# Large Projects and CMake and git, <u>oh my</u>!

C++Now 2015

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# Recognition

- Will Dicharry (Stellar Science)
- John McIver (Stellar Science)
- Conrad Poelman (Stellar Science)
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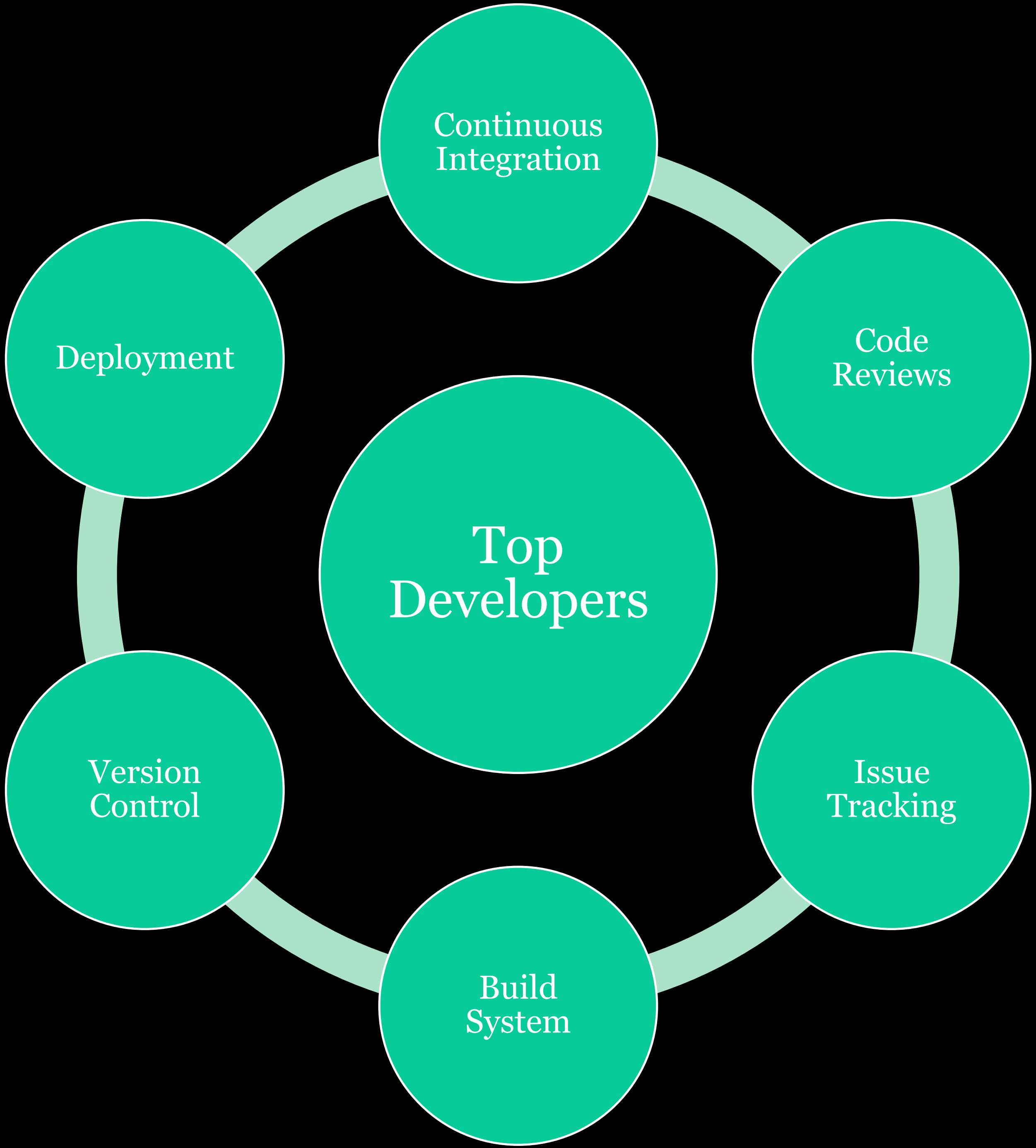

Top Developers

Continuous Integration

Code Reviews

Issue Tracking

Build System

Version Control

Deployment

# So, why version control and build systems?

# We’ve got a problem.

- A dozen build systems, each incompatible with the other.

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- A handful of version control systems, each person chooses his favorite.

