Why Do We Build Our Software in a Different Way Than Everybody Else ?

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Outline

1. Library dependencies
2. A portable, standardised build system, GNU autotools
3. Standardising the installation

How We Build and Install Software

- Handcrafted GNU make files
  $\longrightarrow$ no standard enforced.
  $\longrightarrow$ functionality varies from package to package.
- Each package resides in its own directory
  (source code, header files, executables and libraries)
  $\longrightarrow$ deviation from UNIX philosophy
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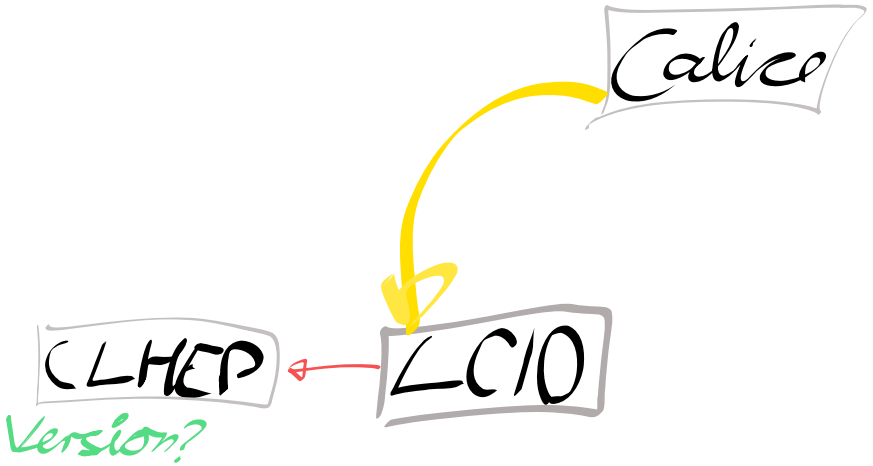

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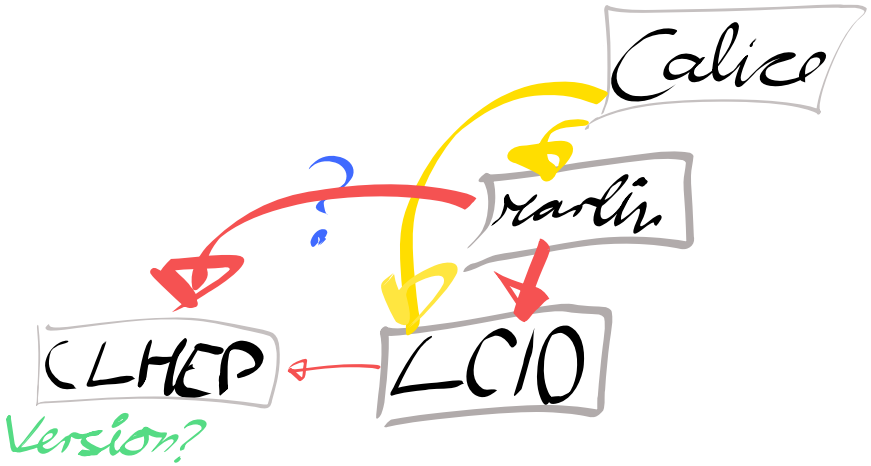

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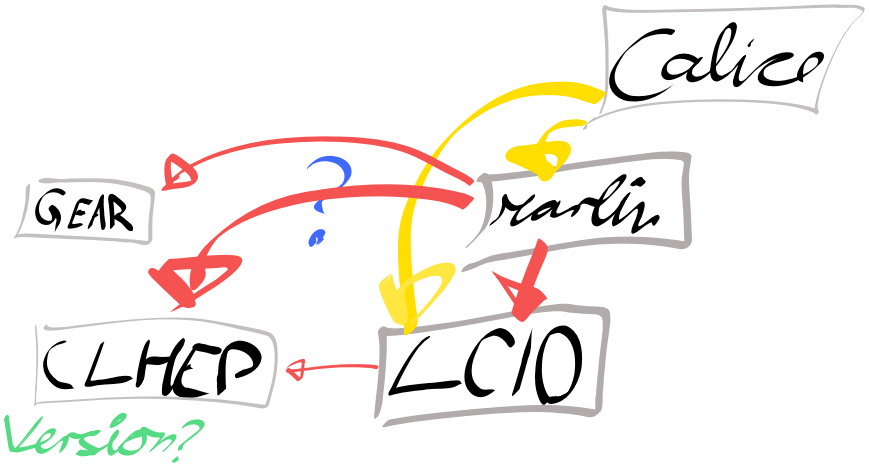

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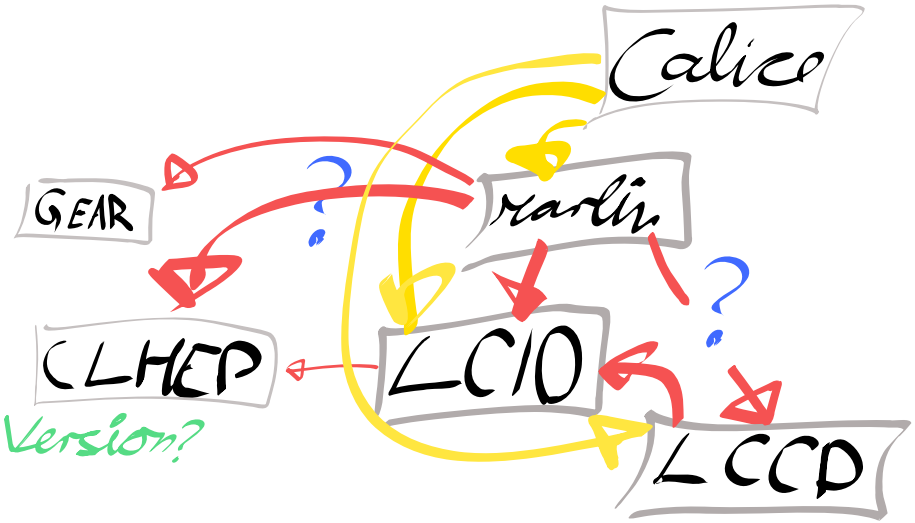

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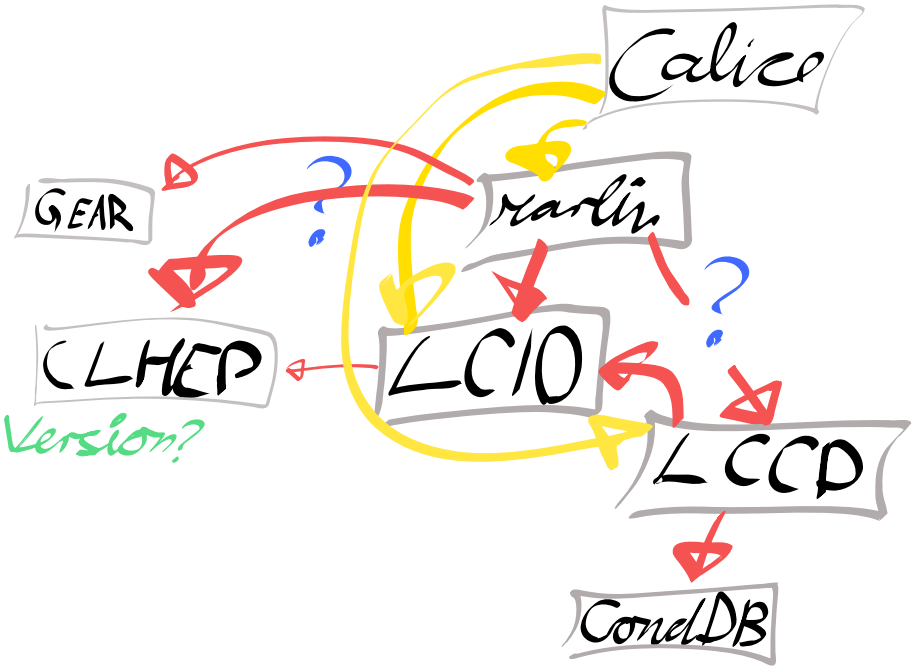

