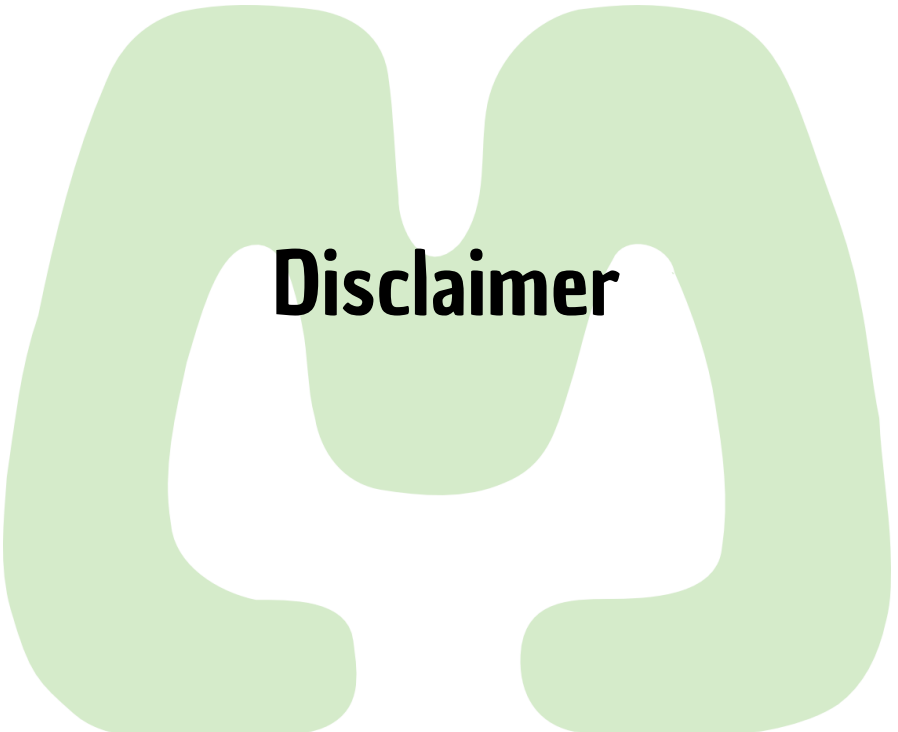
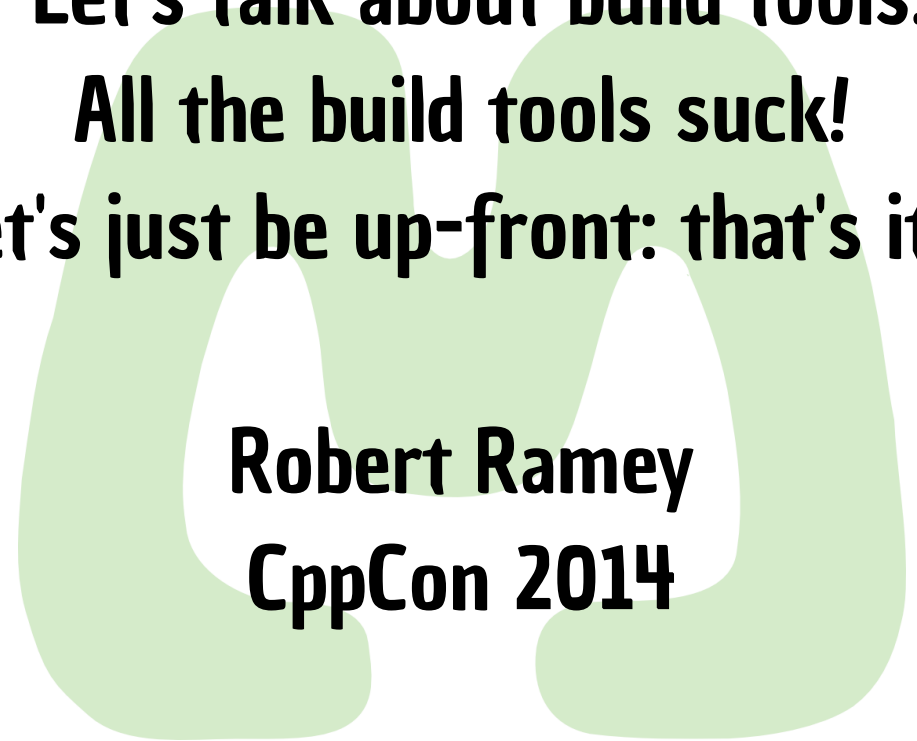
Making build systems not suck!

Jussi Pakkanen
jpakkane@gmail.com
@jpakkane
https://github.com/jpakkane/meson



Disclaimer

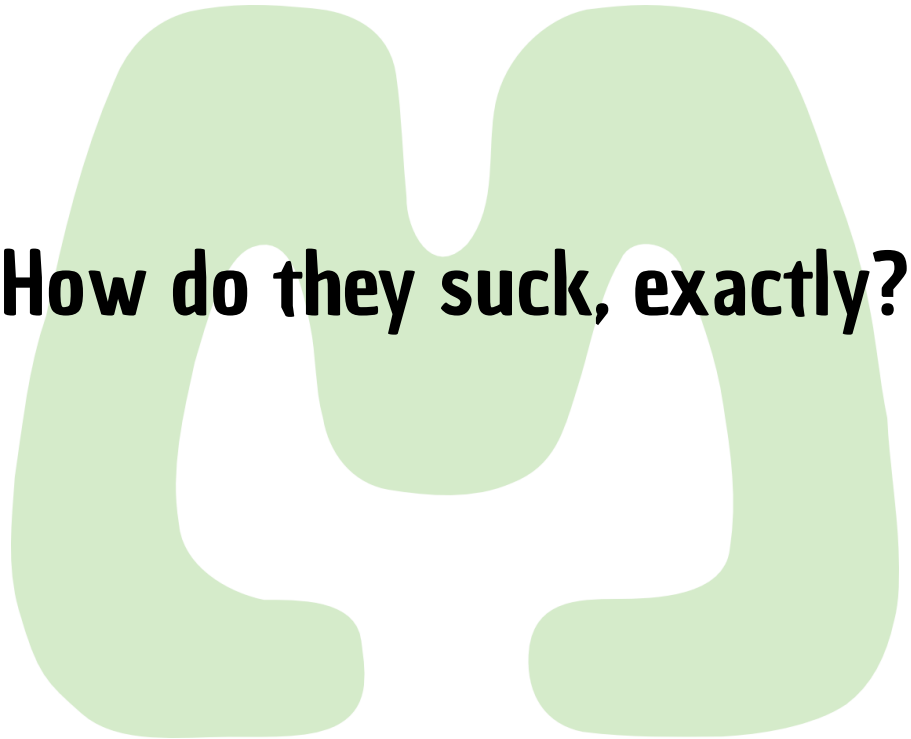
https://github.com/jpakkane/meson



"Let's talk about build tools:
All the build tools suck!
Let's just be up-front: that's it!"

Robert Ramey
CppCon 2014

https://github.com/jpakkane/meson



How do they suck, exactly?

