A CMake-based build and configuration framework

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CERN - LHCb

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Outline

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Building LHCb Software

- Software projects need build tools
  - make, autotools, ant, jam, ...
- HEP software has special requirements
  - reproducibility and control
- CMT: a Configuration Management Tool
  - manages concurrent versions of projects and packages
  - dynamic runtime environment

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- Code organized in packages
  - configuration file
    - *use* other packages
    - declare products
    - declare environment
  - sources
  - data files
- Packages grouped in projects
  - configuration file
  - *container* package
  - *policy* package
- Coexisting versions

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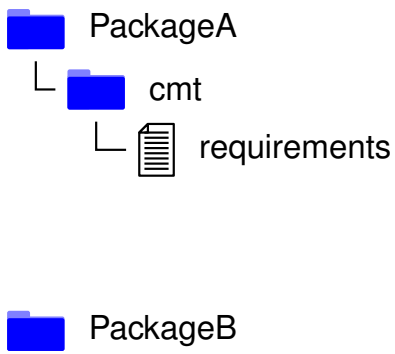

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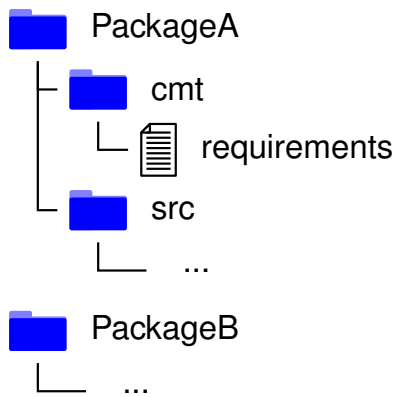

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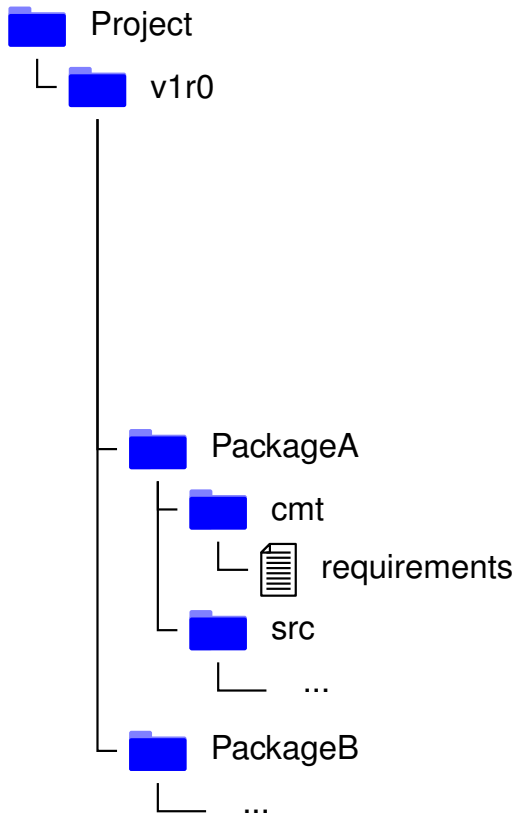

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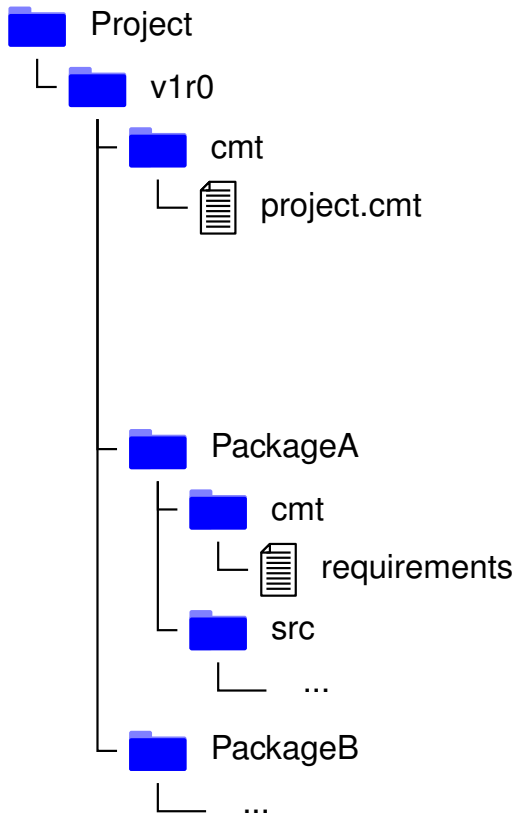

