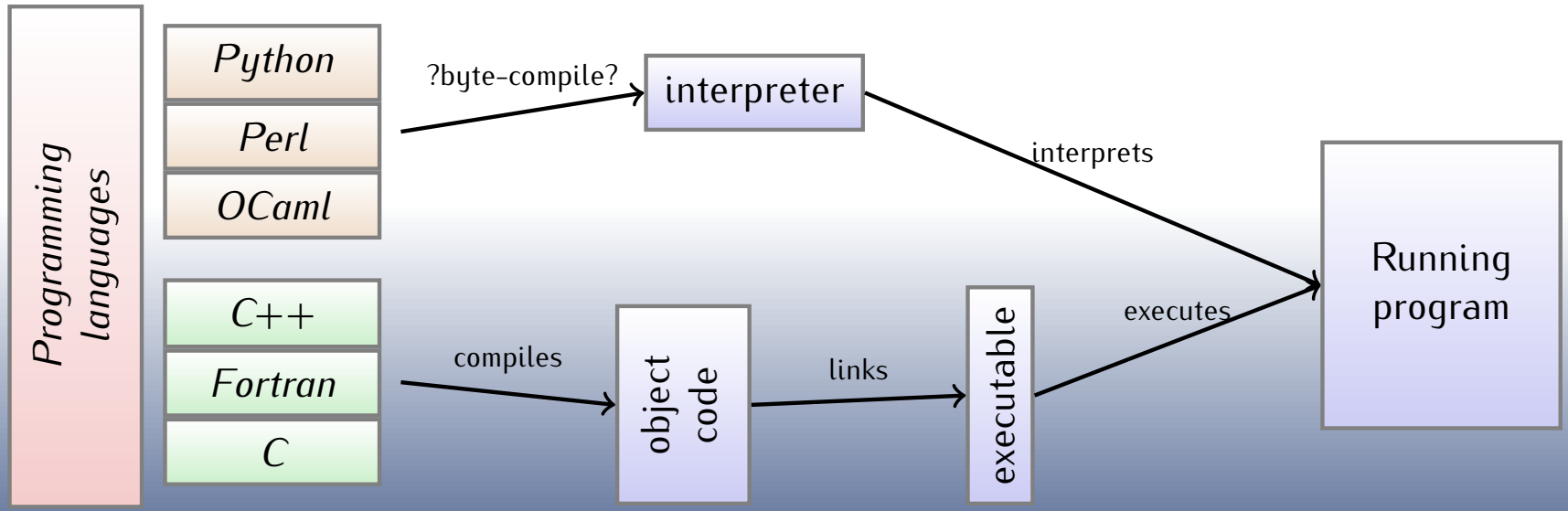
- because most softwares consist of several parts that need some building to put them together,
- because softwares are written in various languages that may share the same building process,
- because we want to build the same software for various computers (PC, Macintosh, Workstation, mobile phones and other PDA, embedded computers) and systems (Windows, Linux, *BSD, other Unices (many), Android, etc...)

Programming languages

Compiled vs interpreted or what?

Building an application requires the use of some programming language: Python, Java, C++, Fortran, C, Go, Tcl/Tk, Ruby, Perl, OCaml,...



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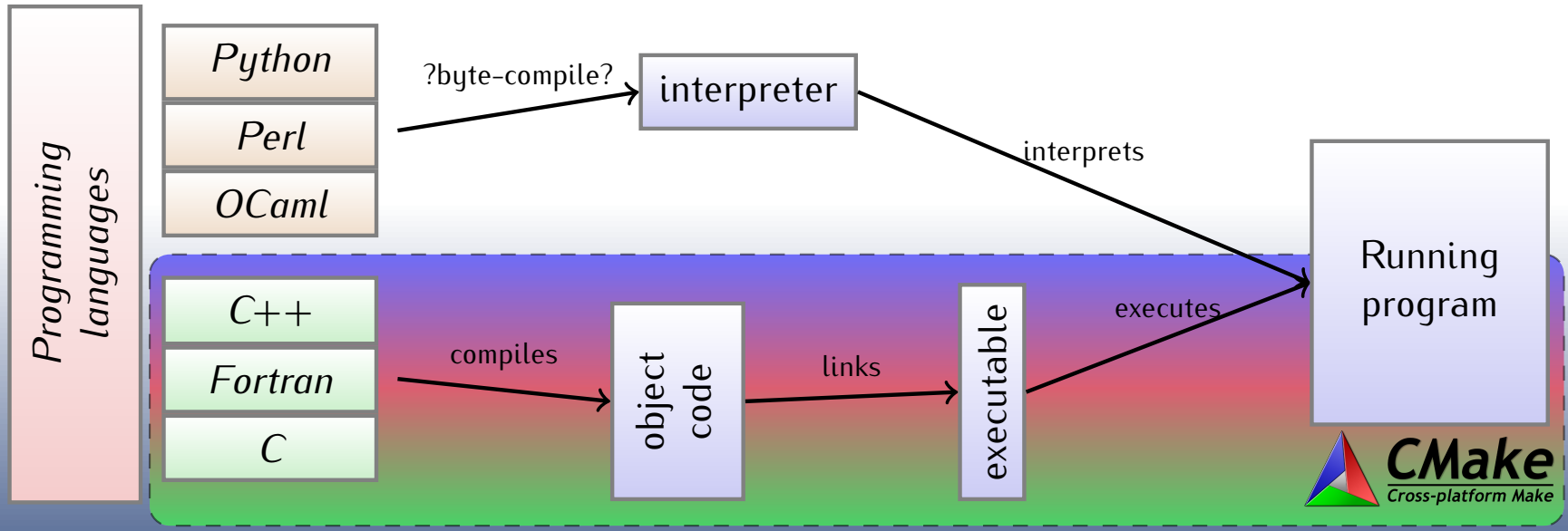


Build systems: several choices

Alternatives

CMake is not the only build system [generator]:

- (portable) hand-written Makefiles, depends on `make` tool.
- Apache ant http://ant.apache.org/, dedicated to Java (almost).
- Portable IDE: Eclipse, Code::Blocks, Geany, NetBeans, ...
- GNU Autotools: Autoconf, Automake, Libtool. Produce makefiles. Bourne shell needed (and M4 macro processor). see e.g. http://www.gnu.org/software/autoconf/
- SCons: http://www.scons.org only depends on Python. Extensible with Python.
- ...

Comparisons and [success] stories

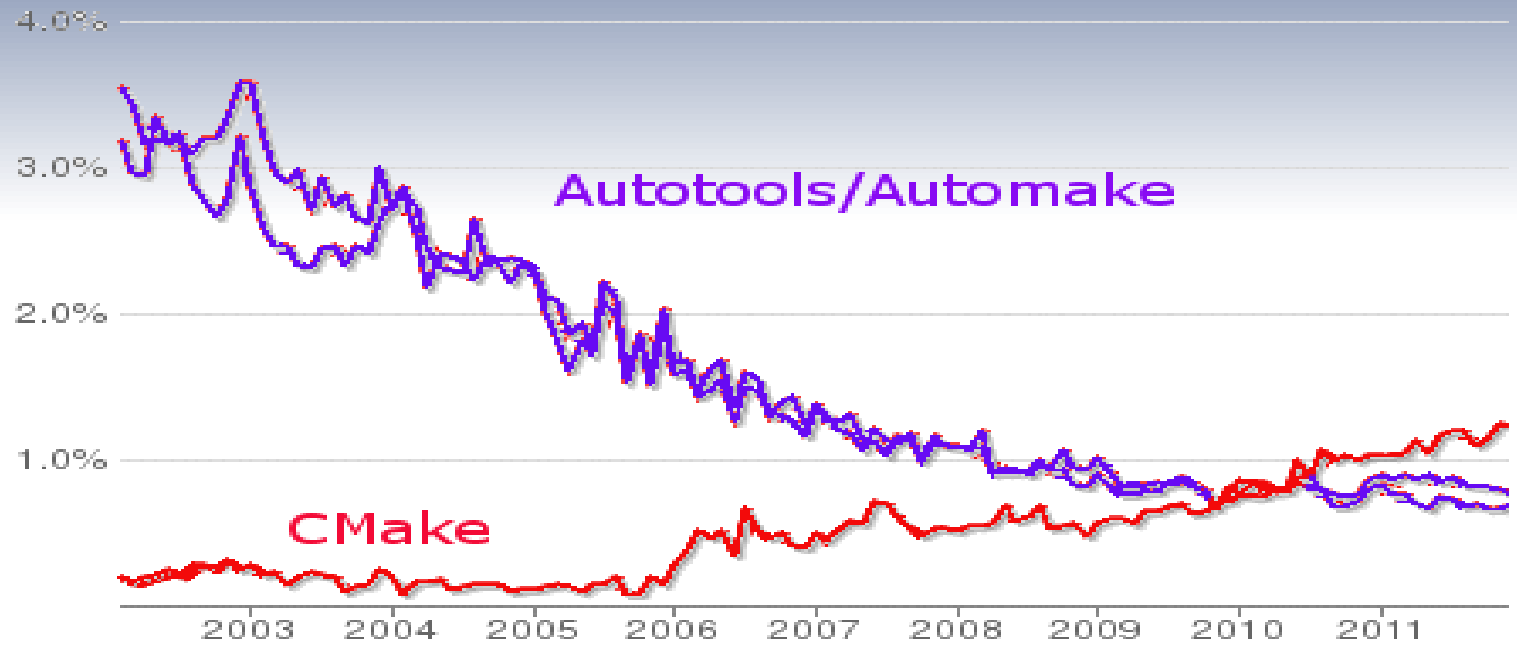
Disclaimer

This presentation is biased. I mean totally.
I am a big CMake fan, I'm contributing to CMake, thus I'm not impartial at all. But I will be ready to discuss why CMake is the greatest build system out there :-)

Go and forge your own opinion:

- Bare list: http://en.wikipedia.org/wiki/List_of_build_automation_software
- A comparison: http://www.scons.org/wiki/SconsVsOtherBuildTools
- KDE success story (2006): "Why the KDE project switched to CMake – and how" http://lwn.net/Articles/188693/

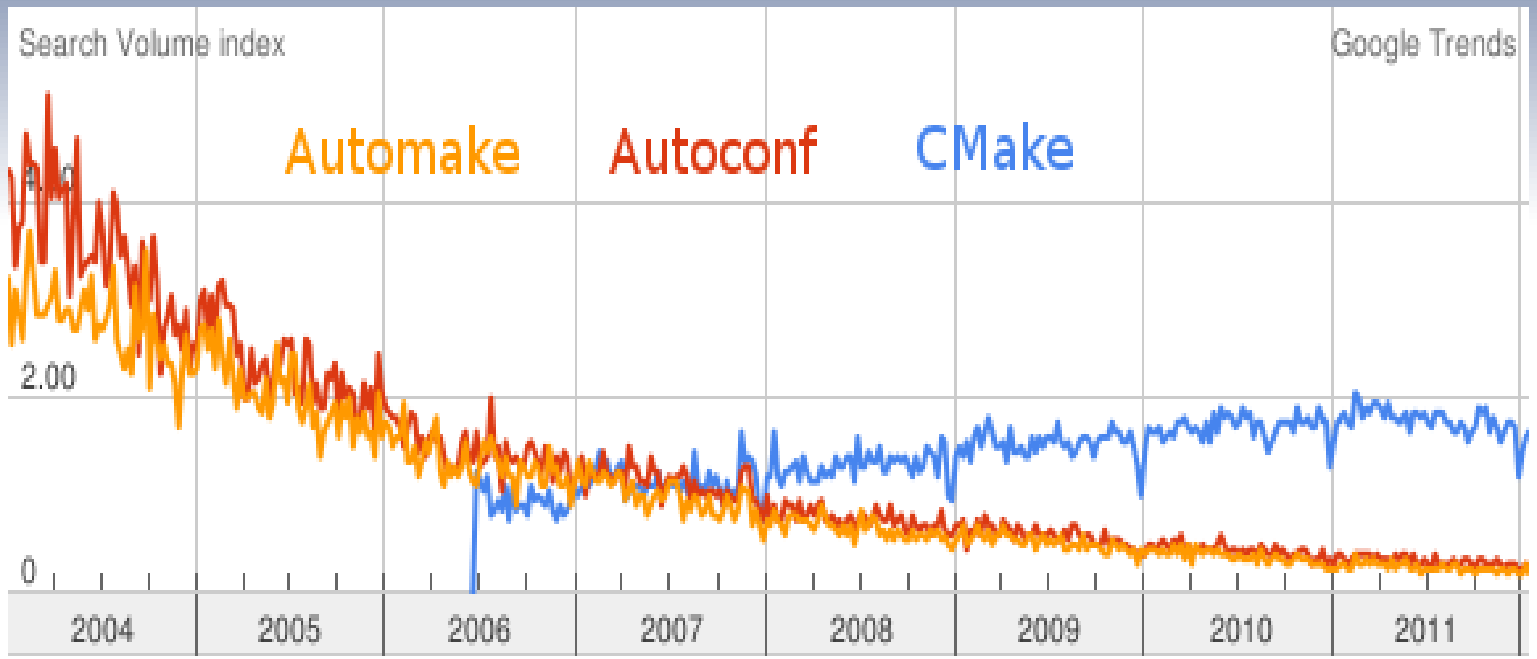
CMake/Auto[conf|make] on Ohloh



https://www.ohloh.net/languages/compare

Language comparison of CMake to automake and autoconf showing the percentage of developers commits that modify a source file of the respective language.

CMake/Auto[conf|make] on Google Trend



http://www.google.com/trends

Scale is based on the average worldwide traffic of CMake in all years.

Outline

A build system generator

- CMake is a generator: it generates native build systems files (Makefile, Ninja, IDE project files, ...),
- CMake scripting language (declarative) is used to describe the build,
- The developer edits `CMakeLists.txt`, invokes CMake but should never edit the generated files,
- CMake may be (automatically) re-invoked by the build system,

The CMake workflow

When do things take place?

CMake is a generator which means it does not compile (i.e. build) the sources, the underlying build tool (make, XCode, Code::Blocks...) does.

The CMake workflow

1. CMake time: CMake is running & processing `CMakeLists.txt`

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4. CPack time: CPack is running for building package

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4. CPack time: CPack is running for building package
5. Package Install time: the package (from previous step) is installed

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The CMake workflow (pictured)

CMakeLists.txt

Source files

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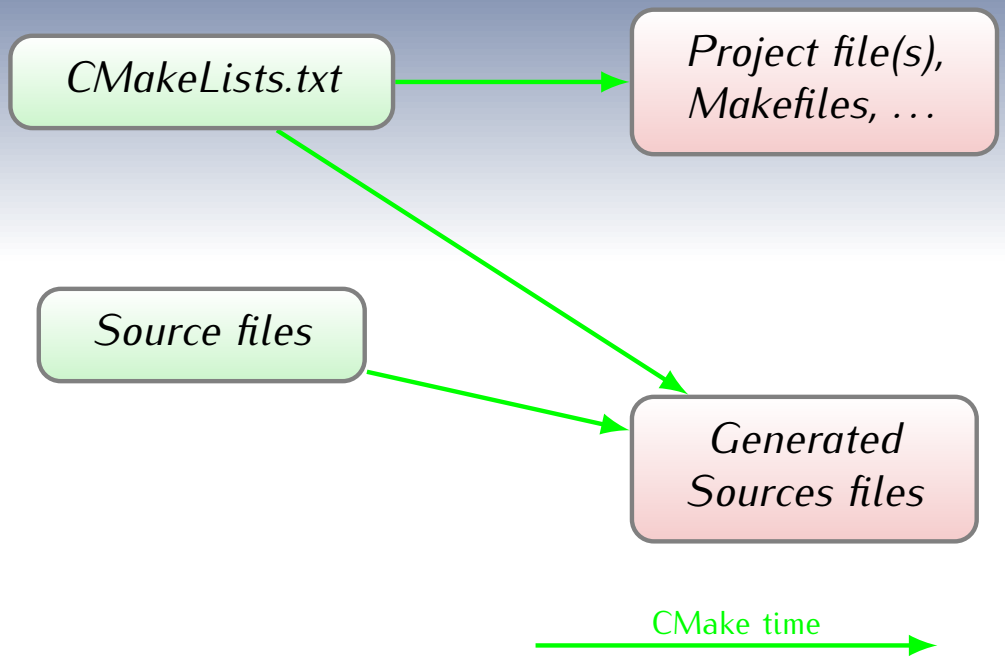