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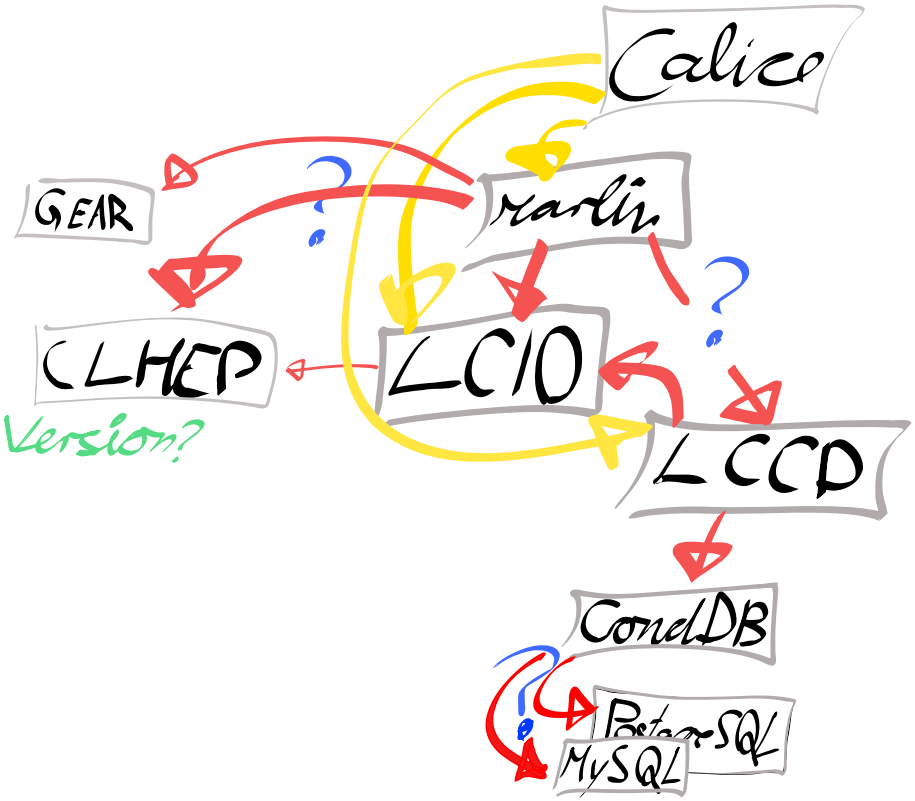

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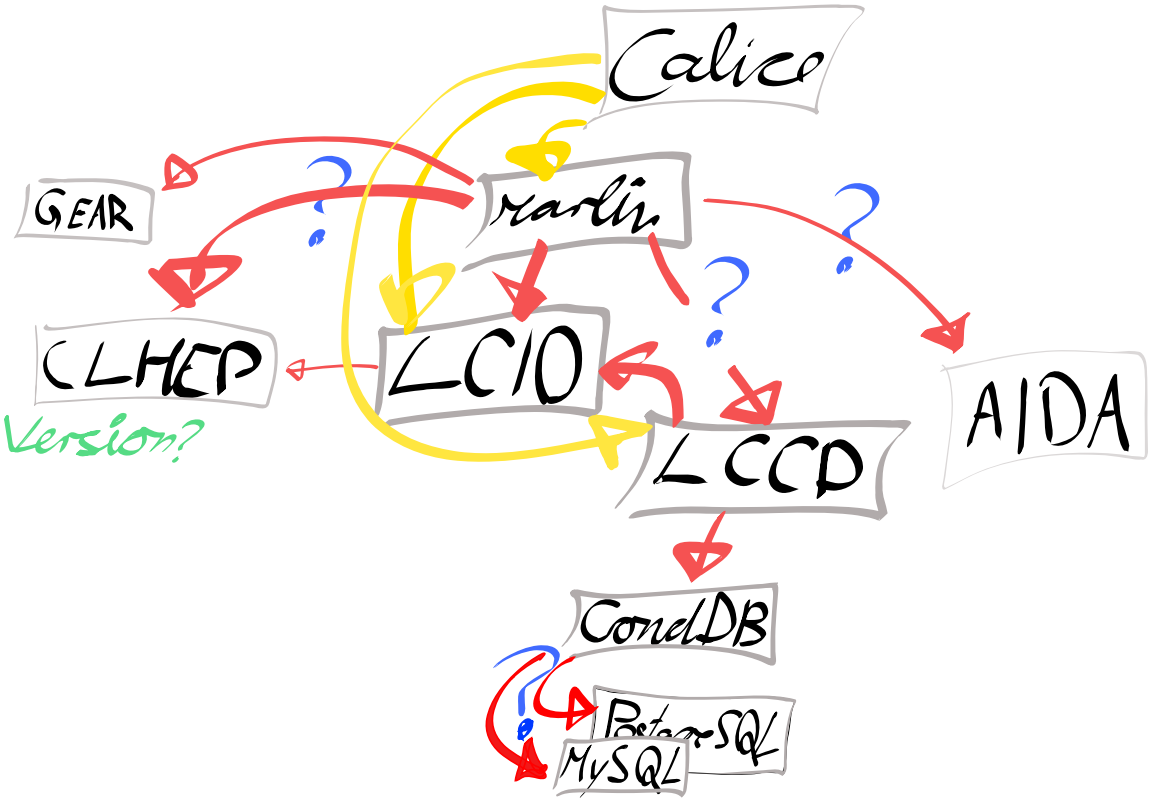

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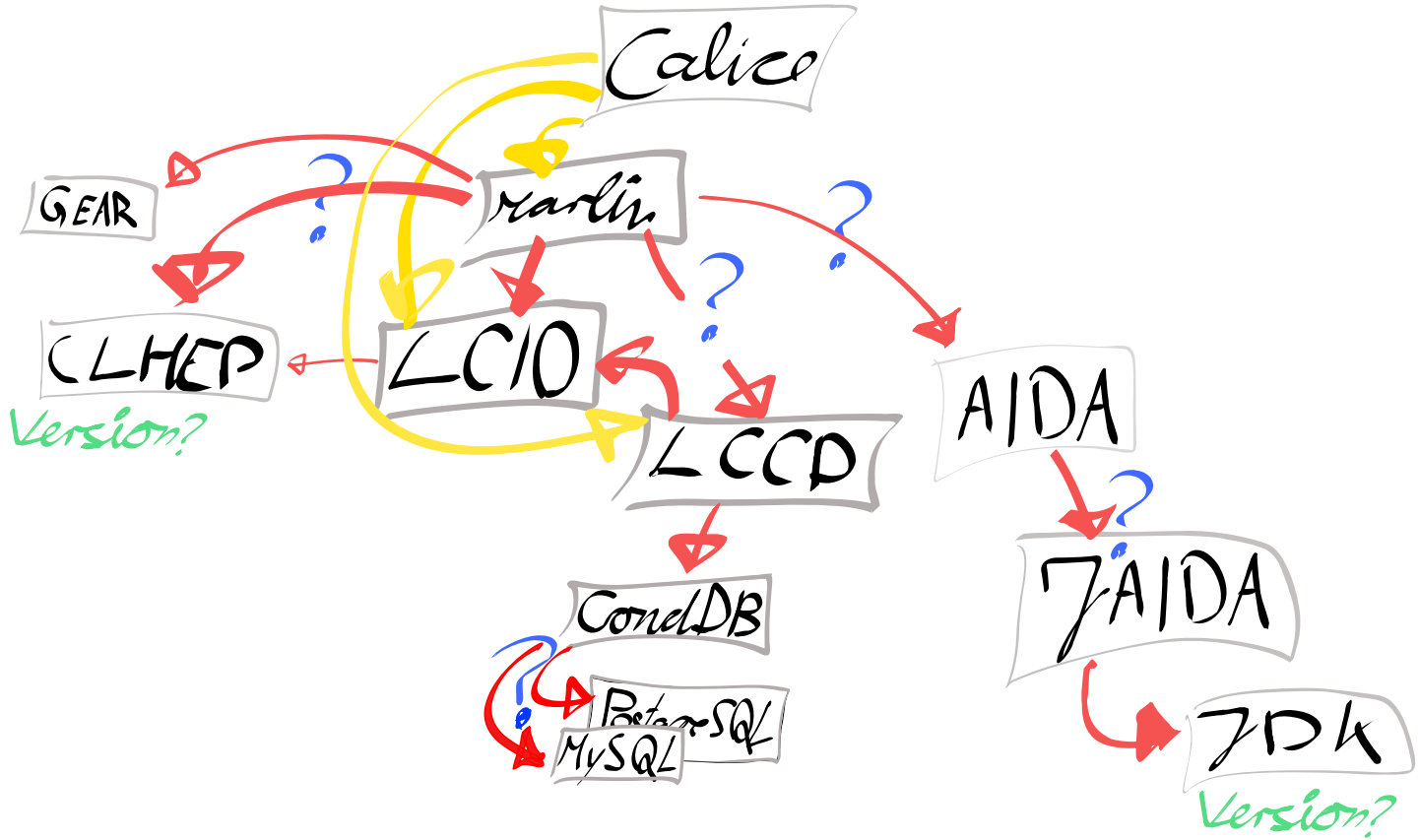