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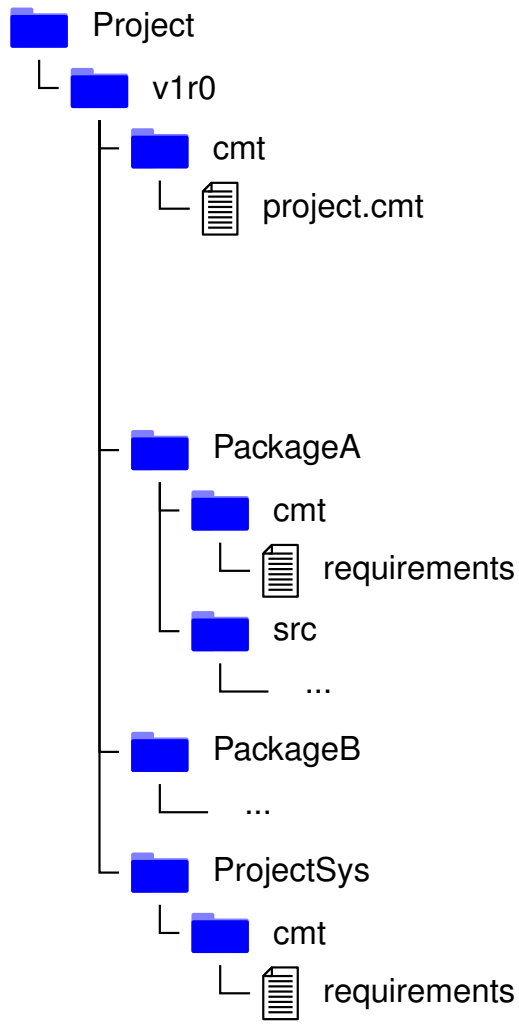

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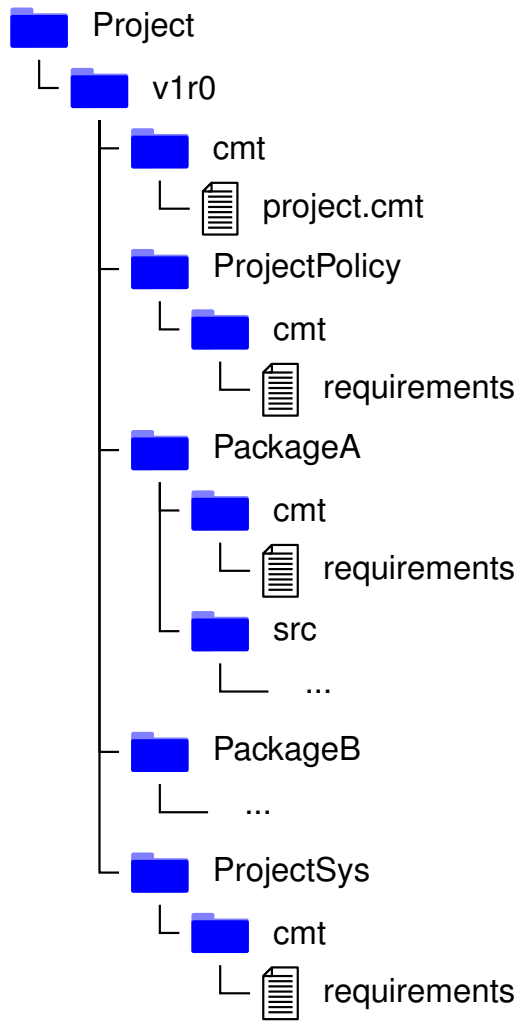

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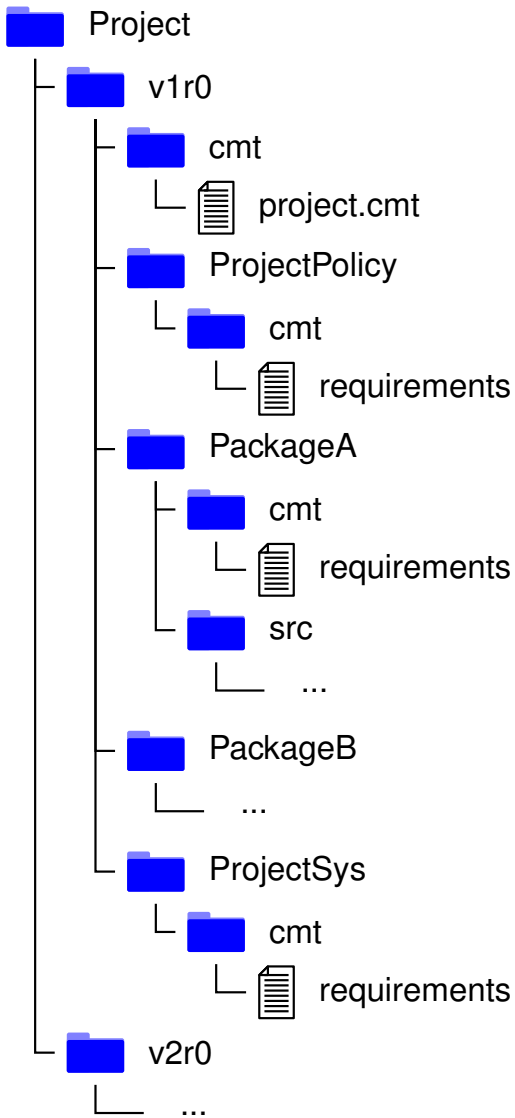