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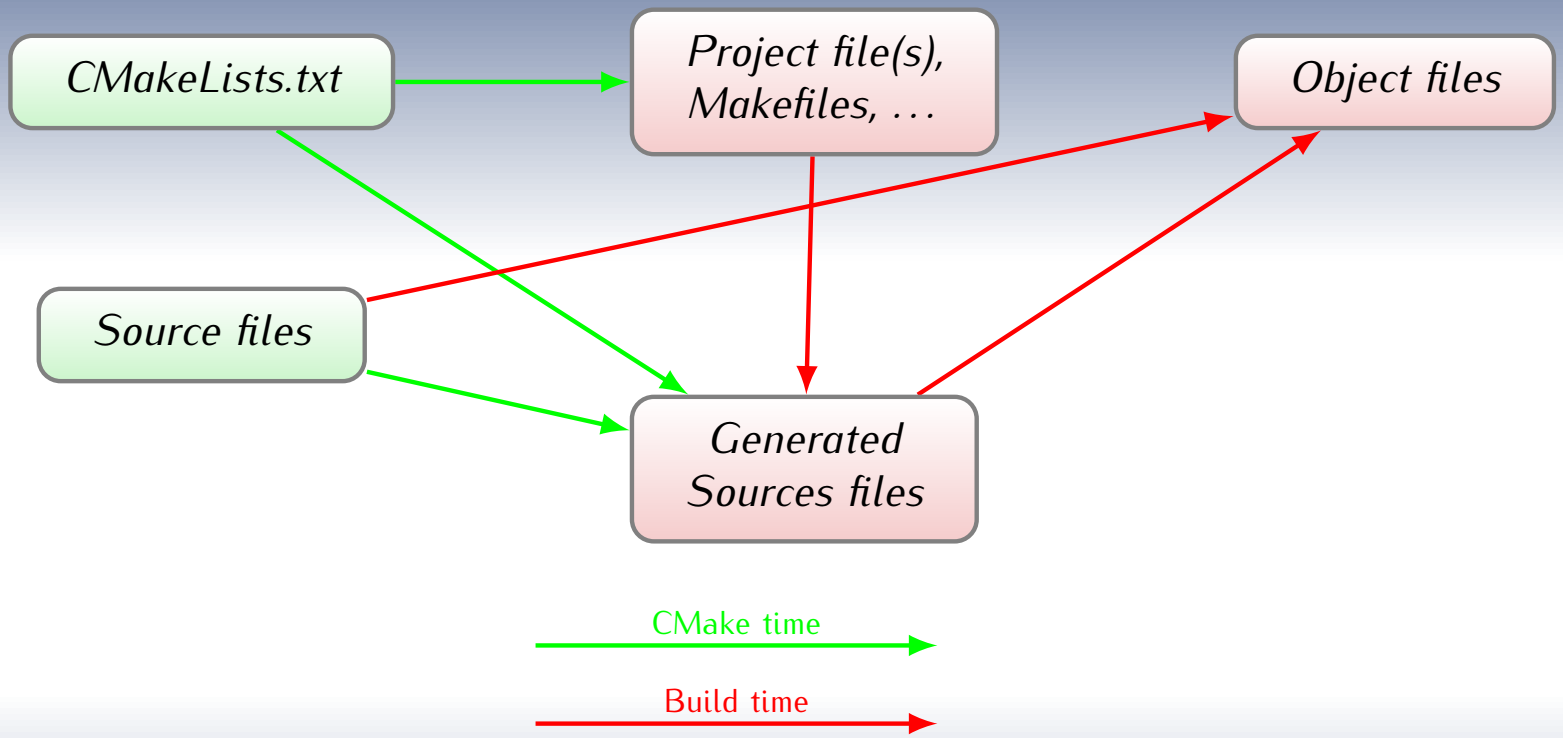

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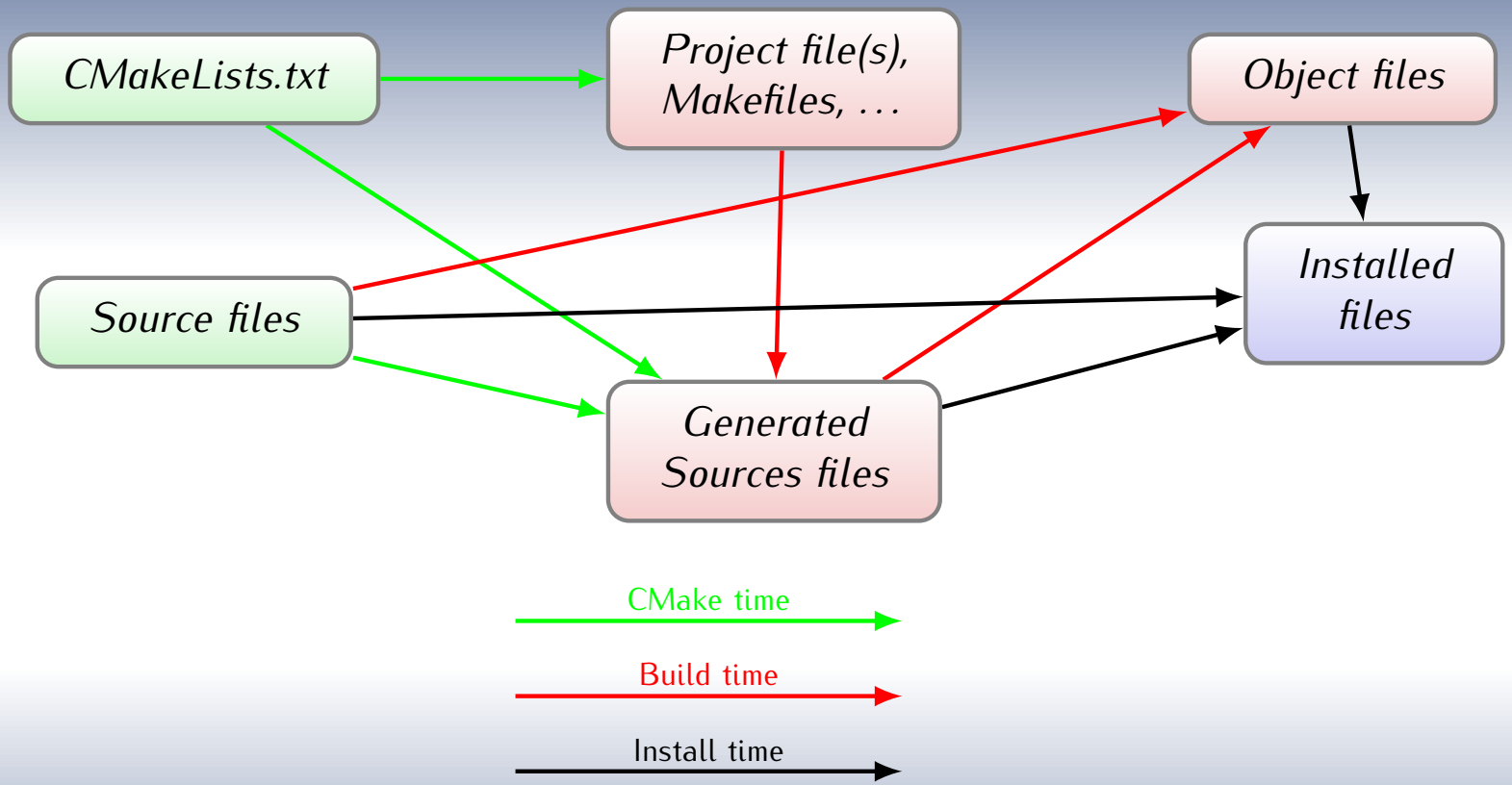

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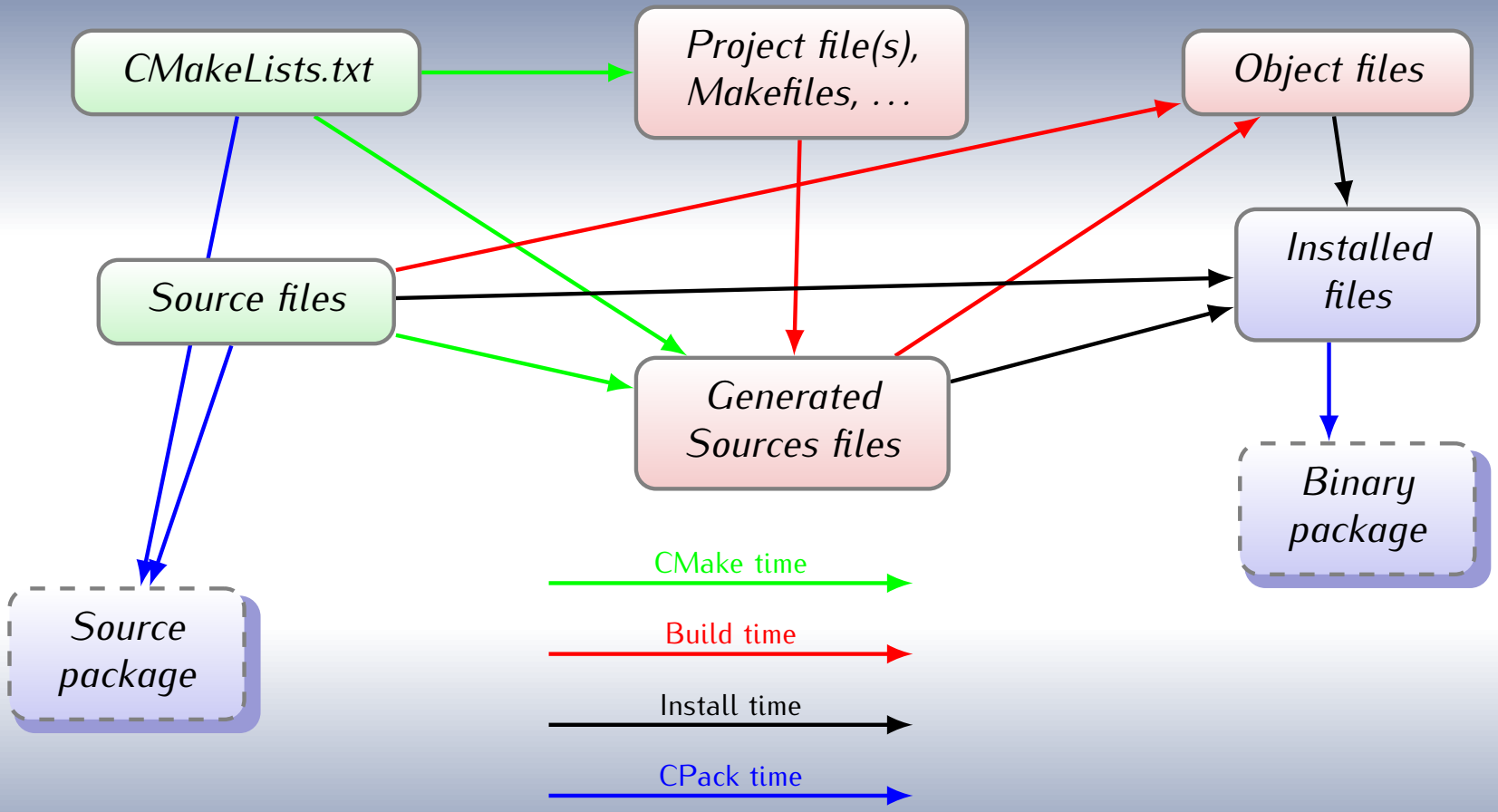

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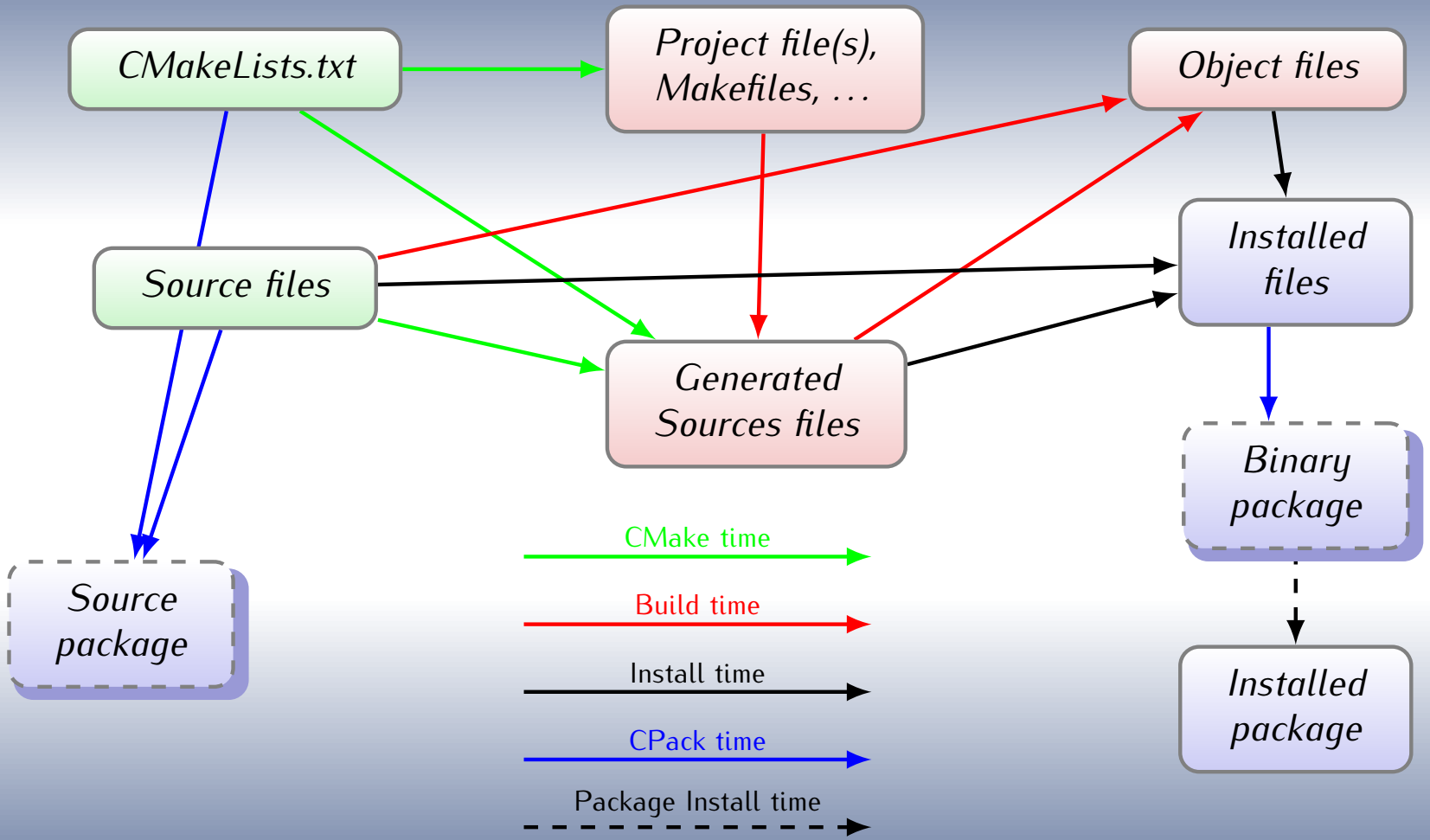

Building an executable

Listing 1: Building a simple program

```
1 cmake_minimum_required (VERSION 2.8)
2 # This project use C source code
3 project (TotallyFree C)
4 # build executable using specified
5 # list of source files
6 add_executable(Acrolibre acrolibre.c)
```

CMake scripting language is [mostly] declarative. It has commands which are documented from within CMake:

```
$ cmake --help-command-list | wc -l
96
$ cmake --help-command add_executable
...
  add_executable
       Add an executable to the project using the specified source files.
```

Builtin documentation

CMake builtin doc for 'project' command

```
$ cmake --help-command project
cmake version 2.8.7.20120121-g751713-dirty
  project
       Set a name for the entire project.

         project(<projectname> [languageName1 languageName2 ... ] )

       Sets the name of the project.  Additionally this sets the variables
       <projectName>_BINARY_DIR and <projectName>_SOURCE_DIR to the
       respective values.

       Optionally you can specify which languages your project supports.
       Example languages are CXX (i.e.  C++), C, Fortran, etc.  By default C
       and CXX are enabled.  E.g.  if you do not have a C++ compiler, you can
       disable the check for it by explicitly listing the languages you want
       to support, e.g.  C.  By using the special language "NONE" all checks
       for any language can be disabled.
```

Generating & building

Building with CMake is easy:

CMake + Unix Makefile

```
1  $ ls totally-free
2  acrolibre.c  CMakeLists.txt
3  $ mkdir build
4  $ cd build
5  $ cmake ../totally-free
6  -- The C compiler identification is GNU 4.6.2
7  -- Check for working C compiler: /usr/bin/gcc
8  -- Check for working C compiler: /usr/bin/gcc -- works
9  ...
10 $ make
11 Scanning dependencies of target Acrolibre
12 [100%] Building C object CMakeFiles/Acrolibre.dir/acrolibre.c.o
13 Linking C executable Acrolibre
14 [100%] Built target Acrolibre
15 $ ./Acrolibre toulibre
```

Source tree vs Build tree

Even the most simple project should never mix-up sources with generated files. CMake supports out-of-source build.

Always build out-of-source

Out-of-source is better

People are lazy (me too) and they think that because building in source is possible and authorizes less typing they can get away with it. In-source build is a BAD choice.

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1. Generated files are separate from manually edited ones (thus you don't have to clutter your favorite VCS ignore files).
2. You can have several build trees for the same source tree
3. This way it's always safe to completely delete the build tree in order to do a clean build

Building program + autonomous library

We now have the following set of files in our source tree:

- `acrolibre.c`, the main C program
- `acrodict.h`, the Acrodict library header
- `acrodict.c`, the Acrodict library source
- `CMakeLists.txt`, the soon to be updated CMake entry file

Building program + autonomous library

Conditional build

We want to keep a version of our program that can be compiled and run without the new Acrodict library and the new version which uses the library.