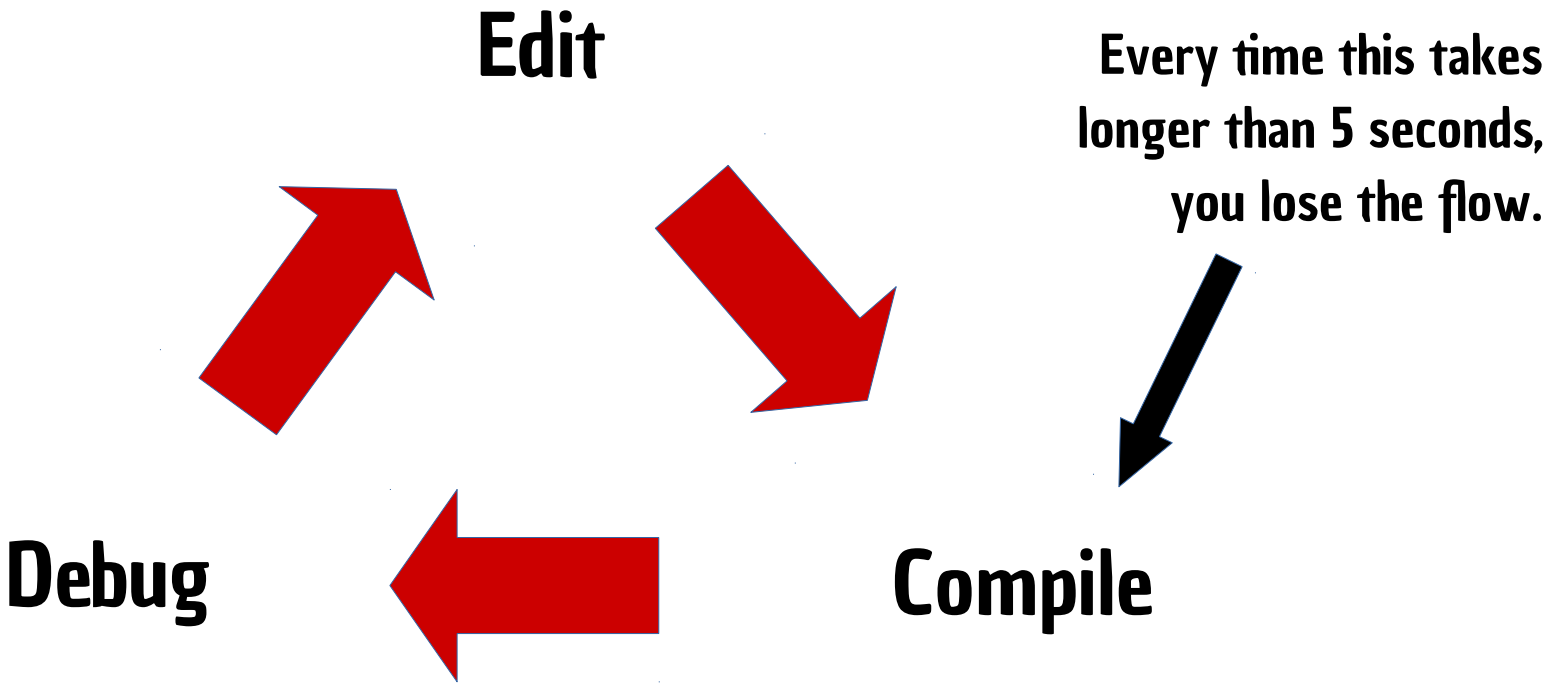
https://github.com/jpakkane/meson

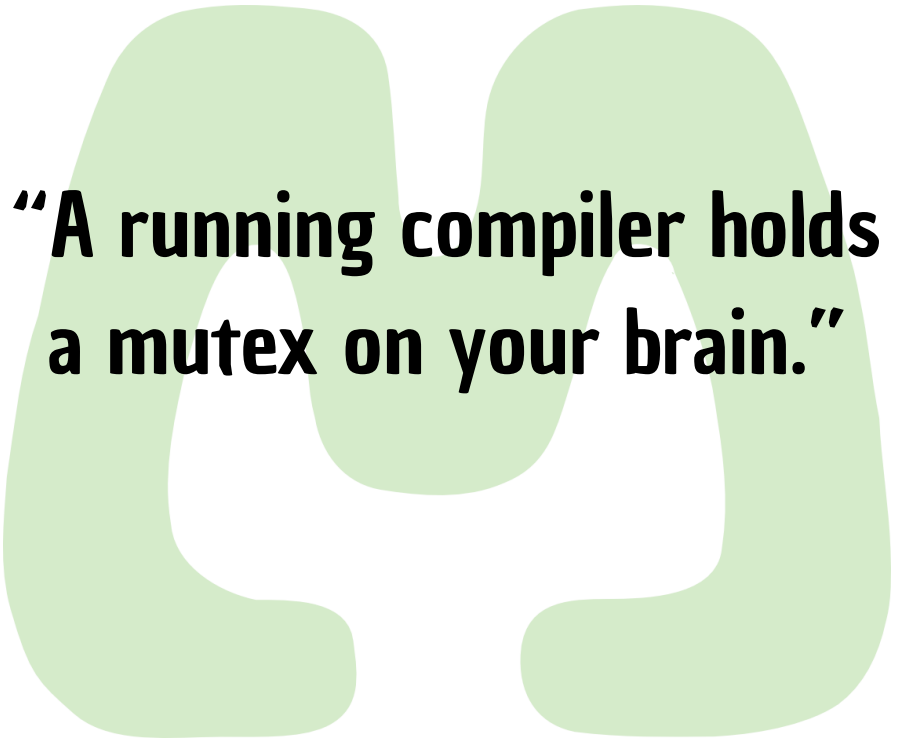
Productivity is all about the Flow

- originally coined by Mihály Csíkszentmihályi
- intense focus arising from lack of distractions
- hard to achieve (>30 minutes), easy to lose
- impossible to achieve with noisy offices, bad tools or irritating coworkers

https://github.com/jpakkane/meson

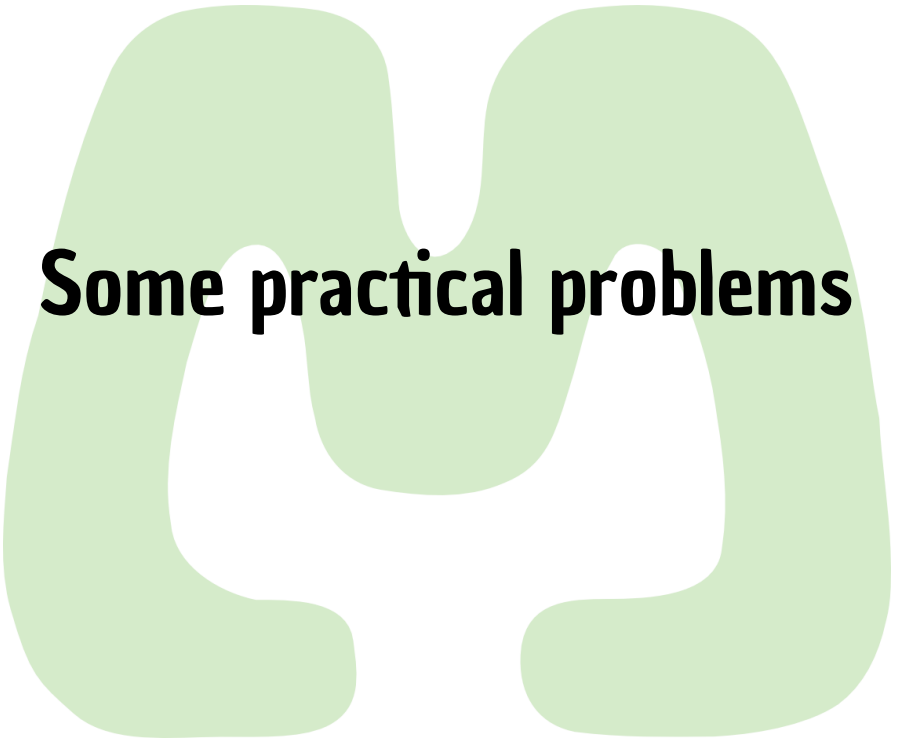
The programmer's eternal cycle





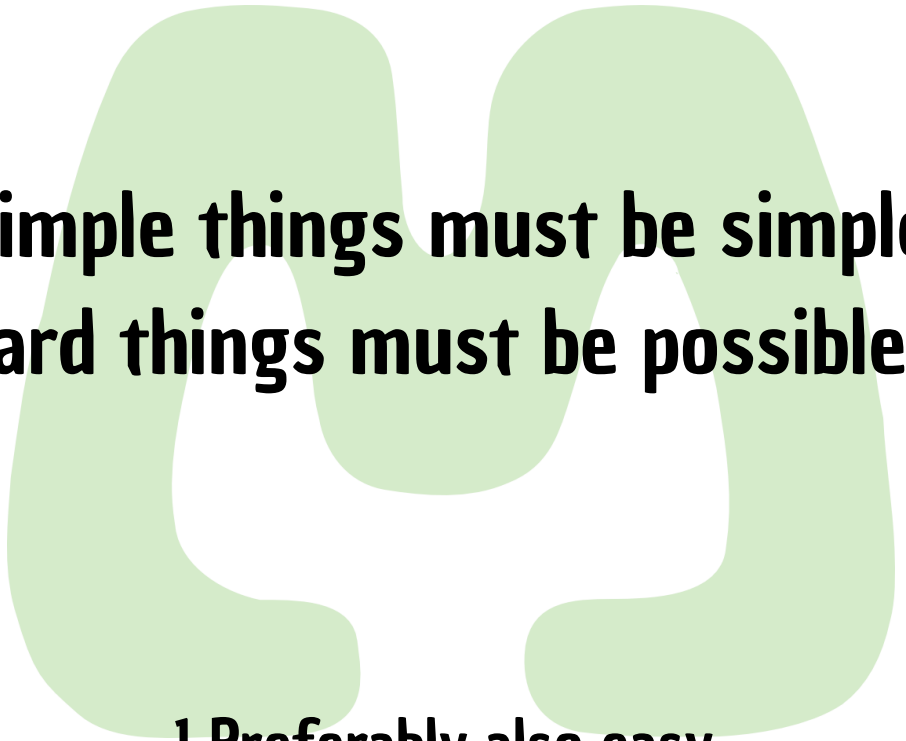
“A running compiler holds
a mutex on your brain.”

https://github.com/jpakkane/meson



Some practical problems

https://github.com/jpakkane/meson



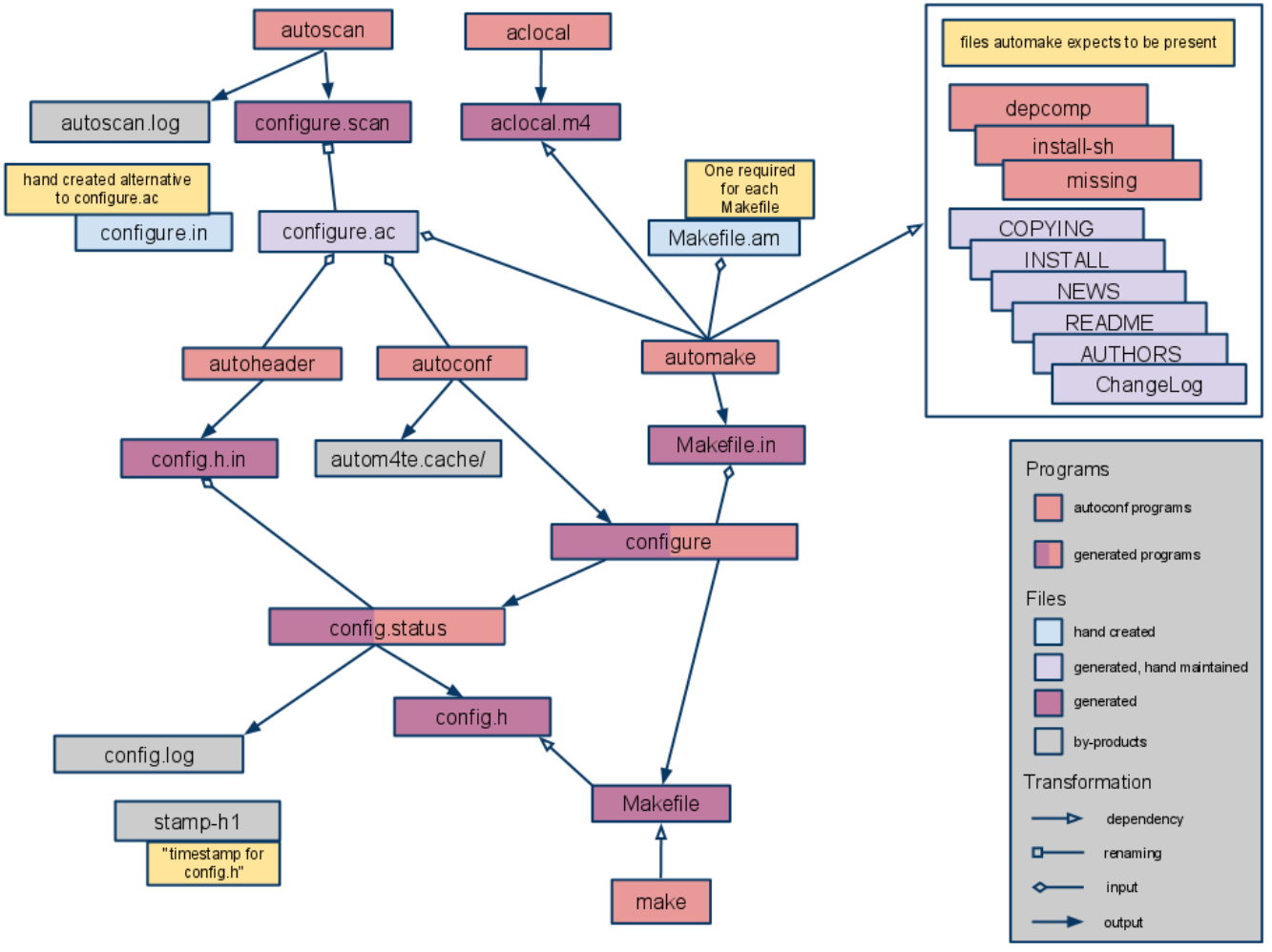
Simple things must be simple,
hard things must be possible[1].