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  - patterns (functions)
  - makefile fragments
- Optimizations
  - improved dependency computation
  - wrapper for parallel build
- Extensions
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- Many functionalities not used

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  - a project can override packages from projects it uses
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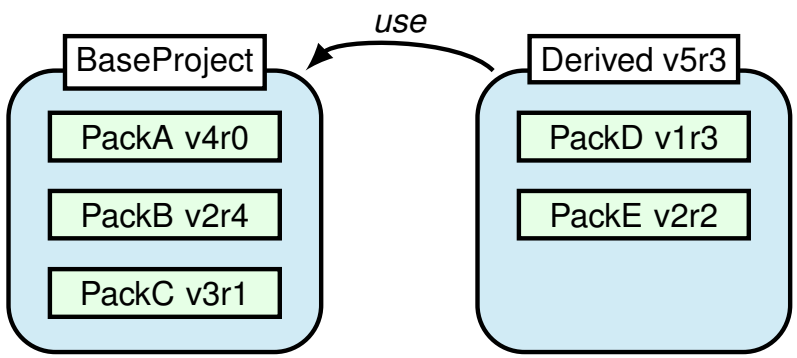

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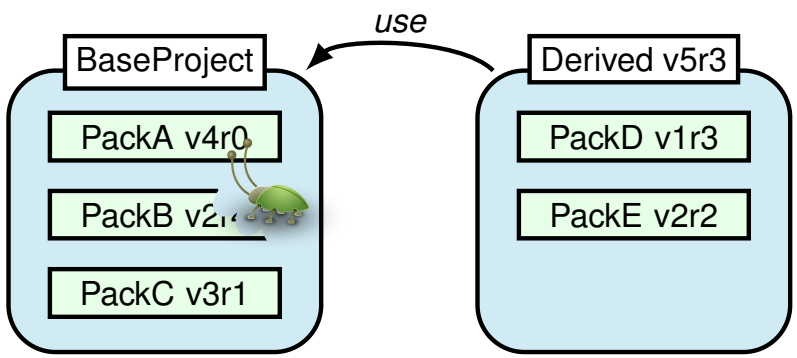

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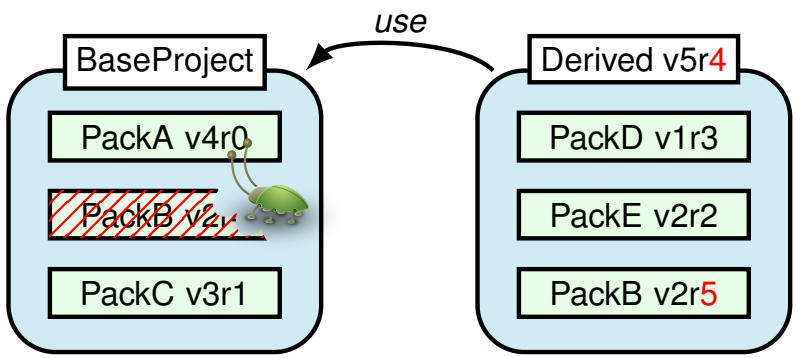

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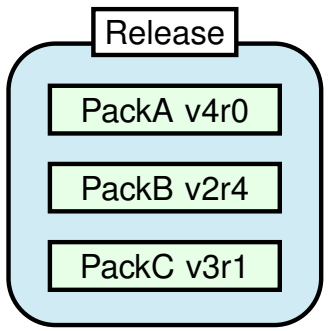

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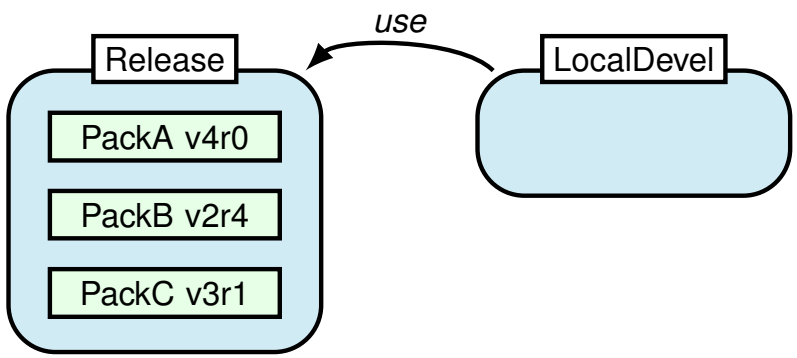

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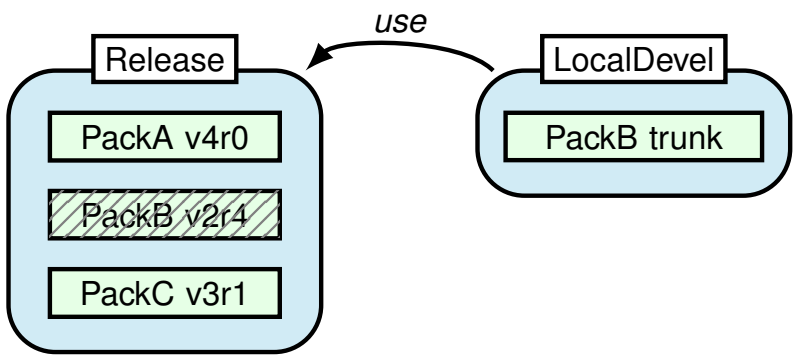

Why to change?

