Tips and Tricks for Becoming a CMake Master

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About me

- Senior consultant at CGI Nederland B.V.
- Experienced C++ software engineer
- Experience with CMake through practical application
  - Converting legacy build to CMake
  - Not a CMake expert

The Case

Build a C++ application that uses Oracle embedded SQL with CMake

- ≈80 files with embedded SQL
- Files spread out over several build targets
- No support for Oracle in CMake
- No support for CMake in Oracle
- Must be usable by colleagues without CMake knowledge

C++ with Embedded SQL

```
 1 void my_func() {
 2   EXEC SQL BEGIN DECLARE SECTION;
 3   char name[NAME_SIZE]; int age;
 4   EXEC SQL END DECLARE SECTION;
 5
 6   // C++ code
 7
 8   EXEC SQL EXECUTE
 9   BEGIN
10     SELECT p.age INTO :age FROM person p WHERE p.name = :name;
11   END;
12   END-EXEC;
13
14   std::cout << "name = " << name ", age = " << age << '\n';
15 }
```

The Environment

- Red Hat Enterprise Linux 7
- GCC 10.3
- CMake 3.18
- Oracle 12

Manual Build

Manual Build

1. From C++ with embedded SQL generate pure C++
2. Compile generated C++ file
3. Link object files

Manual Build

1. From C++ with embedded SQL generate pure C++

```
proc iname=my_source.pcpp oname=my_generated_source.cpp
    code=cpp
    cpp_suffix=cpp
    userid=user/password@database
    option=value
    include=${ORACLE_HOME}/rdbms/public
    include=${ORACLE_HOME}/precomp/public
    include=${GCC_DIR}/include/c++/10.3.0
    include=${GCC_DIR}/include/c++/10.3.0/backward
    include=other_gcc_dirs
    include=project_dir
    include=other_include_dirs
```

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    include=${GCC_DIR}/include/c++/10.3.0/backward
    include=other_gcc_dirs
    include=project_dir
    include=other_include_dirs
```

Manual Build

2. Compile generated C++ file

```
c++ -c my_generated_source.cpp -o my_object.o
    -Iproject_dir
    -Iother_include_dirs
    -isystem ${ORACLE_HOME}/rdbms/public
    -isystem ${ORACLE_HOME}/precomp/public
    -Wall -Wextra -Wpedantic -Wother-warnings
    -Wno-missing-field-initializers
    -Wno-shadow
    -Wno-useless-cast
    -Wno-write-strings
```

Manual Build

2. Compile generated C++ file

```
c++ -c my_generated_source.cpp -o my_object.o
    -Iproject_dir
    -Iother_include_dirs
    -isystem ${ORACLE_HOME}/rdbms/public
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    -Wall -Wextra -Wpedantic -Wother-warnings
    -Wno-missing-field-initializers
    -Wno-shadow
    -Wno-useless-cast
    -Wno-write-strings
```

Manual Build

3. Link object files

```
c++ -o my_executable
    my_object.o
    other_object.o
    -Wl,-rpath,${ORACLE_HOME}/lib:
    ${ORACLE_HOME}/lib/libclntsh.so
    other_lib1.a
    other_lib2.so
```

Quick Overview of CMake

Workflow

1. Configure build

```
1 cmake -S /source/dir -B /build/dir
```

    1. Configure build (parse configuration files)
    2. Generate build configuration
2. Build project

```
1 cmake --build /build/dir
```

3. Test build / install or package artifacts

CMake Configuration

- File `CMakeLists.txt`
- Command `include(/path/to/file)`
  - Load and run a CMake file
- Command `add_subdirectory(sub_dir)`
  - Add a subdirectory to the project
  - Looks for a `CMakeLists.txt` in the directory

Creating Build Targets

- Create an executable target

```
1 add_executable(my_exe source1.cpp source2.cpp)
```

- Create a library target

```
1 add_library(my_lib STATIC|SHARED|... source1.cpp source2.cpp)
```

Working with Targets

- Add source files to a target

```
1 target_sources(my_target INTERFACE|PUBLIC|PRIVATE sourceA.cpp sourceB.cpp)
```

- Add include directories to a target

```
1 target_include_directories(my_target INTERFACE|PUBLIC|PRIVATE /dir/1 dir/2)
```

- Add compile options to a target

```
1 target_compile_options(my_target INTERFACE|PUBLIC|PRIVATE -option1 -option2)
```

Working with Targets

- Add libraries or linker flags to target

```
1 target_link_libraries(my_target INTERFACE|PUBLIC|PRIVATE
2     another_target /path/to/some.so some_lib -flag)
```

  - For `another_target`: Also takes care of include directories, compiler flags, etc.

Working with targets

Scope keywords in `target_*` commands:

Keyword	Scope
`PRIVATE`	Item needed for building target itself
`PUBLIC`	Item needed for building target and depending targets
`INTERFACE`	Item needed for building depending targets only

Working with Variables

- Setting a normal variable

```
1 set(MY_VAR "Some value with ${OTHER_VAR}")
```

- Setting a cache entry (stored for use in later CMake invocations)

```
1 set(MY_CACHE_VAR "Default value" CACHE BOOL|STRING|... "Documentation for CACHE_VAR")
```

User can set when configuring project:

```
1 cmake -DCACHE_VAR:STRING="value" -S /source/dir -B /build/dir
```

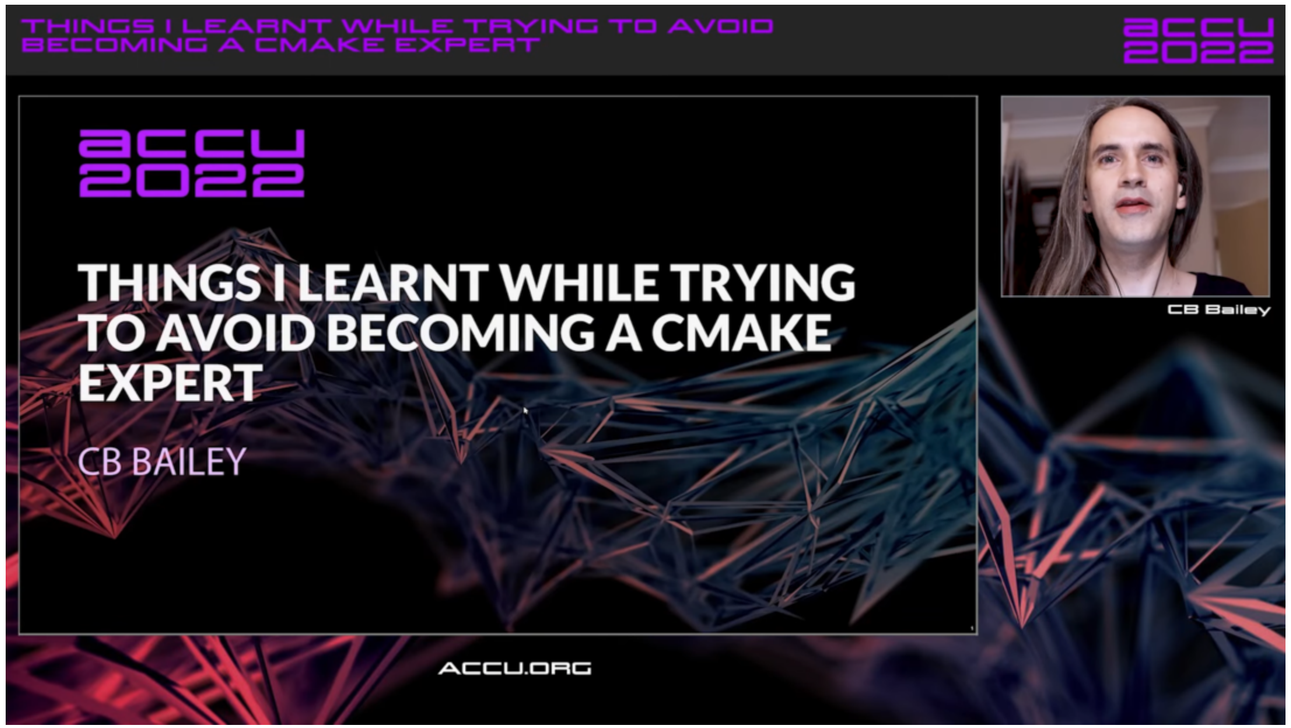
Finding Modules

- Searching for `external_module` with version `1.2.3` or later