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The main program source

```c
#include <stdlib.h>
#include <stdio.h>
#include <strings.h>
#ifdef USE_ACRODICT
#include "acrodict.h"
#endif
int main(int argc, char* argv[]) {

  const char * name;
#ifdef USE_ACRODICT
  const acroItem_t*  item;
#endif

  if (argc < 2) {
    fprintf(stderr,"%s: you need one argument\n",argv[0]);
    fprintf(stderr,"%s <name>\n",argv[0]);
    exit(EXIT_FAILURE);
  }
  name = argv[1];

#ifndef USE_ACRODICT
  if (strcasecmp(name,"toulibre")==0) {
    printf("Toulibre is a french organization promoting FLOSS.\n");
  }
#else
  item = acrodict_get(name);
  if (NULL!=item) {
    printf("%s: %s\n",item->name,item->description);
  } else if (item=acrodict_get_approx(name)) {
    printf("<%s> is unknown may be you mean:\n",name);
    printf("%s: %s\n",item->name,item->description);
  }
#endif
  else {
    printf("Sorry, I don't know: <%s>\n",name);
    return EXIT_FAILURE;
  }
  return EXIT_SUCCESS;
}
```

The library source

```c
#ifndef ACRODICT_H
#define ACRODICT_H
typedef struct acroItem {
  char* name;
  char* description;
} acroItem_t;

const acroItem_t*
acrodict_get(const char* name);
#endif
```

```c
#include <stdlib.h>
#include <string.h>
#include "acrodict.h"
static const acroItem_t acrodict[] = {
  {"Toulibre", "Toulibre is a french
       organization promoting FLOSS"},
  {"GNU", "GNU is Not Unix"},
  {"GPL", "GNU general Public License"
       },
  {"BSD", "Berkeley Software
       Distribution"},
  {"CULTe","Club des Utilisateurs de
       Logiciels libres et de gnu/
       linux de Toulouse et des
       environs"},
  {"Lea", "Lea-Linux: Linux entre ami(e
       )s"},
  {"RMLL","Rencontres Mondiales du
       Logiciel Libre"},
  {"FLOSS","Free Libre Open Source
       Software"},
  {"",""}};
const acroItem_t*
acrodict_get(const char* name) {
  int current =0;
  int found   =0;
  while ((strlen(acrodict[current].name
       )>0) && !found) {
    if (strcasecmp(name,acrodict[
         current].name)==0) {
      found=1;
    } else {
      current++;
    }
  }
  if (found) {
    return &(acrodict[current]);
  } else {
    return NULL;
  }
}
```

Building a library I

Listing 2: Building a simple program + shared library

```
1  cmake_minimum_required (VERSION 2.8)
2  project (TotallyFree C)
3  add_executable(Acrolibre acrolibre.c)
4  set(LIBSRC acrodict.c acrodict.h)
5  add_library(acrodict ${LIBSRC})
6  add_executable(Acrodictlibre acrolibre.c)
7  target_link_libraries(Acrodictlibre acrodict)
8  set_target_properties(Acrodictlibre
9                        PROPERTIES COMPILE_FLAGS "-DUSE_ACRODICT")
```

Building a library II

And it builds...

All in all CMake generates appropriate Unix makefiles which build all this smoothly.

CMake + Unix Makefile

```
$ make
[ 33%] Building C object CMakeFiles/acrodict.dir/acrodict.c.o
Linking C shared library libacrodict.so
[ 33%] Built target acrodict
[ 66%] Building C object CMakeFiles/Acrodictlibre.dir/acrolibre.c.o
Linking C executable Acrodictlibre
[ 66%] Built target Acrodictlibre
[100%] Building C object CMakeFiles/Acrolibre.dir/acrolibre.c.o
Linking C executable Acrolibre
[100%] Built target Acrolibre
$ ls -F
Acrodictlibre*  CMakeCache.txt  cmake_install.cmake  Makefile
Acrolibre*      CMakeFiles/     libacrodict.so*
```

Building a library III

And it works...

We get the two different variants of our program, with varying capabilities.

Building a library IV

```
1   $ ./Acrolibre toulibre
2   Toulibre is a french organization promoting FLOSS.
3   $ ./Acrolibre FLOSS
4   Sorry, I don't know: <FLOSS>
5   $ ./Acrodictlibre FLOSS
6   FLOSS: Free Libre Open Source Software
```

```
$ make help
The following are some of the valid targets
    for this Makefile:
... all (the default if no target is provided)
... clean
... depend
... Acrodictlibre
... Acrolibre
... acrodict
...
```

Generated `Makefiles` has several builtin targets besides the expected ones:

- one per target (library or executable)
- clean, all
- more to come ...

User controlled build option

User controlled option

Maybe our users don't want the acronym dictionary support. We can use CMake **OPTION** command.

Listing 3: User controlled build option

```
1  cmake_minimum_required (VERSION 2.8)
2  # This project use C source code
3  project (TotallyFree C)
4  # Build option with default value to ON
5  option(WITH_ACRODICT "Include acronym dictionary support" ON)
6  set(BUILD_SHARED_LIBS true)
7  # build executable using specified list of source files
8  add_executable(Acrolibre acrolibre.c)
9  if (WITH_ACRODICT)
10    set(LIBSRC acrodict.h acrodict.c)
11    add_library(acrodict ${LIBSRC})
12    add_executable(Acrodictlibre acrolibre.c)
13    target_link_libraries(Acrodictlibre acrodict)
14    set_target_properties(Acrodictlibre PROPERTIES COMPILE_FLAGS "-DUSE_ACRODICT")
15 endif(WITH_ACRODICT)
```

Too much keyboard, time to click? I

CMake comes with severals tools

A matter of choice / taste:

- a command line: `cmake`
- a curses-based TUI: `ccmake`
- a Qt-based GUI: `cmake-gui`

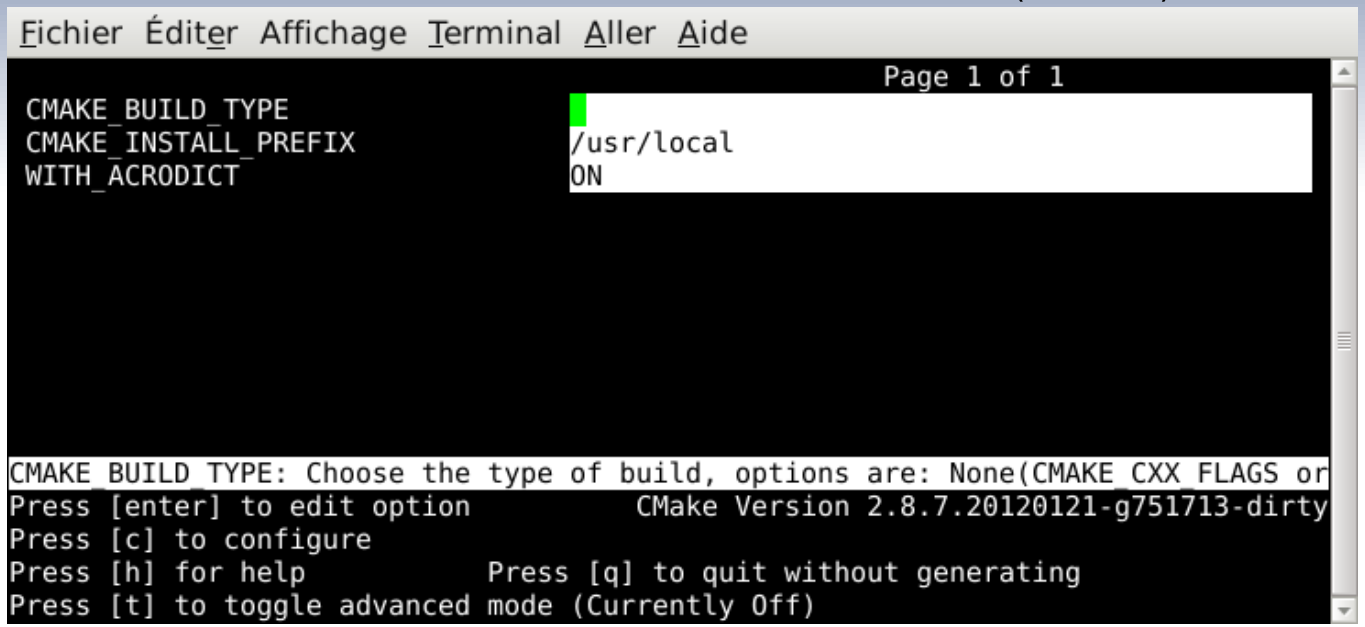
Calling convention

All tools expect to be called with a single argument which may be interpreted in 2 different ways.

- path to the source tree, e.g.: `cmake /path/to/source`
- path to an existing build tree, e.g.: `cmake-gui .`

Too much keyboard, time to click? II

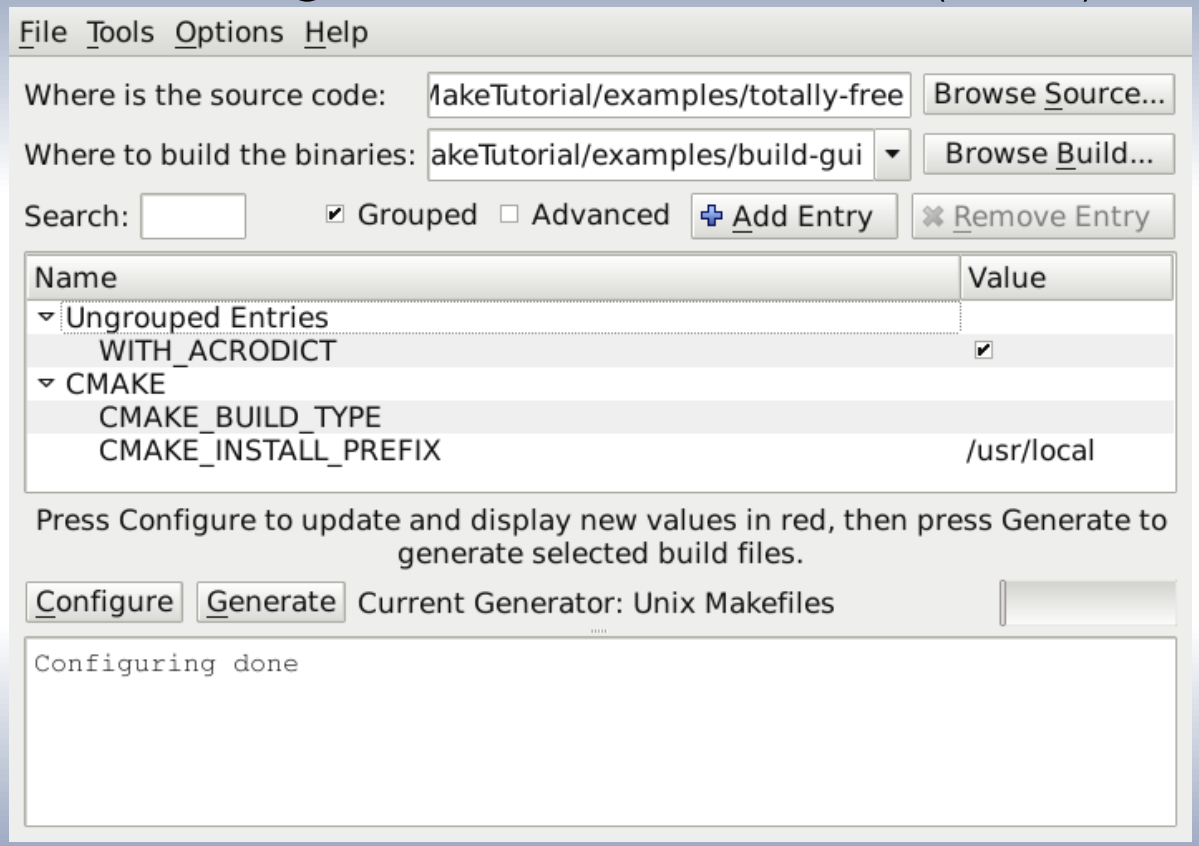
`ccmake` : the curses-based TUI (demo)



Here we can choose to toggle the WITH_ACRODICT **OPTION**.

Too much keyboard, time to click? III

`cmake-gui` : the Qt-based GUI (demo)



Again, we can choose to toggle the WITH_ACRODICT **OPTION**.

Remember CMake is a build **generator**?

The number of active generators depends on the platform we are running on Unix, Apple, Windows:

```
Borland Makefiles
MSYS Makefiles
MinGW Makefiles
NMake Makefiles
NMake Makefiles JOM
Unix Makefiles
Visual Studio 10
Visual Studio 10 IA64
Visual Studio 10 Win64
Visual Studio 11
Visual Studio 11 Win64
Visual Studio 6
Visual Studio 7
Visual Studio 7 .NET 2003
Visual Studio 8 2005
Visual Studio 8 2005 Win64
Visual Studio 9 2008
Visual Studio 9 2008 IA64
Visual Studio 9 2008 Win64
Watcom WMake
CodeBlocks - MinGW Makefiles
CodeBlocks - NMake Makefiles
CodeBlocks - Unix Makefiles
Eclipse CDT4 - MinGW Makefiles
Eclipse CDT4 - NMake Makefiles
Eclipse CDT4 - Unix Makefiles
KDevelop3
KDevelop3 - Unix Makefiles
XCode
Ninja (in development)
  http://martine.github.com/ninja/
```

Equally simple on other platforms

It is as easy for a Windows build, however names for executables and libraries are computed in a platform specific way.

CMake + MinGW Makefile

```
$ ls totally-free
acrodict.h acrodict.c acrolibre.c  CMakeLists.txt
$ mkdir build-win32
$ cd build-win32
...
$ make
Scanning dependencies of target acrodict
[ 33%] Building C object CMakeFiles/acrodict.dir/acrodict.c.obj
Linking C shared library libacrodict.dll
Creating library file: libacrodict.dll.a
[ 33%] Built target acrodict
Scanning dependencies of target Acrodictlibre
[ 66%] Building C object CMakeFiles/Acrodictlibre.dir/acrolibre.c.obj
Linking C executable Acrodictlibre.exe
[ 66%] Built target Acrodictlibre
Scanning dependencies of target Acrolibre
[100%] Building C object CMakeFiles/Acrolibre.dir/acrolibre.c.obj
Linking C executable Acrolibre.exe
[100%] Built target Acrolibre
```

Installing things

Install

Several parts or the software may need to be installed: this is controlled by the CMake **install** command.
Remember `cmake --help-command install`!!

Listing 4: install command examples

```
...
add_executable(Acrolibre acrolibre.c)
install(TARGETS Acrolibre DESTINATION bin)
if (WITH_ACRODICT)
  ...
  install(TARGETS Acrodictlibre acrodict
          RUNTIME DESTINATION bin
          LIBRARY DESTINATION lib
          ARCHIVE DESTINATION lib/static)
  install(FILES acrodict.h DESTINATION include)
endif(WITH_ACRODICT)
```

Controlling installation destination

Use relative DESTINATION

One should always use relative installation DESTINATION unless you really want to use absolute path like `/etc`.

Then depending on when you install:

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Then depending on when you install:

- At CMake-time set **CMAKE_INSTALL_PREFIX** value

```
$ cmake --help-variable CMAKE_INSTALL_PREFIX
```

Controlling installation destination

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One should always use relative installation DESTINATION unless you really want to use absolute path like `/etc`.

Then depending on when you install:

- At CMake-time set **CMAKE_INSTALL_PREFIX** value

```
$ cmake --help-variable CMAKE_INSTALL_PREFIX
```

- At Install-time use `DESTDIR` mechanism (Unix Makefiles)

```
$ make DESTDIR=/tmp/testinstall install
```

Controlling installation destination

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Then depending on when you install:

- At CMake-time set **CMAKE_INSTALL_PREFIX** value

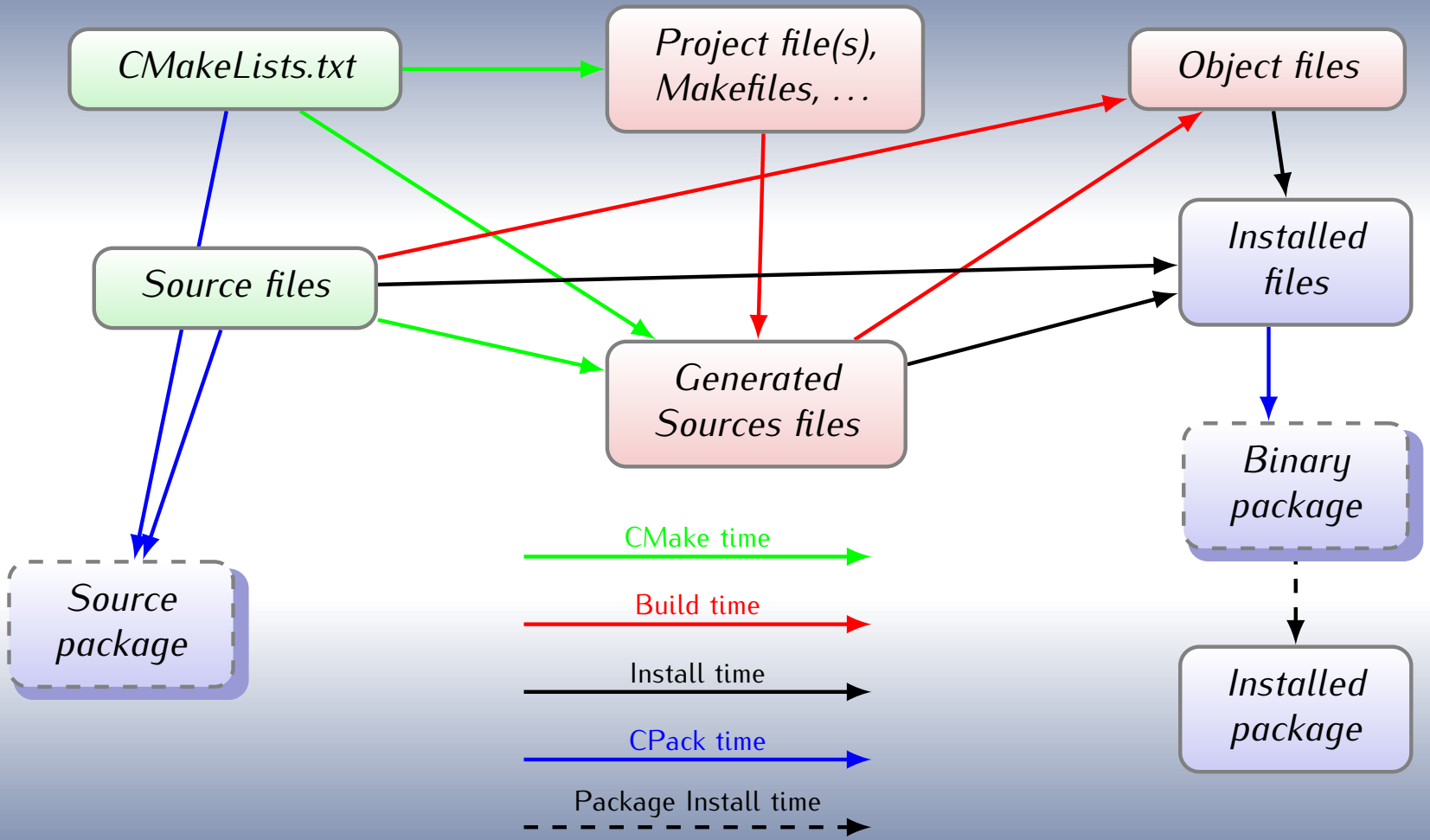
```
$ cmake --help-variable CMAKE_INSTALL_PREFIX
```

- At Install-time use `DESTDIR` mechanism (Unix Makefiles)

```
$ make DESTDIR=/tmp/testinstall install
```

- At CPack-time, CPack what? ...be patient.
- At Package-install-time, we will see that later

The CMake workflow (pictured)



Using CMake variables

CMake variables

They are used by the user to simplify its `CMakeLists.txt`, but CMake uses many (~170+) of them to control/change its [default] behavior. Try: `cmake --help-variables-list`.