- CMT has got limitations
  - OK on small projects, but very slow on big projects
  - limited logic of configuration language
- We know what we need
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  - we extended and customized it to fit better our needs
- New products on the market
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- Flexibility
  - organize code in projects and packages
  - easily add/remove/move packages
- Override packages
  - derived projects can override packages
- Simplicity
  - minimalistic language (no details)
- Runtime environment
  - easy set-up for any version of any project
- Smooth migration
  - allow for adiabatic adoption of new framework

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What to use?

- New products with respect to 10 years ago
- Many tools are too specific
  - wrong language (we need C++ and Python)
  - non portable (Unix only)
  - only specific type of projects
- Few are generic and flexible
  - CMake, SCons, . . .
- CMake is powerful and widely used (e.g. KDE)

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- Pros
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  - very powerful (complete) language
  - library of modules for configuration
  - extensible with functions and macros
  - *properties*
- Cons
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- Projects
  - entry point to the build configuration
  - coordinate the hosted subdirectories
- Subdirectories
  - equivalent to packages in CMT
  - describe the components to build/install
- Toolchains
  - replace the fixed set of external libraries
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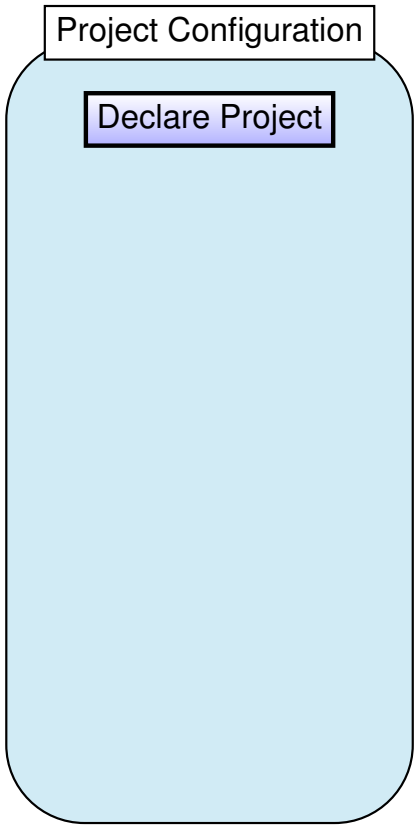

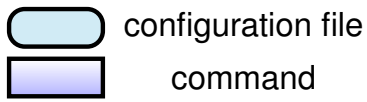

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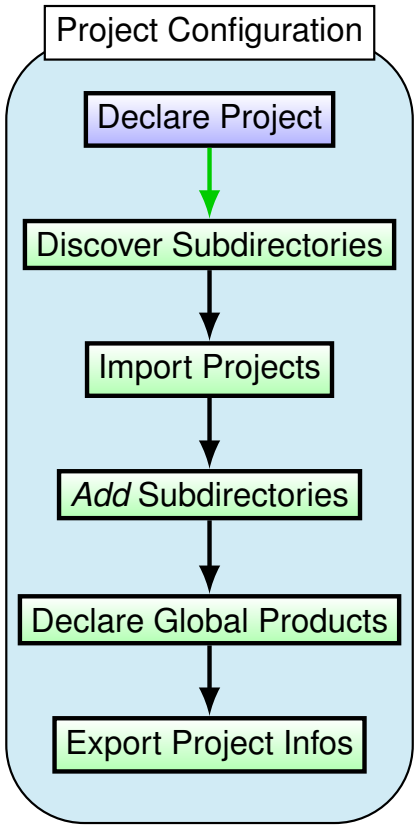

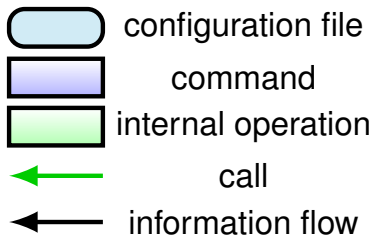

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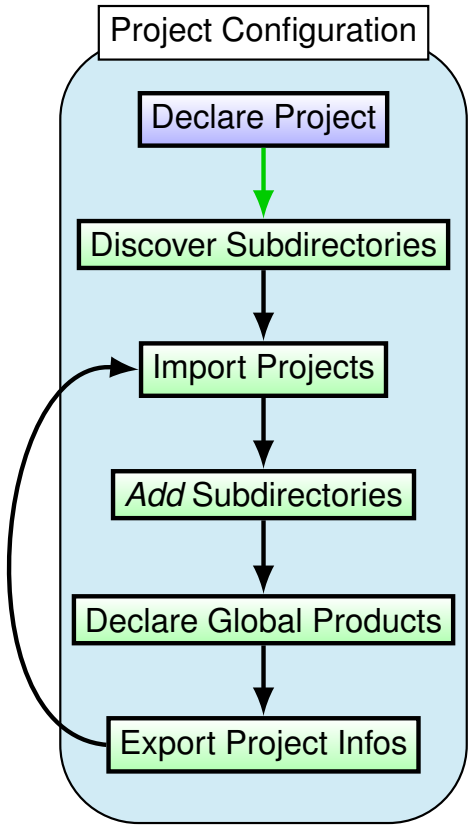