```
1 find_package(external_module 1.2.3 REQUIRED)
```

  - `REQUIRED` makes CMake configuration fail when module not found

Introduction to CMake



https://www.youtube.com/watch?v=852VSXFaDO0

Finding Oracle

Goal

```
1 find_package(Oracle 12.0.0 REQUIRED)
2
3 ...
4
5 target_link_libraries(my_target PRIVATE Oracle::Oracle)
```

Module File

For `find_package(Oracle 12.0.0 REQUIRED)` to work

- CMake must know where to find the module

```
1 list(APPEND CMAKE_MODULE_PATH ${CMAKE_CURRENT_SOURCE_DIR}/cmake/Modules)
```

- Module file must be called `FindOracle.cmake`

Oracle Location

- Module needs to know where Oracle client is installed
- Oracle needs to know where it is installed too
  - Uses environment variable `ORACLE_HOME`

Oracle Location

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- Oracle needs to know where it is installed too
  - Uses environment variable `ORACLE_HOME`

In `FindOracle.cmake`:

```
1 if(NOT Oracle_DIR)
2   if(EXISTS $ENV{ORACLE_HOME})
3     set(Oracle_DIR $ENV{ORACLE_HOME}
4       CACHE PATH "Root directory of the Oracle installation")
5   endif()
6 endif()
```

Oracle Include Path

```
1 find_path(Oracle_INCLUDE_DIR
2   NAMES oratypes.h
3   HINTS ${Oracle_DIR}
4   PATH_SUFFIXES rdbms/public precomp/public
5   DOC "Include path for Oracle headers"
6   NO_DEFAULT_PATH)
7 mark_as_advanced(Oracle_INCLUDE_DIR)
```

Search for directory containing `oratypes.h`

- Store result in `Oracle_INCLUDE_DIR`
- `Oracle_INCLUDE_DIR` is not shown in GUIs
  - unless 'show advanced' is on

Oracle Include Path

```
1 find_path(Oracle_INCLUDE_DIR
2   NAMES oratypes.h
3   HINTS ${Oracle_DIR}
4   PATH_SUFFIXES rdbms/public precomp/public
5   DOC "Include path for Oracle headers"
6   NO_DEFAULT_PATH)
7 mark_as_advanced(Oracle_INCLUDE_DIR)
```

Search in:

- `${Oracle_DIR}`
- `${Oracle_DIR}/rdbms/public`
- `${Oracle_DIR}/precomp/public`
- and no default locations

Oracle Include Path

```
1 find_path(Oracle_INCLUDE_DIR
2   NAMES oratypes.h
3   HINTS ${Oracle_DIR}
4   PATH_SUFFIXES rdbms/public precomp/public
5   DOC "Include path for Oracle headers"
6   NO_DEFAULT_PATH)
7 mark_as_advanced(Oracle_INCLUDE_DIR)
```

Finds location of Oracle RDBMS headers

- Store in `Oracle_INCLUDE_DIR`

Oracle Include Path

```
1 find_path(Oracle_PRECOMP_INCLUDE_DIR
2   NAMES sqlca.h
3   HINTS ${Oracle_DIR}
4   PATH_SUFFIXES rdbms/public precomp/public
5   DOC "Include path for Oracle precompile headers"
6   NO_DEFAULT_PATH)
7 mark_as_advanced(Oracle_PRECOMP_INCLUDE_DIR)
```

Finds location of Oracle precompile headers

- Store in `Oracle_PRECOMP_INCLUDE_DIR`

Oracle Library

```
1 find_library(Oracle_LIBRARY
2   NAMES libclntsh clntsh
3   HINTS ${Oracle_DIR}
4   PATH_SUFFIXES lib
5   DOC "Path to the Oracle client library"
6   NO_DEFAULT_PATH)
7 mark_as_advanced(Oracle_LIBRARY)
```

- Search for one of:
  - `libclntsh`, `libclntsh.so`, `libclntsh.a`
  - `clntsh`, `clntsh.so`, `clntsh.a`
- Search in `${Oracle_DIR}`, `${Oracle_DIR}/lib`

Oracle Client Programs

```
1 find_program(Oracle_SQLPLUS
2   NAMES sqlplus
3   HINTS ${Oracle_DIR}
4   PATH_SUFFIXES bin
5   DOC "Path to the Oracle SQL*Plus command line SQL program"
6   NO_DEFAULT_PATH)
7 mark_as_advanced(Oracle_SQLPLUS)
```

- Search for `sqlplus` (SQL command line interface)
- Search in `${Oracle_DIR}`, `${Oracle_DIR}/bin`

Oracle Client Programs

```
1 find_program(Oracle_PROC
2   NAMES proc
3   HINTS ${Oracle_DIR}
4   PATH_SUFFIXES bin
5   DOC "Path to the Oracle Pro*C compiler program"
6   NO_DEFAULT_PATH)
7 mark_as_advanced(Oracle_PROC)
```

- Search for `proc` (Oracle precompiler)
- Search in `${Oracle_DIR}`, `${Oracle_DIR}/bin`

Oracle Version

Oracle SQL*Plus can tell the version

```
1 $ sqlplus -V
2
3 SQL*Plus: Release 12.2.0.1.0 Production
4
5 $ _
```

Oracle Version

```
$ sqlplus -V

SQL*Plus: Release 12.2.0.1.0 Production

$ _
```

From CMake:

```
if(Oracle_SQLPLUS)
  execute_process(
    COMMAND ${Oracle_SQLPLUS} -V
    OUTPUT_VARIABLE Oracle_version_output
    ERROR_VARIABLE Oracle_version_error
    RESULT_VARIABLE Oracle_version_result
    OUTPUT_STRIP_TRAILING_WHITESPACE)
endif()
```

Oracle Version

```
1 if(Oracle_SQLPLUS)
2   execute_process(
3     COMMAND ${Oracle_SQLPLUS} -V
4     OUTPUT_VARIABLE Oracle_version_output
5     ERROR_VARIABLE Oracle_version_error
6     RESULT_VARIABLE Oracle_version_result
7     OUTPUT_STRIP_TRAILING_WHITESPACE)
8 endif()
```

- `Oracle_version_output`: stdout output
- `Oracle_version_error`: stderr output
- `Oracle_version_result`: exit status

Oracle Version

If `Oracle_version_result` ≠ `0`, command failed

```
1 if(NOT ${Oracle_version_result} EQUAL 0)
2   message(SEND_ERROR
3     "Command \"${Oracle_SQLPLUS} -V\" failed with output:\n${Oracle_version_error}")
4 endif()
```

Oracle Version

`Oracle_version_output` has output:

```
1
2 SQL*Plus: Release 12.2.0.1.0 Production
```

Oracle Version

```
1
2 SQL*Plus: Release 12.2.0.1.0 Production
```

Extract version:

```
1 if("${Oracle_version_output}" MATCHES "[ \t\r\n]*SQL\\*Plus: Release ([^ ]+) .*")
2   set(Oracle_VERSION "${CMAKE_MATCH_1}")
3 endif()
```

Putting it together

We have set the following variables

```
1     Oracle_INCLUDE_DIR
2     Oracle_PRECOMP_INCLUDE_DIR
3     Oracle_LIBRARY
4     Oracle_PROC
5     Oracle_SQLPLUS
6     Oracle_VERSION
```

but don't know if everything is found correctly

Putting it together

Check if

- required variables are set
- version matches with requested version

```
1  find_package(PackageHandleStandardArgs)
2  find_package_handle_standard_args(Oracle
3    REQUIRED_VARS
4      Oracle_INCLUDE_DIR
5      Oracle_PRECOMP_INCLUDE_DIR
6      Oracle_LIBRARY
7      Oracle_PROC
8      Oracle_SQLPLUS
9    VERSION_VAR
10     Oracle_VERSION)
```

Putting it together