Inside a CMake script

set(CMAKE_INSTALL_PREFIX /home/eric/testinstall)

```
$ cmake --help-command set
```

On the command line/TUI/GUI

Remember that (besides options) each CMake tool takes a single argument (source tree or existing build tree)

```
$ cmake -DCMAKE_INSTALL_PREFIX=/home/eric/testinstall .
```

The install target

Install target

The `install` target of the underlying build tool (in our case `make`) appears in the generated build system as soon as some **install** commands are used in the `CMakeLists.txt`.

```
1  $ make DESTDIR=/tmp/testinstall install
2  [ 33%] Built target acrodict
3  [ 66%] Built target Acrodictlibre
4  [100%] Built target Acrolibre
5  Install the project...
6  -- Install configuration: ""
7  -- Installing: /tmp/testinstall/bin/Acrolibre
8  -- Installing: /tmp/testinstall/bin/Acrodictlibre
9  -- Removed runtime path from "/tmp/testinstall/bin/Acrodictlibre"
10 -- Installing: /tmp/testinstall/lib/libacrodict.so
11 -- Installing: /tmp/testinstall/include/acrodict.h
12 $
```

Package the whole thing

CPack

CPack is a CMake friend application (detailed later) which may be used to easily package your software.

Listing 5: add CPack support

```
1  ...
2  endif(WITH_ACRODICT)
3  ...
4  # Near the end of the CMakeLists.txt
5  # Chose your CPack generator
6  set(CPACK_GENERATOR "TGZ")
7  # Setup package version
8  set(CPACK_PACKAGE_VERSION_MAJOR 0)
9  set(CPACK_PACKAGE_VERSION_MINOR 1)
10 set(CPACK_PACKAGE_VERSION_PATCH 0)
11 # 'call' CPack
12 include(CPack)
```

```
$ make package
[ 33%] Built target acrodict
[ 66%] Built target Acrodictlibre
[100%] Built target Acrolibre
Run CPack packaging tool...
CPack: Create package using TGZ
CPack: Install projects
CPack: - Run preinstall target for: TotallyFree
CPack: - Install project: TotallyFree
CPack: Create package
CPack: - package: <build-tree>/...
      TotallyFree-0.1.0-Linux.tar.gz generated.
$ tar ztvf TotallyFree-0.1.0-Linux.tar.gz
... TotallyFree-0.1.0-Linux/include/acrodict.h
... TotallyFree-0.1.0-Linux/bin/Acrolibre
... TotallyFree-0.1.0-Linux/bin/Acrodictlibre
... TotallyFree-0.1.0-Linux/lib/libacrodict.so
```

CPack the packaging friend

CPack is a standalone generator

As we will see later on, CPack is standalone application, which like CMake is a generator.

```
$ cpack -G ZIP
CPack: Create package using ZIP
CPack: Install projects
CPack: - Run preinstall target for: TotallyFree
CPack: - Install project: TotallyFree
CPack: Create package
CPack: - package: <build-tree>/...
      TotallyFree-0.1.0-Linux.zip generated.
$ unzip -t TotallyFree-0.1.0-Linux.zip
Archive:  TotallyFree-0.1.0-Linux.zip
    testing: To.../include/acrodict.h   OK
    testing: To.../bin/Acrolibre   OK
    testing: To.../bin/Acrodictlibre   OK
    testing: To.../lib/libacrodict.so   OK
No errors detected in compressed
   data of TotallyFree-0.1.0-Linux.zip.
```

```
$ cpack -G RPM
CPack: Create package using RPM
CPack: Install projects
CPack: - Run preinstall target for: TotallyFree
CPack: - Install project: TotallyFree
CPack: Create package
CPackRPM: Will use GENERATED spec file: <build-tree>/...
      _CPack_Packages/Linux/RPM/SPECS/totallyfree.spec
CPack: - package: <build-tree>/...
      TotallyFree-0.1.0-Linux.rpm generated.
$ rpm -qpl TotallyFree-0.1.0-Linux.rpm
/usr
/usr/bin
/usr/bin/Acrodictlibre
/usr/bin/Acrolibre
/usr/include
/usr/include/acrodict.h
/usr/lib
/usr/lib/libacrodict.so
```

Didn't you mentioned testing? I

CTest

CTest is a CMake friend application (detailed later) which may be used to easily test your software.

Listing 6: add CTest support

```
...
endif(WITH_ACRODICT)
...
enable_testing()
add_test(toulibre-builtin
         Acrolibre "toulibre")
add_test(toulibre-dict
         Acrodictlibre "toulibre")
add_test(FLOSS-dict
         Acrodictlibre "FLOSS")
add_test(FLOSS-fail
         Acrolibre "FLOSS")
```

```
$ make test
Running tests...
Test project <buildtree-prefix>/build
    Start 1: toulibre-builtin
1/4 Test #1: toulibre-builtin ....   Passed  0.00 sec
    Start 2: toulibre-dict
2/4 Test #2: toulibre-dict........   Passed  0.00 sec
    Start 3: FLOSS-dict
3/4 Test #3: FLOSS-dict ..........   Passed  0.00 sec
    Start 4: FLOSS-fail
4/4 Test #4: FLOSS-fail ..........***Failed  0.00 sec

75% tests passed, 1 tests failed out of 4

Total Test time (real) =   0.01 sec

The following tests FAILED:
      4 - FLOSS-fail (Failed)
```

Didn't you mentioned testing? II

Tailor success rule

CTest uses the return code in order to get success/failure status, but one can tailor the success/fail rule.

Didn't you mentioned testing? III

Listing 7: add CTest support

```
1  ...
2  endif(WITH_ACRODICT)
3  ...
4  enable_testing()
5  add_test(toulibre-builtin
6           Acrolibre "toulibre")
7  add_test(toulibre-dict
8           Acrodictlibre "toulibre")
9  add_test(FLOSS-dict
10          Acrodictlibre "FLOSS")
11 add_test(FLOSS-fail
12          Acrolibre "FLOSS")
13 set_tests_properties (FLOSS-fail
14          PROPERTIES
15          PASS_REGULAR_EXPRESSION
16          "Sorry, I don't know:.*FLOSS")
```

```
$ make test
Running tests...
Test project <buildtree-prefix>/build
    Start 1: toulibre-builtin
1/4 Test #1: toulibre-builtin ....   Passed  0.00 sec
    Start 2: toulibre-dict
2/4 Test #2: toulibre-dict........   Passed  0.00 sec
    Start 3: FLOSS-dict
3/4 Test #3: FLOSS-dict ..........   Passed  0.00 sec
    Start 4: FLOSS-fail
4/4 Test #4: FLOSS-fail ..........   Passed  0.00 sec

100% tests passed, 0 tests failed out of 4

Total Test time (real) =   0.01 sec
```

CTest the testing friend

CTest is a standalone generic test driver

As we will see later on, CTest is standalone application, which can run a set of test programs.

```
$ ctest -R toulibre-
Test project <build-tree>/build
    Start 1: toulibre-builtin
1/2 Test #1: toulibre-builtin .. Passed 0.00 sec
    Start 2: toulibre-dict
2/2 Test #2: toulibre-dict ..... Passed 0.00 sec

100% tests passed, 0 tests failed out of 2

Total Test time (real) =   0.01 sec
```

```
$ ctest -R FLOSS-fail -V
Test project <build-tree>
Constructing a list of tests
Done constructing a list of tests
Checking test dependency graph...
Checking test dependency graph end
test 4
    Start 4: FLOSS-fail
4: Test command: <build-tree>/Acrolibre "FLOSS"
4: Test timeout computed to be: 9.99988e+06
4: Sorry, I don't know: <FLOSS>
1/1 Test #4: FLOSS-fail ...........***Failed 0.00 sec

0% tests passed, 1 tests failed out of 1
Total Test time (real) =   0.00 sec

The following tests FAILED:
      4 - FLOSS-fail (Failed)
Errors while running CTest
```

CDash the test results publishing

Dashboard

CTest may help publishing the results of the tests on a CDash dashboard (http://www.cdash.org/) for easing collective regression testing. More on this later...

http://www.orfeo-toolbox.org/–http://dash.orfeo-toolbox.org/

Site	Build Name	Update		Configure			Build			Test				Build Time	Labels
		Files	Min	Error	Warn	Min	Error	Warn	Min	NotRun	Fail	Pass	Min		
pc-christophe.cst.cnes.fr	ArchLinux-64bits-Release	6	0.1	0	1	1.1	0	6	126	0	60 +15	2410 -15	130.6	2012-02-03T20:11:37 CET	(none)
pc-grizonnetm.cst.cnes.fr	Basic-Ubuntu10.04-64bits-Release	0	0.1	0	2	0.7	0	0	23	0	67 +2 -27	2346 +27 -2	25.2	2012-02-03T23:37:34 CET	(none)
titan	Deb50-64bits-Release	0	0	1	0	0	1	1	0	0	0	0	0	2012-02-03T20:15:19 CET	(none)
leod.c-s.fr	MacOSX10.5-Release-macport	6	0.1	0	0	1.9	0	0	72.9	0	87 +1 -1	2396 +1 -1	46.1	2012-02-03T20:42:25 CET	(none)

Summary

CMake basics

Using CMake basics we can already do a lot of things with minimal writing.

- Write simple build specification file: `CMakeLists.txt`
- Discover compilers (C, C++, Fortran)
- Build executable and library (shared or static) in a cross-platform manner
- Package the resulting binaries with CPack
- Run systematic tests with CTest and publish them with CDash

Seeking more information or help

There are several places you can go by yourself:

1. Read the FAQ:

   http://www.cmake.org/Wiki/CMake_FAQ

2. Read the Wiki:

   http://www.cmake.org/Wiki/CMake

3. Ask on the Mailing List:

   http://www.cmake.org/cmake/help/mailing.html

4. Browse the built-in help:

   `cmake --help-xxxxx`

Outline

Outline

How to discover system

System/compiler specific variables

Right after the **project** command CMake has set up a bunch of variables which can be used to tailor the build in a platform specific way.

- system specific
  - WIN32 True on Windows systems, including Win64.
  - UNIX True for UNIX and UNIX like operating systems.
  - APPLE True if running on Mac OS X.
  - CYGWIN True for Cygwin.
- compiler specific
  - MSVC True when using Microsoft Visual C
  - CMAKE_COMPILER_IS_GNU<LANG> True if the <LANG> compiler is GNU.
  - MINGW true if the compiler is MinGW.

Handle system specific code

Some functions like strcasestr (lines 6 and 7) may not be available on all platforms.

Listing 8: excerpt from acrodict.c

```
1  const acroItem_t* acrodict_get_approx(const char* name) {
2    int current =0;
3    int found   =0;
4  #ifdef GUESS_NAME
5    while ((strlen(acrodict[current].name)>0) && !found) {
6      if ((strcasestr(name,acrodict[current].name)!=0) ||
7          (strcasestr(acrodict[current].name,name)!=0)) {
8        found=1;
9      } else {
10       current++;
11     }
12   }
13   if (found) {
14     return &(acrodict[current]);
15   } else
16 #endif
17   {
18     return NULL;
19   }
20 }
```

Use system specific option

```
1  # Build option with default value to ON
2  option(WITH_ACRODICT "Include acronym dictionary support" ON)
3  if(NOT WIN32)
4    option(WITH_GUESS_NAME "Guess acronym name" ON)
5  endif(NOT WIN32)
6  ...
7  if (WITH_ACRODICT)
8     # list of sources in our library
9     set(LIBSRC acrodict.h acrodict.c)
10    if (WITH_GUESS_NAME)
11      set_source_files_properties(acrodict.c PROPERTIES COMPILE_FLAGS "-DGUESS_NAME")
12    endif(WITH_GUESS_NAME)
13    add_library(acrodict ${LIBSRC})
14 ...
```

Line 4 defines a CMake option, but not on WIN32 system. Then on line 11, if the option is set then we pass a source specific compile flags.

`cmake --help-command set_source_files_properties`

System specific in real life

Real [numeric] life project

Real projects (i.e. not the toy of this tutorial) have many parts of their `CMakeLists.txt` which deal with system/compiler specific option/feature.

- MuseScore : http://musescore.org

  http://mscore.svn.sourceforge.net/viewvc/mscore/trunk/mscore/mscore/

  Display `CMakeLists.txt` from MuseScore
- CERTI : https://savannah.nongnu.org/projects/certi/

  http://cvs.savannah.gnu.org/viewvc/certi/?root=certi
- CMake (of course): http://www.cmake.org
- LLVM: http://llvm.org/docs/CMake.html
- many more ...

What about `projectConfig.h` file? I

Project config files

Sometimes it's easier to test for features and then write a configuration file (`config.h`, `project_config.h`, ...). The CMake way to do that is to:

1. lookup system information using CMake variable, functions, macros (built-in or imported) then set various variables,
2. use the defined variable in order to write a template configuration header file
3. then use **configure_file** in order to produce the actual config file from the template.

What about `projectConfig.h` file? II

Listing 9: Excerpt from CERTI project's main `CMakeLists.txt`

```
1  # Load Checker macros
2  INCLUDE(CheckFunctionExists)
3
4  FIND_FILE(HAVE_STDINT_H NAMES stdint.h)
5  FIND_FILE(HAVE_SYS_SELECT_H NAMES select.h
6    PATH_SUFFIXES sys)
7  INCLUDE(CheckIncludeFile)
8  CHECK_INCLUDE_FILE(time.h HAVE_TIME_H)
9  FIND_LIBRARY(RT_LIBRARY rt)
10 if(RT_LIBRARY)
11   SET(CMAKE_REQUIRED_LIBRARIES ${CMAKE_REQUIRED_LIBRARIES} ${RT_LIBRARY})
12 endif(RT_LIBRARY)
13
14 CHECK_FUNCTION_EXISTS(clock_gettime HAVE_CLOCK_GETTIME)
15 CHECK_FUNCTION_EXISTS(clock_settime HAVE_CLOCK_SETTIME)
16 CHECK_FUNCTION_EXISTS(clock_getres HAVE_CLOCK_GETRES)
17 CHECK_FUNCTION_EXISTS(clock_nanosleep HAVE_CLOCK_NANOSLEEP)
18 IF (HAVE_CLOCK_GETTIME AND HAVE_CLOCK_SETTIME AND HAVE_CLOCK_GETRES)
19     SET(HAVE_POSIX_CLOCK 1)
20 ENDIF (HAVE_CLOCK_GETTIME AND HAVE_CLOCK_SETTIME AND HAVE_CLOCK_GETRES)
21 ...
22 CONFIGURE_FILE(${CMAKE_CURRENT_SOURCE_DIR}/config.h.cmake
23                 ${CMAKE_CURRENT_BINARY_DIR}/config.h)
```

What about `projectConfig.h` file? III

Excerpt from CERTI config.h.cmake

```
1   /* define if the compiler has numeric_limits<T> */
2   #cmakedefine HAVE_NUMERIC_LIMITS
3
4   /* Define to 1 if you have the <stdint.h> header file. */
5   #cmakedefine HAVE_STDINT_H 1
6
7   /* Define to 1 if you have the <stdlib.h> header file. */
8   #cmakedefine HAVE_STDLIB_H 1
9
10  /* Define to 1 if you have the <strings.h> header file. */
11  #cmakedefine HAVE_STRINGS_H 1
12  ...
13  /* Name of package */
14  #cmakedefine PACKAGE "@PACKAGE_NAME@"
15
16  /* Define to the address where bug reports for this package should be sent. */
17  #cmakedefine PACKAGE_BUGREPORT "@PACKAGE_BUGREPORT@"
18
19  /* Define to the full name of this package. */
20  #cmakedefine PACKAGE_NAME "@PACKAGE_NAME@"
21
22  /* Define to the full name and version of this package. */
23  #cmakedefine PACKAGE_STRING "@PACKAGE_NAME@-@PACKAGE_VERSION@"
```

What about `projectConfig.h` file? IV

And you get something like:

Excerpt from generated CERTI config.h

```
1   /* define if the compiler has numeric_limits<T> */
2   #define HAVE_NUMERIC_LIMITS
3
4   /* Define to 1 if you have the <stdint.h> header file. */
5   #define HAVE_STDINT_H 1
6
7   /* Define to 1 if you have the <stdlib.h> header file. */
8   #define HAVE_STDLIB_H 1
9
10  /* Define to 1 if you have the <strings.h> header file. */
11  #define HAVE_STRINGS_H 1
12  ...
13  /* Name of package */
14  /* #undef PACKAGE */
15
16  /* Define to the address where bug reports for this package should be sent. */
17  #define PACKAGE_BUGREPORT "certi-devel@nongnu.org"
18
19  /* Define to the full name of this package. */
20  #define PACKAGE_NAME "CERTI"
21
22  /* Define to the full name and version of this package. */
23  /* #undef PACKAGE_STRING */
```

Outline

The find_package command I

Finding external package

Project may be using external libraries, programs, files etc... Those can be found using the **find_package** command.