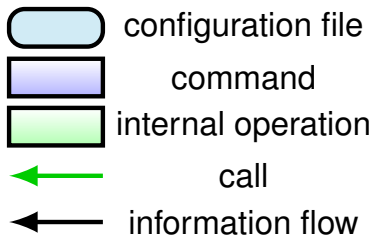

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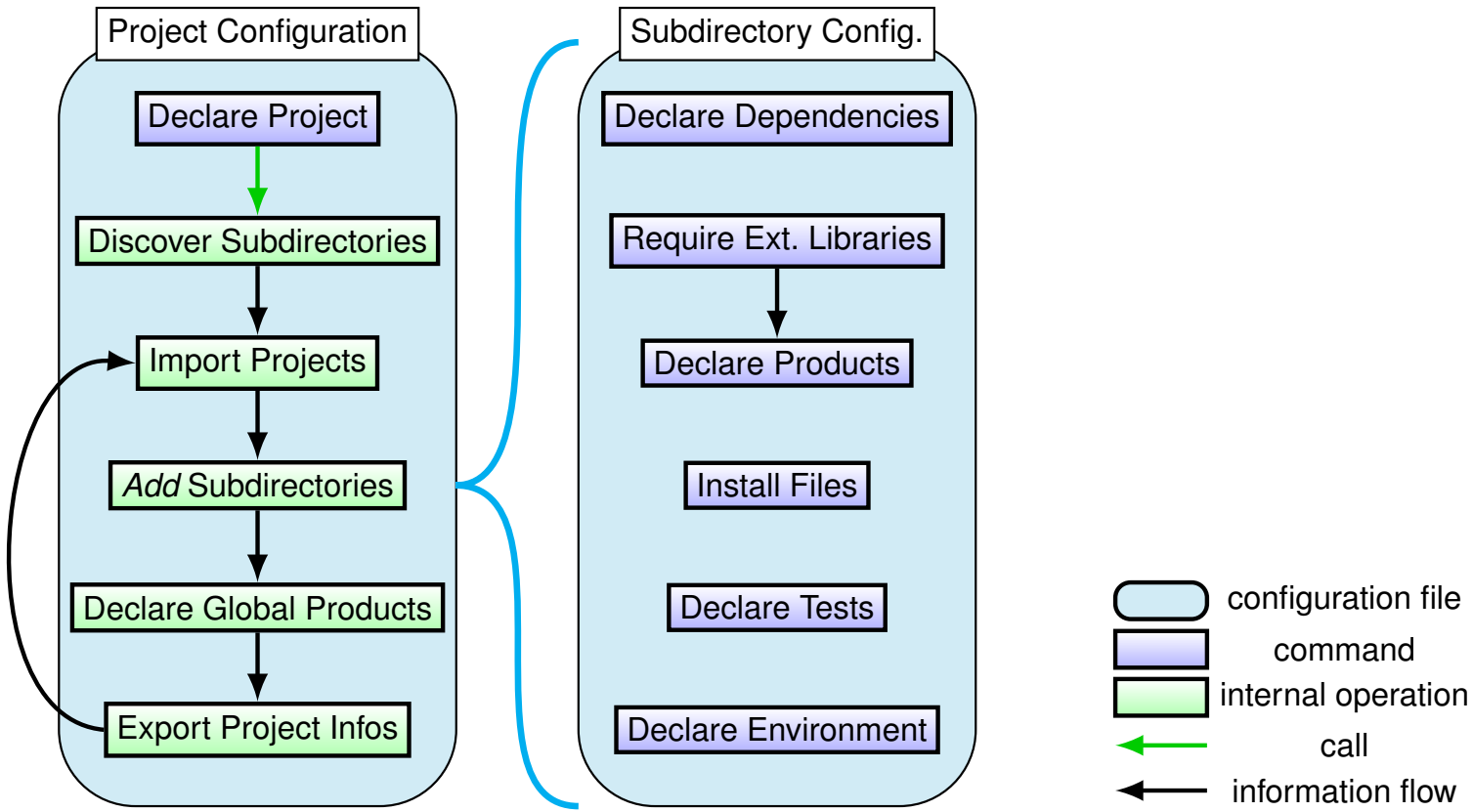