```
1  find_package(PackageHandleStandardArgs)
2  find_package_handle_standard_args(Oracle
3    REQUIRED_VARS
4      Oracle_INCLUDE_DIR
5      Oracle_PRECOMP_INCLUDE_DIR
6      Oracle_LIBRARY
7      Oracle_PROC
8      Oracle_SQLPLUS
9    VERSION_VAR
10     Oracle_VERSION)
```

- Sets variable `Oracle_FOUND`
- Aborts configuration when `REQUIRED` option to `find_package` is set

Putting it together

Create target `Oracle::Oracle`

```
if(Oracle_FOUND)
  set(Oracle_INCLUDE_DIRS
    ${Oracle_INCLUDE_DIR}
    ${Oracle_PRECOMP_INCLUDE_DIR})
  set(Oracle_LIBRARIES ${Oracle_LIBRARY})

  if(NOT TARGET Oracle::Oracle)
    add_library(Oracle::Oracle UNKNOWN IMPORTED)
    set_target_properties(Oracle::Oracle PROPERTIES
      IMPORTED_LOCATION "${Oracle_LIBRARIES}"
      INTERFACE_INCLUDE_DIRECTORIES "${Oracle_INCLUDE_DIRS}")
  endif()
endif()
```

Putting it together

Create target `Oracle::Oracle`

```
 1 if(Oracle_FOUND)
 2   set(Oracle_INCLUDE_DIRS
 3     ${Oracle_INCLUDE_DIR}
 4     ${Oracle_PRECOMP_INCLUDE_DIR})
 5   set(Oracle_LIBRARIES ${Oracle_LIBRARY})
 6
 7   if(NOT TARGET Oracle::Oracle)
 8     add_library(Oracle::Oracle UNKNOWN IMPORTED)
 9     set_target_properties(Oracle::Oracle PROPERTIES
10       IMPORTED_LOCATION "${Oracle_LIBRARIES}"
11       INTERFACE_INCLUDE_DIRECTORIES "${Oracle_INCLUDE_DIRS}")
12   endif()
13 endif()
```

Oracle Found

Now we can use the Oracle library

```
find_package(Oracle 12.0.0 REQUIRED)

...

target_link_libraries(my_lib PUBLIC Oracle::Oracle)
target_link_libraries(my_exe PRIVATE Oracle::Oracle)
```

Default Include Dirs

Default Include Dirs

- Pro*C needs to be able to find standard headers
- Compiler has their location internalised

Default Include Dirs

- Pro*C needs to be able to find standard headers
- Compiler has their location internalised

- Need to specify location to Pro*C explicitly
- GCC can report the include search path

Default Include Dirs

```
$ g++ -xc++ -E -v /dev/null
... <output truncated>
#include "..." search starts here:
#include <...> search starts here:
 /usr/include/c++/10
 /usr/include/c++/10/x86_64-pc-linux-linux
 /usr/include/c++/10/backward
 /usr/local/include
 /usr/include
End of search list.
... <output truncated>
$ _
```

- Runs preprocessor only (−E)
- Prints what it does on stderr (−v)

Default Include Dirs

We'll create a function to add the default include dirs to a target:
`compiler_default_include_dirs(<target>)`

Using the Function

In `FindOracle.cmake`:

```
1 if(NOT TARGET compiler_internals)
2   include(${CMAKE_CURRENT_LIST_DIR}/CompilerInternals.cmake)
3   add_library(compiler_internals INTERFACE)
4   compiler_default_include_dirs(compiler_internals)
5 endif()
```

- Include `CompilerInternals.cmake`
- Create interface library `compiler_internals`
- Add default include dirs to interface library

Defining the Function

In `CompilerInternals.cmake`:

```
1 function(compiler_default_include_dirs target)
2   if(CMAKE_CXX_COMPILER_ID STREQUAL "GNU")
3     _gnu_default_include_dirs(${target})
4   else()
5     message(AUTHOR_WARNING
6       "Default include directories not set for '${CMAKE_CXX_COMPILER_ID}' compiler.")
7   endif()
8 endfunction()
```

Defining the Function

In `CompilerInternals.cmake`:

```
1 function(compiler_default_include_dirs target)
2   if(CMAKE_CXX_COMPILER_ID STREQUAL "GNU")
3     _gnu_default_include_dirs(${target})
4   else()
5     message(AUTHOR_WARNING
6       "Default include directories not set for '${CMAKE_CXX_COMPILER_ID}' compiler.")
7   endif()
8 endfunction()
```

`_gnu_default_include_dirs` does the actual work for GCC

Defining the Function

`_gnu_default_include_dirs` executes `g++ -xc++ -E -v /dev/null`:

```
1 function(_gnu_default_include_dirs target)
2   execute_process(
3     COMMAND ${CMAKE_CXX_COMPILER} -xc++ -E -v /dev/null
4     OUTPUT_QUIET
5     ERROR_VARIABLE compiler_output)
6
7   ...
8 endfunction()
```

Defining the Function

Transform output into list of lines

```
1 function(_gnu_default_include_dirs target)
2   execute_process(
3     COMMAND ${CMAKE_CXX_COMPILER} -xc++ -E -v /dev/null
4     OUTPUT_QUIET
5     ERROR_VARIABLE compiler_output)
6   string(REGEX REPLACE "\n" ";" output_list "${compiler_output}")
7
8   ...
9 endfunction()
```

Intermezzo: Lists

- A list in CMake is a group of ';' separated strings
- `set(var a b c)` creates the list `a;b;c`
- `set(var "a b c")` creates the string `a b c`
- More list manipulation with `list` command

Defining the Function

Find first line with an include path

```
1  function(_gnu_default_include_dirs target)
2    execute_process(
3      COMMAND ${CMAKE_CXX_COMPILER} -xc++ -E -v /dev/null
4      OUTPUT_QUIET
5      ERROR_VARIABLE compiler_output)
6    string(REGEX REPLACE "\n" ";" output_list "${compiler_output}")
7
8    list(FIND output_list "#include <...> search starts here:" include_dirs_begin)
9    math(EXPR include_dirs_begin "${include_dirs_begin} + 1")
10   ...
11 endfunction()
```

Defining the Function

Find first line with an include path

```
function(_gnu_default_include_dirs target)
  execute_process(
    COMMAND ${CMAKE_CXX_COMPILER} -xc++ -E -v /dev/null
    OUTPUT_QUIET
    ERROR_VARIABLE compiler_output)
  string(REGEX REPLACE "\n" ";" output_list "${compiler_output}")

  list(FIND output_list "#include <...> search starts here:" include_dirs_begin)
  math(EXPR include_dirs_begin "${include_dirs_begin} + 1")
  ...
endfunction()
```

Defining the Function

Calculate number of include paths

```
1  function(_gnu_default_include_dirs target)
2    execute_process(
3      COMMAND ${CMAKE_CXX_COMPILER} -xc++ -E -v /dev/null
4      OUTPUT_QUIET
5      ERROR_VARIABLE compiler_output)
6    string(REGEX REPLACE "\n" ";" output_list "${compiler_output}")
7
8    list(FIND output_list "#include <...> search starts here:" include_dirs_begin)
9    math(EXPR include_dirs_begin "${include_dirs_begin} + 1")
10
11   list(FIND output_list "End of search list." include_dirs_end)
12   math(EXPR include_dirs_length "${include_dirs_end} - ${include_dirs_begin}")
13   ...
14 endfunction()
```

Defining the Function

Extract include paths from list

```
 3       COMMAND ${CMAKE_CXX_COMPILER} -xc++ -E -v /dev/null
 4       OUTPUT_QUIET
 5       ERROR_VARIABLE compiler_output)
 6     string(REGEX REPLACE "\n" ";" output_list "${compiler_output}")
 7
 8     list(FIND output_list "#include <...> search starts here:" include_dirs_begin)
 9     math(EXPR include_dirs_begin "${include_dirs_begin} + 1")
10
11     list(FIND output_list "End of search list." include_dirs_end)
12     math(EXPR include_dirs_length "${include_dirs_end} - ${include_dirs_begin}")
13
14     list(SUBLIST output_list ${include_dirs_begin} ${include_dirs_length} include_dirs)
15     list(TRANSFORM include_dirs STRIP)
16     ...
17 endfunction()
```

Defining the Function

Add include paths to target