The find_package command II

Listing 10: using libxml2

```
1 find_package(LibXml2)
2 if (LIBXML2_FOUND)
3     add_definitions(-DHAVE_XML ${LIBXML2_DEFINITIONS})
4     include_directories(${LIBXML2_INCLUDE_DIR})
5 else (LIBXML2_FOUND)
6     set(LIBXML2_LIBRARIES "")
7 endif (LIBXML2_FOUND)
8 ...
9 target_link_libraries(MyTarget ${LIBXML2_LIBRARIES})
```

- Find modules usually define standard variables (for module XXX)
  1. `XXX_FOUND`: Set to false, or undefined, if we haven't found, or don't want to use `XXX`.
  2. `XXX_INCLUDE_DIRS`: The final set of include directories listed in one variable for use by client code.

The find_package command III

3. `XXX_LIBRARIES`: The libraries to link against to use `XXX`. These should include full paths.
4. `XXX_DEFINITIONS`: Definitions to use when compiling code that uses `XXX`.
5. `XXX_EXECUTABLE`: File location of the `XXX` tool's binary.
6. `XXX_LIBRARY_DIRS`: Optionally, the final set of library directories listed in one variable for use by client code.

- See doc `cmake --help-module FindLibXml2`
- Many modules are provided by CMake (130 as of CMake 2.8.7)
- You may write your own:

  http://www.cmake.org/Wiki/CMake:Module_Maintainers
- You may find/borrow modules from other projects which use CMake

The find_package command IV

- KDE4: http://websvn.kde.org/trunk/KDE/kdelibs/cmake/modules/
- PlPlot: http://plplot.svn.sourceforge.net/viewvc/plplot/trunk/cmake/modules/
- http://cmake-modules.googlecode.com/svn/trunk/Modules/
- probably many more...

- A module may provide not only CMake variables but new CMake macros (we will see that later with the MACRO, FUNCTION CMake language commands)

The other find_xxxx commands I

The find_xxx command family

find_package is a high level module finding mechanism but there are lower-level CMake commands which may be used to write find modules or anything else inside `CMakeLists.txt`

- to find an executable program: **find_program**
- to find a library: **find_library**
- to find any kind of file: **find_file**
- to find a path where a file resides: **find_path**

The other find_xxxx commands II

```
1  #- Find Prelude compiler
2  # Find the Prelude synchronous language compiler with associated includes path.
3  # See http://www.lifl.fr/~forget/prelude.html
4  # This module defines
5  #  PRELUDE_COMPILER, the prelude compiler
6  #  PRELUDE_COMPILER_VERSION, the version of the prelude compiler
7  #  PRELUDE_INCLUDE_DIR, where to find dword.h, etc.
8  #  PRELUDE_FOUND, If false, Prelude was not found.
9  # On can set PRELUDE_PATH_HINT before using find_package(Prelude) and the
10 # module with use the PATH as a hint to find preludec.
11 ...
12 if(PRELUDE_PATH_HINT)
13   message(STATUS "FindPrelude: using PATH HINT: ${PRELUDE_PATH_HINT}")
14 else()
15   set(PRELUDE_PATH_HINT)
16 endif()
17 # FIND_PROGRAM twice using NO_DEFAULT_PATH on first shot
18 find_program(PRELUDE_COMPILER NAMES preludec
19   PATHS ${PRELUDE_PATH_HINT} PATH_SUFFIXES bin
20   NO_DEFAULT_PATH
21   DOC "Path to the Prelude compiler command 'preludec'")
22 find_program(PRELUDE_COMPILER NAMES preludec
23   PATHS ${PRELUDE_PATH_HINT} PATH_SUFFIXES bin
24   DOC "Path to the Prelude compiler command 'preludec'")
```

The other find_xxxx commands III

```
25
26 if(PRELUDE_COMPILER)
27     # get the path where the prelude compiler was found
28     get_filename_component(PRELUDE_PATH ${PRELUDE_COMPILER} PATH)
29     # remove bin
30     get_filename_component(PRELUDE_PATH ${PRELUDE_PATH} PATH)
31     # add path to PRELUDE_PATH_HINT
32     list(APPEND PRELUDE_PATH_HINT ${PRELUDE_PATH})
33     execute_process(COMMAND ${PRELUDE_COMPILER} -version
34         OUTPUT_VARIABLE PRELUDE_COMPILER_VERSION
35         OUTPUT_STRIP_TRAILING_WHITESPACE)
36 endif(PRELUDE_COMPILER)
37
38 find_path(PRELUDE_INCLUDE_DIR NAMES dword.h
39           PATHS ${PRELUDE_PATH_HINT}  PATH_SUFFIXES lib/prelude
40           DOC "The␣Prelude␣include␣headers")
41 ...
42 # handle the QUIETLY and REQUIRED arguments and set PRELUDE_FOUND to TRUE if
43 # all listed variables are TRUE
44 include(FindPackageHandleStandardArgs)
45 FIND_PACKAGE_HANDLE_STANDARD_ARGS(PRELUDE
46                                   REQUIRED_VARS PRELUDE_COMPILER PRELUDE_INCLUDE_DIR)
```

Advanced use of external package I

Installed External package

The previous examples suppose that you have the package you are looking for on your host

- you did install the runtime libraries
  - you did install eventual developer libraries, headers and tools

What if the external packages:

- are only available as source (tarball, VCS repositories, ...)
- use a build system (autotools or CMake or ...)

Advanced use of external package II

ExternalProject_Add

The `ExternalProject.cmake` CMake module defines a high-level macro which does just that:

1. download/checkout source
2. update/patch
3. configure
4. build
5. install (and test)

...an external project

```
$ cmake --help-module ExternalProject
```

Outline

The different CMake "modes"

- Normal mode: the mode used when processing `CMakeLists.txt`
- Command mode: `cmake -E <command>`, command line mode which offers basic commands in a portable way:
- Process scripting mode: `cmake -P <script>`, used to execute a CMake script which is not a CMakeLists.txt filename.
- Wizard mode: `cmake -i`, interactive equivalent of the Normal mode.

The different CMake “modes”

- Normal mode: the mode used when processing `CMakeLists.txt`
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  works on all supported CMake platforms. I.e. you don't want to rely on shell or native command interpreter capabilities.
- Process scripting mode: `cmake -P <script>`, used to execute a CMake script which is not a CMakeLists.txt filename.

- Wizard mode: `cmake -i`, interactive equivalent of the Normal mode.

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  works on all supported CMake platforms. I.e. you don't want to rely on shell or native command interpreter capabilities.
- Process scripting mode: `cmake -P <script>`, used to execute a CMake script which is not a CMakeLists.txt filename.

  Not all CMake commands are scriptable!!
- Wizard mode: `cmake -i`, interactive equivalent of the Normal mode.

Command mode

Just try:

list of command mode commands

```
$ cmake -E
CMake Error: cmake version 2.8.7
Usage: cmake -E [command] [arguments ...]
Available commands:
  chdir dir cmd [args]...   - run command in a given directory
  compare_files file1 file2 - check if file1 is same as file2
  copy file destination     - copy file to destination (either file or directory)
  copy_directory source destination   - copy directory 'source' content to directory 'destination'
  copy_if_different in-file out-file  - copy file if input has changed
  echo [string]...          - displays arguments as text
  echo_append [string]...   - displays arguments as text but no new line
  environment               - display the current environment
  make_directory dir        - create a directory
  md5sum file1 [...]        - compute md5sum of files
  remove [-f] file1 file2 ... - remove the file(s), use -f to force it
  remove_directory dir      - remove a directory and its contents
  rename oldname newname    - rename a file or directory (on one volume)
  tar [cxt][vfz][cvfj] file.tar file/dir1 file/dir2 ... - create a tar archive
  time command [args] ...   - run command and return elapsed time
  touch file                - touch a file.
  touch_nocreate file       - touch a file but do not create it.
Available on UNIX only:
  create_symlink old new    - create a symbolic link new -> old
```

CMake scripting

Overview of CMake language

CMake is a declarative language which contains 90+ commands. It contains general purpose constructs: **set**, **unset**, **if**, **elseif**, **else**, **endif**, **foreach**, **while**, **break**

Remember:

```
$ cmake --help-command-list
$ cmake --help-command <command-name>
$ cmake --help-command message
cmake version 2.8.7
  message
       Display a message to the user.
         message([STATUS|WARNING|AUTHOR_WARNING|FATAL_ERROR|SEND_ERROR]
                 "message to display" ...)
       The optional keyword determines the type of message:
         (none)         = Important information
         STATUS         = Incidental information
         WARNING        = CMake Warning, continue processing
         AUTHOR_WARNING = CMake Warning (dev), continue processing
         SEND_ERROR     = CMake Error, continue but skip generation
         FATAL_ERROR    = CMake Error, stop all processing
```

Higher level commands as well

- file manipulation with **file** : READ, WRITE, APPEND, RENAME, REMOVE, MAKE_DIRECTORY
- advanced files operations: GLOB, GLOB_RECURSE file name in a path, DOWNLOAD, UPLOAD
- working with path: **file** (TO_CMAKE_PATH /TO_NATIVE_PATH ...), **get_filename_component**
- execute an external process (with stdout, stderr and return code retrieval): **execute_process**
- builtin list manipulation command: **list** with sub-commands LENGTH, GET, APPEND, FIND, APPEND, INSERT, REMOVE_ITEM, REMOVE_AT, REMOVE_DUPLICATES REVERSE, SORT
- string manipulation: **string**, upper/lower case conversion, length, comparison, substring, regular expression match, ...

Portable script for building CMake I

As an example of what can be done with pure CMake script (script mode) here is a script for building the CMake package using a previously installed CMake.

```
1  # Simple cmake script which may be used to build
2  # cmake from automatically downloaded source
3  #
4  #   cd tmp/
5  #   cmake -P CMake-autobuild-v2.cmake
6  # you should end up with a
7  #   tmp/cmake-x.y.z source tree
8  #   tmp/cmake-x.y.z-build build tree
9  # configure and compiled tree, using the tarball found on Kitware.
10
11 cmake_minimum_required(VERSION 2.8)
12 set(CMAKE_VERSION "2.8.7")
13 set(CMAKE_FILE_PREFIX "cmake-${CMAKE_VERSION}")
14 set(CMAKE_REMOTE_PREFIX "http://www.cmake.org/files/v2.8/")
15 set(CMAKE_FILE_SUFFIX ".tar.gz")
16 set(CMAKE_BUILD_TYPE "Debug")
17 set(CPACK_GEN "TGZ")
18
```

Portable script for building CMake II

```
19 set(LOCAL_FILE "./${CMAKE_FILE_PREFIX}${CMAKE_FILE_SUFFIX}")
20 set(REMOTE_FILE "${CMAKE_REMOTE_PREFIX}${CMAKE_FILE_PREFIX}${CMAKE_FILE_SUFFIX}")
21
22 message(STATUS "Trying to autoinstall CMake version ${CMAKE_VERSION} using ${
       REMOTE_FILE} file...")
23
24 message(STATUS "Downloading...")
25 if (EXISTS ${LOCAL_FILE})
26    message(STATUS "Already there: nothing to do")
27 else (EXISTS ${LOCAL_FILE})
28    message(STATUS "Not there, trying to download...")
29    file(DOWNLOAD ${REMOTE_FILE} ${LOCAL_FILE}
30         TIMEOUT 600
31         STATUS DL_STATUS
32         LOG DL_LOG
33         SHOW_PROGRESS)
34    list(GET DL_STATUS 0 DL_NOK)
35    if ("${DL_LOG}" MATCHES "404 Not Found")
36       set(DL_NOK 1)
37    endif ("${DL_LOG}" MATCHES "404 Not Found")
38    if (DL_NOK)
39       # we shall remove the file because it is created
40       # with an inappropriate content
41       file(REMOVE ${LOCAL_FILE})
42       message(SEND_ERROR "Download failed: ${DL_LOG}")
```

Portable script for building CMake III

```
43      else (DL_NOK)
44         message(STATUS "Download successful.")
45      endif (DL_NOK)
46   endif (EXISTS ${LOCAL_FILE})
47
48   message(STATUS "Unarching the file")
49   execute_process(COMMAND ${CMAKE_COMMAND} -E tar zxvf ${LOCAL_FILE}
50                   RESULT_VARIABLE UNTAR_RES
51                   OUTPUT_VARIABLE UNTAR_OUT
52                   ERROR_VARIABLE UNTAR_ERR
53                   )
54   message(STATUS "CMake version ${CMAKE_VERSION} has been unarched in ${
         CMAKE_CURRENT_SOURCE_DIR}/${CMAKE_FILE_PREFIX}.")
55
56   message(STATUS "Configuring with CMake (build type=${CMAKE_BUILD_TYPE})...")
57   file(MAKE_DIRECTORY ${CMAKE_FILE_PREFIX}-build)
58   execute_process(COMMAND ${CMAKE_COMMAND} -DCMAKE_BUILD_TYPE=${CMAKE_BUILD_TYPE} -
         DBUILD_QtDialog:BOOL=ON ../${CMAKE_FILE_PREFIX}
59                   WORKING_DIRECTORY ${CMAKE_FILE_PREFIX}-build
60                   RESULT_VARIABLE CONFIG_RES
61                   OUTPUT_VARIABLE CONFIG_OUT
62                   ERROR_VARIABLE CONFIG_ERR
63                   TIMEOUT 200)
64
65   message(STATUS "Building with cmake --build ...")
```

Portable script for building CMake IV

```
66 execute_process(COMMAND ${CMAKE_COMMAND} --build .
67                  WORKING_DIRECTORY ${CMAKE_FILE_PREFIX}-build
68                  RESULT_VARIABLE CONFIG_RES
69                  OUTPUT_VARIABLE CONFIG_OUT
70                  ERROR_VARIABLE CONFIG_ERR)
71
72 message(STATUS "Create package ${CPACK_GEN} with CPack...")
73 execute_process(COMMAND ${CMAKE_CPACK_COMMAND} -G ${CPACK_GEN}
74                  WORKING_DIRECTORY ${CMAKE_FILE_PREFIX}-build
75                  RESULT_VARIABLE CONFIG_RES
76                  OUTPUT_VARIABLE CONFIG_OUT
77                  ERROR_VARIABLE CONFIG_ERR)
78 message(STATUS "CMake version ${CMAKE_VERSION} has been built in ${
       CMAKE_CURRENT_SOURCE_DIR}/${CMAKE_FILE_PREFIX}.")
79 string(REGEX MATCH "CPack: - package: (.*) generated" PACKAGES "${CONFIG_OUT}")
80 message(STATUS "CMake package(s) are: ${CMAKE_MATCH_1}")
```

Build specific commands

- create executable or library: **add_executable**, **add_library**
- add compiler/linker definitions/options: add_definition , **include_directories** , **target_link_libraries**
- powerful installation specification: **install**
- probing command: **try_compile**, **try_run**
- fine control of various properties: **set_target_properties** , **set_source_files_properties** , **set_directory_properties** , **set_tests_properties** : 190+ different properties may be used.

```
$ cmake --help-property-list
$ cmake --help-property COMPILE_FLAGS
```

Outline

What are CMake targets?

CMake target

Many times in the documentation you may read about CMake target. A target is something that CMake should build (i.e. generate something enabling the building of the target).
A CMake target has dependencies and properties.

1. Executables are targets: **add_executable**
2. Libraries are targets: **add_library**
3. There exist some builtin targets: `install`, `clean`, `package`, ...
4. You may create custom targets: **add_custom_target**

Target dependencies and properties I

A CMake target has dependencies and properties.

Dependencies

Most of the time, source dependencies are computed from target specifications using CMake builtin dependency scanner (C, C++, Fortran) whereas library dependencies are inferred via **target_link_libraries** specification.

If this is not enough then one can use **add_dependencies**, or some properties.

Target dependencies and properties II

Properties

Properties may be attached to either target or source file (or even test). They may be used to tailor the prefix or suffix to be used for libraries, compile flags, link flags, linker language, shared libraries version, ...

see : **set_target_properties** or **set_source_files_properties**

Sources vs Targets

Properties set to a target like COMPILE_FLAGS are used for all sources of the concerned target. Properties set to a source are used for the source file itself (which may be involved in several targets).

Custom targets and commands

Custom

Custom targets and custom commands are a way to create a target which may be used to execute arbitrary commands at Build time.

- for target : **add_custom_target**
- for command : **add_custom_command**, in order to add some custom build step to another (existing) target.

This is usually for: generating source files (Flex, Bison) or other files derived from source like embedded documentation (Doxygen), ...