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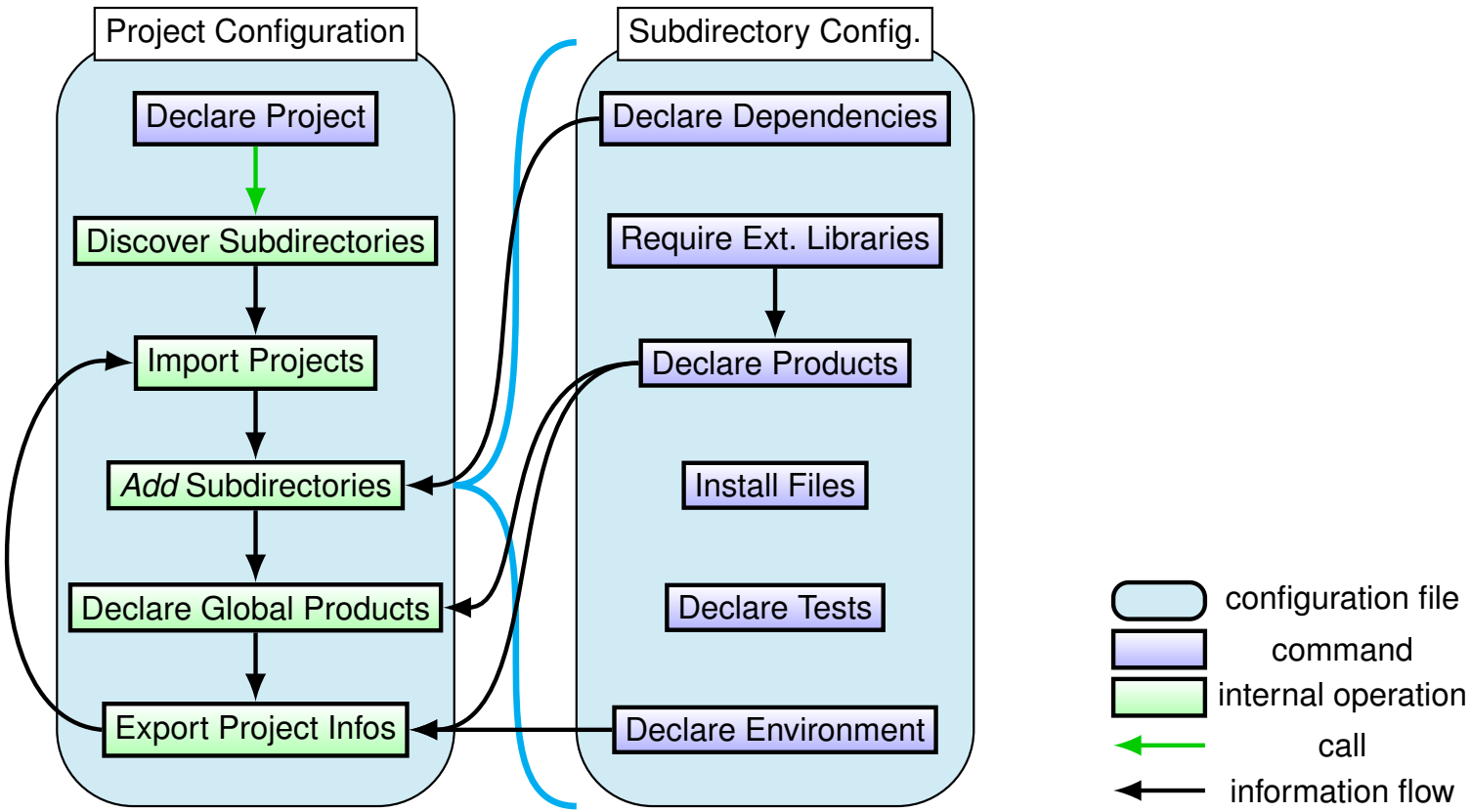