```
4       OUTPUT_QUIET
5       ERROR_VARIABLE compiler_output)
6     string(REGEX REPLACE "\n" ";" output_list "${compiler_output}")
7
8     list(FIND output_list "#include <...> search starts here:" include_dirs_begin)
9     math(EXPR include_dirs_begin "${include_dirs_begin} + 1")
10
11    list(FIND output_list "End of search list." include_dirs_end)
12    math(EXPR include_dirs_length "${include_dirs_end} - ${include_dirs_begin}")
13
14    list(SUBLIST output_list ${include_dirs_begin} ${include_dirs_length} include_dirs)
15    list(TRANSFORM include_dirs STRIP)
16
17    target_include_directories(${target} SYSTEM INTERFACE ${include_dirs})
18  endfunction()
```

The Precompiler

The Precompiler

Refresher on the Pro*C invocation:

```
proc iname=my_source.pcpp oname=my_generated_source.cpp
     code=cpp
     cpp_suffix=cpp
     userid=user/password@database
     option=value
     include=${ORACLE_HOME}/rdbms/public
     include=${ORACLE_HOME}/precomp/public
     include=${GCC_DIR}/include/c++/10.3.0
     include=${GCC_DIR}/include/c++/10.3.0/backward
     include=other_gcc_dirs
     include=project_dir
     include=other_include_dirs
```

The Precompiler

Refresher on the Pro*C invocation:

```
1 proc iname=input.pcpp oname=output.cpp
2     option=value ... # more options
3     include=path ... # more include directories
```

Pro*C needs:

- an input file
- an output file
- 0 or more options
- 0 or more include paths

The Compiler

Compare this to compiler invocation:

```
1 c++ -c example.cpp -o example.o
2     -Wall ... # more options
3     -I/usr/include ... # more include directories
```

Compiler needs:

- an input file
- an output file
- 0 or more options
- 0 or more include paths

The Compiler

CMake generates compiler command with information supplied by:

- `target_sources` for input files
- internal heuristics for output files
- `target_compile_options` for options
- `target_include_directories` for include paths

The Precompiler

Similar to this we will:

- create `target_oracle_sources` for input files
- use internal heuristics for output files
- create `target_oracle_options` for options

We can use `target_include_directories` for include paths

Intermezzo: Target Properties

Target Properties

- CMake commands for working with targets manipulate properties of the target
- These properties come in pairs
  - One for the target itself
  - One for dependent targets

Target Properties

Command	Property for Target	Property for Dependants
target_compile_definitions	COMPILE_DEFINITIONS	INTERFACE_COMPILE_DEFINITIONS
target_compile_features	COMPILE_FEATURES	INTERFACE_COMPILE_FEATURES
target_compile_options	COMPILE_OPTIONS	INTERFACE_COMPILE_OPTIONS
target_include_directories	INCLUDE_DIRECTORIES	INTERFACE_INCLUDE_DIRECTORIES
target_link_directories	LINK_DIRECTORIES	INTERFACE_LINK_DIRECTORIES
target_link_libraries	LINK_LIBRARIES	INTERFACE_LINK_LIBRARIES
target_link_options	LINK_OPTIONS	INTERFACE_LINK_OPTIONS
target_precompile_headers	PRECOMPILE_HEADERS	INTERFACE_PRECOMPILE_HEADERS
target_sources	SOURCES	INTERFACE_SOURCES

Target Properties

- Keywords in `target_<name>` decide to which property things are added
  - `PRIVATE` adds to `<name>`
  - `INTERFACE` adds to `INTERFACE_<name>`
  - `PUBLIC` adds to both `<name>` and `INTERFACE_<name>`

Target Properties

- Calling a target command multiple times appends to the properties
- When generating the build configuration, those properties are used to create build commands

Target Properties

Target properties can be manipulated directly

- `get_target_property`
  - gets a single property
- `set_target_properties`
  - sets multiple properties

Precompiler Options

Precompiler Options

Mimicking

```
1 target_compile_options(target
2     INTERFACE option1=value1 ...
3     PUBLIC option2=value2 ...
4     PRIVATE option3=value3 ...)
```

we create

```
1 target_oracle_options(target
2     INTERFACE option1=value1 ...
3     PUBLIC option2=value2 ...
4     PRIVATE option3=value3 ...)
```

Precompiler Options

```
1 function(target_oracle_options target)
2   ...
3 endfunction()
```

Intermezzo: Functions

```
1 function(my_func first_arg second_arg)
```

defines a function named `my_func`

- having 2 formal parameters; and
- having 0 or more optional parameters

Intermezzo: Functions

```
1 function(my_func first_arg second_arg)
```

- Function names are case insensitive
- Function arguments are case sensitive
- Not supplying a formal argument is an error
- Formal arguments can be referenced by name
  - e.g. `${first_arg}`

Intermezzo: Functions

```
1 function(my_func first_arg second_arg)
```

- Variable ARGC has the number of arguments
- Variable ARGV# references the #'s argument
  - First argument is `${ARGV0}`
- Variable ARGV has a list of all arguments
- Variable ARGN has a list of all optional arguments
- Function name is never included

Precompiler Options

```
1 function(target_oracle_options target)
2   ...
3 endfunction()
```

Precompiler Options

```
1 function(target_oracle_options target)
2   set(options "")
3   set(one_value_args "")
4   set(multi_value_args INTERFACE PUBLIC PRIVATE)
5   cmake_parse_arguments(OPTS
6     "${options}" "${one_value_args}" "${multi_value_args}" ${ARGN})
7
8   ...
9 endfunction()
```

Precompiler Options

```cmake
set(multi_value_args INTERFACE PUBLIC PRIVATE)
cmake_parse_arguments(OPTS
  "${options}" "${one_value_args}" "${multi_value_args}" ${ARGN})
```

Creates and sets variables:

- OPTS_INTERFACE
- OPTS_PUBLIC
- OPTS_PRIVATE
- OPTS_UNPARSED_ARGUMENTS
- OPTS_KEYWORDS_MISSING_VALUES

Precompiler Options

```
function(target_oracle_options target)
  set(options "")
  set(one_value_args "")
  set(multi_value_args INTERFACE PUBLIC PRIVATE)
  cmake_parse_arguments(OPTS
    "${options}" "${one_value_args}" "${multi_value_args}" ${ARGN})

  if(OPTS_UNPARSED_ARGUMENTS)
    message(FATAL_ERROR
      "target_oracle_options: for target ${target}: "
      "unknown arguments \"${OPTS_UNPARSED_ARGUMENTS}\"")
  endif()

  get_target_property(oracle_options ${target} ORACLE_OPTIONS)
  get_target_property(interface_oracle_options ${target} INTERFACE_ORACLE_OPTIONS)
```

Precompiler Options

```
 3  set(one_value_args "")
 4  set(multi_value_args INTERFACE PUBLIC PRIVATE)
 5  cmake_parse_arguments(OPTS
 6    "${options}" "${one_value_args}" "${multi_value_args}" ${ARGN})
 7
 8  if(OPTS_UNPARSED_ARGUMENTS)
 9    message(FATAL_ERROR
10      "target_oracle_options: for target ${target}: "
11      "unknown arguments \"${OPTS_UNPARSED_ARGUMENTS}\"")
12  endif()
13
14  get_target_property(oracle_options ${target} ORACLE_OPTIONS)
15  get_target_property(interface_oracle_options ${target} INTERFACE_ORACLE_OPTIONS)
16
17  if(NOT oracle_options)
```

Precompiler Options

```
 8  if(OPTS_UNPARSED_ARGUMENTS)
 9    message(FATAL_ERROR
10      "target_oracle_options: for target ${target}: "
11      "unknown arguments \"${OPTS_UNPARSED_ARGUMENTS}\"")
12  endif()
13
14  get_target_property(oracle_options ${target} ORACLE_OPTIONS)
15  get_target_property(interface_oracle_options ${target} INTERFACE_ORACLE_OPTIONS)
16
17  if(NOT oracle_options)
18    set(oracle_options "")
19  endif()
20  if(NOT interface_oracle_options)
21    set(interface_oracle_options "")
22  endif()
```

Precompiler Options