Outline

Generated files

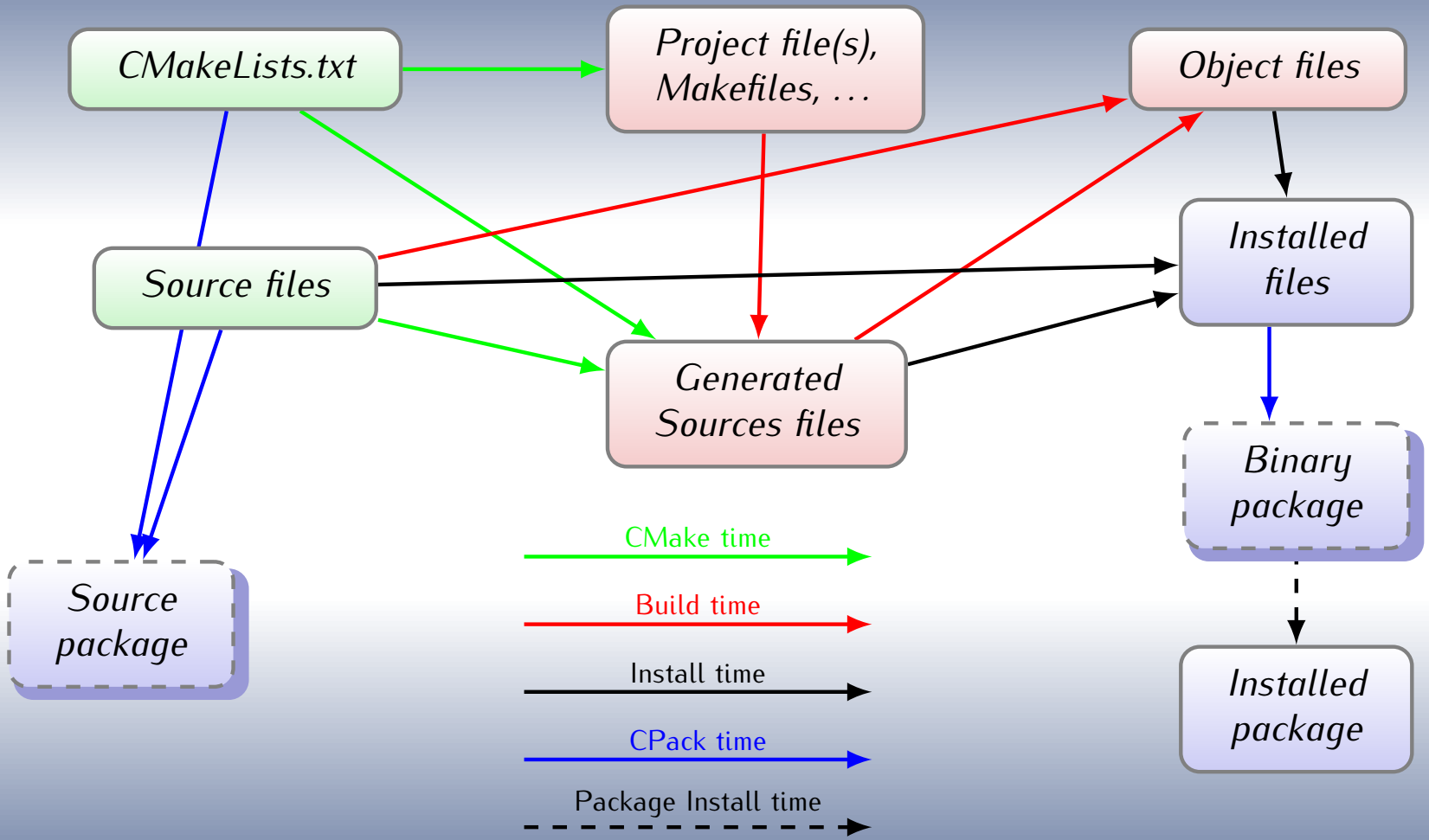
List all the sources

CMake advocates to specify all the source files explicitly (i.e. do not use **file** (GLOB ...)) This is the only way to keep robust dependencies. Moreover you usually already need to do that when using a VCS (CVS, Subversion, Git, hg,...).

However some files may be generated during the build (using add_custom_xxx), in which case you must tell CMake that they are GENERATED files using:

```
1 set_source_files_properties(${SOME_GENERATED_FILES}
2                             PROPERTIES GENERATED TRUE)
```

The CMake workflow (pictured)



Example I

```
1  ### Handle Source generation for task file parser
2  include_directories(${CMAKE_CURRENT_SOURCE_DIR})
3  find_package(LexYacc)
4  set(YACC_SRC                ${CMAKE_CURRENT_SOURCE_DIR}/lsmc_taskfile_syntax.yy)
5  set(YACC_OUT_PREFIX         ${CMAKE_CURRENT_BINARY_DIR}/y.tab)
6  set(YACC_WANTED_OUT_PREFIX  ${CMAKE_CURRENT_BINARY_DIR}/lsmc_taskfile_syntax)
7  set(LEX_SRC                 ${CMAKE_CURRENT_SOURCE_DIR}/lsmc_taskfile_tokens.ll)
8  set(LEX_OUT_PREFIX          ${CMAKE_CURRENT_BINARY_DIR}/lsmc_taskfile_tokens_yy)
9  set(LEX_WANTED_OUT_PREFIX   ${CMAKE_CURRENT_BINARY_DIR}/lsmc_taskfile_tokens)
10
11 #Exec Lex
12 add_custom_command(
13    OUTPUT  ${LEX_WANTED_OUT_PREFIX}.c
14    COMMAND ${LEX_PROGRAM} ARGS -I -o${LEX_WANTED_OUT_PREFIX}.c ${LEX_SRC}
15    DEPENDS ${LEX_SRC}
16    )
17 set(GENERATED_SRCS ${GENERATED_SRCS} ${LEX_WANTED_OUT_PREFIX}.c)
18 #Exec Yacc
19 add_custom_command(
20    OUTPUT  ${YACC_WANTED_OUT_PREFIX}.c ${YACC_WANTED_OUT_PREFIX}.h
21    COMMAND ${YACC_PROGRAM} ARGS ${YACC_COMPAT_ARG} -d ${YACC_SRC}
22    COMMAND ${CMAKE_COMMAND} -E copy ${YACC_OUT_PREFIX}.h  ${YACC_WANTED_OUT_PREFIX}.h
23    COMMAND ${CMAKE_COMMAND} -E copy ${YACC_OUT_PREFIX}.c  ${YACC_WANTED_OUT_PREFIX}.c
24    DEPENDS ${YACC_SRC}
```

Example II

```
25      )
26  set(GENERATED_SRCS ${GENERATED_SRCS}
27      ${YACC_WANTED_OUT_PREFIX}.c ${YACC_WANTED_OUT_PREFIX}.h)
28  # Tell CMake that some file are generated
29  set_source_files_properties(${GENERATED_SRCS} PROPERTIES GENERATED TRUE)
30
31  # Inhibit compiler warning for LEX/YACC generated files
32  # Note that the inhibition is COMPILER dependent ...
33  # GNU CC specific warning stop
34  if (CMAKE_COMPILER_IS_GNUCC)
35     message(STATUS "INHIBIT␣Compiler␣warning␣for␣LEX/YACC␣generated␣files")
36     SET_SOURCE_FILES_PROPERTIES(${YACC_WANTED_OUT_PREFIX}.c ${YACC_WANTED_OUT_PREFIX}.h
37                                 PROPERTIES COMPILE_FLAGS "-w")
38
39     SET_SOURCE_FILES_PROPERTIES(${LEX_WANTED_OUT_PREFIX}.c
40                                 PROPERTIES COMPILE_FLAGS "-w")
41  endif(CMAKE_COMPILER_IS_GNUCC)
42  ...
43  set(LSCHED_SRC
44      lsmc_dependency.c  lsmc_core.c  lsmc_utils.c
45      lsmc_time.c lsmc_taskfile_parser.c
46      ${GENERATED_SRCS})
47  add_library(lsmc ${LSCHED_SRC})
```

Outline

Outline

Cross-compiling

Definition: Cross-compiling

Cross-compiling is when the host system, the one the compiler is running on, is not the same as the target system, the one the compiled program will be running on.

CMake can handle cross-compiling using a Toolchain description file, see
http://www.cmake.org/Wiki/CMake_Cross_Compiling.

```
1  mkdir build-win32
2  cd build-win32
3  cmake -DCMAKE_TOOLCHAIN_FILE=../totally-free/Toolchain-cross-mingw32-linux.cmake ../totally-free/
```

Demo

Linux to Win32 Toolchain example

```
1  # the name of the target operating system
2  SET(CMAKE_SYSTEM_NAME Windows)
3  # Choose an appropriate compiler prefix
4  # for classical mingw32 see http://www.mingw.org/
5  #set(COMPILER_PREFIX "i586-mingw32msvc")
6  # for 32 or 64 bits mingw-w64 see http://mingw-w64.sourceforge.net/
7  set(COMPILER_PREFIX "i686-w64-mingw32")
8  #set(COMPILER_PREFIX "x86_64-w64-mingw32"
9
10 # which compilers to use for C and C++
11 find_program(CMAKE_RC_COMPILER NAMES ${COMPILER_PREFIX}-windres)
12 #SET(CMAKE_RC_COMPILER ${COMPILER_PREFIX}-windres)
13 find_program(CMAKE_C_COMPILER NAMES ${COMPILER_PREFIX}-gcc)
14 #SET(CMAKE_C_COMPILER ${COMPILER_PREFIX}-gcc)
15 find_program(CMAKE_CXX_COMPILER NAMES ${COMPILER_PREFIX}-g++)
16 #SET(CMAKE_CXX_COMPILER ${COMPILER_PREFIX}-g++)
17
18 # here is the target environment located
19 SET(USER_ROOT_PATH /home/erk/erk-win32-dev)
20 SET(CMAKE_FIND_ROOT_PATH  /usr/${COMPILER_PREFIX} ${USER_ROOT_PATH})
21 # adjust the default behaviour of the FIND_XXX() commands:
22 # search headers and libraries in the target environment, search
23 # programs in the host environment
24 set(CMAKE_FIND_ROOT_PATH_MODE_PROGRAM NEVER)
25 set(CMAKE_FIND_ROOT_PATH_MODE_LIBRARY ONLY)
26 set(CMAKE_FIND_ROOT_PATH_MODE_INCLUDE ONLY)
```

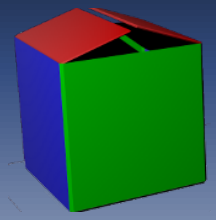
Outline

Exporting/Import your project

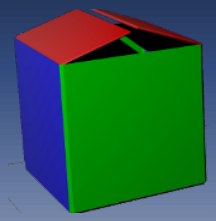
Export/Import to/from others

CMake can help a project using CMake as a build system to export/import targets to/from another project using CMake as a build system.

No more time for that today sorry, see:
http://www.cmake.org/Wiki/CMake/Tutorials/Exporting_and_Importing_Targets



Outline

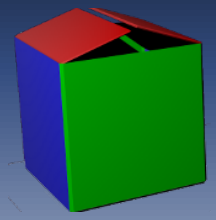


Introduction

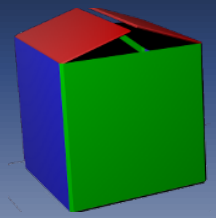
A Package generator

In the same way that CMake generates build files, CPack generates package files.

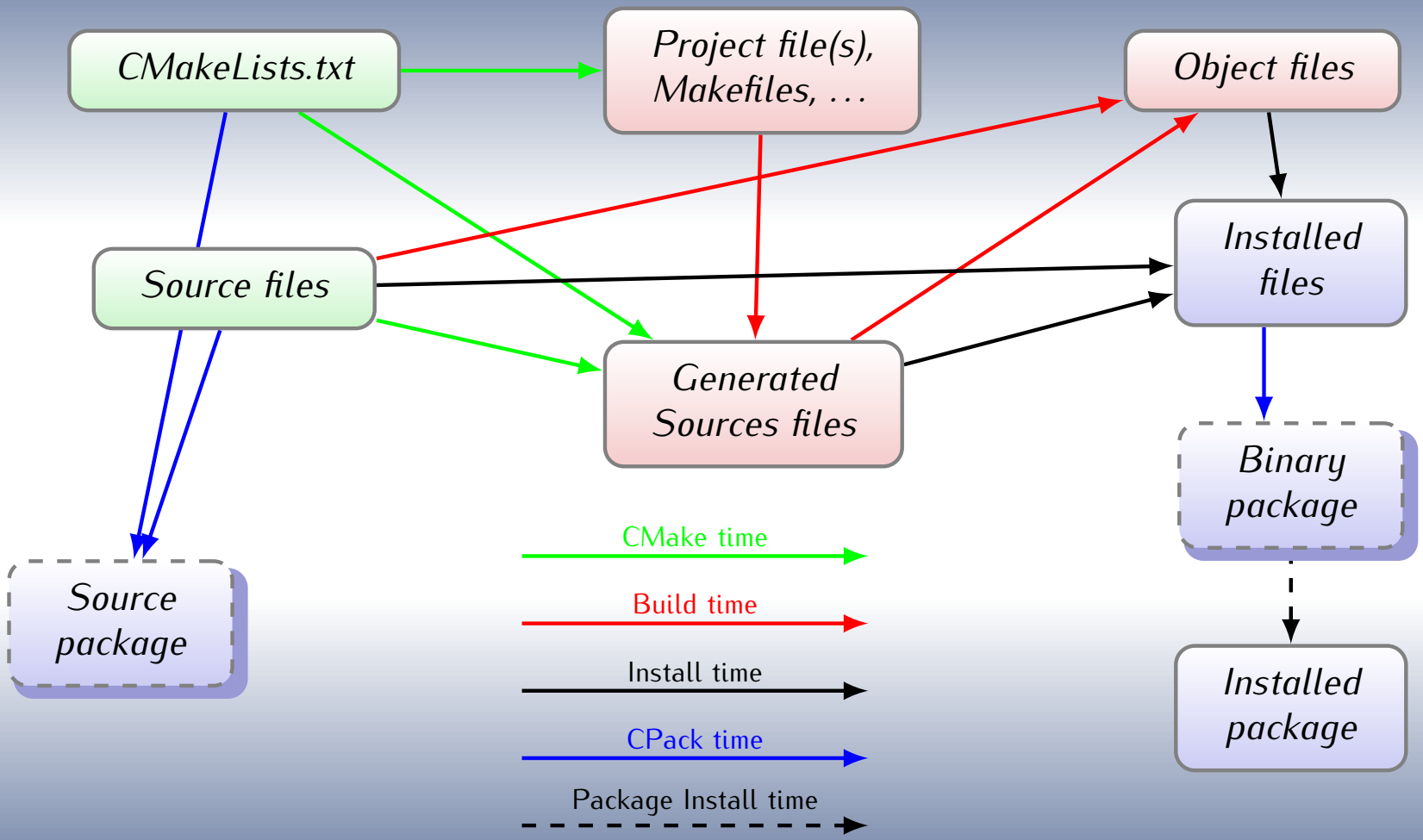
- Archive generators [ZIP,TGZ,...] (All platforms)
- DEB, RPM (Linux)
- Cygwin Source or Binary (Windows/Cygwin)
- NSIS (Windows, Linux)
- DragNDrop, Bundle, OSXX11 (Mac OS)

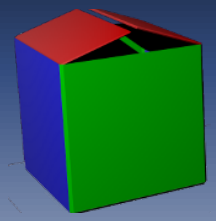


Outline



The CMake workflow (pictured)





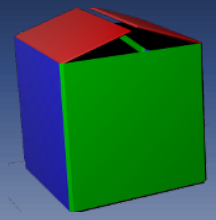
The CPack application

CPack standalone

CPack is a standalone application whose behavior is driven by a configuration file e.g. `CPackConfig.cmake`. This file is a CMake language script which defines CPACK_XXXX variables: the config parameters of the CPack run.

CPack with CMake

When CPack is used to package a project built with CPack, then the CPack configuration is usually generated by CMake by including `CPack.cmake` in the main `CMakeLists.txt`:
include(CPack)

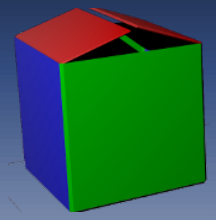


CPack variables in CMakeLists.txt

When used with CMake, one writes something like this in CMakeLists.txt:

```
1  set(CPACK_GENERATOR "TGZ")
2  if (WIN32)
3      list(APPEND CPACK_GENERATOR "NSIS")
4  elseif (APPLE)
5      list(APPEND CPACK_GENERATOR "Bundle")
6  endif(WIN32)
7  set(CPACK_SOURCE_GENERATOR "ZIP;TGZ")
8  set(CPACK_PACKAGE_VERSION_MAJOR 0)
9  set(CPACK_PACKAGE_VERSION_MINOR 1)
10 set(CPACK_PACKAGE_VERSION_PATCH 0)
11 include(CPack)
```

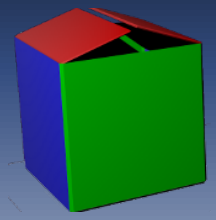
This will create CPackSourceConfig.cmake and CPackConfig.cmake in the build tree and will bring you the package and package_source built-in targets.