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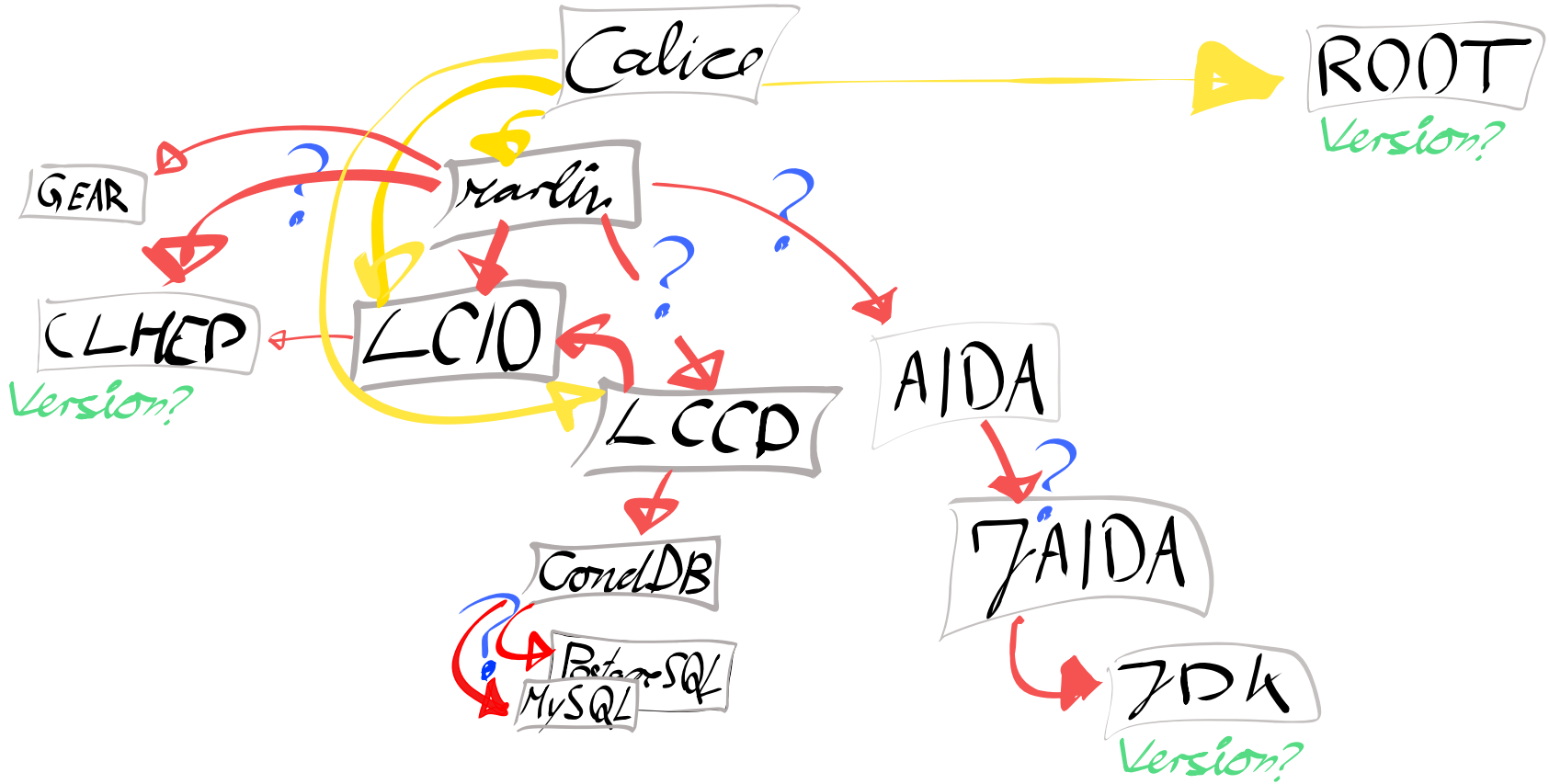

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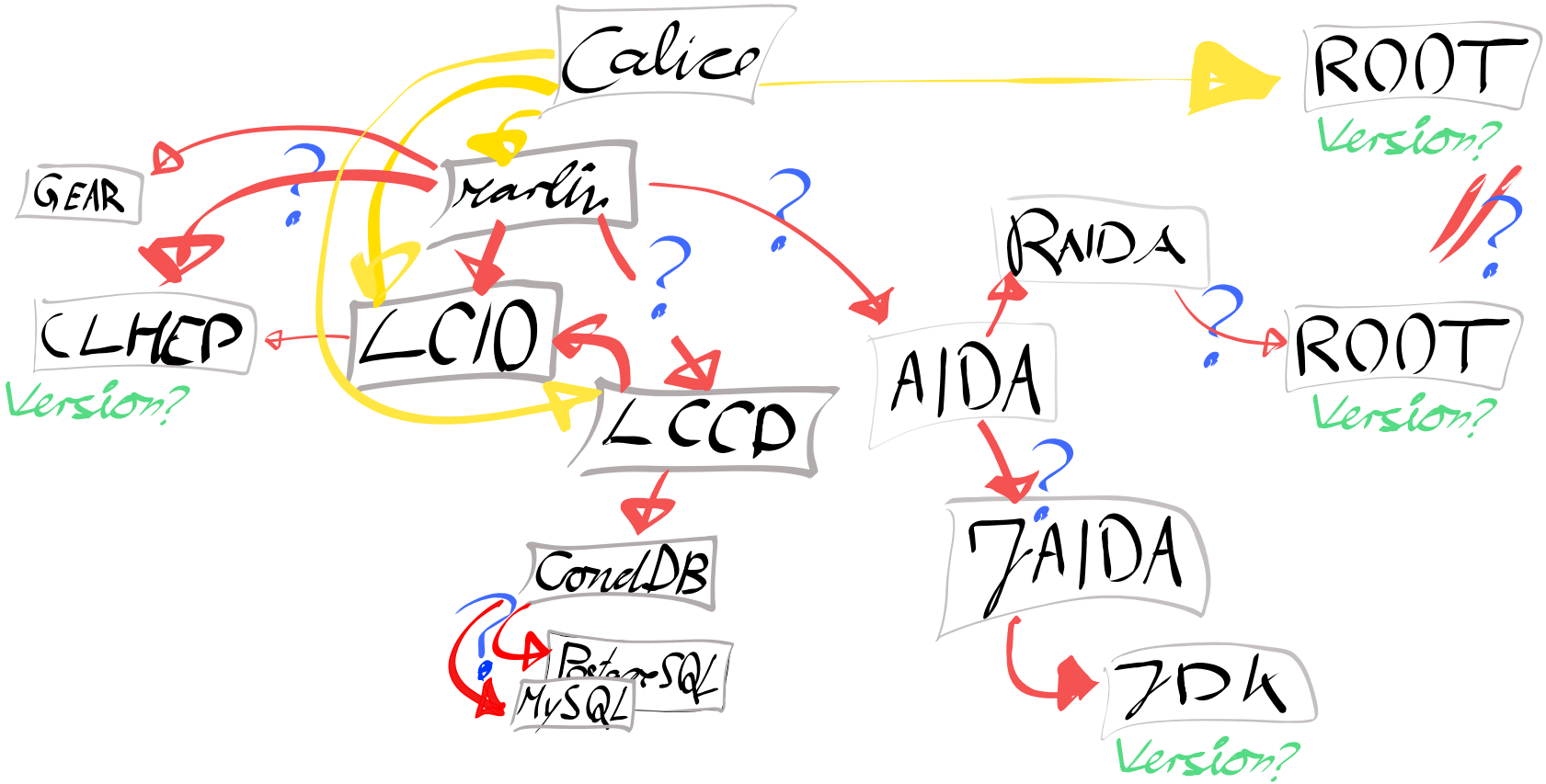