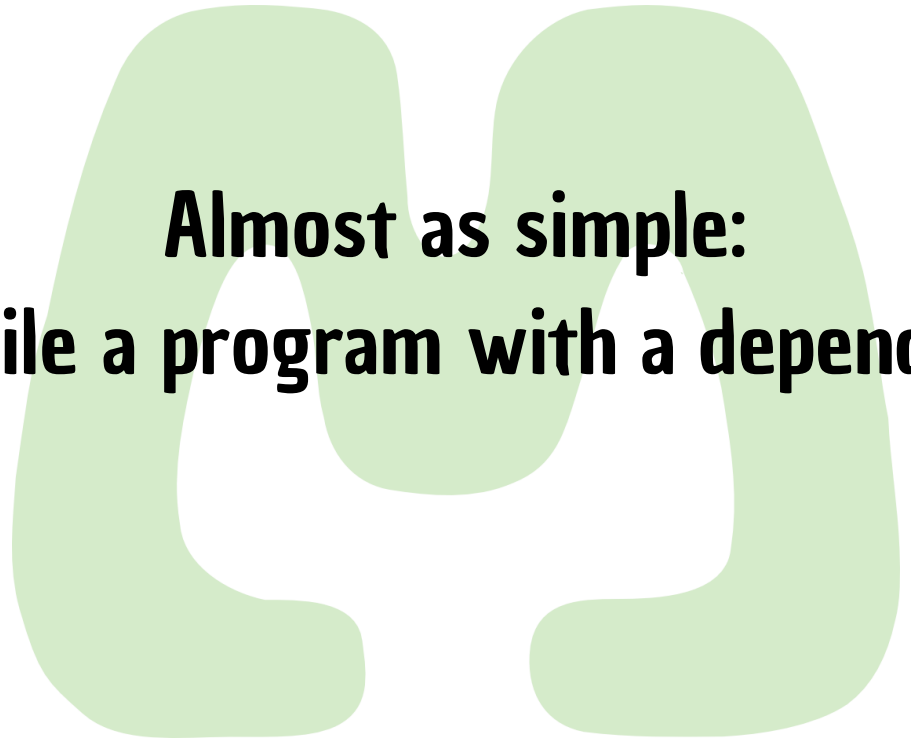
[1] Preferably also easy.

https://github.com/jpakkane/meson

Simplest possible case: build helloworld

https://github.com/jpakkane/meson


autoscan
aclocal
autoscan.log
configure.scan
aclocal.m4
hand created alternative to configure.ac
configure.in
configure.ac
One required for each Makefile
Makefile.am
files automake expects to be present
depcomp
install-sh
missing
COPYING
INSTALL
NEWS
README
AUTHORS
ChangeLog
autoheader
autoconf
automake
config.h.in
autom4te.cache/
Makefile.in
configure
config.status
config.h
config.log
stamp-h1
"timestamp for config.h"
Makefile
make
Programs
autoconf programs
generated programs
Files
hand created
generated, hand maintained
generated
by-products
Transformation
dependency
renaming
input
output



Almost as simple:
compile a program with a dependency

https://github.com/jpakkane/meson

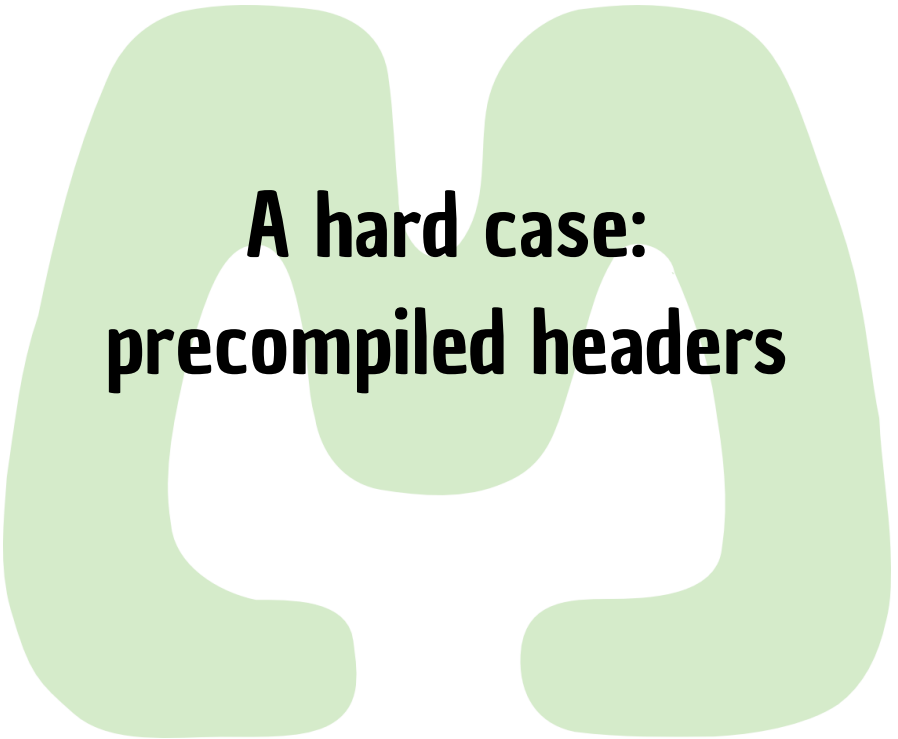
A common pattern with CMake

```
project(sampleapp C)
cmake_minimum_required(VERSION 2.8.9)
include(FindPkgConfig)
pkg_search_module(GTK3 gtk+-3.0)
include_directories(${GTK3_INCLUDE_DIRS})
add_executable(sampleapp sampleapp.c)
target_link_libraries(sampleapp ${GTK3_LIBRARIES})
```

BUG!

BUG!

BUG!



A hard case: precompiled headers

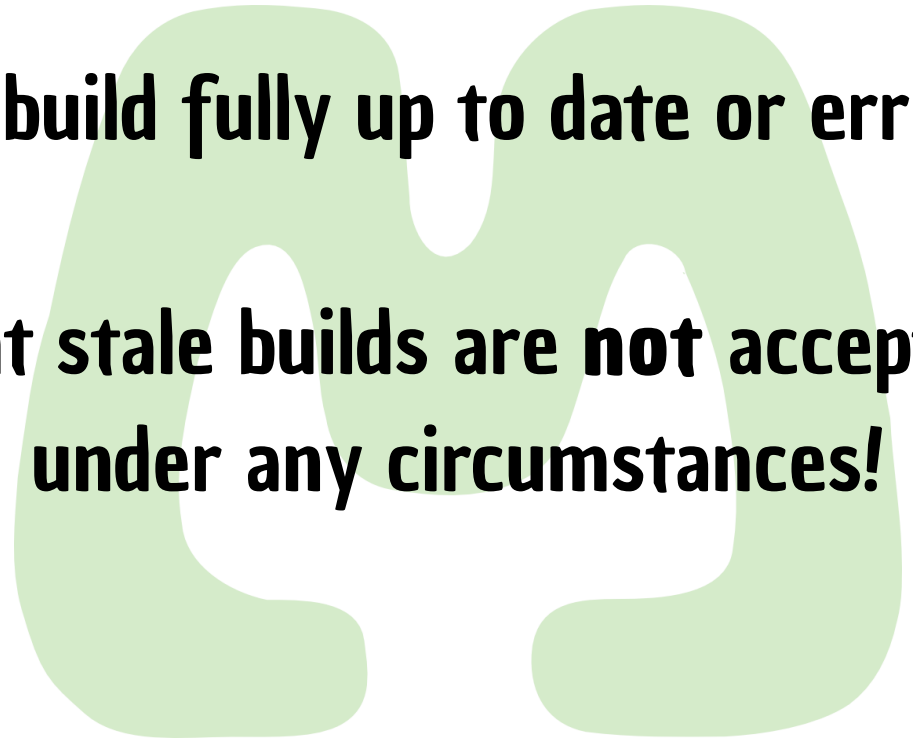
https://github.com/jpakkane/meson

http://public.kitware.com/Bug/view.php?id=1260

(0014943) **Brad King** (manager) 2009-02-16 09:30	Sorry, but doing this right as a first-class feature is very non-trivial. Every platform does PCH differently, so it is hard to define a common interface. It is probably possible, but we've not had the motivation/time /funding to do it. Currently CMake does provide enough primitives for projects to do it themselves on each platform. For example, the OBJECT_OUTPUTS and OBJECT_DEPENDS properties can be used to do MSVC-style PCH dependencies in Makefile generators. Custom commands can achieve gcc-style PCH. I think the contributed scripts attached to this bug help with some of this.

Design goals to not sucking.

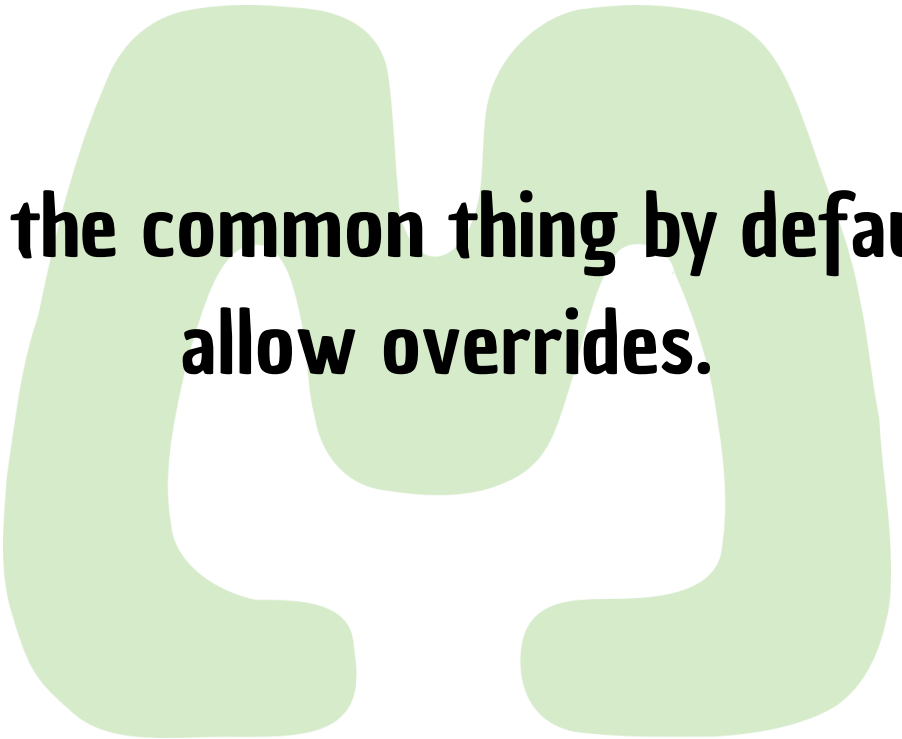
https://github.com/jpakkane/meson



Either build fully up to date or error out.