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- A dozen build systems, each incompatible with the other.
- A handful of version control systems, each person chooses his favorite.
- Everyone uses each of them differently.

End result?

High cost to use third party code.

Wheels reinvented.

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Updates not propagated.

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Old versions proliferate.

Wheels reinvented.

Buggy code!

High cost to use third party code.

Updates not propagated.

Old versions proliferate.

**a·so·cial** (āˈsōSHəl) *adjective* avoiding social interaction; inconsiderate of or hostile to others.

**et·i·quette** (ˈe-ti-kət, -ˌket) *noun* the rules indicating the proper and polite way to behave

# How to choose?

- Incremental steps from already adopted tools.
- Works for the majority of situations.
- Engineering superiority

Which version control system is the polite one to use for C++?

No!

No!

No!

No!

Git is the only viable option.

But how do we use it?

# Laying out your git project with submodules

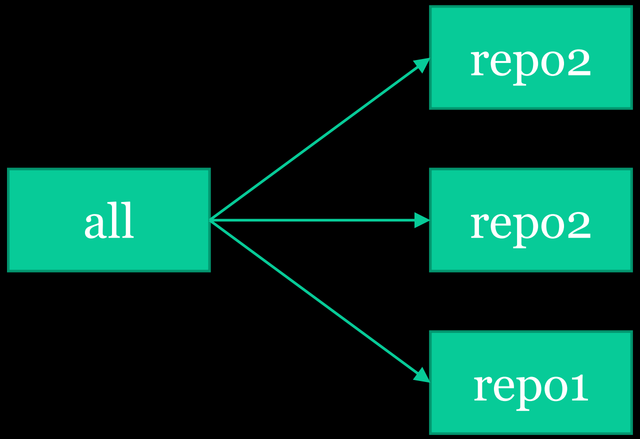
| On your server: | On your client: |
|---|---|
| /git/all.git | all/ |
| /git/repo1.git | all/repo1 |
| /git/repo2.git | all/repo2 |
| /git/repo3.git | all/repo3 |

```
git submodule add –b master ../<newRepoName> <newRepoName>
```

# Some Rules

- The ‘all’ superproject contains everything.
- All your submodules are hosted on your project’s git server.
- Security is handled based on the granularity of repositories.
- Your submodules do not have their own submodules.
- Other superprojects that don’t include everything can be created on an as-needed basis.

# Automatic submodule pointer updates



# Automatic submodule pointer updates

- Add post-receive hook on server to update the submodule pointers.

# Typical Usage

- Initial Checkout

```
git clone ssh://git.wherever.com/git/all.git
cd all
git submodule update –init
git submodule foreach git checkout master
```

