CMake as a Build System for DUNE

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Autotools build system

dunecontrol provides an easy way of building DUNE modules

1. dunecontrol autogen: prepares modules for configure
2. dunecontrol configure: configures modules
3. dunecontrol make: builds modules.

Works on Linux/Unix, Mac and partly on Windows (Cygwin)

Uses several tools: autoconf, automake, libtool, make files, etc.

Why CMake? from a user perspective

- building is a two step procedure:
  - configuration using CMake for the generator: cmake /source/path
  - building using the generators, e. g. make, ninja-build
- generate projects for Xcode, KDevelop, Code::Blocks, Eclipse/CDT, Visual Studio
- platform independent
- easier to update
- faster configure
- shorter and more verbose build system files
- less cryptic files and output
- out of source builds
- used by increasing number of projects

Anatomy of a DUNE module with CMake

- Test for modules are found in cmake/modules/<DuneModuleName>Macros.cmake
- Package config files for installation: cmake/pkg/<dune-module-name>-config.cmake.in
- Build tree package configuration: <dune-module>-{config,version}.cmake.in!
- config.h.cmake contains module specific preprocessor directives
- various CMakeLists.txt
- duneproject can create this infrastructure for new modules.

Sample Top-level CMakeLists.txt for DUNE

```
1  cmake_minimum_required(VERSION 2.8.6)
   project(dune-testtest CXX)
3  [..]
   #find dune-common and set the module path
5  find_package(dune-common)
   list(APPEND CMAKE_MODULE_PATH ${dune-common_MODULE_PATH}
7    "${PROJECT_SOURCE_DIR}/cmake/modules")

9  #include the dune macros
   include(DuneMacros)
11
   # start a dune project with information from dune.module
13 dune_project()

15 add_subdirectory("dune")
   [..]
17 add_subdirectory("m4")

19 # finalize the dune project, e.g. generating config.h etc.
   finalize_dune_project(GENERATE_CONFIG_H_CMAKE)
```

Finding and Using Package

- If not available DUNE provides Find<Package>.cmake
- Easy compile/link flags setting with `add_dune_<package>_flags`
- Support for package specific tests that get executed by dependent modules.
- Less code duplication.
- `DuneMacros`
  - parses the dune.module files
  - generates dependency tree
  - searches for modules
  - executes tests.

The file config.h

- Contains macros and preprocessor defines for the platform.
- Watch out for the “ENABLE”- trick!
- Inherited by dependent modules
- Created by CMake from
  - <dune-common-module-source>/config.h.cmake
  - ...
  - <module-source>/config.h.cmake
- config.h.cmake has a module specific section
- with a private part.
- The non-private part of the module specific section gets inherited by dependant modules.
- Mimics the one created by autoconf.

The ENABLE trick

- Known and feared from DUNE's autotools build system.
- If package found HAVE_<PACKAGE> = ENABLE_<PACKAGE>
- Activates some packages if COMPILE_DEFINITIONS contains ENABLE_<PACKAGE>
- Needed because
  - distributions might not have activated some feature (e.g. SuperLU)
  - it enables testing with and without a specific feature (MPI)
- No problem if headers only!

Sample config.h.cmake

```
/* begin dune-istl */
/* begin private */
/* Name of package */
#define PACKAGE "@DUNE_MOD_NAME"

/* Define to the address for bug reports. */
#define PACKAGE_BUGREPORT "@DUNE_MAINTAINER@"

/* Define to the full name of this package. */
#define PACKAGE_NAME "@DUNE_MOD_NAME@"
/* ...*/
/* end private */

/* define if the Boost::Fusion headers are available */
#cmakedefine HAVE_BOOST_FUSION

/* Define to ENABLE_BOOST if the Boost is there */
#define HAVE_BOOST ENABLE_BOOST
/* end dune-istl */
```

Creating Documentation with CMake

- DUNE adds target make doc!
- Use `add_doxygen_target()` to create and install doxygen documentation
- Create PDFs with `dune_add_latex_document`:

```
dune_add_latex_document(communication.tex FATHER_TARGET
    doc
  BIBFILES communication.bib DEFAULT_SAFEPDF INPUTS
     poosc08_test.cc
  IMAGE_DIRS figures)
```

- and install it with make doc:

```
create_doc_install(${CMAKE_CURRENT_BINARY_DIR}/
    communication.pdf ${CMAKE_INSTALL_DOCDIR}/comm
    communication_safepdf)
```

Testing Framework

- Tests for are in subdirectories named tests.
- Several of these are supported per module.
- Built (nearly) on demand.
- For $(PROJECT_SOURCE_DIR)/.../tests $(PROJECT_BINARY_DIR)/.../tests/BuildTests.cmake is created to contain build commands and targets
- No tests built during “make all”

Example CMakeFile.txt for test

- Use CMakeLists.txt of parent directory.
- Add test target and add build dependencies

```
add_directory_test_target(_test_target)
add_dependencies(${_test_target} ${TESTPROGS})
```

- Add tests:

```
add_executable(bitsetvectortest bitsetvectortest.cc)
add_test(bitsetvectortest bitsetvectortest)
```

Creating New DUNE Modules

We have modified the duneproject script to create infrastructure for CMake:

- `<dune-module>/CMakeLists.txt`
- `<dune-module>/src/CMakeLists.txt`
- `<dune-module>/m4/CMakeLists.txt`
- `<dune-module>/dune/CMakeLists.txt`
- `<dune-module>/dune/<dune-module>/CMakeLists.txt`
- `<dune-module>/doc/CMakeLists.txt`
- `<dune-module>/doc/doxygen/CMakeLists.txt`
- `<dune-module>/config.h.cmake`
- `<dune-module>/cmake/pkg/<dune-module>-config.cmake.in`
- `<dune-module>/<dune-module>-config.cmake.in`
- `<dune-module>/<dune-module>-version.cmake.in`

Using CMake for DUNE

using dunecontrol

- Activate it using the `--use-cmake` switch (default is autotools)
- Provided option files will be parsed and translated for CMake

Pure CMake

- created build directories, configure, and build:

```
for i in $MODULES; do
    mkdir $i-build; pushd $i-build
    cmake ../dune-$i
    make
    popd
done
```

- Uses CMake's package registry to automatically find location of module.