Silent stale builds are **not** acceptable
under any circumstances!

https://github.com/jpakkane/meson



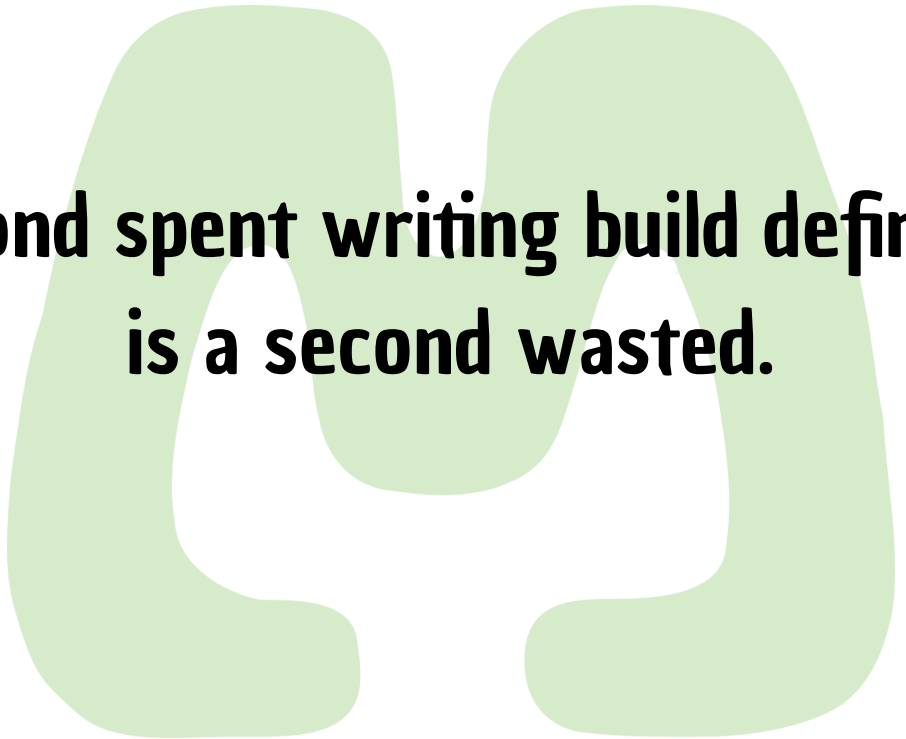
Do the common thing by default,
allow overrides.

https://github.com/jpakkane/meson

$$Syntax $$must $$not $$look
$$like $$line $$noise.

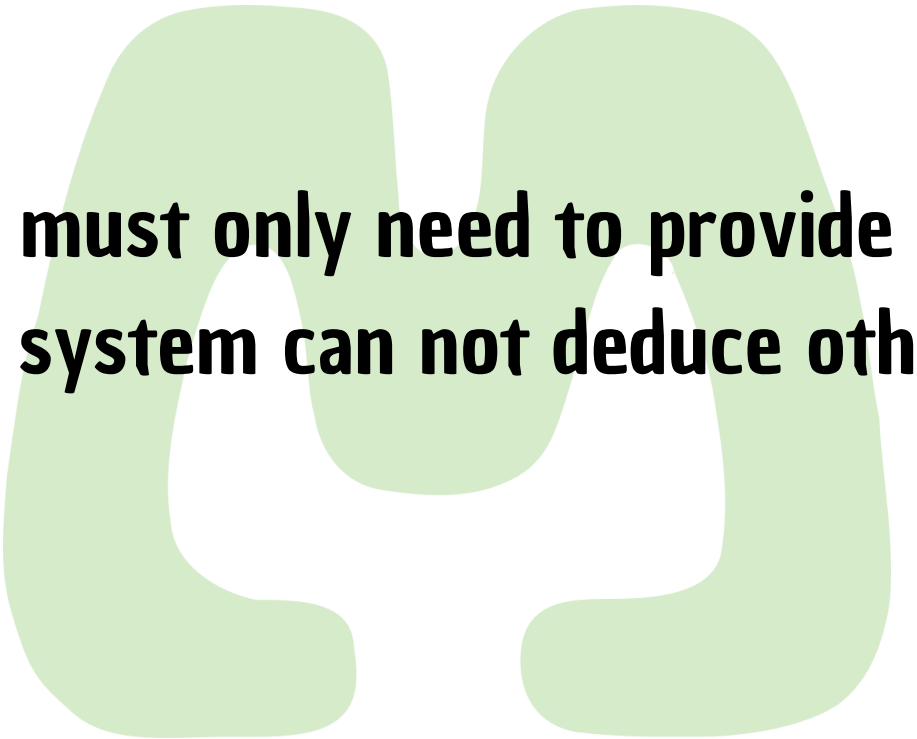
Addendum: no quoting hell ever!

https://github.com/jpakkane/meson



A second spent writing build definitions
is a second wasted.

https://github.com/jpakkane/meson



User must only need to provide info
that the system can not deduce otherwise.

https://github.com/jpakkane/meson

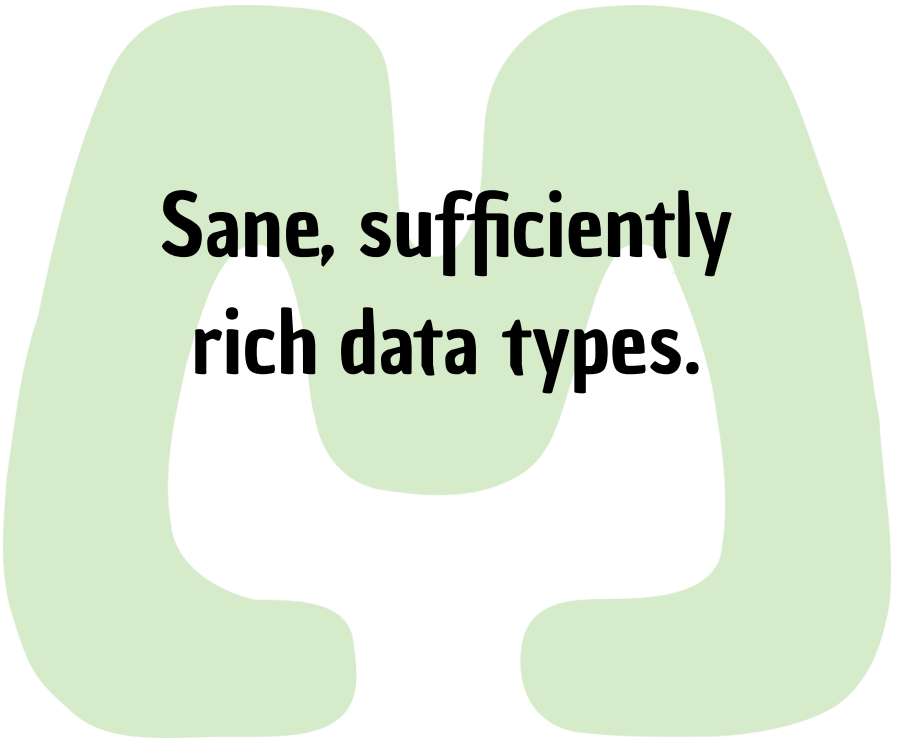
Minimize global state

https://github.com/jpakkane/meson

Build speed is essential!

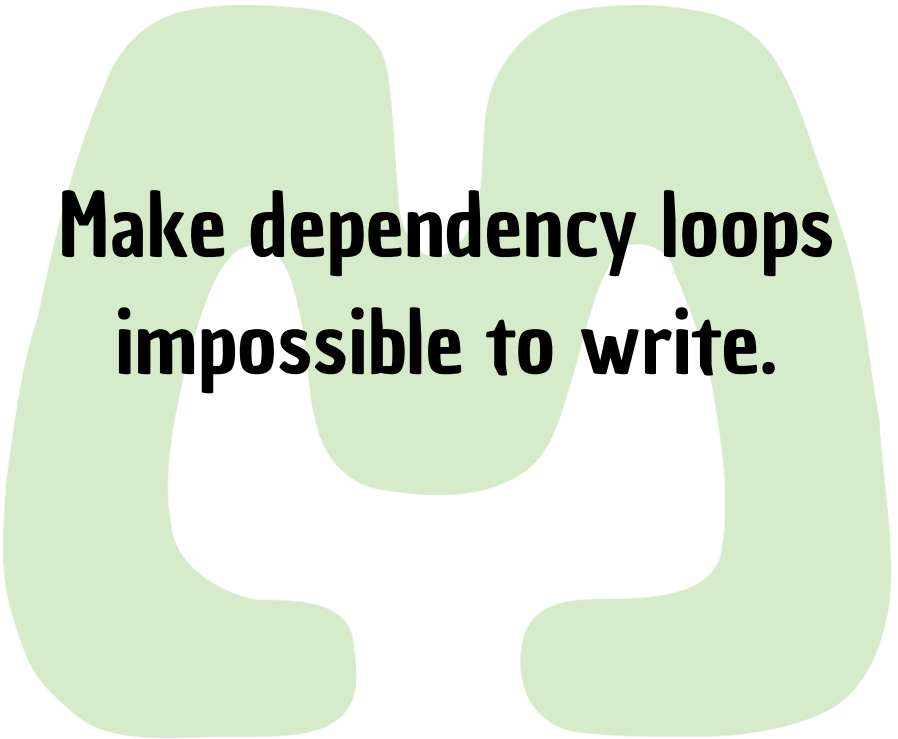
Dirty implementation tricks are OK
assuming they are reliable and
don't leak to the interface.

https://github.com/jpakkane/meson



Sane, sufficiently
rich data types.