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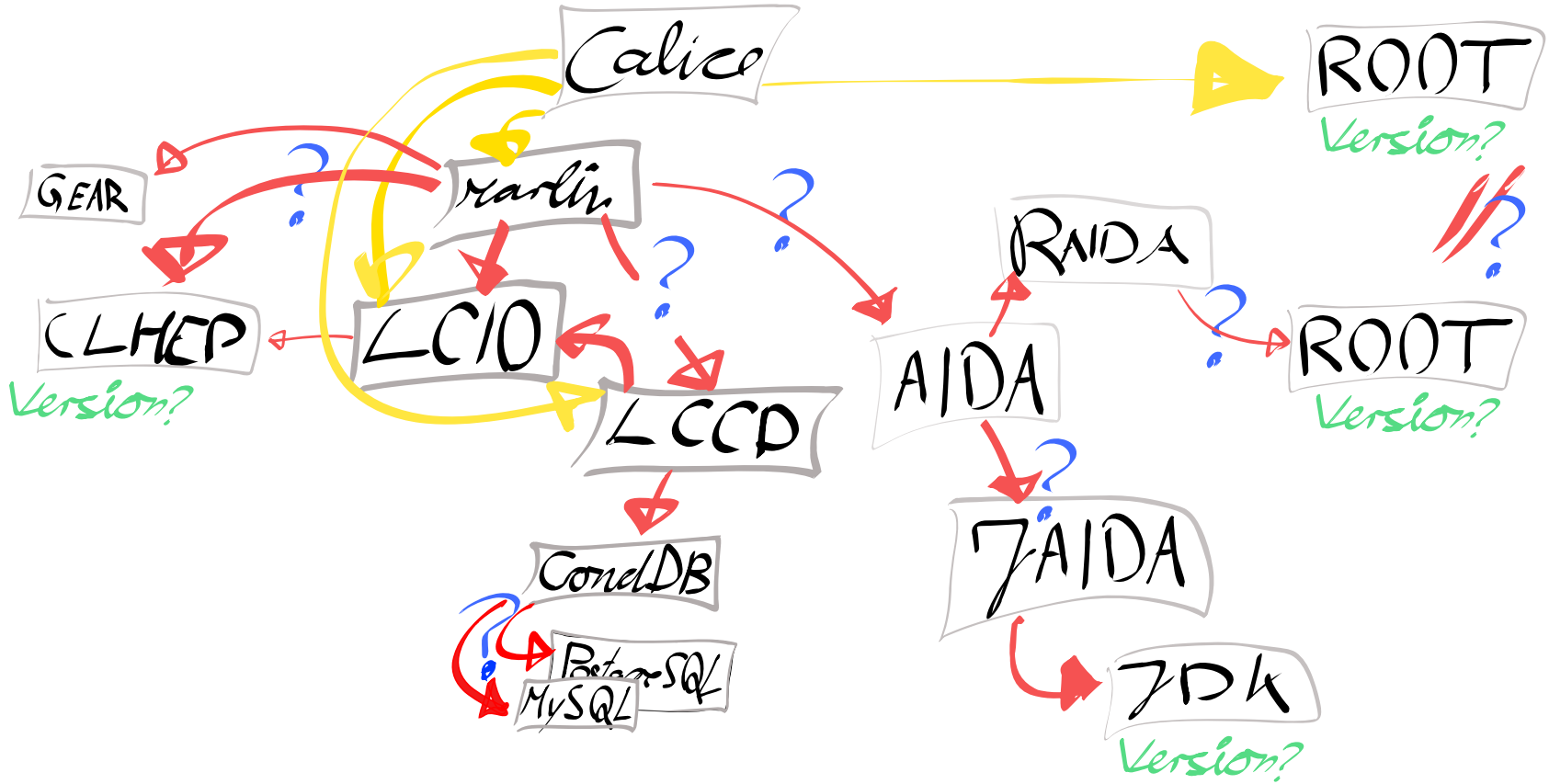

How to find out which libraries need to be linked ?

Bookkeeping of Library Dependencies – pkg-config

Solution: each library provides a file which describes preprocessor/linker flags and dependencies:

```
prefix=/ILC-soft
exec_prefix=${prefix}
libdir=${exec_prefix}/lib
includedir=${prefix}/include

Name: Marlin
Description: Modular Analysis and Reconstruction ...
Requires: lcio lccd jaida
Version: 0.9.5
Libs: -L${libdir}  \
 -Wl,-whole-archive,-lMarlin,-no-whole-archive
Cflags: -I${includedir}/marlin -DUSE_LCCD
```

Compiling/Linking using pkg-config

```
g++ -c MyMarlin.cc `pkg-config --cflags Marlin` \
   -o MyMarlin.o

g++ MyMarlin.o `pkg-config --libs Marlin`
```

pkg-config resolves dependencies. It returns all necessary preprocessor and linker flags.

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  Or, do we have a monoculture ?
- Is the current way of building standardised enough ?
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GNU autotools would provide a standardised, portable build system.

GNU Autotools

- Automatic configuration:using results of feature tests :
  (tests use the compiler/linker)
  - OS and CPU,
  - standard conformance and features of compiler,
  - availability of functions/libraries,
  - function interfaces,
  - ...

  $\longrightarrow$ Portability.
- Portable generation of shared/static libraries.
- Standardised Makefiles.
  - Work with every implementation of make.
  - Scale from simple to complex projects.
  - Can install/uninstall, produce distributable source packages.
  - Track changes of source/headers and compile accordingly.
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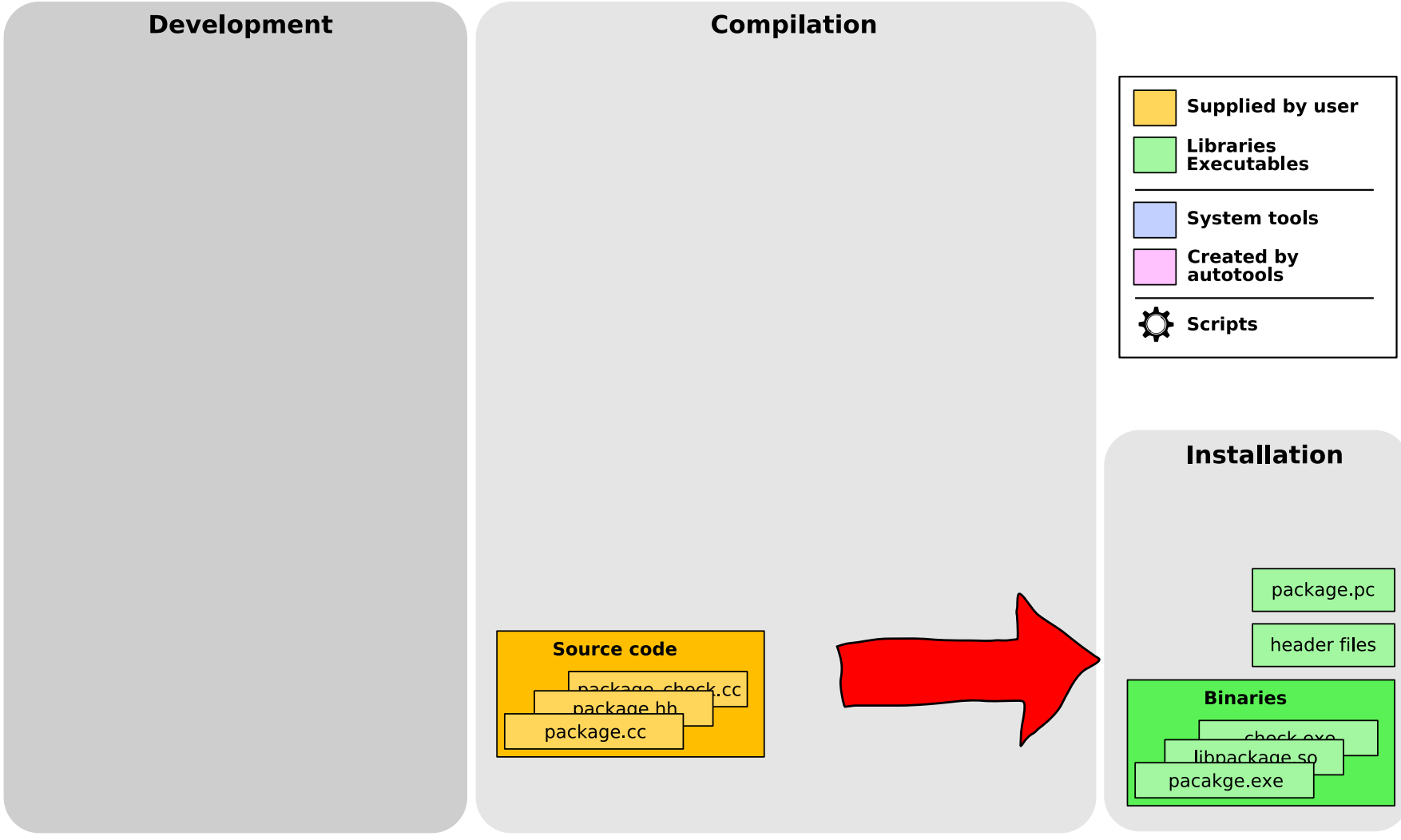
The GNU Autotools