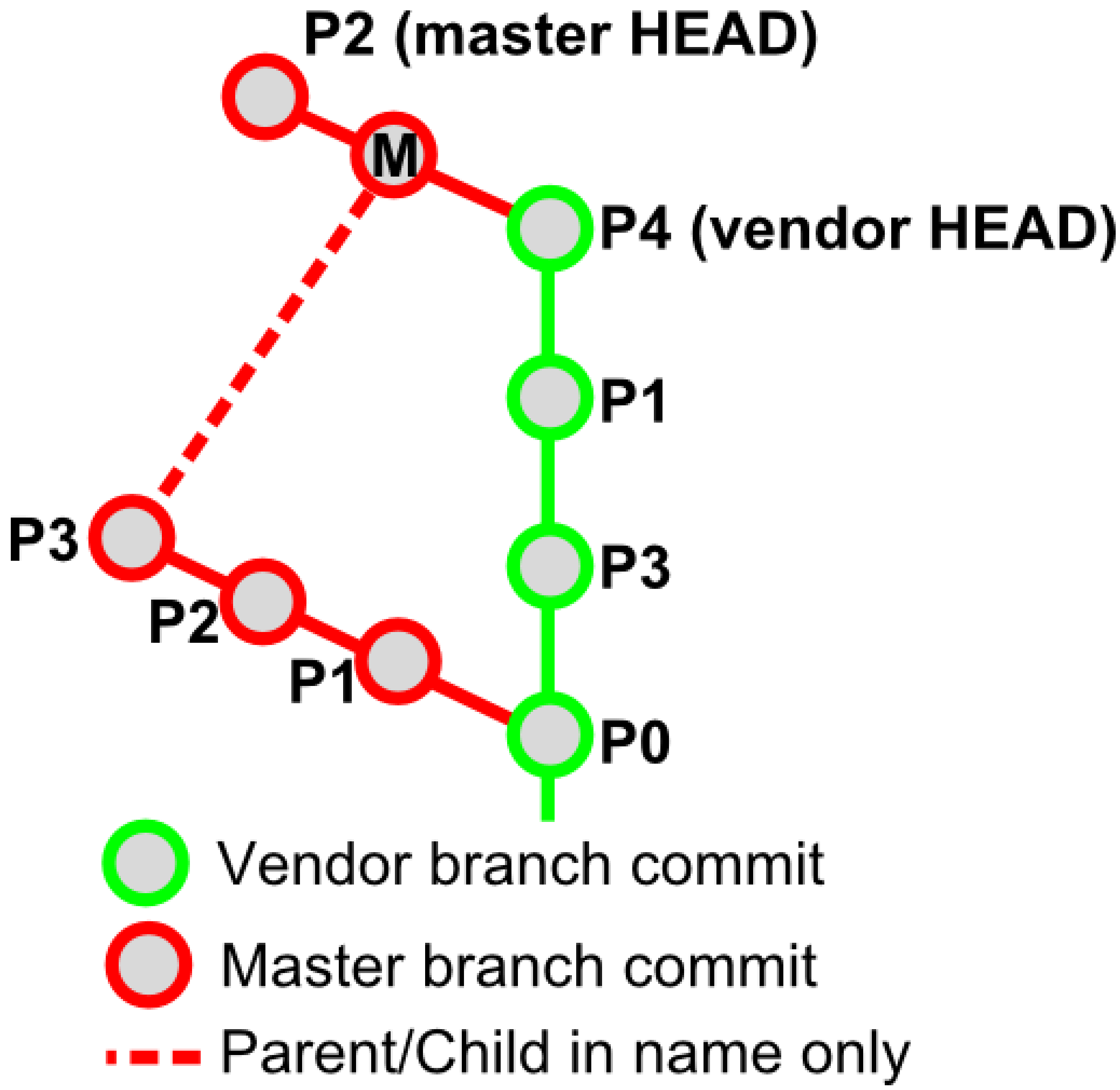
- Commit a modification

```
cd all/repo1
git checkout -b my_branch
# make modifications
git gui # commit locally
git push origin my_branch:my_branch # Push back to server
```