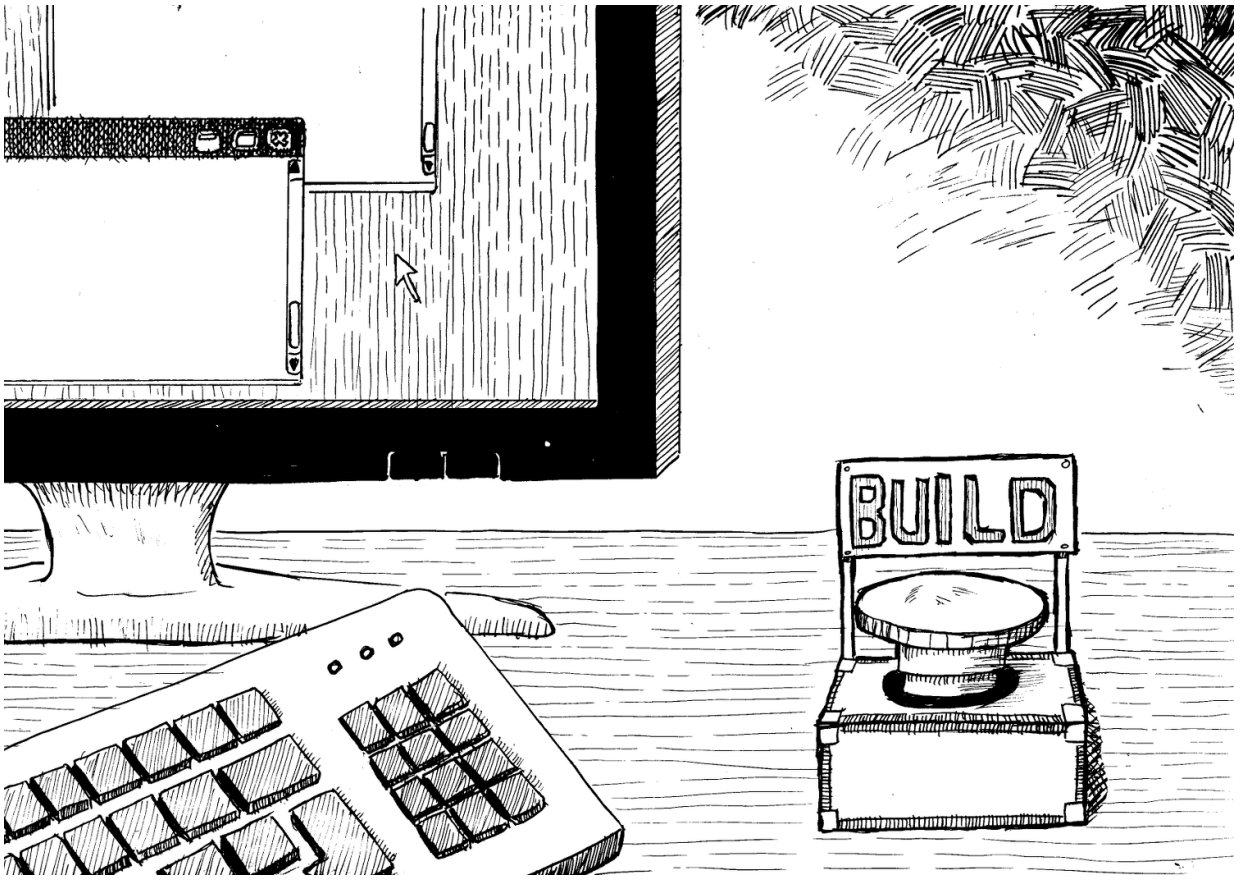
https://github.com/jpakkane/meson

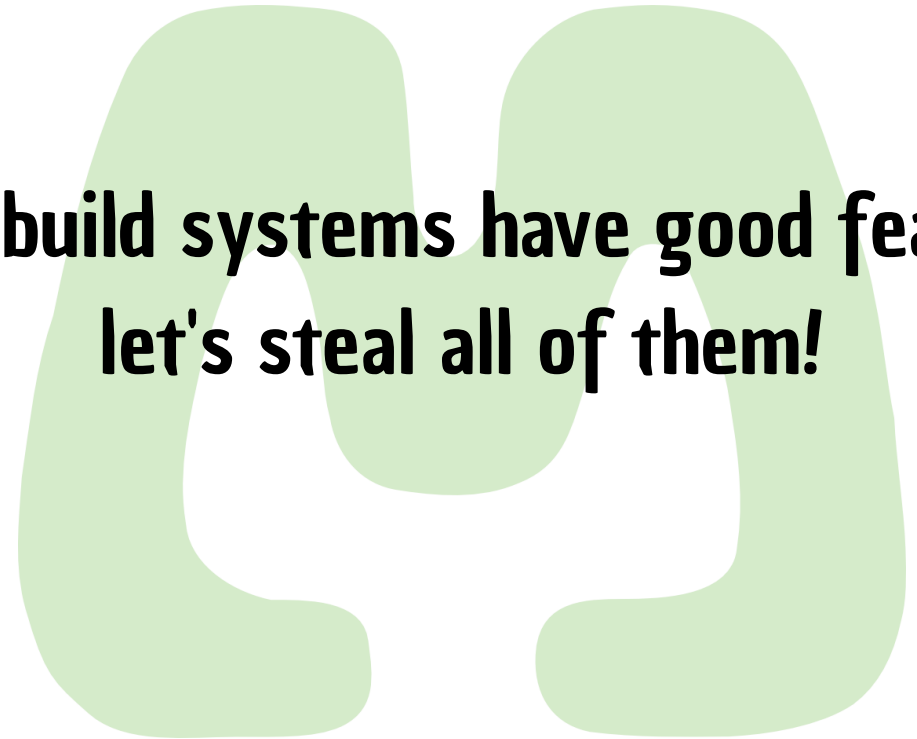


Make dependency loops
impossible to write.

https://github.com/jpakkane/meson

User experience should be roughly this

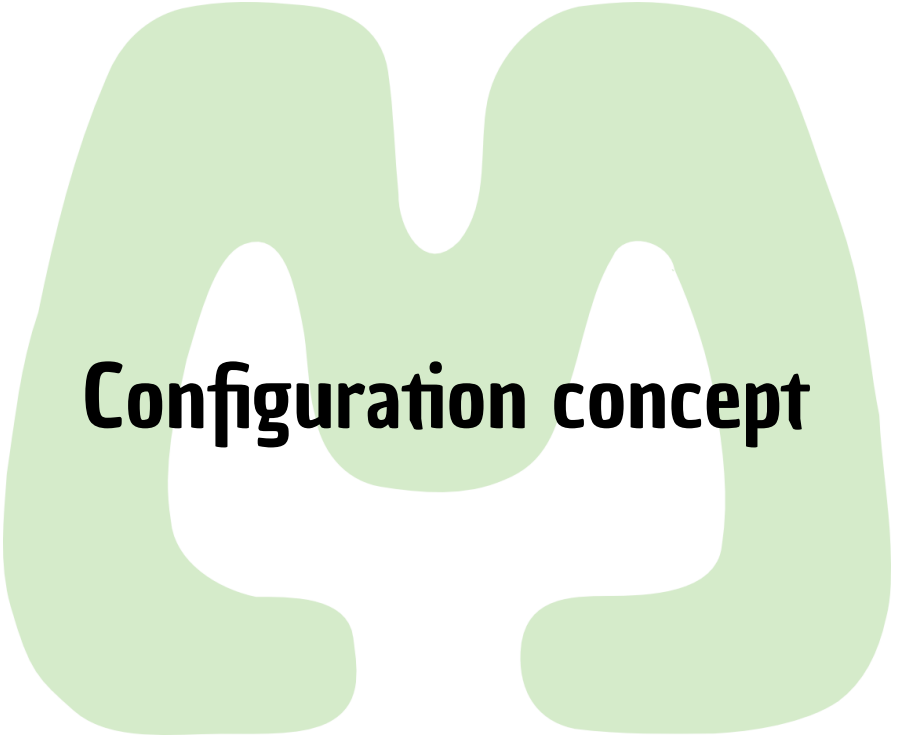




Other build systems have good features,
let's steal all of them!