A CPack config file I

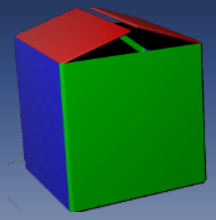
A CPack config file looks like this one:

```
1  # This file will be configured to contain variables for CPack.
2  # These variables should be set in the CMake list file of the
3  # project before CPack module is included.
4  ...
5  SET(CPACK_BINARY_BUNDLE "")
6  SET(CPACK_BINARY_CYGWIN "")
7  SET(CPACK_BINARY_DEB "")
8  ...
9  SET(CPACK_BINARY_ZIP "")
10 SET(CPACK_CMAKE_GENERATOR "Unix Makefiles")
11 SET(CPACK_GENERATOR "TGZ")
12 SET(CPACK_INSTALL_CMAKE_PROJECTS "/home/erk/erkit/CMakeTutorial/
       examples/build;TotallyFree;ALL;/")
13 SET(CPACK_INSTALL_PREFIX "/usr/local")
14 SET(CPACK_MODULE_PATH "")
15 SET(CPACK_NSIS_DISPLAY_NAME "TotallyFree 0.1.0")
```



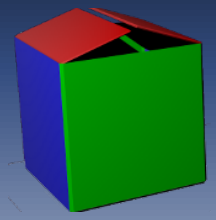
A CPack config file II

```
16 SET(CPACK_NSIS_INSTALLER_ICON_CODE "")
17 SET(CPACK_NSIS_INSTALL_ROOT "$PROGRAMFILES")
18 SET(CPACK_NSIS_PACKAGE_NAME "TotallyFree 0.1.0")
19 SET(CPACK_OUTPUT_CONFIG_FILE "/home/erk/erkit/CMakeTutorial/
       examples/build/CPackConfig.cmake")
20 SET(CPACK_PACKAGE_DEFAULT_LOCATION "/")
21 SET(CPACK_PACKAGE_DESCRIPTION_FILE "/home/erk/CMake/cmake-Verk-
       HEAD/share/cmake-2.8/Templates/CPack.GenericDescription.txt
       ")
22 SET(CPACK_PACKAGE_DESCRIPTION_SUMMARY "TotallyFree built using
       CMake")
23 SET(CPACK_PACKAGE_FILE_NAME "TotallyFree-0.1.0-Linux")
24 SET(CPACK_PACKAGE_INSTALL_DIRECTORY "TotallyFree 0.1.0")
25 SET(CPACK_PACKAGE_INSTALL_REGISTRY_KEY "TotallyFree 0.1.0")
26 SET(CPACK_PACKAGE_NAME "TotallyFree")
27 SET(CPACK_PACKAGE_RELOCATABLE "true")
28 SET(CPACK_PACKAGE_VENDOR "Humanity")
29 SET(CPACK_PACKAGE_VERSION "0.1.0")
```



A CPack config file III

```
30 SET(CPACK_RESOURCE_FILE_LICENSE "/home/erk/CMake/cmake-Verk-HEAD
       /share/cmake-2.8/Templates/CPack.GenericLicense.txt")
31 SET(CPACK_RESOURCE_FILE_README "/home/erk/CMake/cmake-Verk-HEAD/
       share/cmake-2.8/Templates/CPack.GenericDescription.txt")
32 SET(CPACK_RESOURCE_FILE_WELCOME "/home/erk/CMake/cmake-Verk-HEAD
       /share/cmake-2.8/Templates/CPack.GenericWelcome.txt")
33 SET(CPACK_SET_DESTDIR "OFF")
34 SET(CPACK_SOURCE_CYGWIN "")
35 SET(CPACK_SOURCE_GENERATOR "TGZ;TBZ2;TZ")
36 SET(CPACK_SOURCE_OUTPUT_CONFIG_FILE "/home/erk/erkit/
       CMakeTutorial/examples/build/CPackSourceConfig.cmake")
37 SET(CPACK_SOURCE_TBZ2 "ON")
38 SET(CPACK_SOURCE_TGZ "ON")
39 SET(CPACK_SOURCE_TZ "ON")
40 SET(CPACK_SOURCE_ZIP "OFF")
41 SET(CPACK_SYSTEM_NAME "Linux")
42 SET(CPACK_TOPLEVEL_TAG "Linux")
```



CPack running steps I

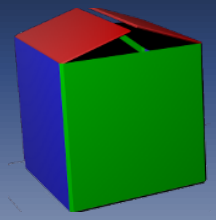
For a CMake enabled project one can run CPack in two ways:

1. use the build tool to run targets: `package` or `package_source`
2. invoke CPack manually from within the build tree e.g.:

```
$ cpack -G RPM
```

Currently cpack has [almost] no builtin documentation support besides `cpack --help` (work is underway though), thus the best CPack documentation is currently found on the Wiki:

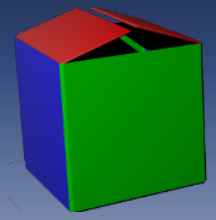
- http://www.cmake.org/Wiki/CMake:CPackConfiguration
- http://www.cmake.org/Wiki/CMake:CPackPackageGenerators
- http://www.cmake.org/Wiki/CMake:Component_Install_With_CPack



CPack running steps II

Whichever way you call it, the CPack steps are:

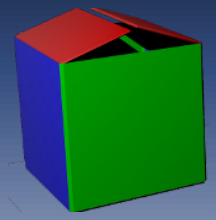
1. cpack command starts and parses arguments etc...
2. it reads `CPackConfig.cmake` (usually found in the build tree) or the file given as an argument to `--config` command line option.
3. it iterates over the generators list found in `CPACK_GENERATOR` (or from `-G` command line option). For each generator:
   3. (re)sets `CPACK_GENERATOR` to the one currently being iterated over
   3. includes the `CPACK_PROJECT_CONFIG_FILE`
   3. installs the project into a CPack private location (using `DESTDIR`)
   3. calls the generator and produces the package(s) for that generator



CPack running steps III

cpack command line example

```
1  $ cpack -G "TGZ;RPM"
2  CPack: Create package using TGZ
3  CPack: Install projects
4  CPack: - Run preinstall target for: TotallyFree
5  CPack: - Install project: TotallyFree
6  CPack: Create package
7  CPack: - package: <...>/build/TotallyFree-0.1.0-Linux.tar.gz generated.
8  CPack: Create package using RPM
9  CPack: Install projects
10 CPack: - Run preinstall target for: TotallyFree
11 CPack: - Install project: TotallyFree
12 CPack: Create package
13  CPackRPM: Will use GENERATED spec file: <...>/build/_CPack_Packages/Linux/RPM/SPECS/totallyfree.spec
14 CPack: - package: <...>/build/TotallyFree-0.1.0-Linux.rpm generated.
15 $
```



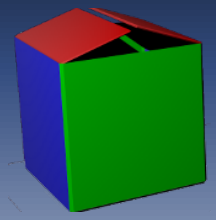
CPack running steps IV

make package example

```
1  $ make package
2  [ 33%] Built target acrodict
3  [ 66%] Built target Acrodictlibre
4  [100%] Built target Acrolibre
5  Run CPack packaging tool...
6  CPack: Create package using TGZ
7  CPack: Install projects
8  CPack: - Run preinstall target for: TotallyFree
9  CPack: - Install project: TotallyFree
10 CPack: Create package
11 CPack: - package: <...>/build/TotallyFree-0.1.0-Linux.tar.gz generated.
```

Rebuild project

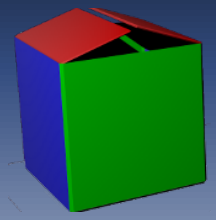
In the `make package` case CMake is checking that the project does not need a rebuild.



CPack running steps V

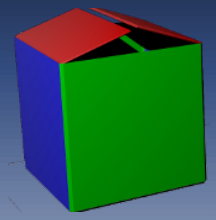
make package_source example

```
1  $ make package_source
2  make package_source
3  Run CPack packaging tool for source...
4  CPack: Create package using TGZ
5  CPack: Install projects
6  CPack: - Install directory: <...>/totally-free
7  CPack: Create package
8  CPack: - package: <...>/build/TotallyFree-0.1.0-Source.tar.gz generated.
9  CPack: Create package using TBZ2
10 CPack: Install projects
11 CPack: - Install directory: <...>/totally-free
12 CPack: Create package
13 CPack: - package: <...>/build/TotallyFree-0.1.0-Source.tar.bz2 generated.
14 CPack: Create package using TZ
15 CPack: Install projects
16 CPack: - Install directory: <...>/totally-free
```



CPack running steps VI

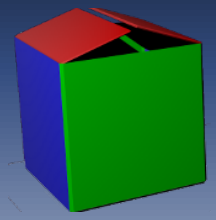
```
17  CPack: Create package
18  CPack: - package: <...>/build/TotallyFree-0.1.0-Source.tar.Z generated.
```



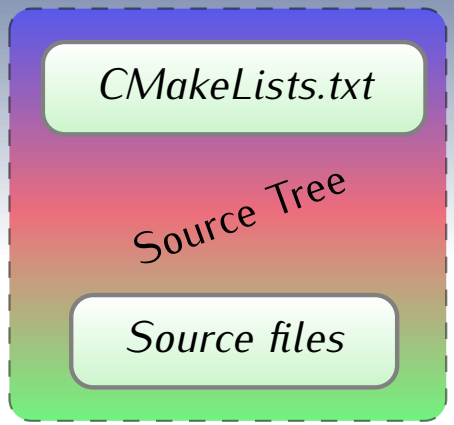
The CPack workflow (pictured)

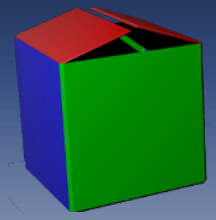
CMakeLists.txt

Source files

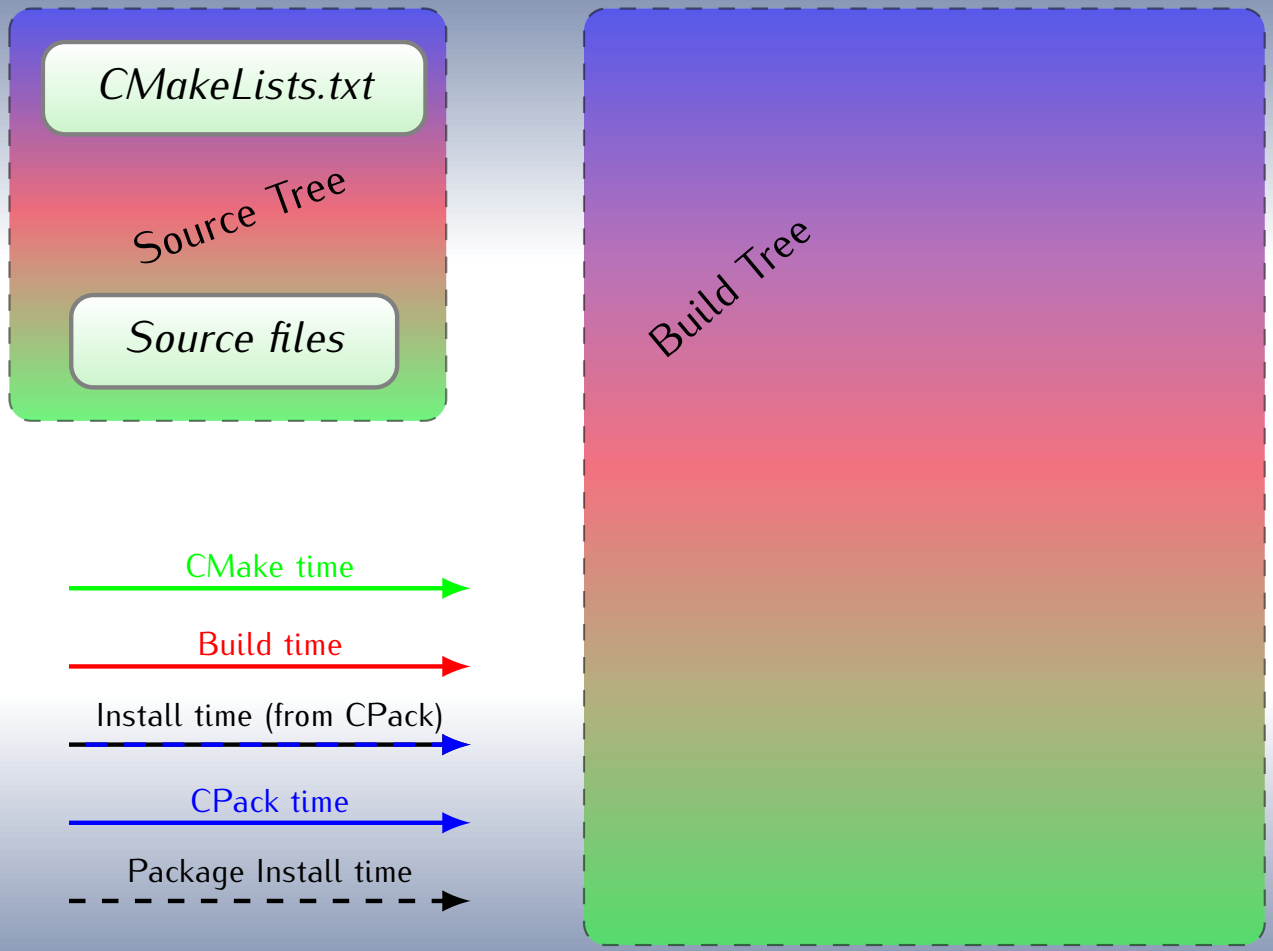


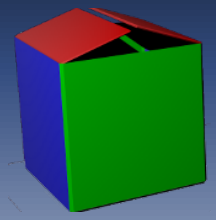
The CPack workflow (pictured)



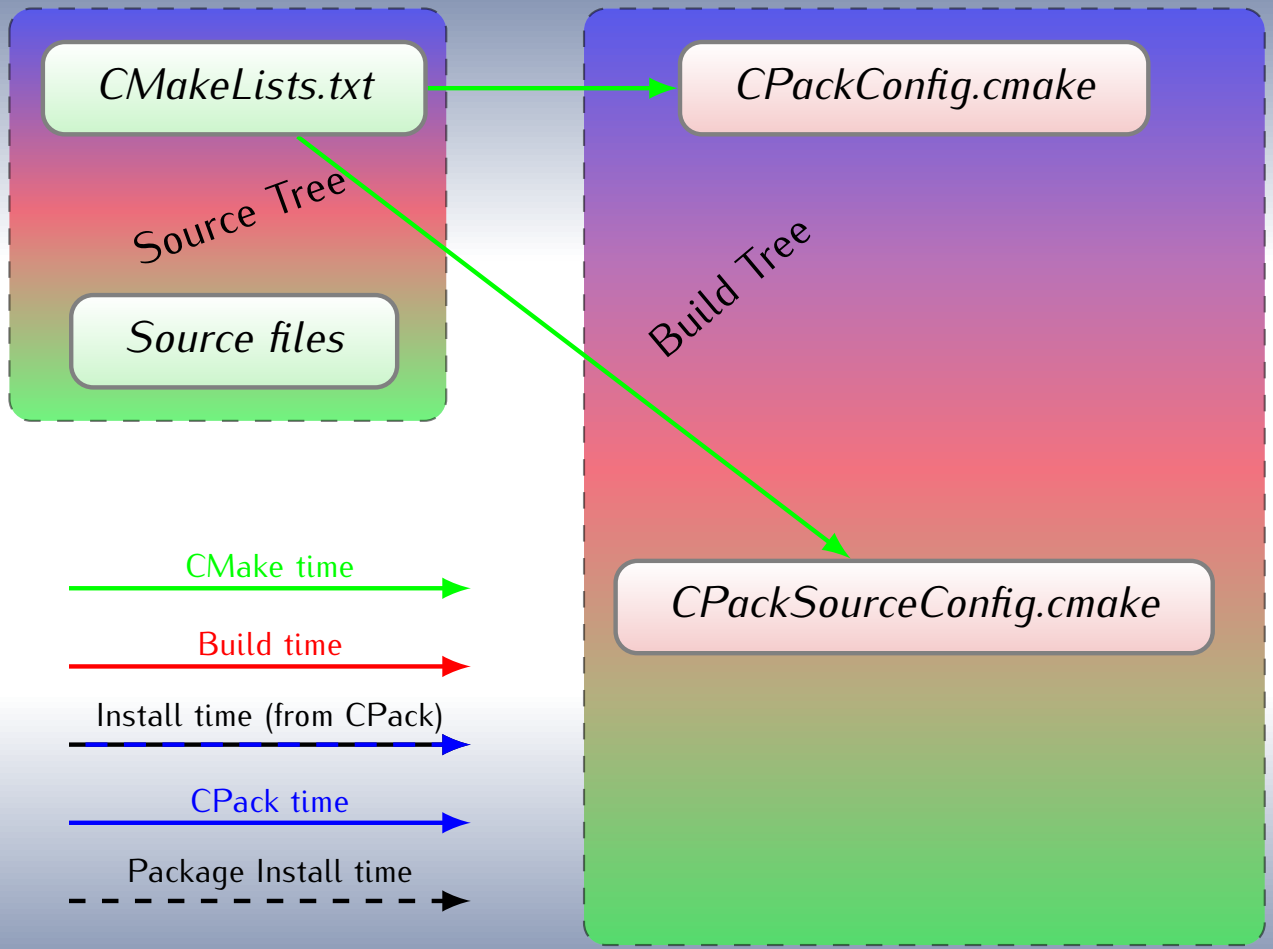


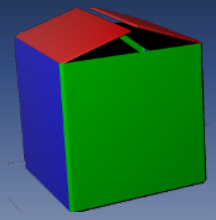
The CPack workflow (pictured)





The CPack workflow (pictured)