```
12  endif()
13
14  get_target_property(oracle_options ${target} ORACLE_OPTIONS)
15  get_target_property(interface_oracle_options ${target} INTERFACE_ORACLE_OPTIONS)
16
17  if(NOT oracle_options)
18    set(oracle_options "")
19  endif()
20  if(NOT interface_oracle_options)
21    set(interface_oracle_options "")
22  endif()
23
24  list(APPEND oracle_options ${OPTS_PRIVATE})
25  list(APPEND oracle_options ${OPTS_PUBLIC})
26  list(APPEND interface_oracle_options ${OPTS_PUBLIC})
27  list(APPEND interface_oracle_options ${OPTS_INTERFACE})
```

Precompiler Options

```
18      set(oracle_options "")
19    endif()
20    if(NOT interface_oracle_options)
21      set(interface_oracle_options "")
22    endif()
23
24    list(APPEND oracle_options ${OPTS_PRIVATE})
25    list(APPEND oracle_options ${OPTS_PUBLIC})
26    list(APPEND interface_oracle_options ${OPTS_PUBLIC})
27    list(APPEND interface_oracle_options ${OPTS_INTERFACE})
28
29    set_target_properties(${target} PROPERTIES
30        ORACLE_OPTIONS "${oracle_options}"
31        INTERFACE_ORACLE_OPTIONS "${interface_oracle_options}")
32  endfunction()
```

Precompiler Options

```
18      set(oracle_options "")
19    endif()
20    if(NOT interface_oracle_options)
21      set(interface_oracle_options "")
22    endif()
23
24    list(APPEND oracle_options ${OPTS_PRIVATE})
25    list(APPEND oracle_options ${OPTS_PUBLIC})
26    list(APPEND interface_oracle_options ${OPTS_PUBLIC})
27    list(APPEND interface_oracle_options ${OPTS_INTERFACE})
28
29    set_target_properties(${target} PROPERTIES
30        ORACLE_OPTIONS "${oracle_options}"
31        INTERFACE_ORACLE_OPTIONS "${interface_oracle_options}")
32  endfunction()
```

Precompiler Sources

Precompiler Sources

Mimicking

```
1 target_sources(target
2     INTERFACE source1.cpp ...
3     PUBLIC source2.cpp ...
4     PRIVATE source3.cpp ...)
```

we create

```
1 target_oracle_sources(target
2     INTERFACE source1.pcpp ...
3     PUBLIC source2.pcpp ...
4     PRIVATE source3.pcpp ...)
```

Precompiler Sources

```
function(target_oracle_sources target)
  ...
endfunction()
```

Precompiler Sources

```
1 function(target_oracle_sources target)
2   set(options "")
3   set(one_value_args "")
4   set(multi_value_args INTERFACE PUBLIC PRIVATE)
5   cmake_parse_arguments(SRCS
6     "${options}" "${one_value_args}" "${multi_value_args}" ${ARGN})
7
8   ...
9 endfunction()
```

Precompiler Sources

```
1 set(multi_value_args INTERFACE PUBLIC PRIVATE)
2 cmake_parse_arguments(SRCS
3   "${options}" "${one_value_args}" "${multi_value_args}" ${ARGN})
```

Creates and sets variables:

- SRCS_INTERFACE
- SRCS_PUBLIC
- SRCS_PRIVATE
- SRCS_UNPARSED_ARGUMENTS
- SRCS_KEYWORDS_MISSING_VALUES

Precompiler Sources

```
1  function(target_oracle_sources target)
2    set(options "")
3    set(one_value_args "")
4    set(multi_value_args INTERFACE PUBLIC PRIVATE)
5    cmake_parse_arguments(SRCS
6      "${options}" "${one_value_args}" "${multi_value_args}" ${ARGN})
7
8    if(SRCS_UNPARSED_ARGUMENTS)
9      message(FATAL_ERROR
10       "target_oracle_sources: for target ${target}: "
11       "unknown arguments \"${SRCS_UNPARSED_ARGUMENTS}\"")
12   endif()
13
14   target_link_libraries(${target} PRIVATE compiler_internals)
15
```

Precompiler Sources

```
 3   set(one_value_args "")
 4   set(multi_value_args INTERFACE PUBLIC PRIVATE)
 5   cmake_parse_arguments(SRCS
 6     "${options}" "${one_value_args}" "${multi_value_args}" ${ARGN})
 7
 8   if(SRCS_UNPARSED_ARGUMENTS)
 9     message(FATAL_ERROR
10       "target_oracle_sources: for target ${target}: "
11       "unknown arguments \"${SRCS_UNPARSED_ARGUMENTS}\"")
12   endif()
13
14   target_link_libraries(${target} PRIVATE compiler_internals)
15
16   file(MAKE_DIRECTORY ${CMAKE_CURRENT_BINARY_DIR}/proc)
17   ...
```

Precompiler Sources

```
 4   set(multi_value_args INTERFACE PUBLIC PRIVATE)
 5   cmake_parse_arguments(SRCS
 6     "${options}" "${one_value_args}" "${multi_value_args}" ${ARGN})
 7
 8   if(SRCS_UNPARSED_ARGUMENTS)
 9     message(FATAL_ERROR
10       "target_oracle_sources: for target ${target}: "
11       "unknown arguments \"${SRCS_UNPARSED_ARGUMENTS}\"")
12   endif()
13
14   target_link_libraries(${target} PRIVATE compiler_internals)
15
16   file(MAKE_DIRECTORY ${CMAKE_CURRENT_BINARY_DIR}/proc)
17   ...
18 endfunction()
```

Precompiler Sources

```
 4   set(multi_value_args INTERFACE PUBLIC PRIVATE)
 5   cmake_parse_arguments(SRCS
 6     "${options}" "${one_value_args}" "${multi_value_args}" ${ARGN})
 7
 8   if(SRCS_UNPARSED_ARGUMENTS)
 9     message(FATAL_ERROR
10       "target_oracle_sources: for target ${target}: "
11       "unknown arguments \"${SRCS_UNPARSED_ARGUMENTS}\"")
12   endif()
13
14   target_link_libraries(${target} PRIVATE compiler_internals)
15
16   file(MAKE_DIRECTORY ${CMAKE_CURRENT_BINARY_DIR}/proc)
17   ...
18 endfunction()
```

Precompiler Sources

- Variables `SRCS_INTERFACE`, `SRCS_PUBLIC` and `SRCS_PRIVATE` contain lists of source files

Precompiler Sources

- Variables `SRCS_INTERFACE`, `SRCS_PUBLIC` and `SRCS_PRIVATE` contain lists of source files

```
1 function(target_oracle_sources target)
2   ...
3
4   file(MAKE_DIRECTORY ${CMAKE_CURRENT_BINARY_DIR}/proc)
5   foreach(file IN LISTS SRCS_INTERFACE)
6     ... # Process a single file
7   endforeach()
8   # Repeat for SRCS_PUBLIC and SRCS_PRIVATE
9 endfunction()
```

Precompiler Sources

- Variables `SRCS_INTERFACE`, `SRCS_PUBLIC` and `SRCS_PRIVATE` contain lists of source files
- Variable `multi_value_args` contains list of scopes: `INTERFACE;PUBLIC;PRIVATE`

```
1 function(target_oracle_sources target)
2   ...
3
4   file(MAKE_DIRECTORY ${CMAKE_CURRENT_BINARY_DIR}/proc)
5   foreach(file IN LISTS SRCS_INTERFACE)
6     ... # Process a single file
7   endforeach()
8   # Repeat for SRCS_PUBLIC and SRCS_PRIVATE
9 endfunction()
```

Precompiler Sources

- Variables `SRCS_INTERFACE`, `SRCS_PUBLIC` and `SRCS_PRIVATE` contain lists of source files
- Variable `multi_value_args` contains list of scopes: `INTERFACE;PUBLIC;PRIVATE`