Goal: source $\longrightarrow$ libraries, executable, pkg-config file.

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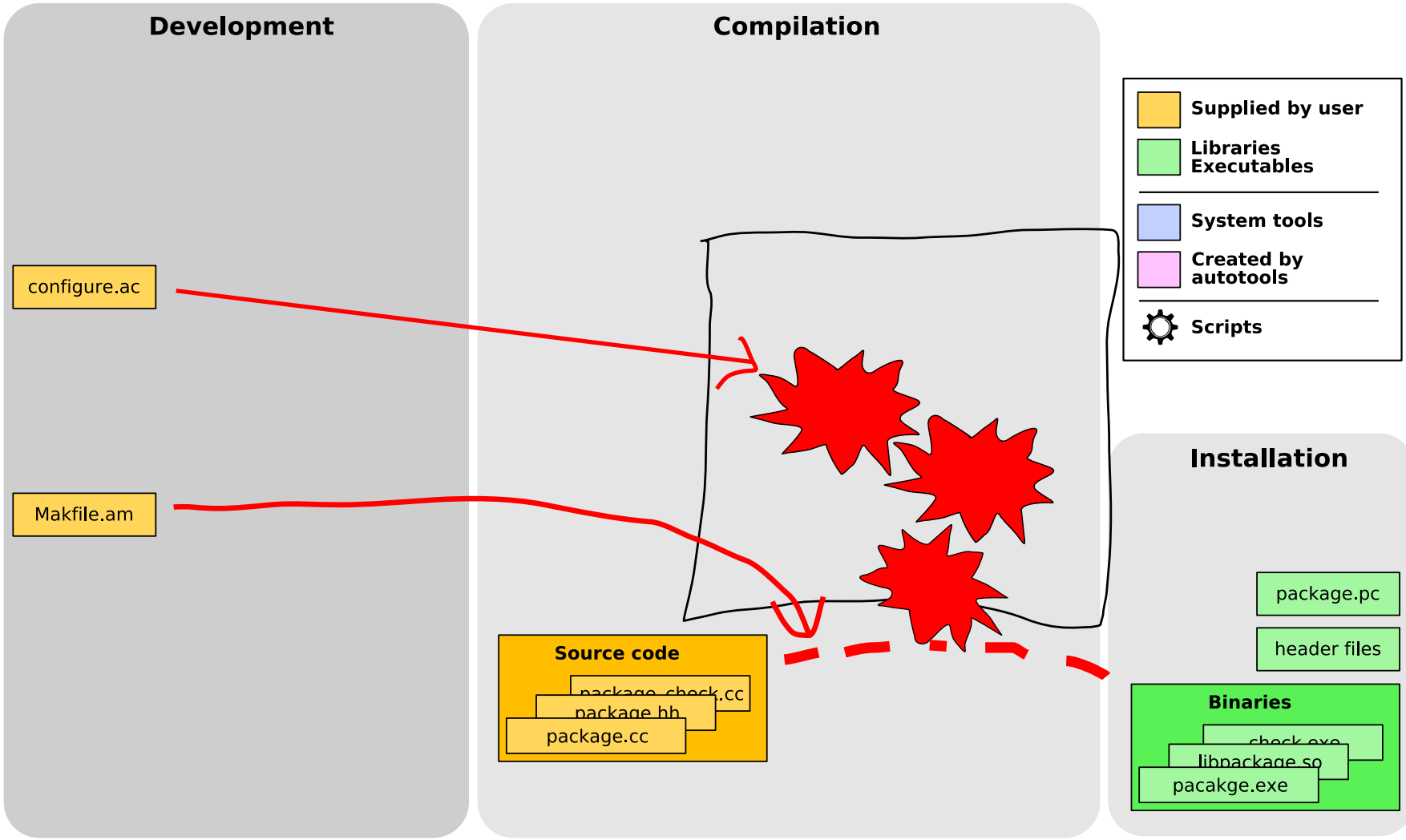
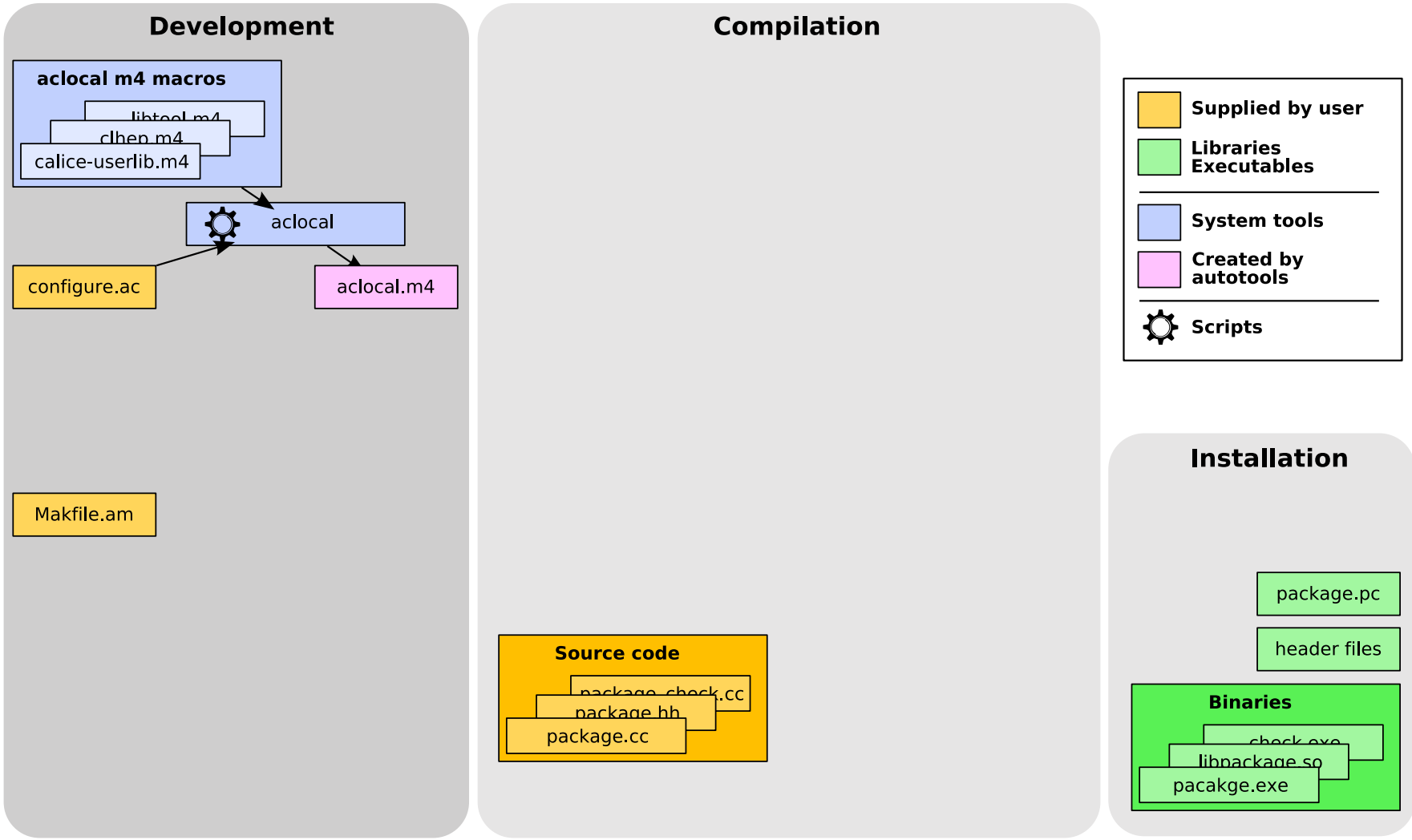


Developer has to provide files which describe the configuration and building.