https://github.com/jpakkane/meson

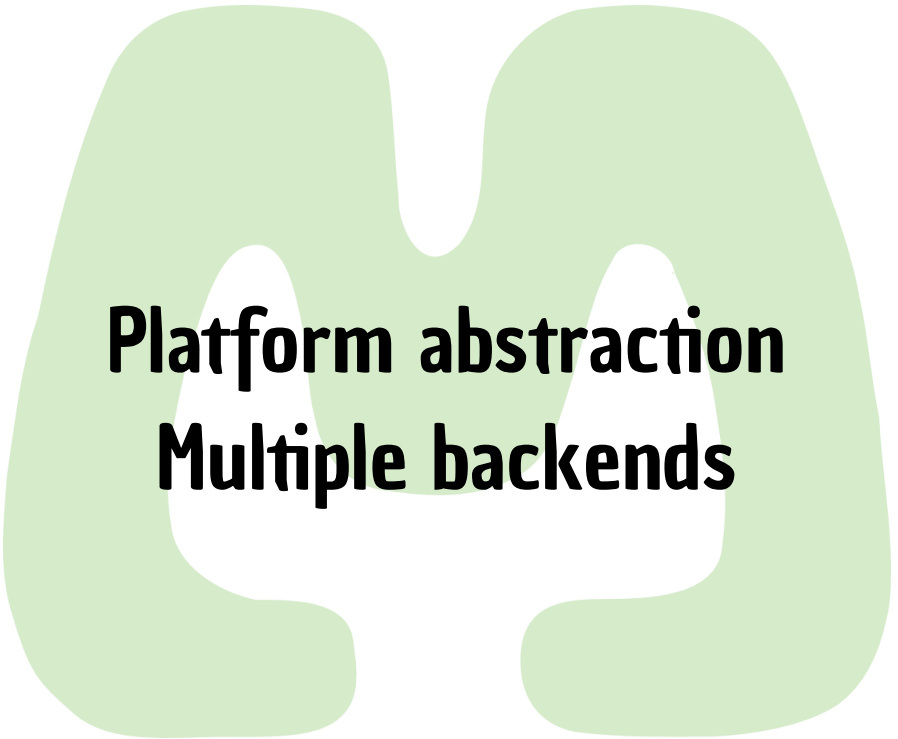
GNU Autotools



Configuration concept

https://github.com/jpakkane/meson

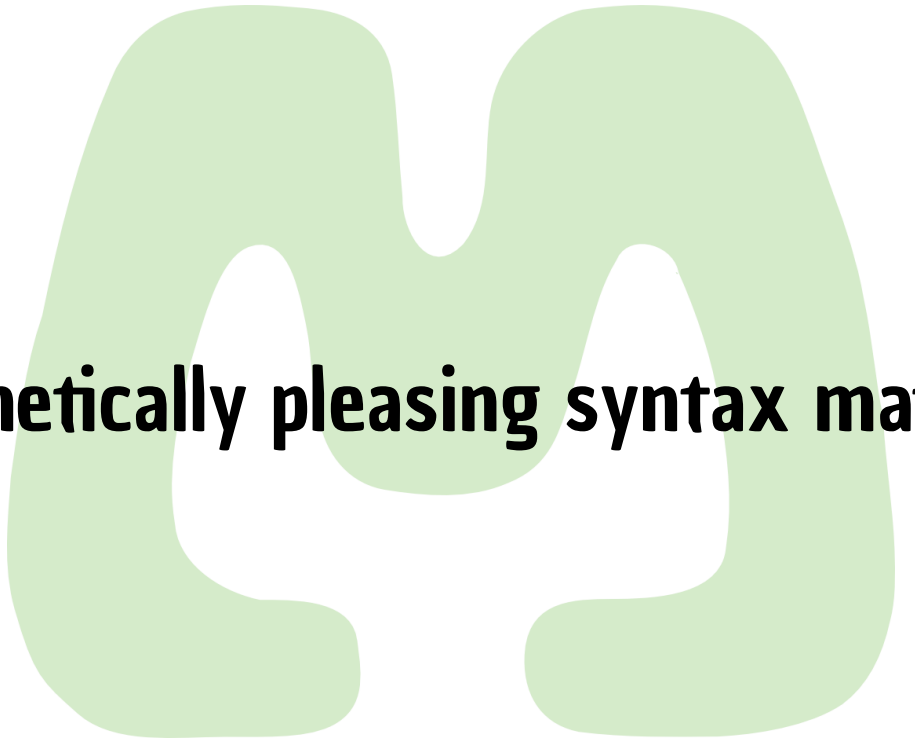
CMake



Platform abstraction
Multiple backends

https://github.com/jpakkane/meson

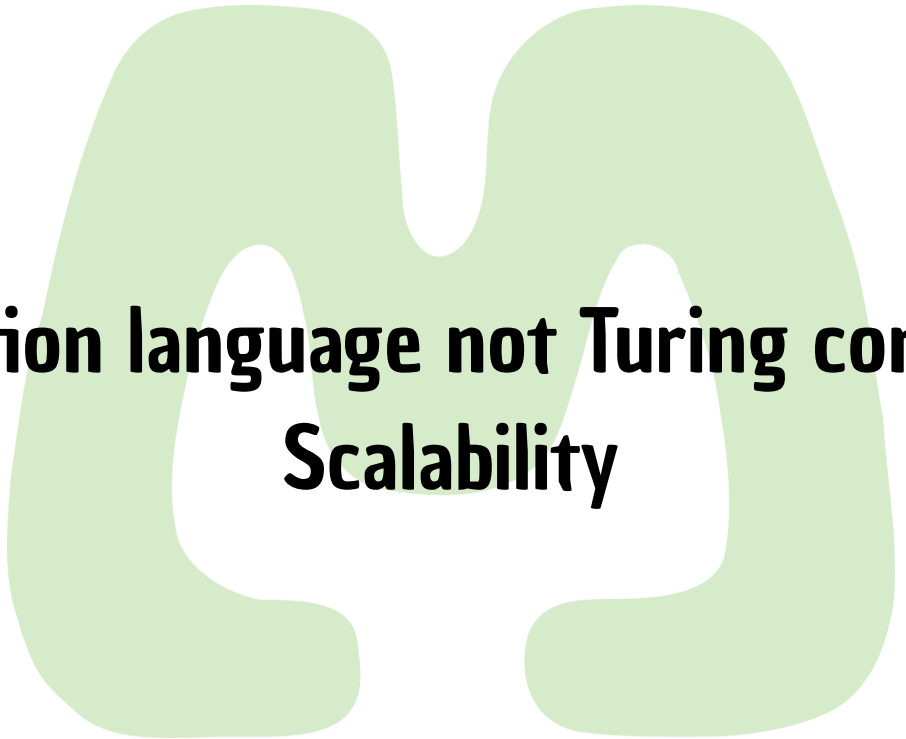
SCons



Aesthetically pleasing syntax matters

https://github.com/jpakkane/meson

GYP



Definition language not Turing complete

Scalability

https://github.com/jpakkane/meson

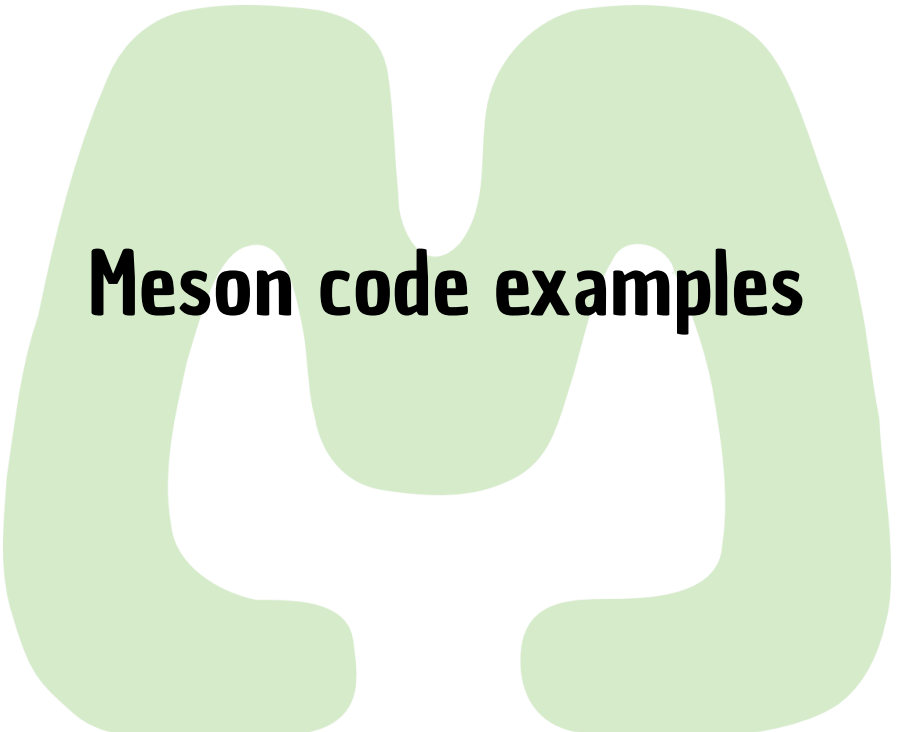
QMake/QBS

Native Qt support

https://github.com/jpakkane/meson

By your powers combined, come I:

The Meson Build system



Meson code examples

https://github.com/jpakkane/meson

The helloworld

```
project('sample project', 'c')
executable('prog', 'sample.c')
```

https://github.com/jpakkane/meson

What do these two lines get you?

- build on Linux, OSX, Windows, others
- compiler warnings enabled by default
- different build types (debug, optimized etc)
- cross-compilation
- outputs are native binaries, produced by the native toolchain

https://github.com/jpakkane/meson

Using a dependency

```
project('dep sample', 'c')
gtk3_dep = dependency('gtk+-3.0')
executable('gtkprog', 'gsample.c',
 dependencies : gtk3_dep)
```

https://github.com/jpakkane/meson

Unit tests

```
project('sample', 'c')
exe = executable('sample', 'sample.c')
test('simple test', exe)
```

https://github.com/jpakkane/meson

Precompiled headers

```
project('sample', 'cpp')
exe = executable('sample', 'sample.cc',
 cpp_pch : 'pch/sample_pch.h')
```

Compilation time for simple Qt5 dbus tool on Ubuntu phone went from 2 minutes to 55 seconds.

https://github.com/jpakkane/meson

A real world example

- a C++ shared library that uses GLib
- unit test
- install
- create a pkg-config file

https://github.com/jpakkane/meson

Top level

```
project('c++ foolib', 'cpp')

add_global_arguments('-std=c++11', language : 'cpp')
glib_dep = dependency('glib-2.0')

inc = include_directories('include')

subdir('include')
subdir('src')
subdir('test')
```

include subdir

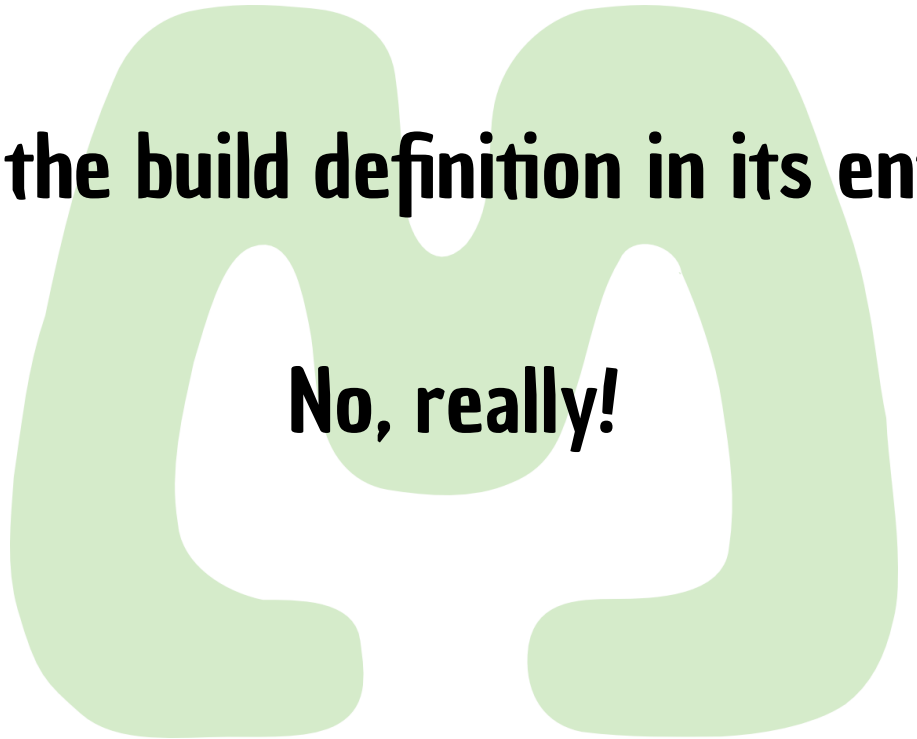
```
install_headers('foolib.h')
```

src subdirectory

```
foolib = shared_library('foo', 'source1.cpp', 'source2.cpp',
                        include_directories : inc,
                        dependencies : glib_dep,
                        install : true)
pkgconfig_gen(libraries : foolib,
              version : '1.0',
              name : 'libfoobar',
              filebase : 'foobar',
              description : 'A Library to barnicate your foos.')
```

test subdirectory

```
testexe = executable('testexe', 'footest.cpp',
                     include_directories : inc,
                     link_with : foolib)
test('foolib test', testexe)
```



That's the build definition in its entirety.

No, really!