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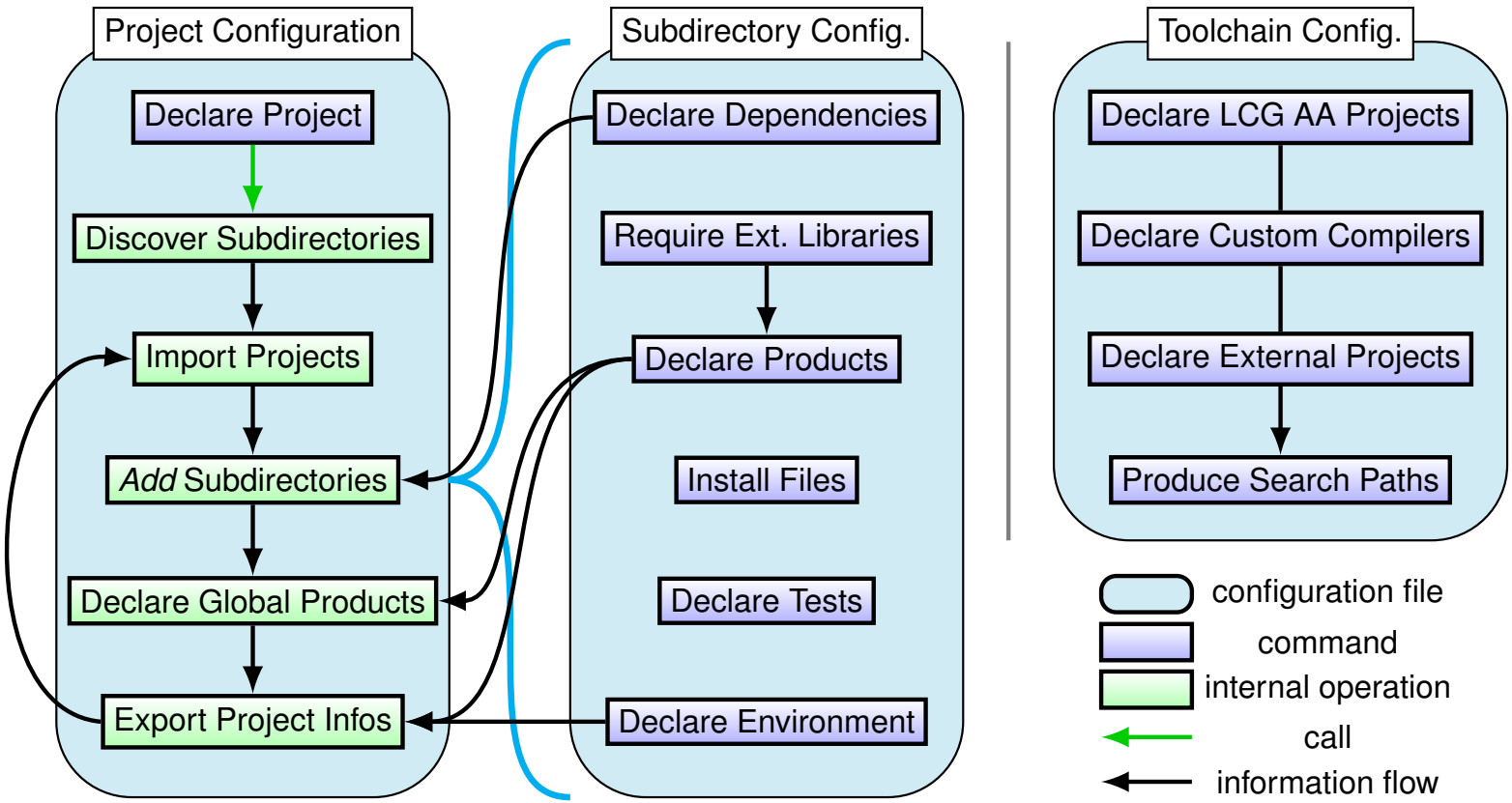

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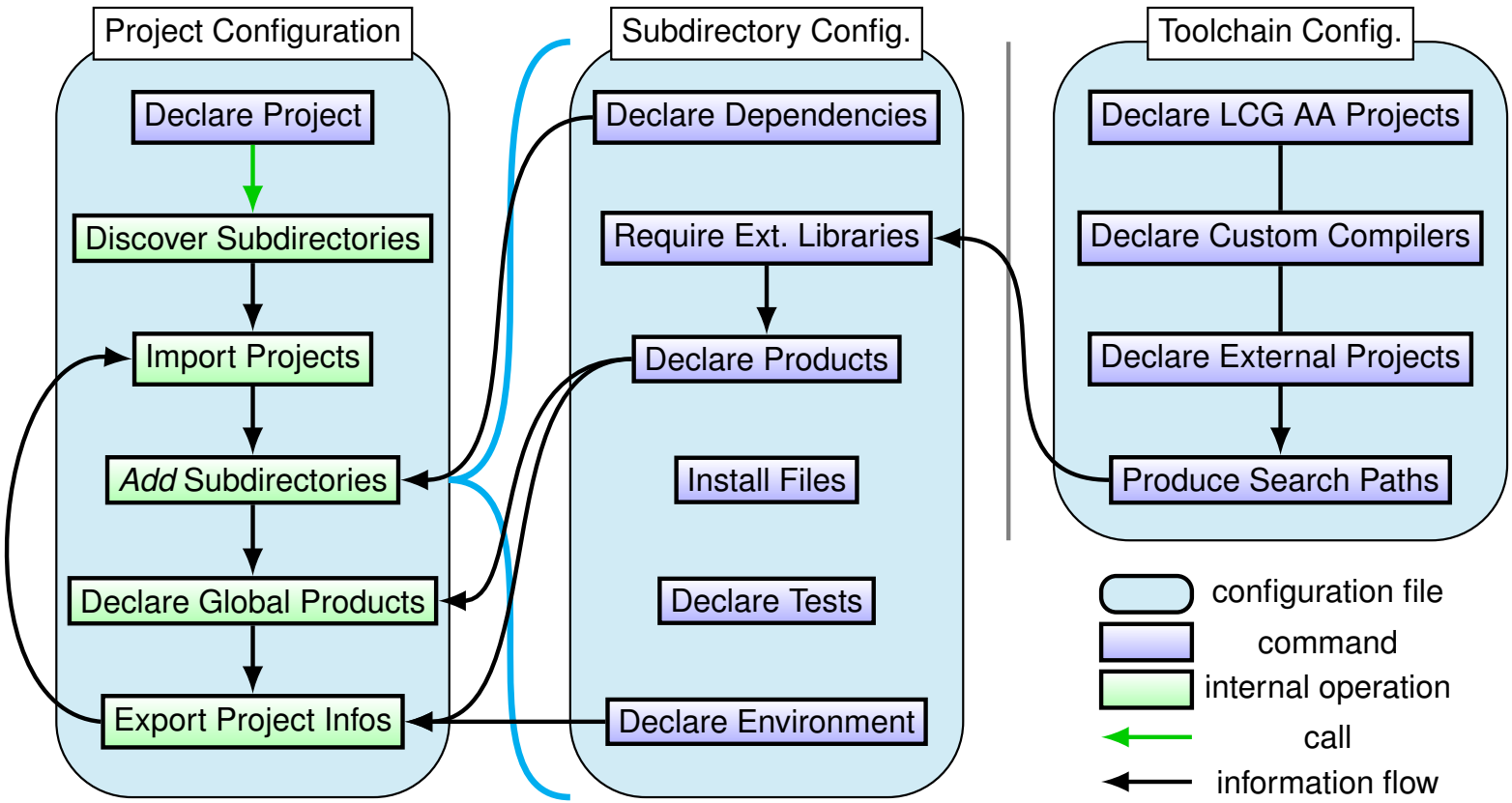