# Third Party Libraries - Requirements

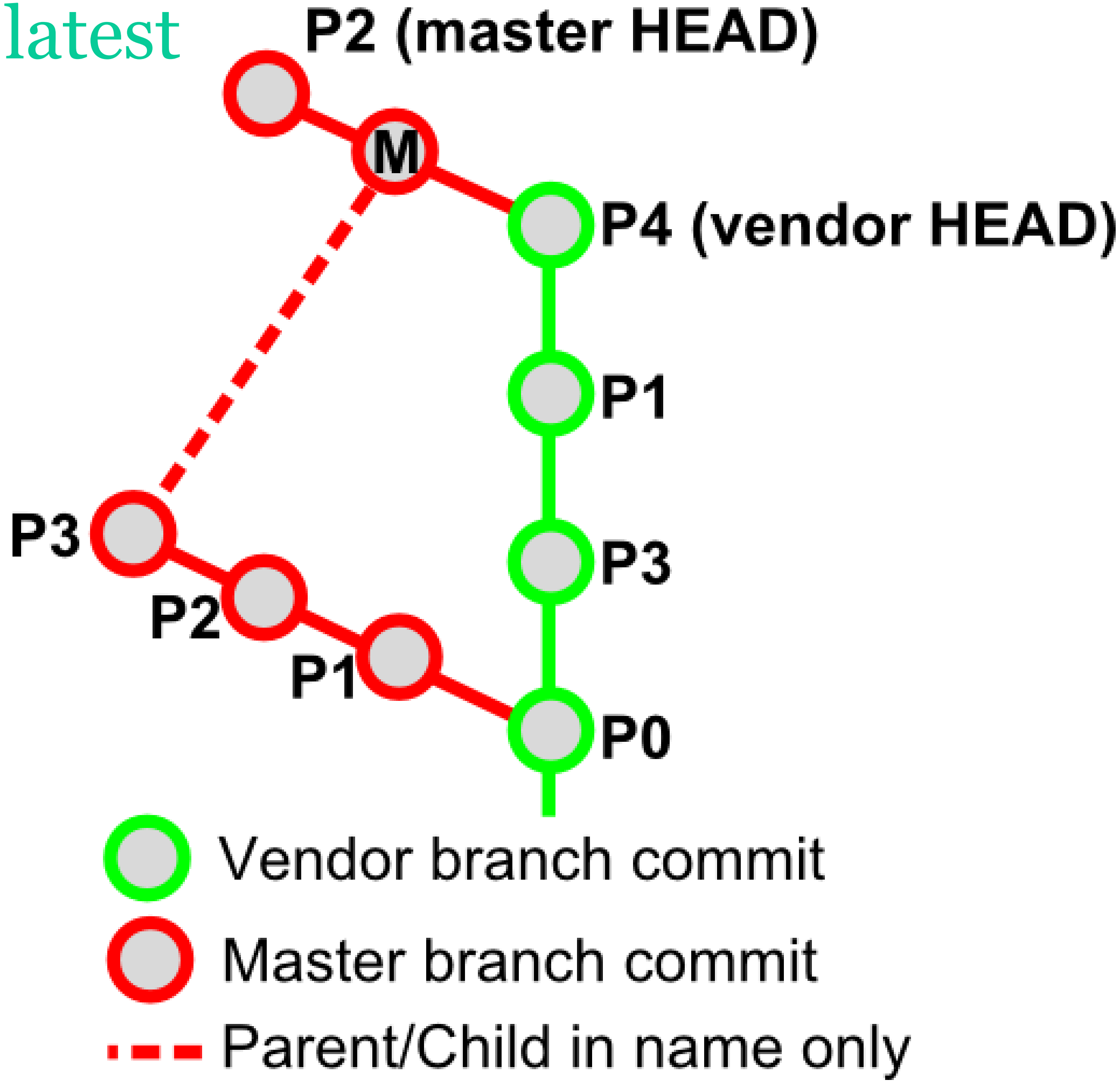
- Seemless to use.
- Host locally.
- Apply fixes before the maintainer applies them.
- Encourage contribution.
- Easy to update.