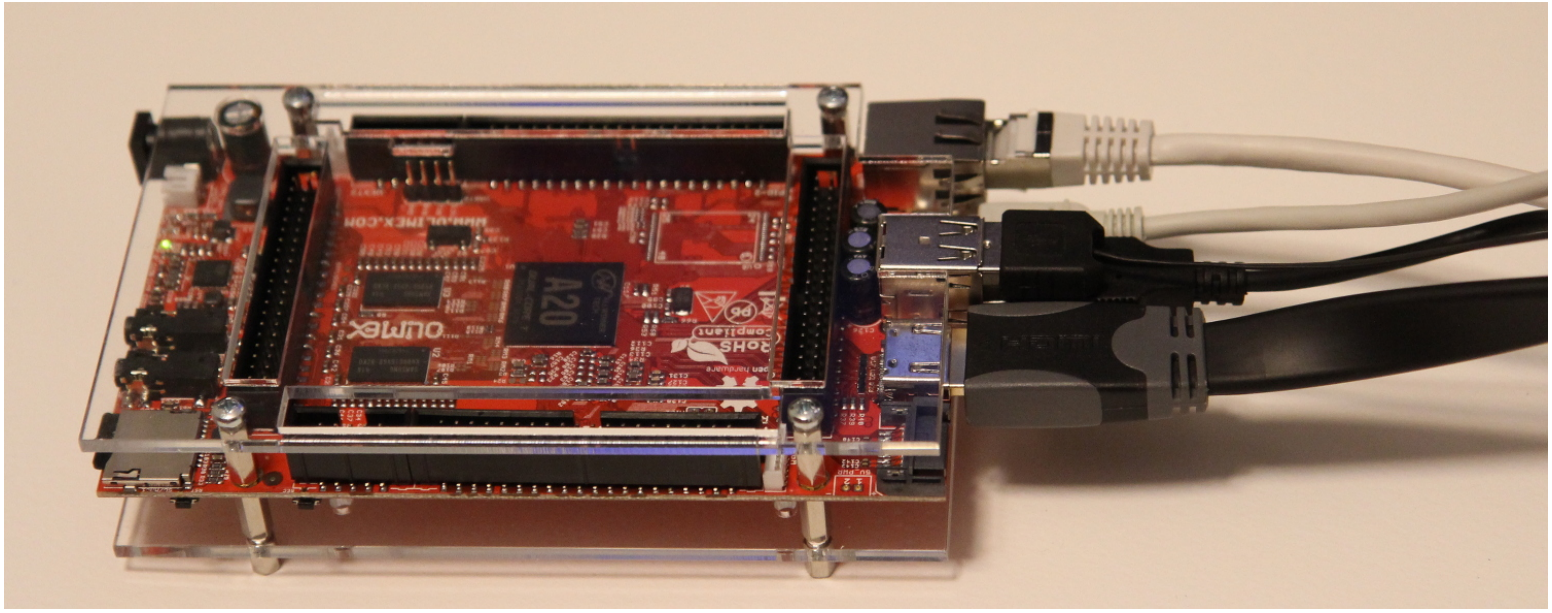
https://github.com/jpakkane/meson

Oh, and one more thing ...

```
project('qt5 sample', 'cpp')

qt5dep = dependency('qt5', modules : 'Widgets')

q5exe = executable('qt5app',
 sources      : ['main.cpp', 'mainWindow.cpp']
 moc_headers  : 'mainWindow.h',
 ui_files     : 'mainWindow.ui',
 qresources   : 'stuff.qrc',
 dependencies : qt5dep)
```

https://github.com/jpakkane/meson

Performance experiment: Compiling GLib (without GIO)



GLib configuration times

- CFLAGS='-O0 -g' CXXFLAGS='-O0 -g' ./autogen.sh
  - 5 minutes
- default settings for Meson
  - 24 seconds

https://github.com/jpakkane/meson

GLib full build times

- make -j 2 for Autotools
  - 4m 55s
- ninja -j 2 for Meson
  - 1m 28s
- CAVEAT: Meson builds slightly less code

https://github.com/jpakkane/meson

GLib incremental build times

- rebuild with no changes
  - 3s for Autotools
  - 0.062s for Meson
- rebuild after "touch glib/gprintf.c"
  - 1m 18s for Autotools
  - 1.1s for Meson

https://github.com/jpakkane/meson

Desktop performance

- configuration step usually <5 seconds
- no-op build time <1s even for >10k files
- full CPU saturation due to single Ninja process

https://github.com/jpakkane/meson

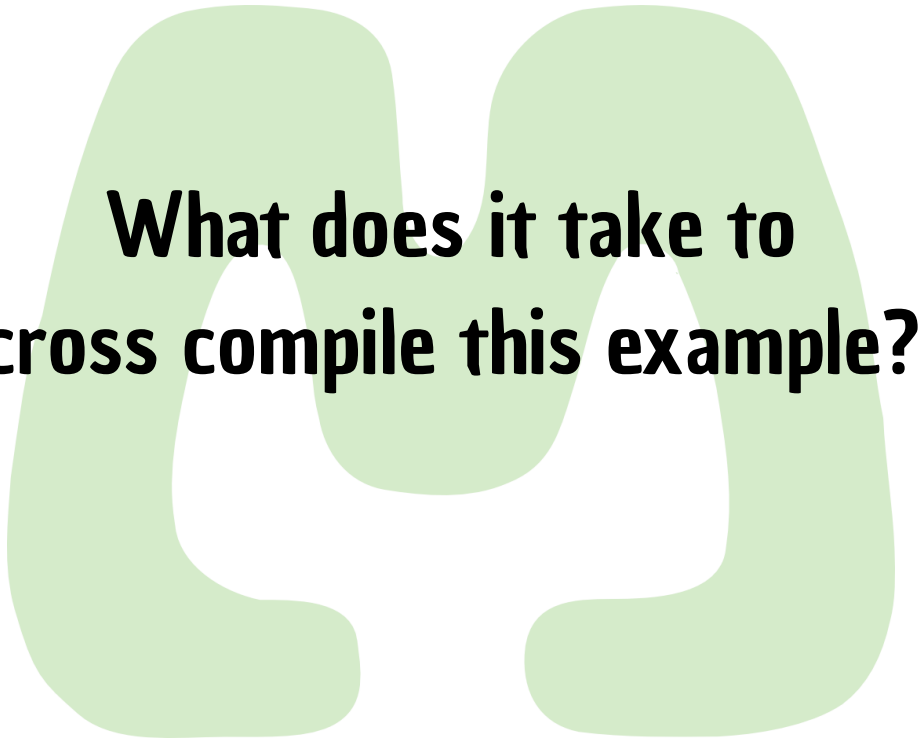
Advanced features

https://github.com/jpakkane/meson

Source generation

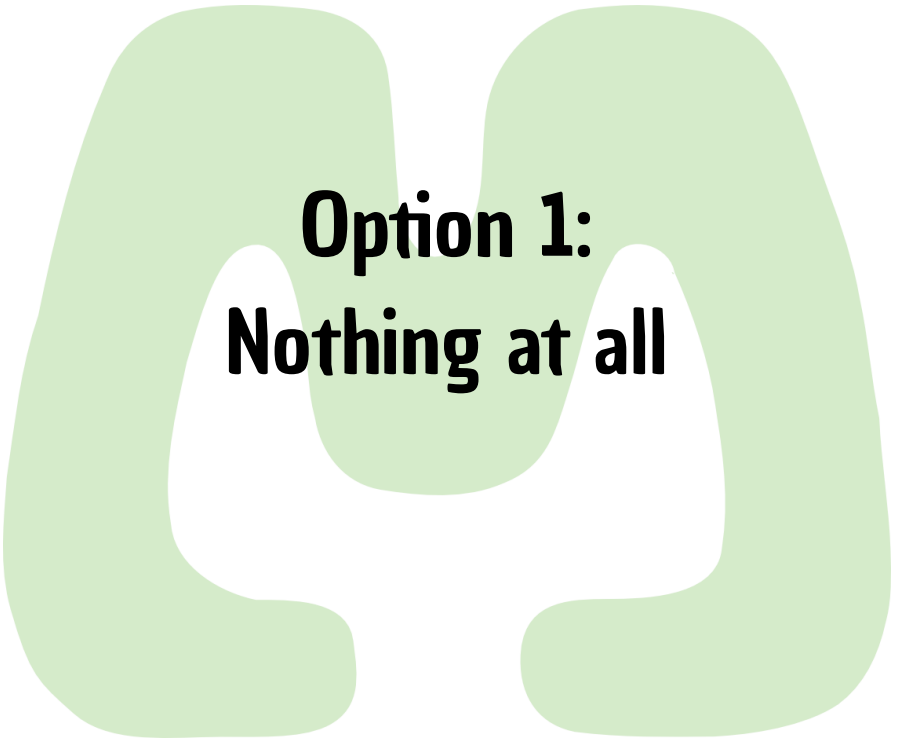
```
idlc = executable('idlcompiler', 'idlcompiler.c')

gen = generator(idlc,
 output  : ['@BASENAME@.h', '@BASENAME@.c'],
 arguments : ['@INPUT@', '@OUTPUT0@', '@OUTPUT1@'])

generated = gen.process('class1.idl', 'class2.idl', 'class3.idl')

e2 = executable('prog', 'prog.c', generated)
```

https://github.com/jpakkane/meson



What does it take to cross compile this example?

https://github.com/jpakkane/meson



Option 1:
Nothing at all

https://github.com/jpakkane/meson

Option 2

```
idlc = executable('idlcompiler', 'idlcompiler.c', native : true)

gen = generator(idlc,
 output  : ['@BASENAME@.h', '@BASENAME@.c'],
 arguments : ['@INPUT@', '@OUTPUT0@', '@OUTPUT1@'])

generated = gen.process('class1.idl', 'class2.idl', 'class3.idl')

e2 = executable('prog', 'prog.c', generated)
```

https://github.com/jpakkane/meson

Project options

- **strongly typed user-definable options**

```
option('testoption', type : 'string', value : 'optval',
       description : 'An option to do something')
option('combo_opt', type : 'combo', choices : ['one', 'two', 'combo'],
value : 'combo')
```

- **query and set from the command line**

```
mesonconf -Dcombo_opt=one
```

https://github.com/jpakkane/meson

Supported languages

- Tier 1: C, C++
- Tier 2: ObjC, ObC++, Fortran
- Tier 3: Java, C#, Vala, Rust

https://github.com/jpakkane/meson

Code quality

- over 100 unit tests
- each one is also documentation
- all new features must come with a test

https://github.com/jpakkane/meson

The most controversial feature

https://github.com/jpakkane/meson

No in-source builds

- Can only build out-of-source
- Arbitrarily many parallel builds for one source tree
- Turns out you can only reliably do in-source or out-of-source but not both
- Join the dark side, we have cookies

https://github.com/jpakkane/meson

Benefit of OSB: static analyzer

- **steps to analyze are the always the same**

```
mkdir scantmp && cd scantmp
scan-build meson ..
scan-build ninja
cd .. && rm -rf scantmp
```

https://github.com/jpakkane/meson

Run it with “ninja staticanalyze”

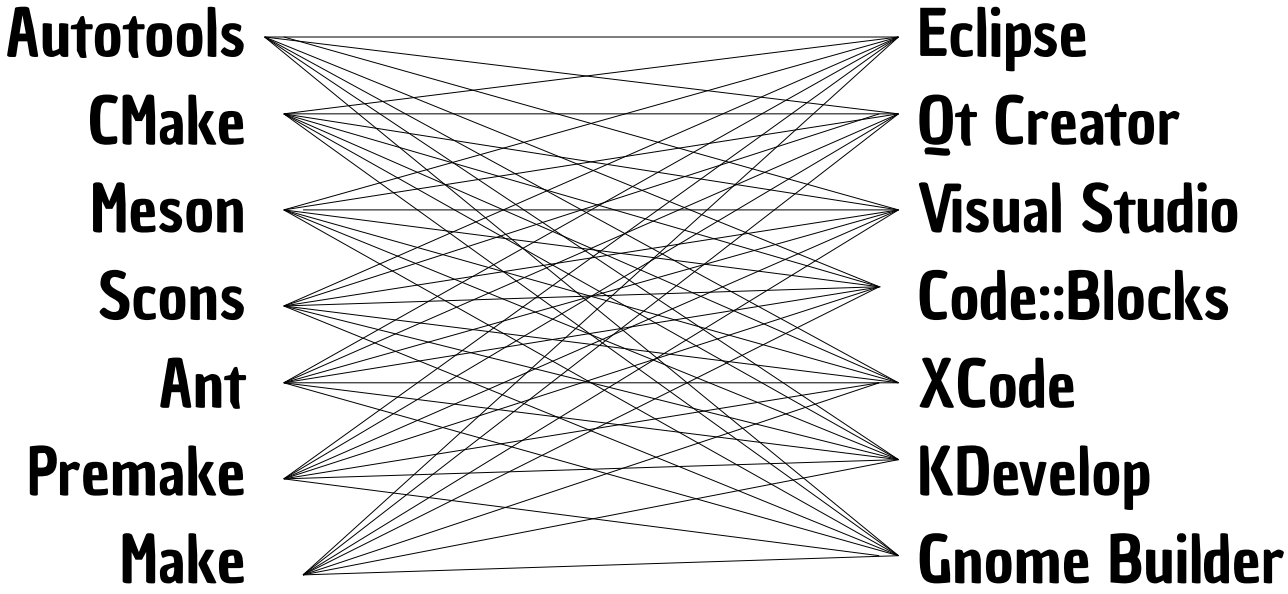
```
run_target('staticanalyze', 'scripts/staticanalyze.sh')
```

```
#!/bin/sh
cd “${MESON_SOURCE_ROOT}”
rm -rf scantmp
mkdir scantmp && cd scantmp
scan-build meson ..
scan-build ninja
cd .. & rm -rf scantmp
```