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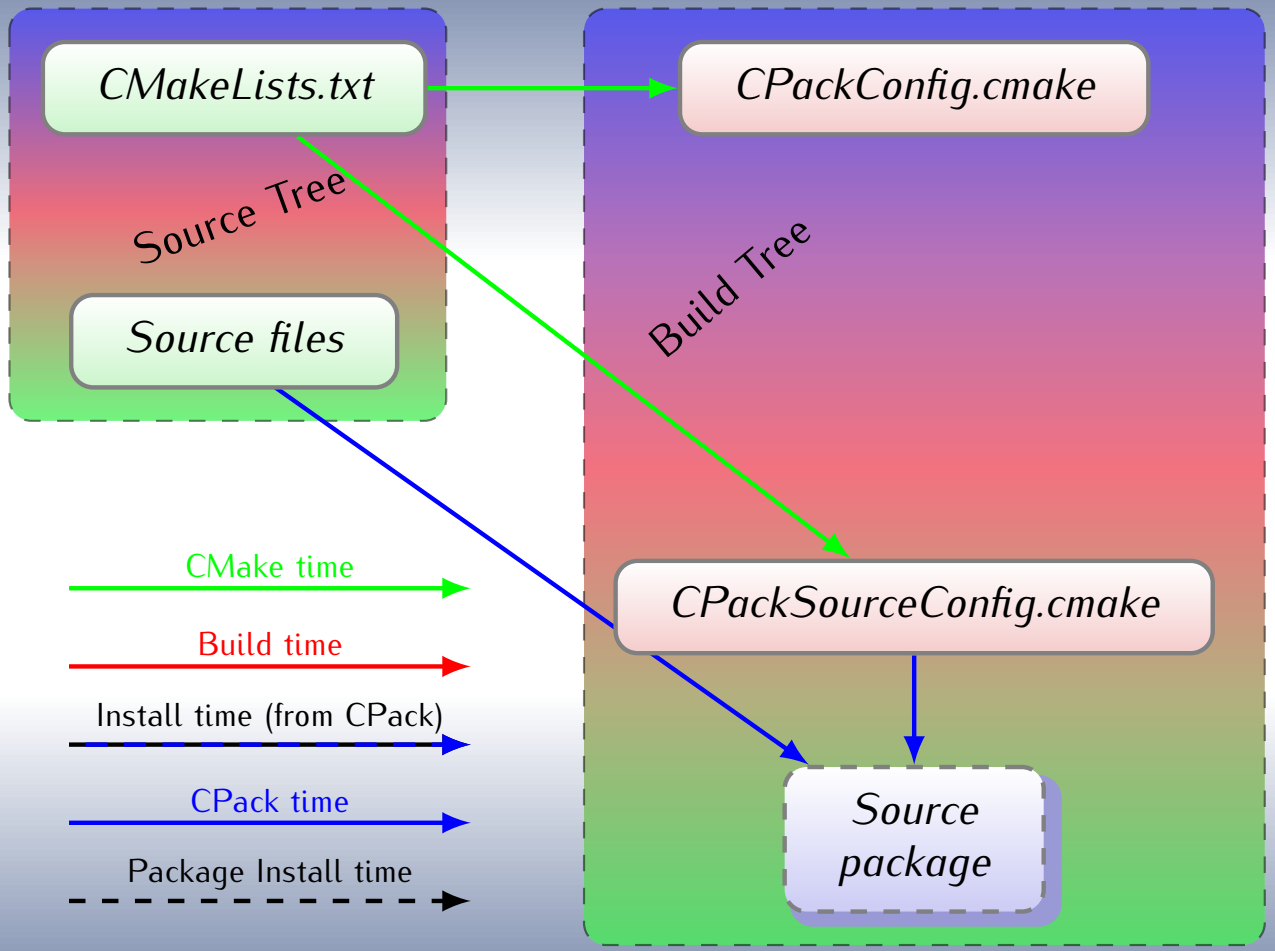
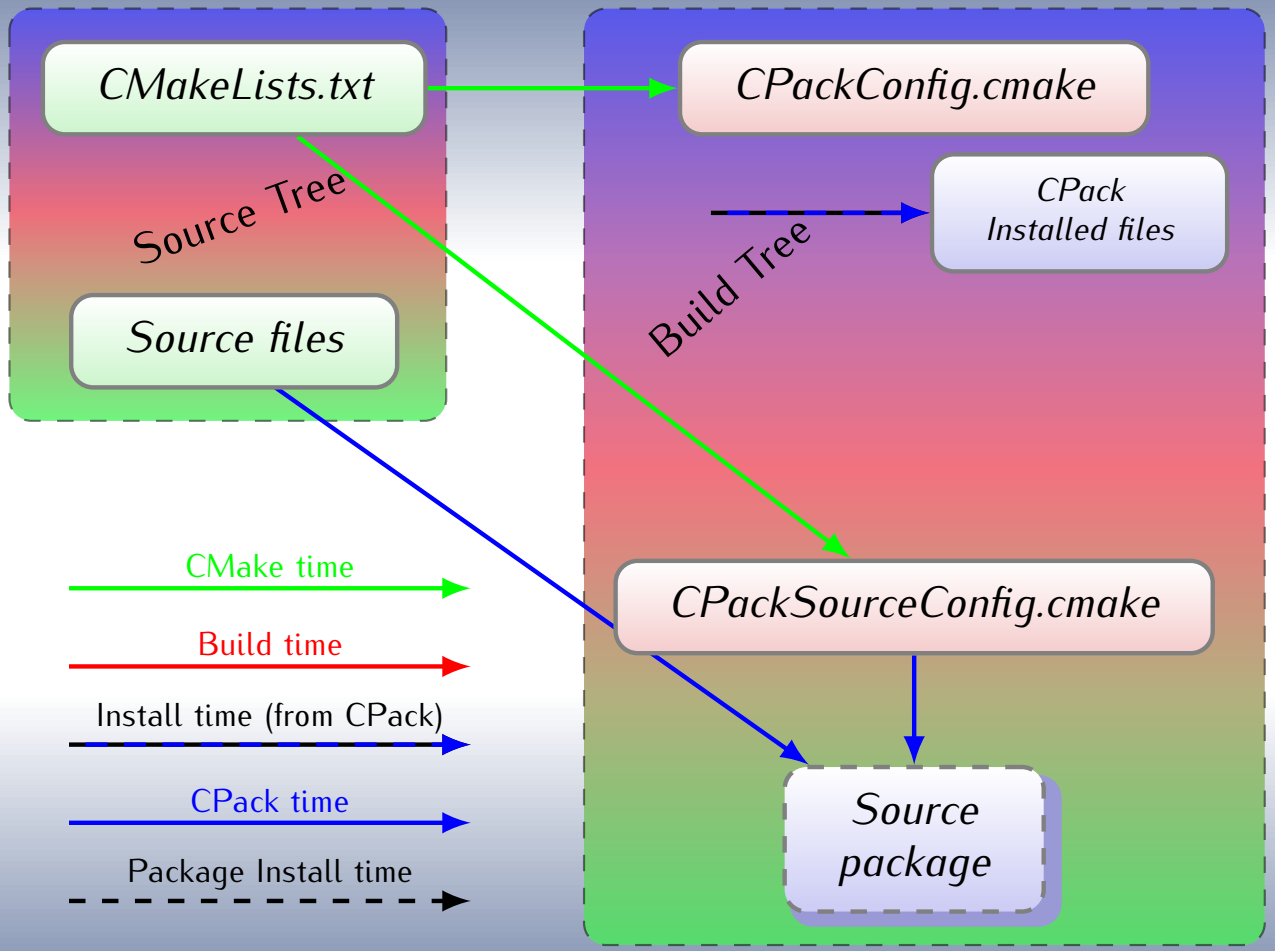
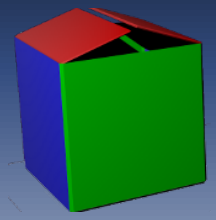
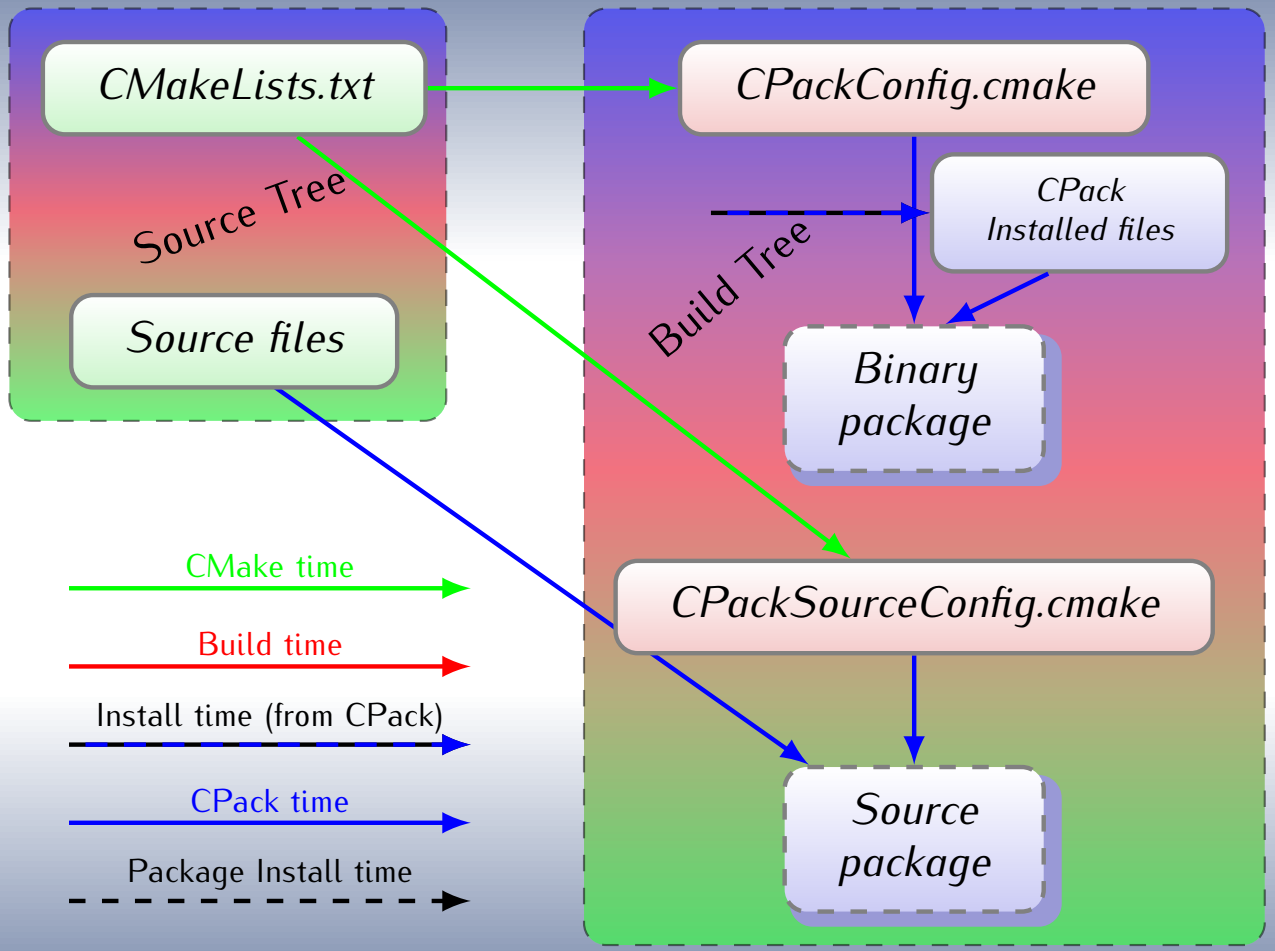


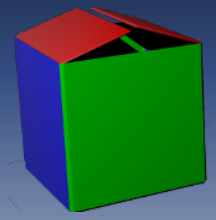
The CPack workflow (pictured)



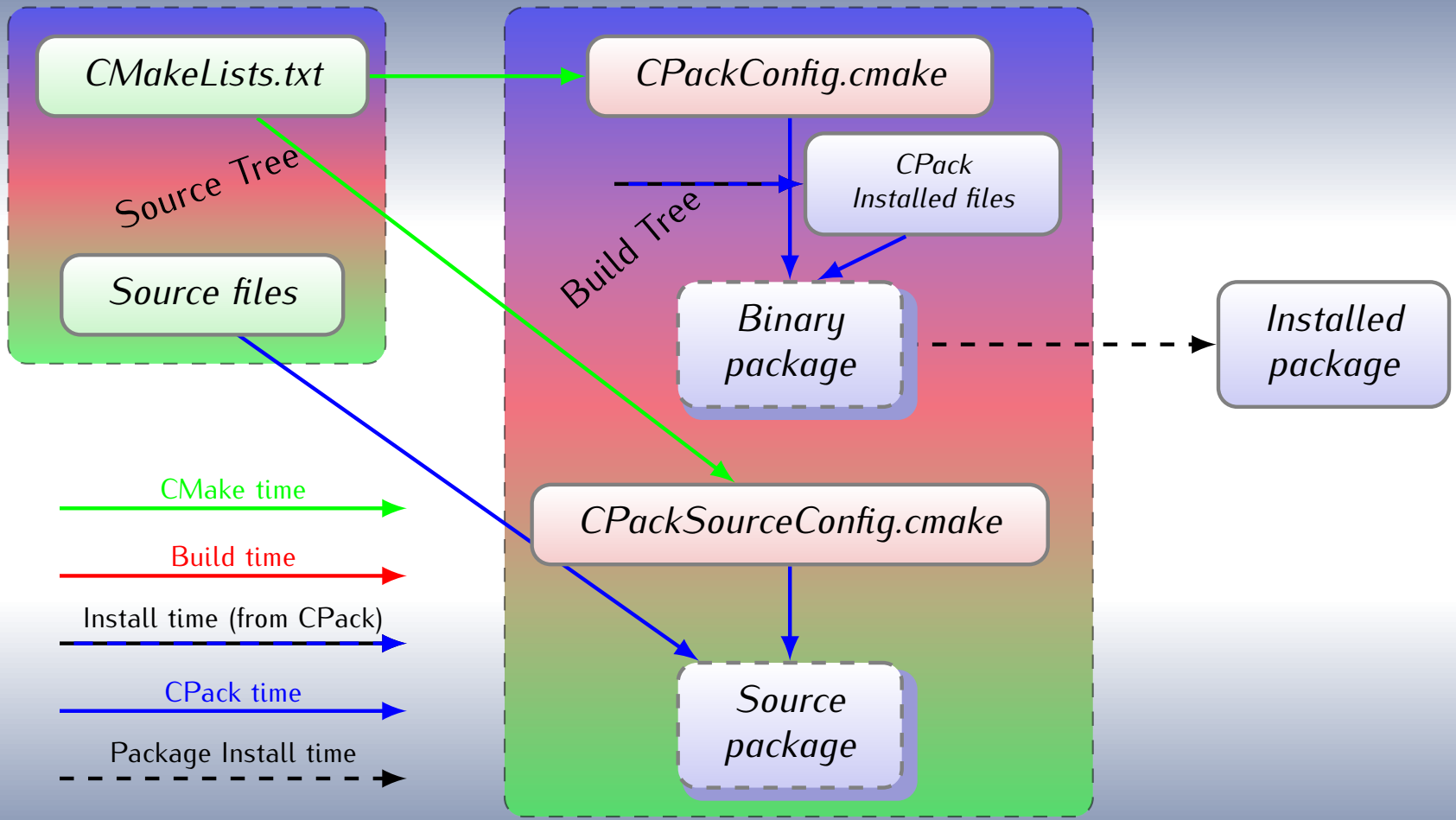


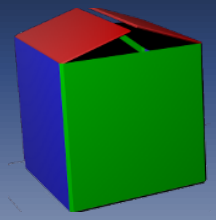
The CPack workflow (pictured)





The CPack workflow (pictured)





Source vs Binary Generators

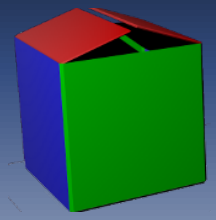
CPack does not really distinguish “source” from “binaries”!!

CPack source package

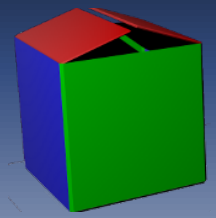
The CPack configuration file is: `CPackSourceConfig.cmake`. The CPack source generator is essentially packaging directories with install, exclude and include rules.

CPack binary package

The CPack configuration file is: `CPackConfig.cmake`. Moreover CPack knows that a project is built with CMake and inherits many properties from the install rules found in the project.



Outline



Archive Generators

A family of generators

The archive generators is a family of generators which is supported on all CMake supported platforms through `libarchive`: http://code.google.com/p/libarchive/.

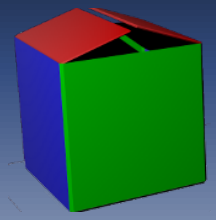
STGZ Self extracting Tar GZip compression

TBZ2 Tar BZip2 compression

TGZ Tar GZip compression

TZ Tar Compress compression

ZIP Zip archive



Linux-friendly generators

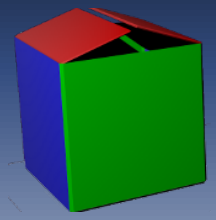
- Tar-kind archive generators
- Binary RPM: only needs `rpmbuild` to work.
- Binary DEB: works on any Linux distros.

CPack vs native tools

One could argue "why use CPack for building .deb or .rpm". The primary target of CPack RPM and DEB generators are people who are NOT professional packagers. Those people can get a clean package without too much effort and get a better package than a bare TAR archive.

No official packaging replacement

Those generators are no replacement for official packaging tools.

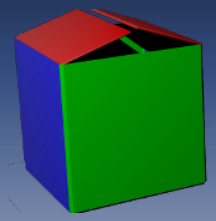


Windows-friendly generators

- Zip archive generator
- NullSoft System Installer generator (http://nsis.sourceforge.net/

  Supports component installation, produces nice GUI installer.
- MSI installer requested:

  http://public.kitware.com/Bug/view.php?id=11575.
- Cygwin: Binary and Source generators.



Mac OS-friendly generators

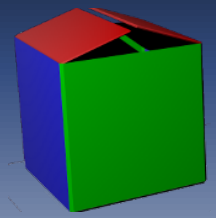
- Tar-kind archive generators
- DragNDrop
- PackageMaker
- Bundle
- OSXX11

Don't ask me

I'm not a Mac OS user and I don't know them. Go and read the Wiki or ask on the ML.

http://www.cmake.org/Wiki/CMake:CPackPackageGenerators

http://www.cmake.org/cmake/help/mailing.html

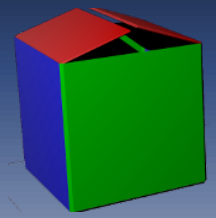


Packaging Components I

CMake+CPack installation components?

Sometimes you want to split the installer into components.

1. Use `COMPONENT` argument in your install rules (in the CMakeLists.txt),
2. Add some more [CPack] information about how to group components,
3. Choose a component-aware CPack generator
4. Choose the behavior (1 package file per component, 1 package file per group, etc...)
5. Possibly specify generator specific behavior in `CPACK_PROJECT_CONFIG_FILE`
6. Run CPack.

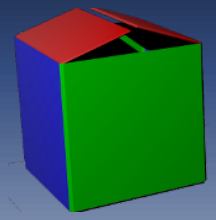


Packaging Components II

demo with ComponentExample

More detailed documentation here:

http://www.cmake.org/Wiki/CMake:Component_Install_With_CPack



Packaging Components III

Component aware generator

- Not all generators do support components

  (i.e. they are `MONOLITHIC`)
- Some produce a single package file containing all components.

  (e.g. NSIS)
- Others produce several package files containing one or several components.

  (e.g. ArchiveGenerator, RPM, DEB)

Outline

Outline

More to come on CTest/CDash

Sorry...out of time!!

CMake and its friends are so much fun and powerful that I ran out of time to reach a detailed presentation of CTest/CDash, stay tuned for next time...

In the meantime:

- Go there: http://www.cdash.org
- Open your own (free) Dashboard: http://my.cdash.org/
- CDash 2.0 should be released in the next few weeks (mid-february)
- A course on CMake/CTest/CDash in Lyon on April, 2 2012 (http://formations.kitware.fr)

Outline

References I

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