```
 1 function(target_oracle_sources target)
 2   ...
 3
 4   file(MAKE_DIRECTORY ${CMAKE_CURRENT_BINARY_DIR}/proc)
 5   foreach(scope IN LISTS multi_value_args)
 6     foreach(file IN LISTS SRCS_${scope})
 7       ... # Process a single file
 8     endforeach()
 9   endforeach()
10 endfunction()
```

Precompiler Sources

Inner loop:

```
foreach(file IN LISTS SRCS_${scope})
  get_filename_component(input_file ${file} REALPATH)
  get_filename_component(filename ${file} NAME)
  set(output_file ${CMAKE_CURRENT_BINARY_DIR}/proc/${filename}.cpp)
  file(RELATIVE_PATH rel_output_file "${CMAKE_BINARY_DIR}" "${output_file}")

  add_custom_command(...) # Creates ${output_file}

  target_sources(${target} ${scope} ${output_file})

  ...
endforeach()
```

Precompiler Sources

Inner loop:

```
foreach(file IN LISTS SRCS_${scope})
  get_filename_component(input_file ${file} REALPATH)
  get_filename_component(filename ${file} NAME)
  set(output_file ${CMAKE_CURRENT_BINARY_DIR}/proc/${filename}.cpp)
  file(RELATIVE_PATH rel_output_file "${CMAKE_BINARY_DIR}" "${output_file}")

  add_custom_command(...) # Creates ${output_file}

  target_sources(${target} ${scope} ${output_file})

  ...
endforeach()
```

Precompiler Sources

Inner loop:

```
foreach(file IN LISTS SRCS_${scope})
  get_filename_component(input_file ${file} REALPATH)
  get_filename_component(filename ${file} NAME)
  set(output_file ${CMAKE_CURRENT_BINARY_DIR}/proc/${filename}.cpp)
  file(RELATIVE_PATH rel_output_file "${CMAKE_BINARY_DIR}" "${output_file}")

  add_custom_command(...) # Creates ${output_file}

  target_sources(${target} ${scope} ${output_file})

  ...
endforeach()
```

Precompiler Sources

Inner loop:

```
foreach(file IN LISTS SRCS_${scope})
  get_filename_component(input_file ${file} REALPATH)
  get_filename_component(filename ${file} NAME)
  set(output_file ${CMAKE_CURRENT_BINARY_DIR}/proc/${filename}.cpp)
  file(RELATIVE_PATH rel_output_file "${CMAKE_BINARY_DIR}" "${output_file}")

  add_custom_command(...) # Creates ${output_file}

  target_sources(${target} ${scope} ${output_file})

  ...
endforeach()
```

Precompiler Sources

Inner loop:

```
foreach(file IN LISTS SRCS_${scope})
  get_filename_component(input_file ${file} REALPATH)
  get_filename_component(filename ${file} NAME)
  set(output_file ${CMAKE_CURRENT_BINARY_DIR}/proc/${filename}.cpp)
  file(RELATIVE_PATH rel_output_file "${CMAKE_BINARY_DIR}" "${output_file}")

  add_custom_command(...) # Creates ${output_file}

  target_sources(${target} ${scope} ${output_file})

  ...
endforeach()
```

Precompiler Sources

Inner loop:

```
foreach(file IN LISTS SRCS_${scope})
  get_filename_component(input_file ${file} REALPATH)
  get_filename_component(filename ${file} NAME)
  set(output_file ${CMAKE_CURRENT_BINARY_DIR}/proc/${filename}.cpp)
  file(RELATIVE_PATH rel_output_file "${CMAKE_BINARY_DIR}" "${output_file}")

  add_custom_command(...) # Creates ${output_file}

  target_sources(${target} ${scope} ${output_file})

  ...
endforeach()
```

Precompiler Sources

Inner loop:

```
foreach(file IN LISTS SRCS_${scope})
  get_filename_component(input_file ${file} REALPATH)
  get_filename_component(filename ${file} NAME)
  set(output_file ${CMAKE_CURRENT_BINARY_DIR}/proc/${filename}.cpp)
  file(RELATIVE_PATH rel_output_file "${CMAKE_BINARY_DIR}" "${output_file}")

  add_custom_command(...) # Creates ${output_file}

  target_sources(${target} ${scope} ${output_file})

  ...
endforeach()
```

Precompiler Sources

Inner loop:

```
 3    get_filename_component(filename ${file} NAME)
 4    set(output_file ${CMAKE_CURRENT_BINARY_DIR}/proc/${filename}.cpp)
 5    file(RELATIVE_PATH rel_output_file "${CMAKE_BINARY_DIR}" "${output_file}")
 6
 7    add_custom_command(...) # Creates ${output_file}
 8
 9    target_sources(${target} ${scope} ${output_file})
10
11    set(file_options
12      -Wno-missing-field-initializers
13      -Wno-shadow
14      -Wno-useless-cast
15      -Wno-write-strings)
16    set_source_files_properties(${output_file} PROPERTIES COMPILE_OPTIONS "${file_options}")
17  endforeach()
```

Precompiler Sources

```
add_custom_command(
  OUTPUT ${output_file}
  COMMAND
    ${Oracle_PROC} iname=${input_file} oname=${output_file} ...
        # Options
        # Include directories
  MAIN_DEPENDENCY ${input_file}
  COMMENT "Creating Pro*C/C++ output ${rel_output_file}")
```

Precompiler Sources

```
1 add_custom_command(
2   OUTPUT ${output_file}
3   COMMAND
4     ${Oracle_PROC} iname=${input_file} oname=${output_file} ...
5         # Options
6         # Include directories
7   MAIN_DEPENDENCY ${input_file}
8   COMMENT "Creating Pro*C/C++ output ${rel_output_file}")
```

Specifying dependencies of custom command:

- `DEPENDS`: list of dependencies (files, targets)
- `MAIN_DEPENDENCY`: primary input source file

Intermezzo: Property Use

- With `get_target_property` we get the property as it is at that moment of configuring build

E.g. Value of `my_var` in

```
1 set_target_properties(my_target PROPERTIES CONFERENCE "C++ on Sea")
2 get_target_property(my_var my_target CONFERENCE)
```

is different from value in

```
1 get_target_property(my_var my_target CONFERENCE)
2 set_target_properties(my_target PROPERTIES CONFERENCE "C++ on Sea")
```

Intermezzo: Property Use

- We want to be able to do

```
1 target_oracle_options(my_target PRIVATE conference="C++ on Sea")
2 target_oracle_sources(my_target PRIVATE source.pcpp)
3 target_oracle_options(my_target PRIVATE location=Folkestone)
```

- Need value of target property after configuring build
  - that is, when generating the build
- This is what generator expressions are for

Intermezzo: Generator Expressions

- Are evaluated when generating build
- Can be used in many placed
  - But not everywhere
- Have the form `$<...>`
- Cannot be split across multiple lines

Intermezzo: Generator Expressions

- Support
  - Boolean logic
  - Working with information from targets
  - Working with general build information
  - Utility expressions

Intermezzo: Generator Expressions

- Generator expression for target property

```
1 $<TARGET_PROPERTY:target,property>
```

- For most properties, just gets the property content
- For `INCLUDE_DIRECTORIES` (and some other) target property concatenates:
  - The target property itself
  - The interface target property of dependents

Precompiler Sources

```
1  add_custom_command(
2    OUTPUT ${output_file}
3    COMMAND
4      ${Oracle_PROC} iname=${input_file} oname=${output_file} ...
5          # Options
6          # Include directories
7    MAIN_DEPENDENCY ${input_file}
8    COMMENT "Creating Pro*C/C++ output ${rel_output_file}")
```

Precompiler Sources

```
1  add_custom_command(
2    OUTPUT ${output_file}
3    COMMAND
4      ${Oracle_PROC} iname=${input_file} oname=${output_file}
5          "$<TARGET_PROPERTY:${target},ORACLE_OPTIONS>" ...
6          # Include directories
7    MAIN_DEPENDENCY ${input_file}
8    COMMAND_EXPAND_LISTS
9    VERBATIM
10   COMMENT "Creating Pro*C/C++ output ${rel_output_file}")
```

Precompiler Sources