Comparison CMake vs. Autotools I

Makefile.am of autotools:

```
pamgtest_SOURCES = parallelamgtest.cc
pamgtest_CPPFLAGS = $(AM_CPPFLAGS) \
$(DUNEMPICPPFLAGS) $(PARMETIS_CPPFLAGS)
pamgtest_LDFLAGS = $(AM_LDFLAGS)\
$(DUNEMPILDFLAGS) $(PARMETIS_LDFLAGS)
pamgtest_LDADD = $(PARMETIS_LIBS)\
$(DUNEMPILIBS)
```

CMakeLists.txt of CMake:

```
add_executable(pamgtest "parallelamgtest.cc")
target_link_libraries(pamgtest "dunecommon")
add_dune_parmetis_flags(pamgtest)
```

Comparison CMake vs. Autotools II

Speed measured (gcc-4.7.3, openSuse 12.3, CMake 2.8.11)

1. module=dune-common autogen:configure
2. CONFIGURE_ FLAGS="CXXFLAGS="-O0" –cache-file=/tmp/dune.cache" module=dune-localfunctions,dune-istl all
3. re-run 2. with cache

autotools use configure-cache

	CMake	autotools
1. dune-common	11.4s	20.7s
2. core modules	2m02s	1m45s
3. re-run	9s	1m23s

CMake SuperProjects

- Builtin support for external projects as dependencies:
  - Download (git, svn, homepage)
  - Configure
  - Build
- external projects can be made optional
- No need for the user to check, download, and build 3rd party software.
- Makes reproducible science possible.
- See e.g. Titan `http://titan.sandia.gov/`

Other projects with CMake

Projects using CMake

- UFC/Dolphin
- Trilinos
- deal.II
- Boost (evaluation phase during modularization)
- LLVM / Clang
- ParaView, The Visualization Toolkit
- Qt5, KDE, MySQL, Blender

Status and Outlook

- All core modules do support CMake
- New modules do have CMake support
- Configuring, building, testing work.
- Missing `make dist` and dune-web support.
- Time to convince the rest of the DUNE developers.

What can we do for you?

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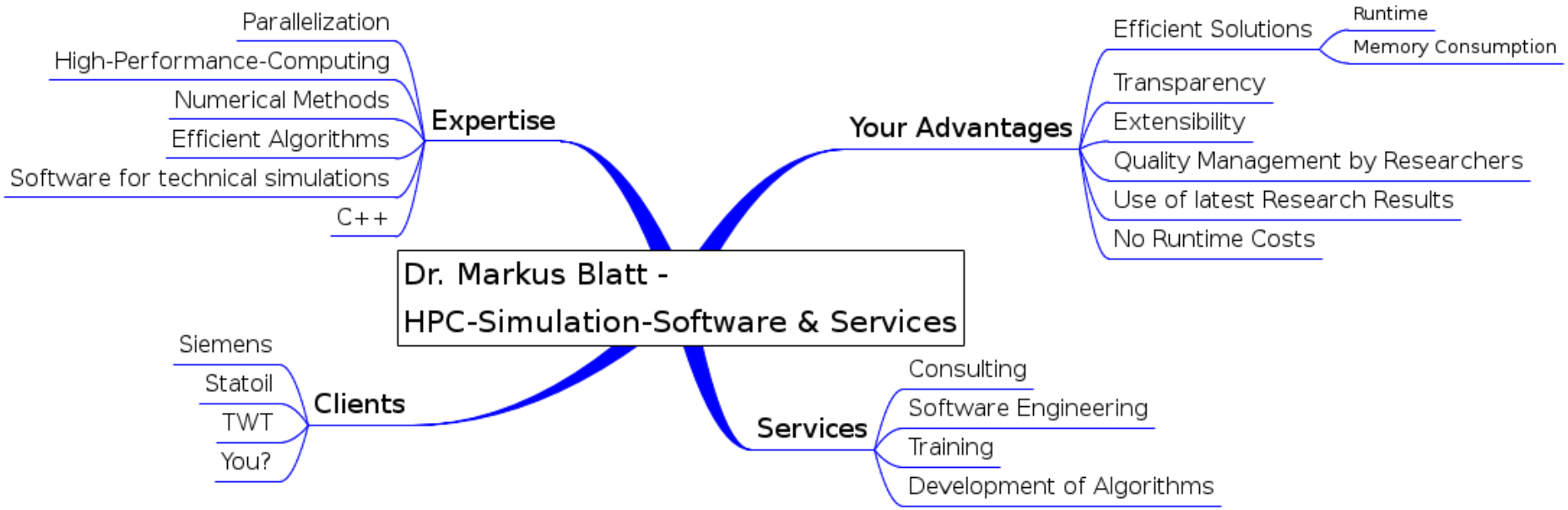

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