From CMT to CMake

- Compatibility
  - produce same filesystem hierarchy as CMT
  - preserve CMT configuration files
- Translation tool
  - Python script to analyze and translate configurations
  - used only for the first translation
- Migration plan
  - Validate framework (Summer)
  - Migrate project by project (LHC shutdown)
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From CMT to CMake (2)

```
# ======================================
package GaudiUtils
version v4r0
# ======= structure ====================
branches GaudiUtils src cmt doc
# ======= dependencies =================
use GaudiKernel *
use ROOT        * LCG_Interfaces
use AIDA        * LCG_Interfaces -no_auto_imports
use Boost       * LCG_Interfaces -no_auto_imports
use Reflex      * LCG_Interfaces -no_auto_imports
use uuid        * LCG_Interfaces -no_auto_imports
use XercesC     * LCG_Interfaces -no_auto_imports
# ======= own includes =================
apply_pattern install_more_includes more=GaudiUtils
# ======= constituents =================
library GaudiUtilsLib Lib/*.cpp \
        -import=AIDA -import=Boost -no_static
apply_pattern linker_library library=GaudiUtilsLib
# ======= constituents =================
library GaudiUtils component/*.cpp \
        -import=Boost -import=Reflex \
        -import=uuid -import=XercesC -no_static
apply_pattern component_library library=GaudiUtils
# ======= local settings ===============
private
  macro_append ROOT_linkopts " -lHist -lXMLIO "
  macro_append Boost_linkopts  " $(Boost_linkopts_date_time) "
end_private
```

From CMT to CMake (2)

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# ========================================
package GaudiUtils
version v4r0
# ======= structure ====================
branches GaudiUtils src cmt doc
# ======= dependencies =================
use GaudiKernel *
use ROOT         * LCG_Interfaces
use AIDA         * LCG_Interfaces -no_auto_imports
use Boost        * LCG_Interfaces -no_auto_imports
use Reflex       * LCG_Interfaces -no_auto_imports
use uuid         * LCG_Interfaces -no_auto_imports
use XercesC      * LCG_Interfaces -no_auto_imports
# ======= own includes =================
apply_pattern install_more_includes more=GaudiUtils
# ======= constituents =================
library GaudiUtilsLib Lib/*.cpp \
        -import=AIDA -import=Boost -no_static
apply_pattern linker_library library=GaudiUtilsLib
# ======= constituents =================
library GaudiUtils component/*.cpp \
        -import=Boost -import=Reflex \
        -import=uuid -import=XercesC -no_static
apply_pattern component_library library=GaudiUtils
# ======= local settings ===============
private
  macro_append ROOT_linkopts " -lHist -lXMLIO "
  macro_append Boost_linkopts  " $(Boost_linkopts_date_time) "
end_private
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```
# ============================
gaudi_subdir(GaudiUtils v4r0)
```

From CMT to CMake (2)

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# ======= libraries =======
gaudi_add_library(GaudiUtilsLib Lib/*.cpp
                  LINK_LIBRARIES GaudiKernel Boost ROOT
                  INCLUDE_DIRS AIDA Boost ROOT
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Outline

Conclusions

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- CMake is not meant to address our use case. . .
- . . . but it is powerful enough to be adapted
- Developed a CMake-based build framework
  - can replace CMT in LHCb use
  - better performance
  - will be adopted by after some more validation

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