# Bounce patching



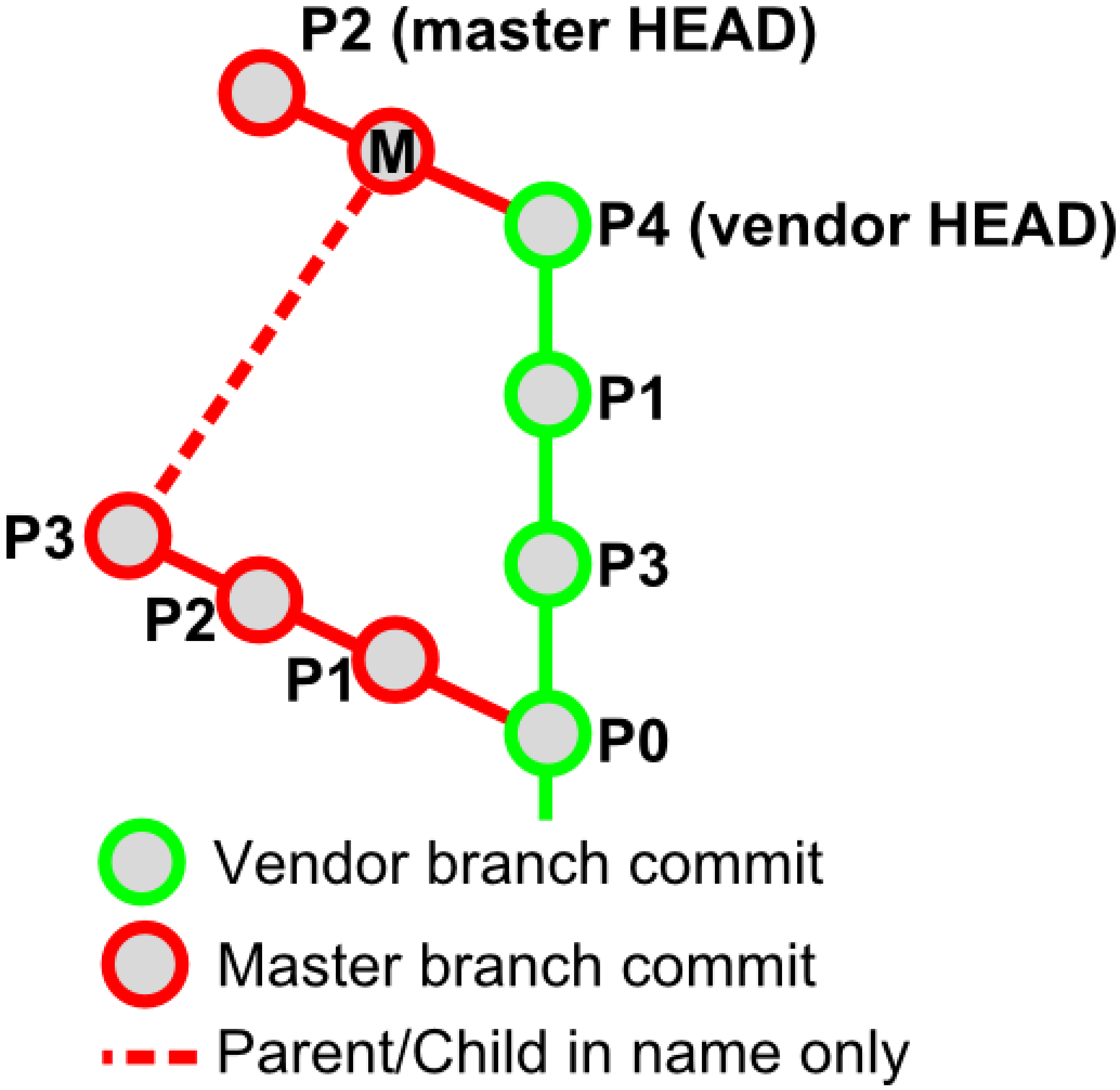
# Update a 3rdparty repo to the latest

```
cd all/repo3
git checkout vendor
git pull
git checkout –b phantom_merge
git merge –s ours master –m “Phantom merge”
git checkout master
git merge --ff-only phantom_merge
git branch –D phantom_merge
git cherry-pick 924989v # etc.
# test
git push origin master:master
```



# Modify a 3rdparty repo

```
cd all/repo3
# make changes
git gui # commit as usual

git checkout vendor
git merge –ff-only origin/vendor
git checkout –b my_change
git cherry-pick 293h39
git push https://github... my_change:my_change
# Use github to make a pull request.
```



# Keep Vendor branch up-to-date always

- Cron job on git server to periodically update the vendor branch to the latest “master” branch on upstream server.

# Non-git libraries ☹

- Make a git repository with a vendor branch corresponding to release dumps.
- Make use the git-svn tools to make a vendor branch and automate keeping it up to date.

So, lets talk about build systems.

Yikes!

# CMake

- Cross compiles.
- Generates Visual Studio projects.
- Generates Ninja files.
- Well supported commercially.
- Kinks worked out over 16 years of use.
- Vast majority of new C++ Open Source projects use CMake.

But, how do we use CMake properly?

Step 1: Write up CMake coding conventions.

# Coding Conventions

- Which CMake version line are you going to use?
- Call functions with UPPERCASE or lowercase names? (lowercase)
- Indentation
- Use `add_definitions` or `target_compile_definitions`? (the latter)
- Use QUIET with find_package.
- Package specific conventions (such as BOOST_ALL_NO_LIB for Boost)
- …

# Dependencies the Wrong Way

- Build each repository in isolation and generate its binaries along with a CMake config file.
- For each project that has dependencies, use ‘find_package’ to load the config file and use the library.

Problem 1: Too tedious. Updating a program implies recompiling its package and then every one of its dependencies manually.

Problem 2: The “export” mechanism used to do this only works with libraries at the base of the dependency graph.

# What we want…

- One build will build the project and all dependencies.
- *Only* required dependencies are built.
- The standard `find_package` libraries (Zlib, Boost, etc.) will also add the source to these to our build, if the source is there, instead of using system versions.