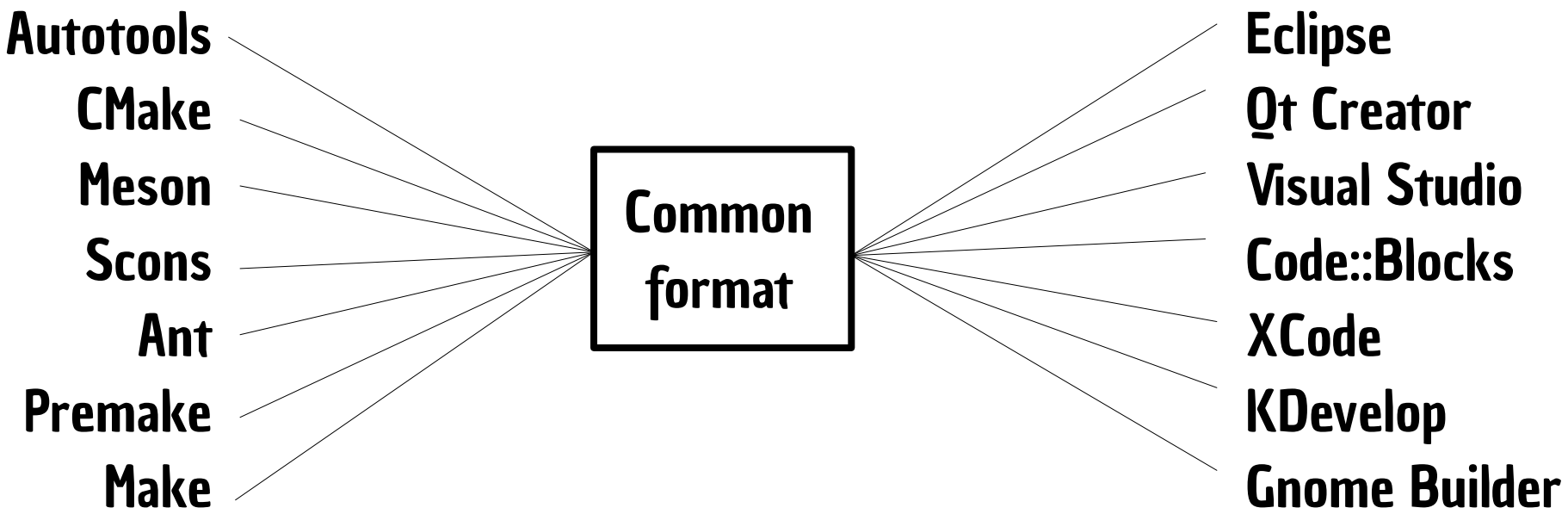
Impossible to achieve if build system allows in-source builds.

https://github.com/jpakkane/meson

The compatibility matrix hell



The obvious solution



Format details

- simple JSON schema for deep build system / IDE integration
- introspectable *everything*
  - projects, source files, targets, build flags, project options, unit tests including command line and environment variables
- right click on failed unit test, select "run in debugger"

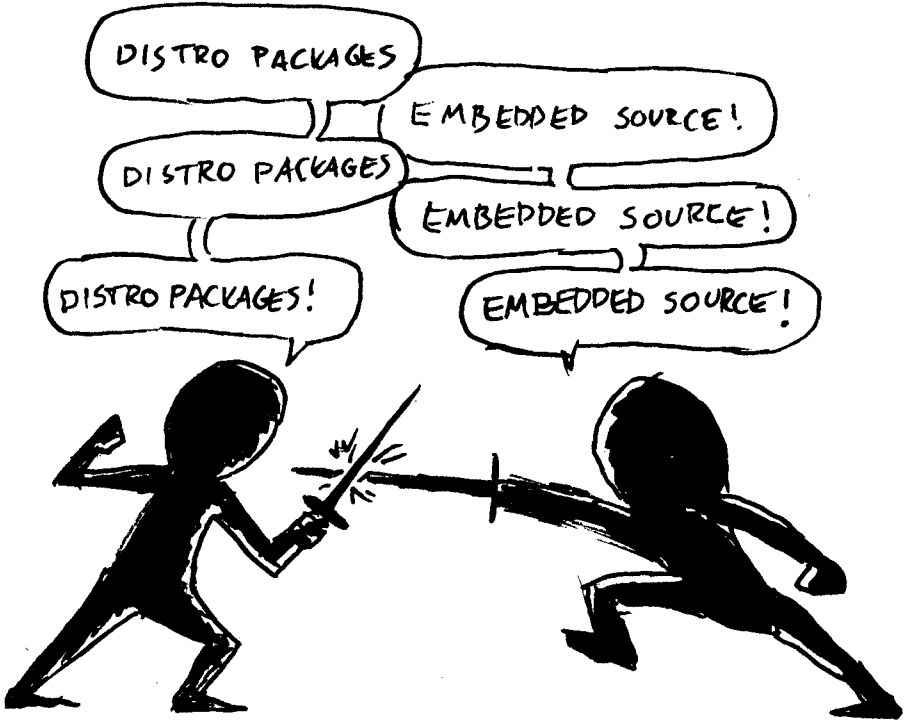
https://github.com/jpakkane/meson

What can you build with it?

- GLib
- Python 3
- Qt Creator
- SDL2
- Mesa 3D
- Mame
- Mozilla NSPR

https://github.com/jpakkane/meson

Distro packages vs embedded source



https://github.com/jpakkane/meson

Meson subprojects

- any Meson project can be used as a subproject
- becomes a sandboxed part of the parent's build
- projects can query if they are being used as subprojects
- "The Go Github thing" but with C/C++

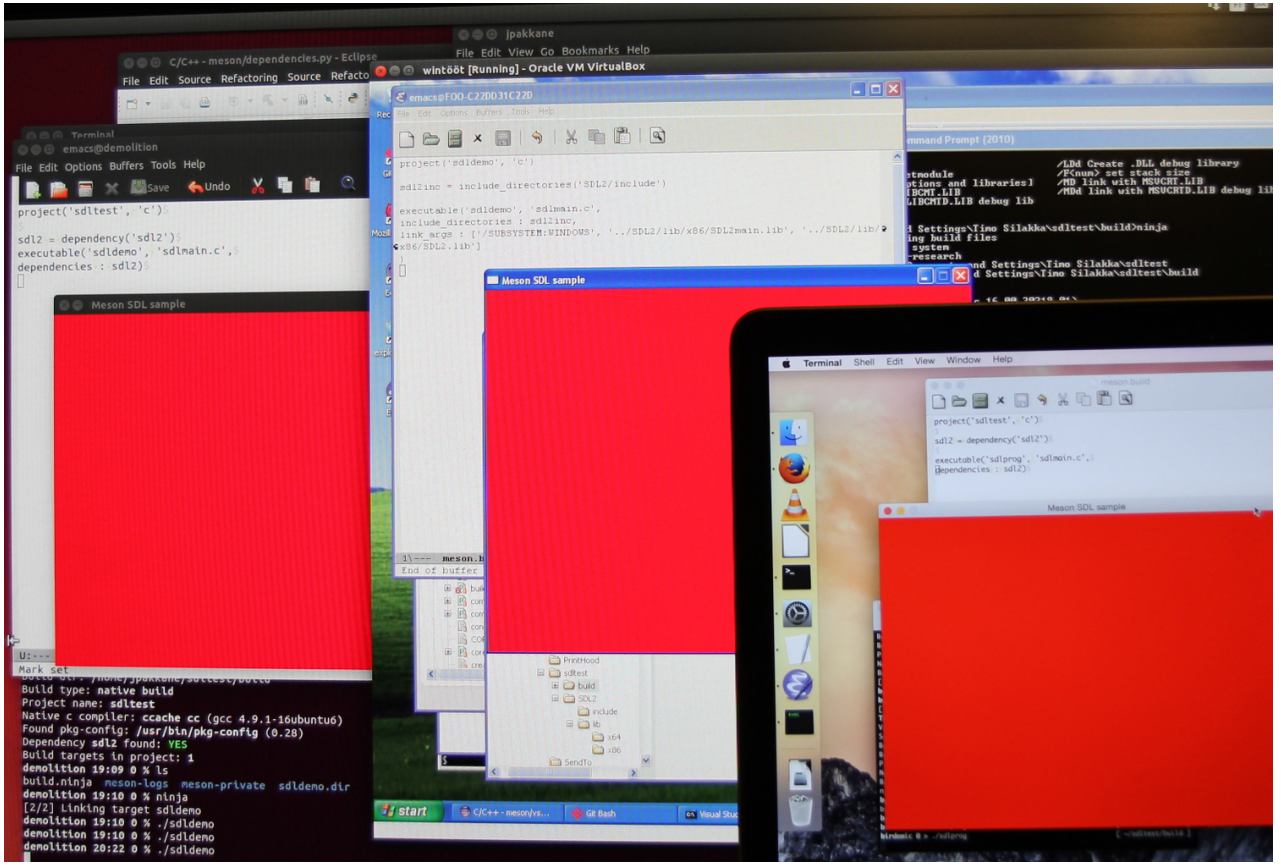
https://github.com/jpakkane/meson

Sample subproject usage snippet

```
foolib = dependency('foo', required : false)
if foolib.found()
  # set up project with external lib
else
  subproject('foo')
  # set up project with embedded lib
endif
```

https://github.com/jpakkane/meson

Here's what it looks like in practice



Further info

- Apache License 2.0
- Reference implementation in Python 3
- Packaged in Ubuntu (14/10) and Debian (Jessie)
- Github has wiki, manual, reference docs ...
- Contributions welcome

https://github.com/jpakkane/meson