```
1  add_custom_command(
2    OUTPUT ${output_file}
3    COMMAND
4      ${Oracle_PROC} iname=${input_file} oname=${output_file}
5          "$<TARGET_PROPERTY:${target},ORACLE_OPTIONS>"
6          "${includes}"
7    MAIN_DEPENDENCY ${input_file}
8    COMMAND_EXPAND_LISTS
9    VERBATIM
10   COMMENT "Creating Pro*C/C++ output ${rel_output_file}")
```

Precompiler Sources

```
1  set(includes ...)
2
3  add_custom_command(
4    OUTPUT ${output_file}
5    COMMAND
6      ${Oracle_PROC} iname=${input_file} oname=${output_file}
7          "$<TARGET_PROPERTY:${target},ORACLE_OPTIONS>"
8          "${includes}"
9    MAIN_DEPENDENCY ${input_file}
10   COMMAND_EXPAND_LISTS
11   VERBATIM
12   COMMENT "Creating Pro*C/C++ output ${rel_output_file}")
```

Precompiler Sources

```
1
2
3
4 set(includes ...)
5
6 add_custom_command(...)
```

Precompiler Sources

```
1 set(include_dirs "$<TARGET_PROPERTY:${target},INCLUDE_DIRECTORIES>")
2
3
4 set(includes ...)
5
6 add_custom_command(...)
```

Precompiler Sources

```
1 set(include_dirs "$<TARGET_PROPERTY:${target},INCLUDE_DIRECTORIES>")
2 set(deduplicated_dirs "$<REMOVE_DUPLICATES:${include_dirs}>")
3
4 set(includes ...)
5
6 add_custom_command(...)
```

Precompiler Sources

```
1 set(include_dirs "$<TARGET_PROPERTY:${target},INCLUDE_DIRECTORIES>")
2 set(deduplicated_dirs "$<REMOVE_DUPLICATES:${include_dirs}>")
3 set(filtered_dirs "$<FILTER:${deduplicated_dirs},EXCLUDE,^$>")
4 set(includes ...)
5
6 add_custom_command(...)
```

Precompiler Sources

```
1 set(include_dirs "$<TARGET_PROPERTY:${target},INCLUDE_DIRECTORIES>")
2 set(deduplicated_dirs "$<REMOVE_DUPLICATES:${include_dirs}>")
3 set(filtered_dirs "$<FILTER:${deduplicated_dirs},EXCLUDE,^$>")
4 set(includes "include=$<JOIN:${filtered_dirs},$<SEMICOLON>include=>")
5
6 add_custom_command(...)
```

Precompiler Sources

```
1 set(includes "include=$<JOIN:${filtered_dirs},$<SEMICOLON>include=>")
```

converts

```
1 /path/to/dir/1;/path/to/dir/2;/path/3
```

into

```
1 include=/path/to/dir/1;include=/path/to/dir/2;include=/path/3
```

Working Build!

```
build $ cmake --build .
[  2%] Automatic UIC for target my_lib
[  2%] Built target my_lib_autogen
[ 36%] Built target my_lib
[ 55%] Built target logger
[ 57%] Creating Pro*C/C++ output src/my_exe/proc/DbCommunicationError.pcpp.cpp

Pro*C/C++: Release 12.2.0.1.0 - Production on Sun May 28 21:16:30 2023

Copyright (c) 1982, 2017, Oracle and/or its affiliates.  All rights reserved.

System default option values taken from: /u01/app/oracle/product/12.2.0/client_1/precomp/admin/pcscfg.cfg


[ 59%] Creating Pro*C/C++ output src/my_exe/proc/DbCommunication.pcpp.cpp

Pro*C/C++: Release 12.2.0.1.0 - Production on Sun May 28 21:16:30 2023

Copyright (c) 1982, 2017, Oracle and/or its affiliates.  All rights reserved.

System default option values taken from: /u01/app/oracle/product/12.2.0/client_1/precomp/admin/pcscfg.cfg


[ 61%] Automatic UIC for target my_exe
[ 61%] Built target my_exe_autogen
Scanning dependencies of target my_exe
[ 63%] Building CXX object src/my_exe/CMakeFiles/my_exe.dir/proc/DbCommunication.pcpp.cpp.o
[ 65%] Building CXX object src/my_exe/CMakeFiles/my_exe.dir/proc/DbCommunicationError.pcpp.cpp.o
[ 68%] Linking CXX executable my_exe
[100%] Built target my_exe
build $
```

Improvement: Silencing Pro*C

Build Output

- Pro*C always outputs some uninteresting text
- Interesting output can be difficult to spot
  - By Pro*C
  - By other tools
- More effort needed to check build logs

Build Output

Wanted output:

```
build $ cmake --build .
[  2%] Automatic UIC for target my_lib
[  2%] Built target my_lib_autogen
[ 36%] Built target my_lib
[ 55%] Built target logger
[ 57%] Creating Pro*C/C++ output src/my_exe/proc/DbCommunicationError.pcpp.cpp
[ 59%] Creating Pro*C/C++ output src/my_exe/proc/DbCommunication.pcpp.cpp
[ 61%] Automatic UIC for target my_exe
[ 61%] Built target my_exe_autogen
Scanning dependencies of target my_exe
[ 63%] Building CXX object src/my_exe/CMakeFiles/my_exe.dir/proc/DbCommunication.pcpp.cpp.o
[ 65%] Building CXX object src/my_exe/CMakeFiles/my_exe.dir/proc/DbCommunicationError.pcpp.cpp.o
[ 68%] Linking CXX executable my_exe
[100%] Built target my_exe
build $
```

- Makes anomalies (warnings) stand out better
- Still want the former output when errors occur

External Commands

Two ways to execute external command

- `execute_process`
- `add_custom_command`

External Commands

	`execute_process`	`add_custom_command`	Wanted
When	build configuration	actual build	actual build
Suppress output	✓	✗	✓[1]
Capture output	✓	✗	✓[1]

[1] Normally suppress output, but capture when error occurs

External Commands

Solution:

- Use `add_custom_command` to call `execute_process`
- Encapsulate in new `add_quiet_custom_command`

External Command Usage

Replace

```
1  function(target_oracle_sources target)
2    ...
3    add_custom_command(
4      OUTPUT ${output_file}
5      COMMAND
6        ${Oracle_PROC} iname=${input_file}
7             oname=${output_file}
8             "$<TARGET_PROPERTY:${target},ORACLE_OPTIONS>"
9             "${includes}"
10     MAIN_DEPENDENCY ${input_file}
11     COMMAND_EXPAND_LISTS
12     VERBATIM
13     COMMENT "Creating Pro*C/C++ output ${rel_output_file}")
14   ...
15 endfunction()
```

External Command Usage

By

```
function(target_oracle_sources target)
  ...
  add_quiet_custom_command(
    OUTPUT ${output_file}
    COMMAND
      ${Oracle_PROC} iname=${input_file}
          oname=${output_file}
          "$<TARGET_PROPERTY:${target},ORACLE_OPTIONS>"
          "${includes}"
    WORKING_DIR ${CMAKE_CURRENT_BINARY_DIR}
    MAIN_DEPENDENCY ${input_file}
    COMMENT "Creating Pro*C/C++ output ${rel_output_file}")
  ...
endfunction()
```

External Command Usage

By

```
include(${CMAKE_CURRENT_LIST_DIR}/Execute.cmake)
function(target_oracle_sources target)
  ...
  add_quiet_custom_command(
    OUTPUT ${output_file}
    COMMAND
      ${Oracle_PROC} iname=${input_file}
          oname=${output_file}
          "$<TARGET_PROPERTY:${target},ORACLE_OPTIONS>"
          "${includes}"
    WORKING_DIR ${CMAKE_CURRENT_BINARY_DIR}
    MAIN_DEPENDENCY ${input_file}
    COMMENT "Creating Pro*C/C++ output ${rel_output_file}")
  ...
endfunction()
```

External Command Usage

File `Execute.cmake` will contain:

- Function `add_quiet_custom_command`
- All other code for the quiet execution of external commands

External Command Usage

File `Execute.cmake` will contain:

- Function `add_quiet_custom_command`
- All other code for the quiet execution of external commands

`Execute.cmake` will be both:

- An include file
- A CMake script

Execute.cmake