# Example project

```
all/CMakeLists.txt

all/gpc/base/CMakeLists.txt
all/gpc/xio/CMakeLists.txt
...

all/cwf/base/CMakeLists.txt
all/cwf/rf/CMakeLists.txt
all/cwf/rf/Foo.h
all/cwf/rf/Foo.cpp
...
```

# Outline of a CMakeLists.txt file

```
cmake_minimum_required(VERSION 3.1)

project( cwf_rf )

find_package(Boost COMPONENTS regex REQUIRED QUIET)

import( “cwf/base” )
import( “gpc/xio” )

add_library( cwf_rf
  Foo.h
  Foo.cpp
  # ...
)

target_include_directories(cwf_rf PUBLIC ../../ ${Boost_INCLUDE_DIRS})
target_compile_definitions(cwf_rf PUBLIC BOOST_ALL_NO_LIB)
target_link_libraries(cwf_rf
  cwf_base
  gpc_xio
  ${Boost_REGEX_LIBRARY}
)
set_target_properties(cwf_rf PROPERTIES FOLDER “cwf_rf")
```

# Poor man’s import

```
import( “cwf/base” )
```

⬇

```
if( NOT TARGET cwf_base )
  add_subdirectory( “../../cwf/base” “${CMAKE_BINARY_DIR}/cwf/base” )
endif()
```

# Fancy import implementation sketch

**import( <RelativePath> )**

- Use a stack to discover dependency loops.
- Use global properties to determine if a directory has already been added (see get_property function)
- Automatically figure out the binary directory to put the library build files into.
- Call add_subdirectory

**add_import_search_dir( <AbsolutePath> )**

- Add the specified path to the list of import search directories. Akin to “-I”.

# find_package fun

- The default find_package tool was intended to be used for precompiled libraries.
- This was a flawed intention. Lets fix it…

# Example project

```
all/CMakeLists.txt

all/gpc/base/CMakeLists.txt
all/gpc/xio/CMakeLists.txt
...

all/cwf/base/CMakeLists.txt
all/cwf/rf/CMakeLists.txt
all/cwf/rf/Foo.h
all/cwf/rf/Foo.cpp
...

all/zlib/CMakeLists.txt
...

all/CMakeModules/FindZLIB.cmake
```

# all/CMakeLists.txt

```
cmake_minimum_required(VERSION 3.1)

project(all)

list(APPEND CMAKE_MODULE_PATH
  ${CMAKE_CURRENT_SOURCE_DIR}/CMakeModules
)

# ...
```

# all/CMakeModules/FindZLIB.cmake

```
if( NOT TARGET zlib)
  add_subdirectory( “../zlib” “${CMAKE_BINARY_DIR}/zlib” )
endif()

set( ZLIB_INCLUDE_DIRS
  "${CMAKE_CURRENT_SOURCE_DIR}/../zlib”
  “${CMAKE_BINARY_DIR}/zlib”
)
set( ZLIB_LIBRARIES zlib )
set( ZLIB_FOUND TRUE )

set( ZLIB_VERSION_STRING “1.2.8” )
# …
```

# Notes on customized find modules

- Customized find modules must match semantics of original.
  (cmake --help-module FindZLIB).
- Making find modules that work with other build systems requires some more work...

# Special Cases (like Boost & Qt)

Two options:

1. Write CMakeLists.txt files to build the project.
2. Wrap the other build system.

# Notes on wrapping other build systems.

General process:

- Use globbing to construct a list of all the files that are required to build the foreign target.
- Use results of find_package to configure the foreign build system to use libraries generated by CMake.
- Create a custom command and custom target that executes the build. The command is declared to generate the libraries it generates.
- Create an empty library that depends on the library's dependencies.
- Make the custom target depend on the dependency transfer target.
- Use CMake's "client requirements" feature to make users of the custom target link to the libraries it generates.

# Selectively Enabling Projects

- With a large set of projects, it’s nice to select a subset.
    - Quicker build and dependency checking.
- CMake doesn’t have a way to do that.
    - Lets make it happen!