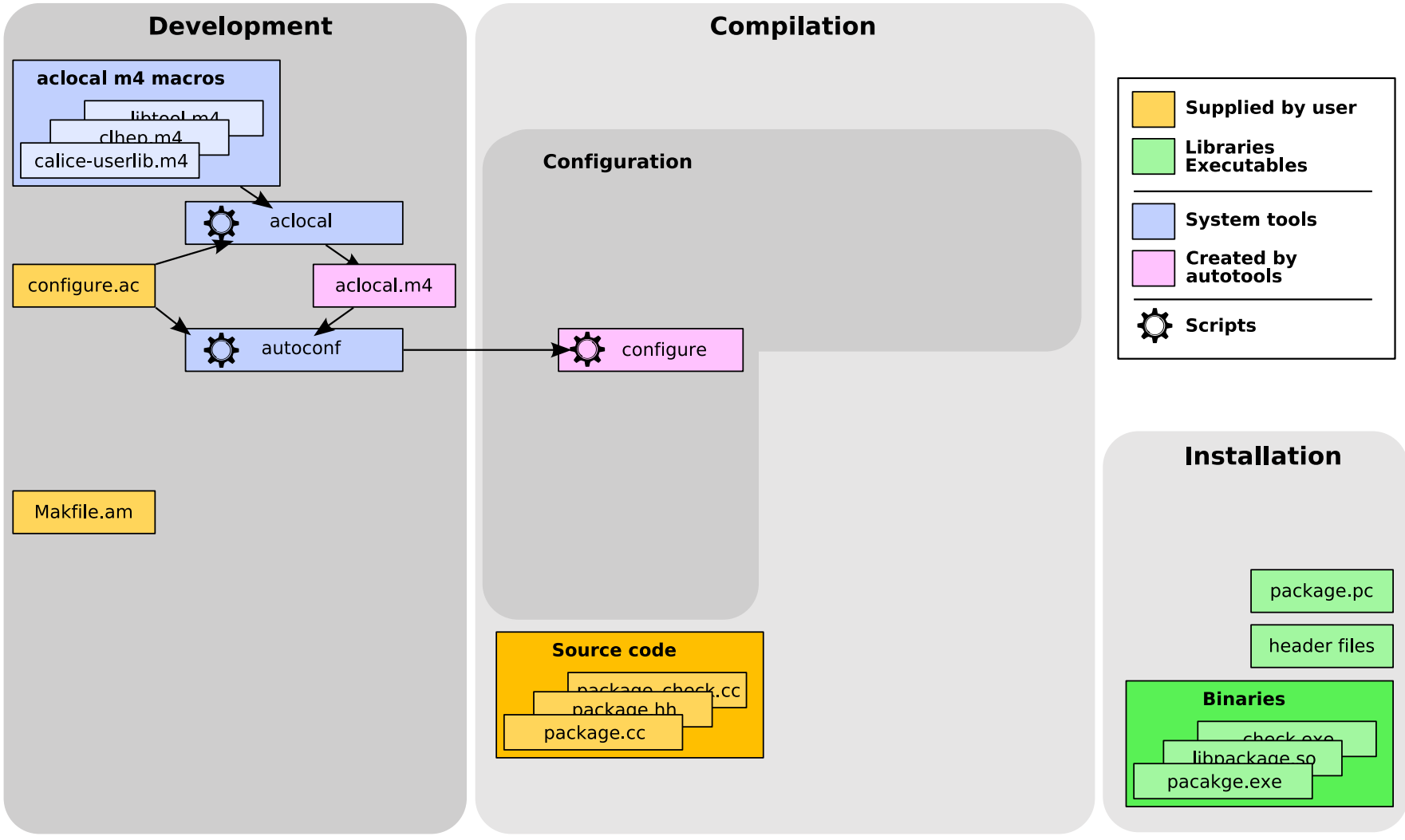
The GNU Autotools



Configuration described with high level macros.

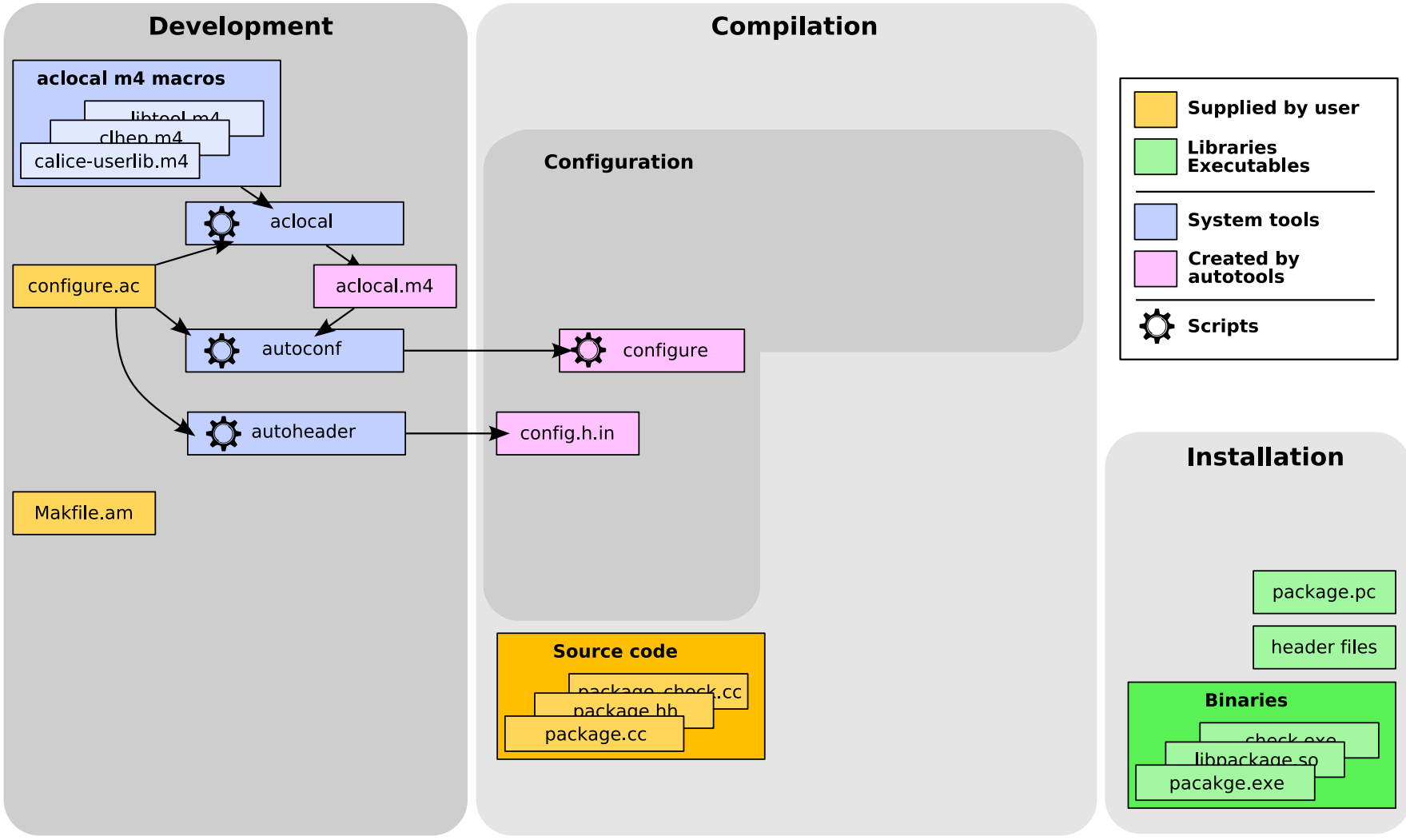
First step, collect definitions of all needed macros.