```
1 set(EXECUTE_SCRIPT ${CMAKE_CURRENT_LIST_FILE})
2
3 function(add_quiet_custom_command)
4   ... # call add_custom_command
5 endfunction()
6
7 if(EXECUTE_COMMAND STREQUAL "OUTPUT_SUPPRESSION")
8   ... # call execute_process
9 endif()
```

Quiet Custom Command

```
function(add_quiet_custom_command)
  set(options "")
  set(one_value_args COMMENT MAIN_DEPENDENCY WORKING_DIR)
  set(multi_value_args COMMAND DEPENDS OUTPUT)
  cmake_parse_arguments(ARG
    "${options}" "${one_value_args}" "${multi_value_args}" ${ARGN})

  if(ARG_UNPARSED_ARGUMENTS)
    message(FATAL_ERROR "add_quiet_custom_command:
        Unknown arguments \"${ARG_UNPARSED_ARGUMENTS}\"")
  endif()

  foreach(argument COMMAND MAIN_DEPENDENCY OUTPUT WORKING_DIR)
    if(NOT ARG_${argument})
      message(FATAL_ERROR "add_quiet_custom_command:
```

Quiet Custom Command

```
 8   if(ARG_UNPARSED_ARGUMENTS)
 9     message(FATAL_ERROR "add_quiet_custom_command:
10         Unknown arguments \"${ARG_UNPARSED_ARGUMENTS}\"")
11   endif()
12
13   foreach(argument COMMAND MAIN_DEPENDENCY OUTPUT WORKING_DIR)
14     if(NOT ARG_${argument})
15       message(FATAL_ERROR "add_quiet_custom_command:
16           Missing required argument \"${argument}\"")
17     endif()
18   endforeach()
19
20   foreach(opt_arg DEPENDS COMMENT)
21     if(ARG_${opt_arg})
22       set(${opt_arg}_LINE ${opt_arg} "${ARG_${opt_arg}}")
23     else()
```

Quiet Custom Command

```
15        message(FATAL_ERROR "add_quiet_custom_command:
16            Missing required argument \"${argument}\"")
17      endif()
18    endforeach()
19
20    foreach(opt_arg DEPENDS COMMENT)
21      if(ARG_${opt_arg})
22        set(${opt_arg}_LINE ${opt_arg} "${ARG_${opt_arg}}")
23      else()
24        set(${opt_arg}_LINE)
25      endif()
26    endforeach()
27
28    ... # call add_custom_command
29  endfunction()
```

Intermezzo: Variable Substitution

```
1 set(${opt_arg}_LINE ${opt_arg} "${ARG_${opt_arg}}")
```

Intermezzo: Variable Substitution

```
1 set(opt_arg DEPENDS)
2 set(ARG_DEPENDS "A dependency")
3
4 set(${opt_arg}_LINE ${opt_arg} "${ARG_${opt_arg}}")
```

Intermezzo: Variable Substitution

```
1 set(opt_arg DEPENDS)
2 set(ARG_DEPENDS "A dependency")
3
4 set(DEPENDS_LINE DEPENDS "${ARG_DEPENDS}")
```

Intermezzo: Variable Substitution

```
1 set(opt_arg DEPENDS)
2 set(ARG_DEPENDS "A dependency")
3
4 set(DEPENDS_LINE DEPENDS "A dependency")
```

Quiet Custom Command

```
16        message(FATAL_ERROR "add_quiet_custom_command:
17            Missing required argument \"${argument}\"")
18      endif()
19    endforeach()
20
21    foreach(opt_arg DEPENDS COMMENT)
22      if(ARG_${opt_arg})
23        set(${opt_arg}_LINE ${opt_arg} "${ARG_${opt_arg}}")
24      else()
25        set(${opt_arg}_LINE)
26      endif()
27    endforeach()
28
29    ... # call add_custom_command
30  endfunction()
```

Quiet Custom Command

```
16        message(FATAL_ERROR "add_quiet_custom_command:
17            Missing required argument \"${argument}\"")
18      endif()
19    endforeach()
20
21    foreach(opt_arg DEPENDS COMMENT)
22      if(ARG_${opt_arg})
23        set(${opt_arg}_LINE ${opt_arg} "${ARG_${opt_arg}}")
24      else()
25        set(${opt_arg}_LINE)
26      endif()
27    endforeach()
28
29    ... # call add_custom_command
30  endfunction()
```

Quiet Custom Command

```
26      endif()
27    endforeach()
28
29    add_custom_command(
30      OUTPUT ${ARG_OUTPUT}
31      COMMAND
32        ${CMAKE_COMMAND}
33        -DEXECUTE_COMMAND="OUTPUT_SUPPRESSION"
34        -DWORKING_DIR=${ARG_WORKING_DIR}
35        -DCOMMAND="${ARG_COMMAND}"
36        -P ${EXECUTE_SCRIPT}
37      MAIN_DEPENDENCY ${ARG_MAIN_DEPENDENCY}
38      COMMAND_EXPAND_LISTS
39      ${DEPENDS_LINE} ${COMMENT_LINE})
40  endfunction()
```

The Script

```
1  if(EXECUTE_COMMAND STREQUAL "OUTPUT_SUPPRESSION")
2    separate_arguments(command_as_list UNIX_COMMAND "${COMMAND}")
3    execute_process(
4      COMMAND ${command_as_list}
5      WORKING_DIRECTORY "${WORKING_DIR}"
6      RESULT_VARIABLE execute_result
7      OUTPUT_VARIABLE execute_output
8      ERROR_VARIABLE execute_output)
9
10   if(NOT ${execute_result} EQUAL 0)
11     message(FATAL_ERROR
12       "Execution of '${COMMAND}' failed with result"
13       "${execute_result}\n"
14       "${execute_output}\n")
15   endif()
```

The Script

```
if(EXECUTE_COMMAND STREQUAL "OUTPUT_SUPPRESSION")
  separate_arguments(command_as_list UNIX_COMMAND "${COMMAND}")
  execute_process(
    COMMAND ${command_as_list}
    WORKING_DIRECTORY "${WORKING_DIR}"
    RESULT_VARIABLE execute_result
    OUTPUT_VARIABLE execute_output
    ERROR_VARIABLE execute_output)

  if(NOT ${execute_result} EQUAL 0)
    message(FATAL_ERROR
      "Execution of '${COMMAND}' failed with result"
      "${execute_result}\n"
      "${execute_output}\n")
  endif()
```

The Script

```
2   separate_arguments(command_as_list UNIX_COMMAND "${COMMAND}")
3   execute_process(
4     COMMAND ${command_as_list}
5     WORKING_DIRECTORY "${WORKING_DIR}"
6     RESULT_VARIABLE execute_result
7     OUTPUT_VARIABLE execute_output
8     ERROR_VARIABLE execute_output)
9
10  if(NOT ${execute_result} EQUAL 0)
11    message(FATAL_ERROR
12      "Execution of '${COMMAND}' failed with result"
13      "${execute_result}\n"
14      "${execute_output}\n")
15  endif()
16 endif()
```

Done

We have a "silent" build!

```
build $ cmake --build .
[  2%] Automatic UIC for target my_lib
[  2%] Built target my_lib_autogen
[ 36%] Built target my_lib
[ 55%] Built target logger
[ 57%] Creating Pro*C/C++ output src/my_exe/proc/DbCommunicationError.pcpp.cpp
[ 59%] Creating Pro*C/C++ output src/my_exe/proc/DbCommunication.pcpp.cpp
[ 61%] Automatic UIC for target my_exe
[ 61%] Built target my_exe_autogen
Scanning dependencies of target my_exe
[ 63%] Building CXX object src/my_exe/CMakeFiles/my_exe.dir/proc/DbCommunication.pcpp.cpp.o
[ 65%] Building CXX object src/my_exe/CMakeFiles/my_exe.dir/proc/DbCommunicationError.pcpp.cpp.o
[ 68%] Linking CXX executable my_exe
[100%] Built target my_exe
build $
```

Thank you

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References:

- Craig Scott: "Professional CMake: A Practical Guide"
- CMake Reference Documentation: https://cmake.org/cmake/help/latest/index.html