# all/CMakeLists.txt

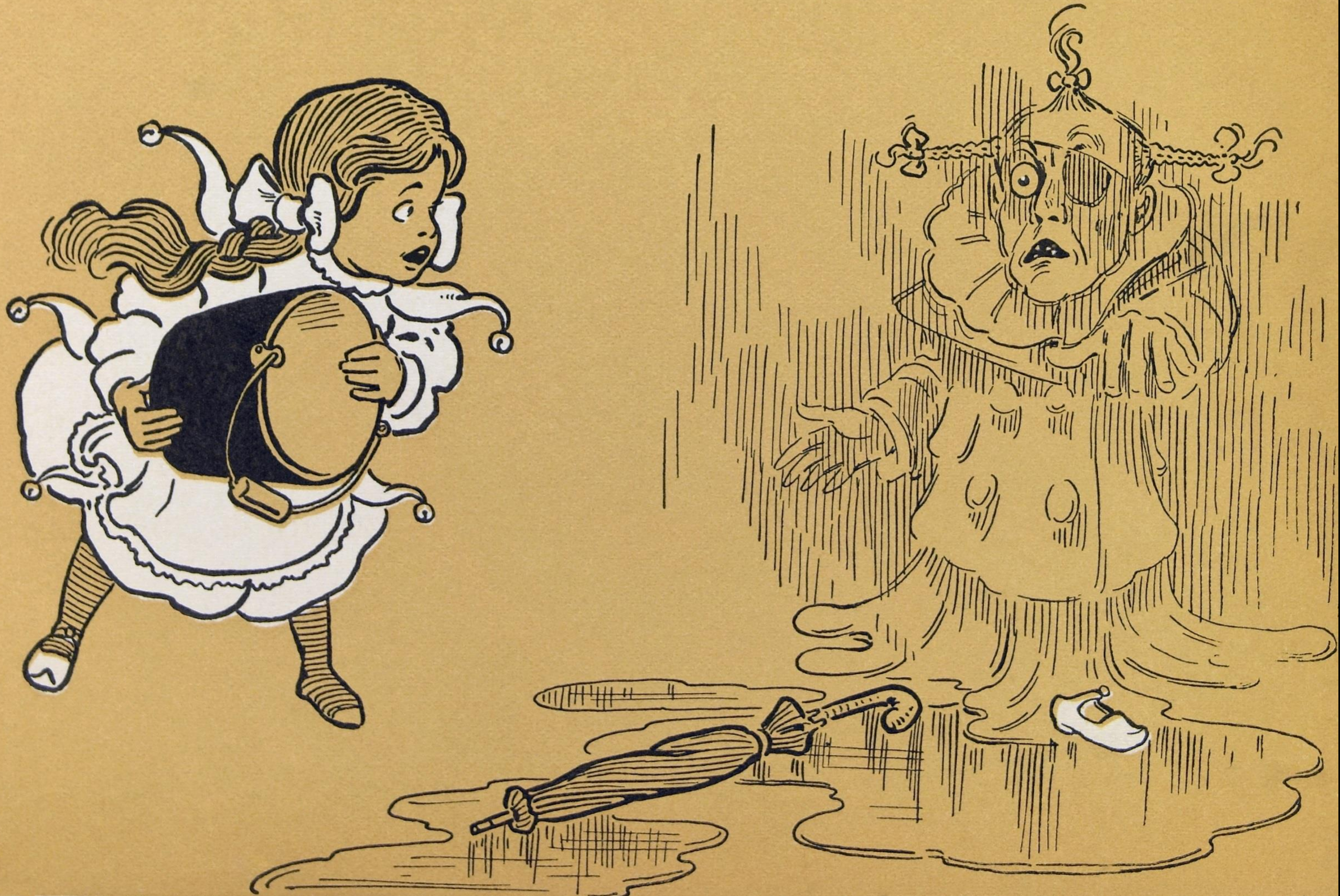
```
cmake_minimum_required(VERSION 3.1)

project(all)

list(APPEND CMAKE_MODULE_PATH
  ${CMAKE_CURRENT_SOURCE_DIR}/CMakeModules
)

file( GLOB project_files
  "${CMAKE_CURRENT_SOURCE_DIR}/*/Project.cmake“
)

foreach( project_file ${project_files} )
  include( ${file} )
endforeach()
```

# all/gpc/Project.cmake

```
option( all_gpc_enable “Enable GPC" FALSE )
if( ${all_gpc_enable} )
  import( “gpc” )
endif()
```

# CMake misc. takeaways

- Enforcement of strict conventions is very important.
- It does the job and, when done carefully, can be pretty nice.



# Some Results from Stellar Science

- System in use now with >40 active developers on dozens of projects.
- Contributions to Open Source projects are frequent.
- Multi-platform development and multi-platform deployment is the rule more often than the exception.

CMake and Git…

Mind your manners.