The GNU Autotools



Then, macros are expand, the `configure` script is created.

The GNU Autotools



`configure.ac` also defines possible options for the build process (preprocessor definitions).

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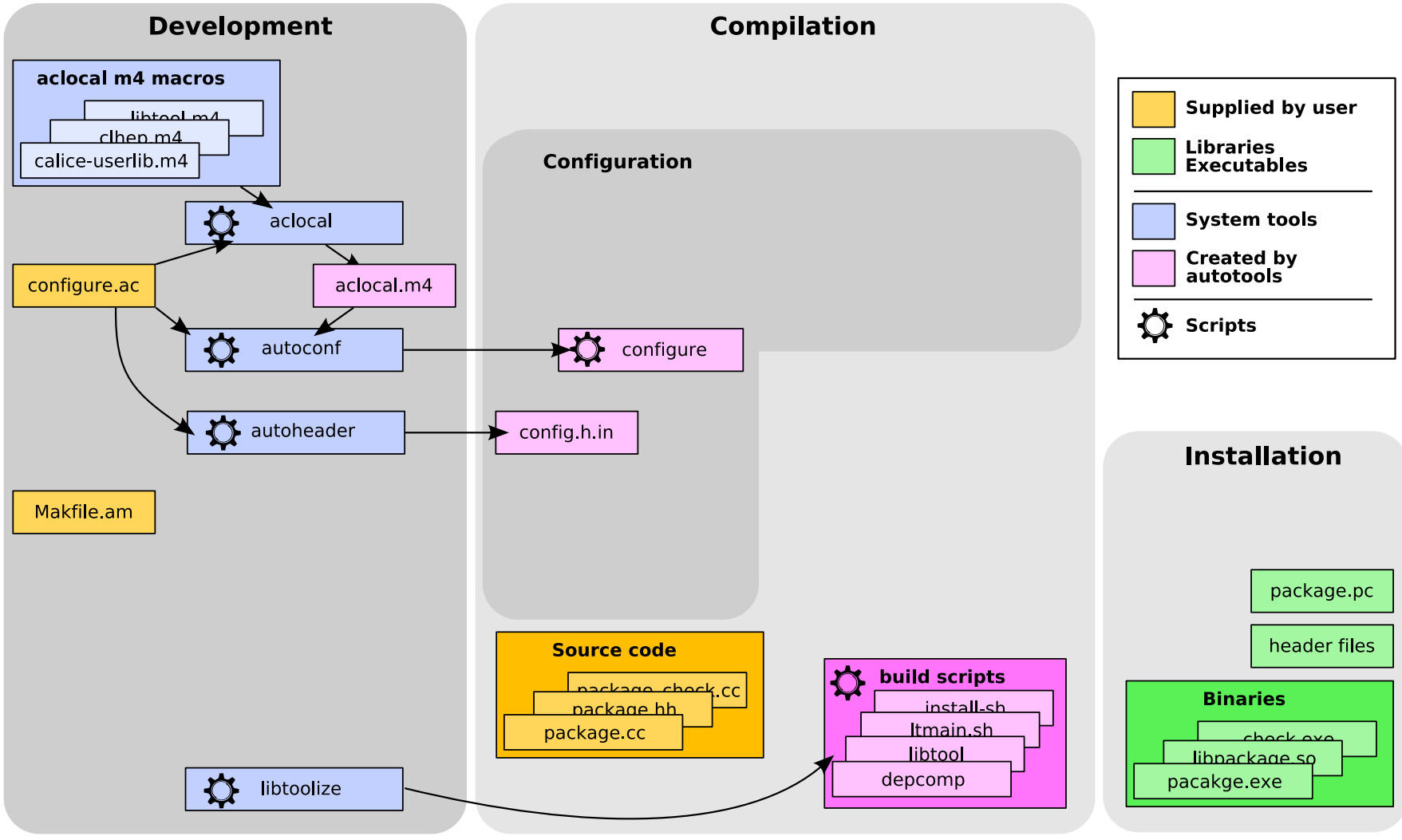
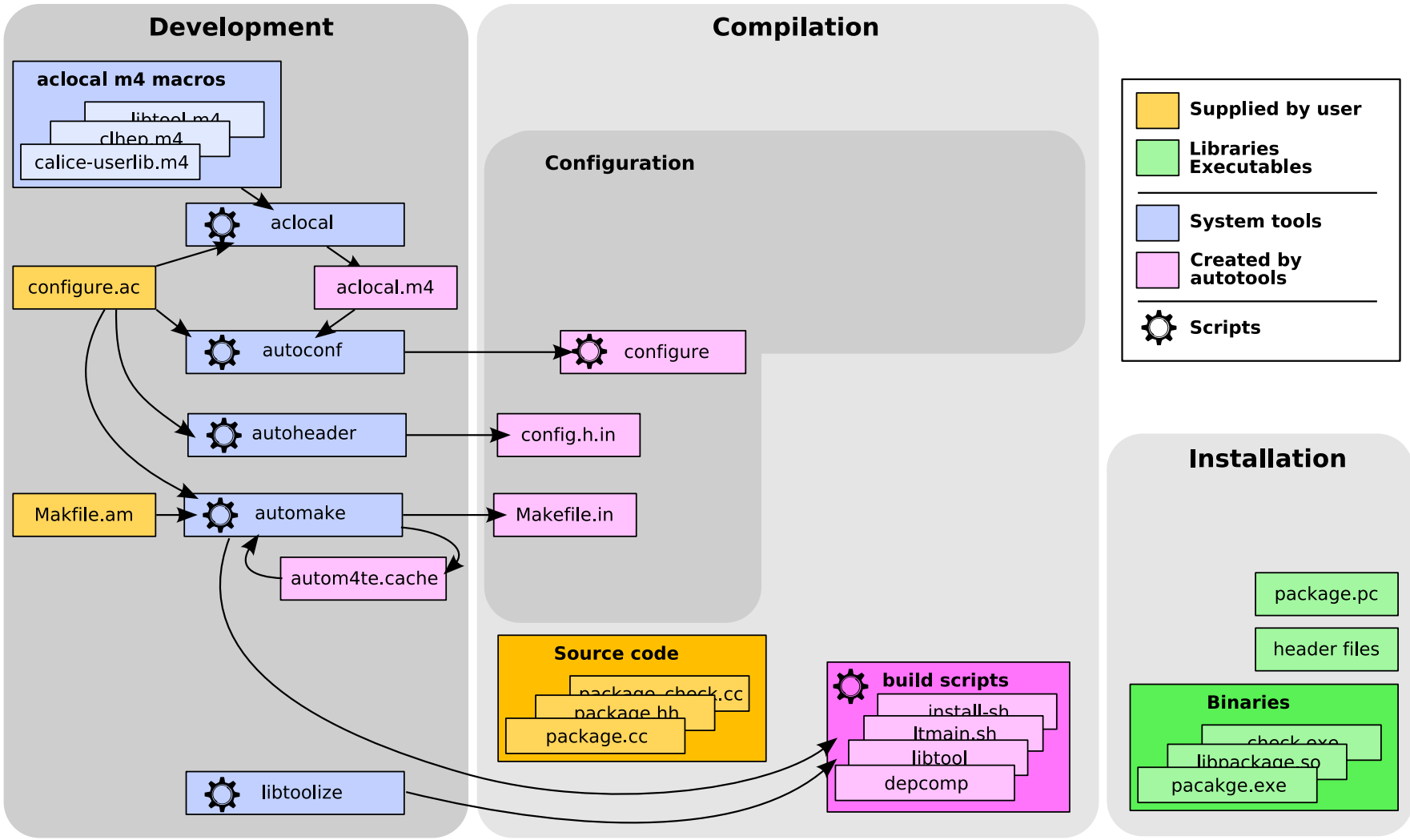


Autotools use scripts to build shared/static libraries → portability.

The GNU Autotools



Makefile templates with standard build targets are create from `Makefile.am` files.

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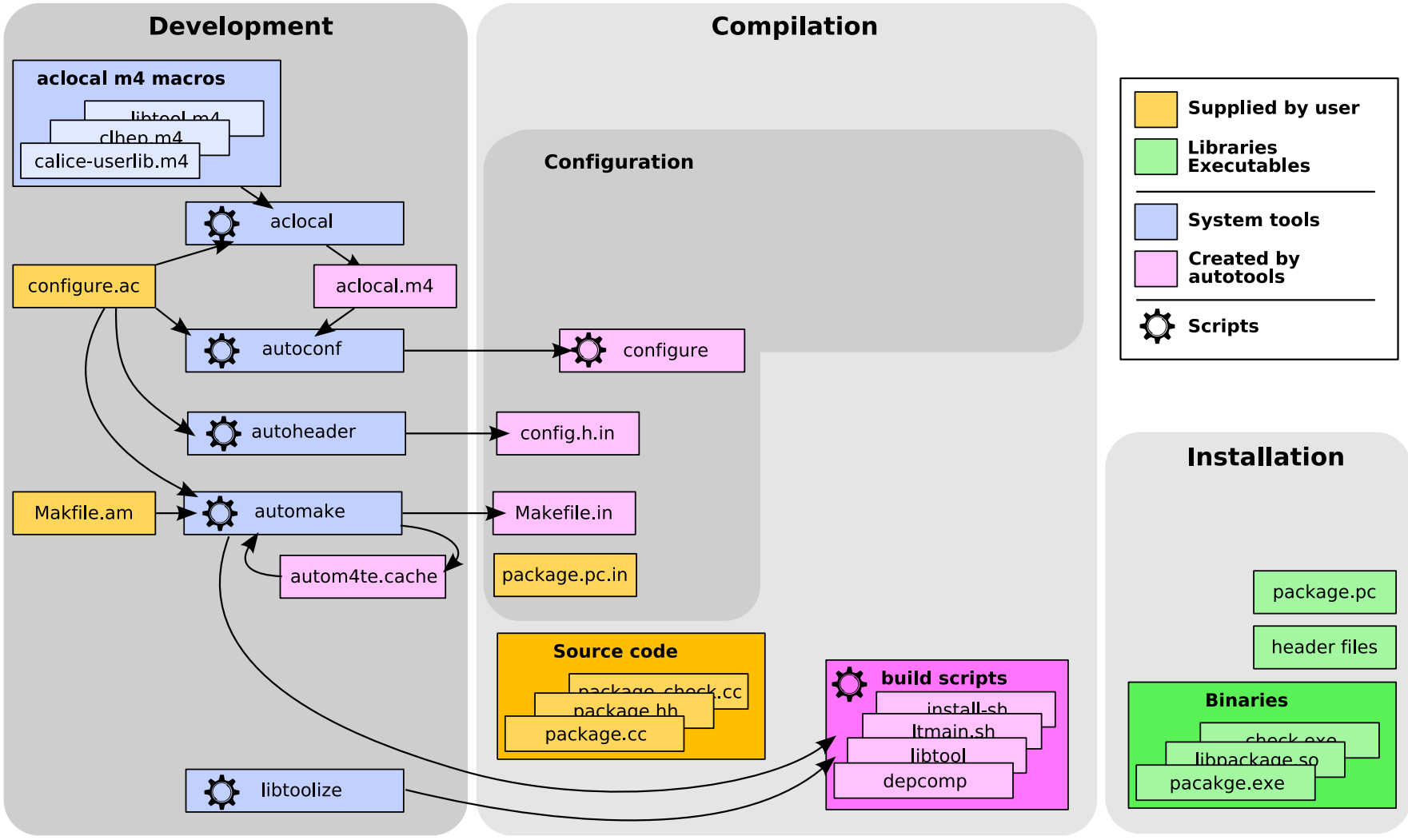

Developer has to provider template for pkg-config file. Will be filled by `configure`.

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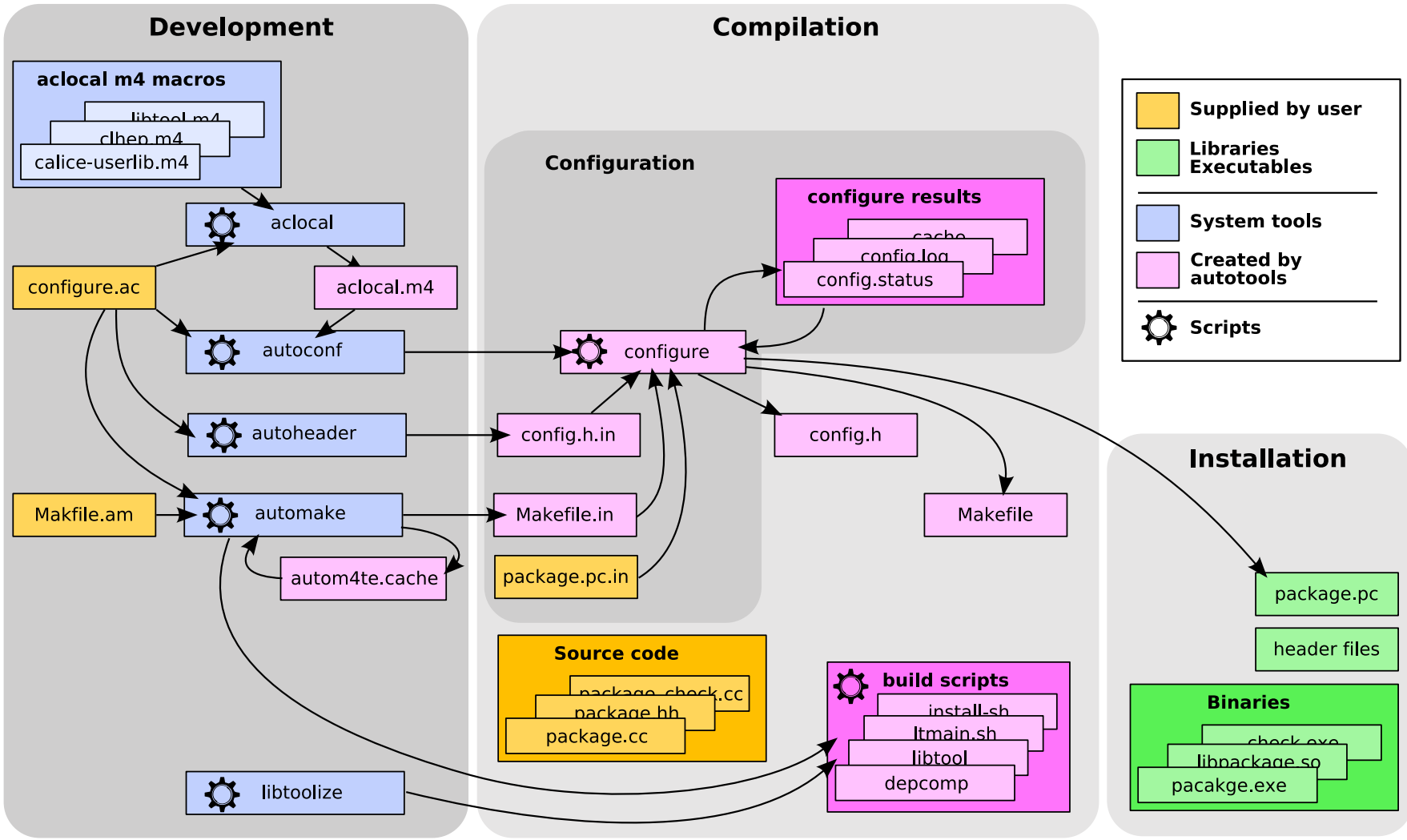

The configure script creates Makefiles, etc. from templates.
It fills in parameters specific to target system.

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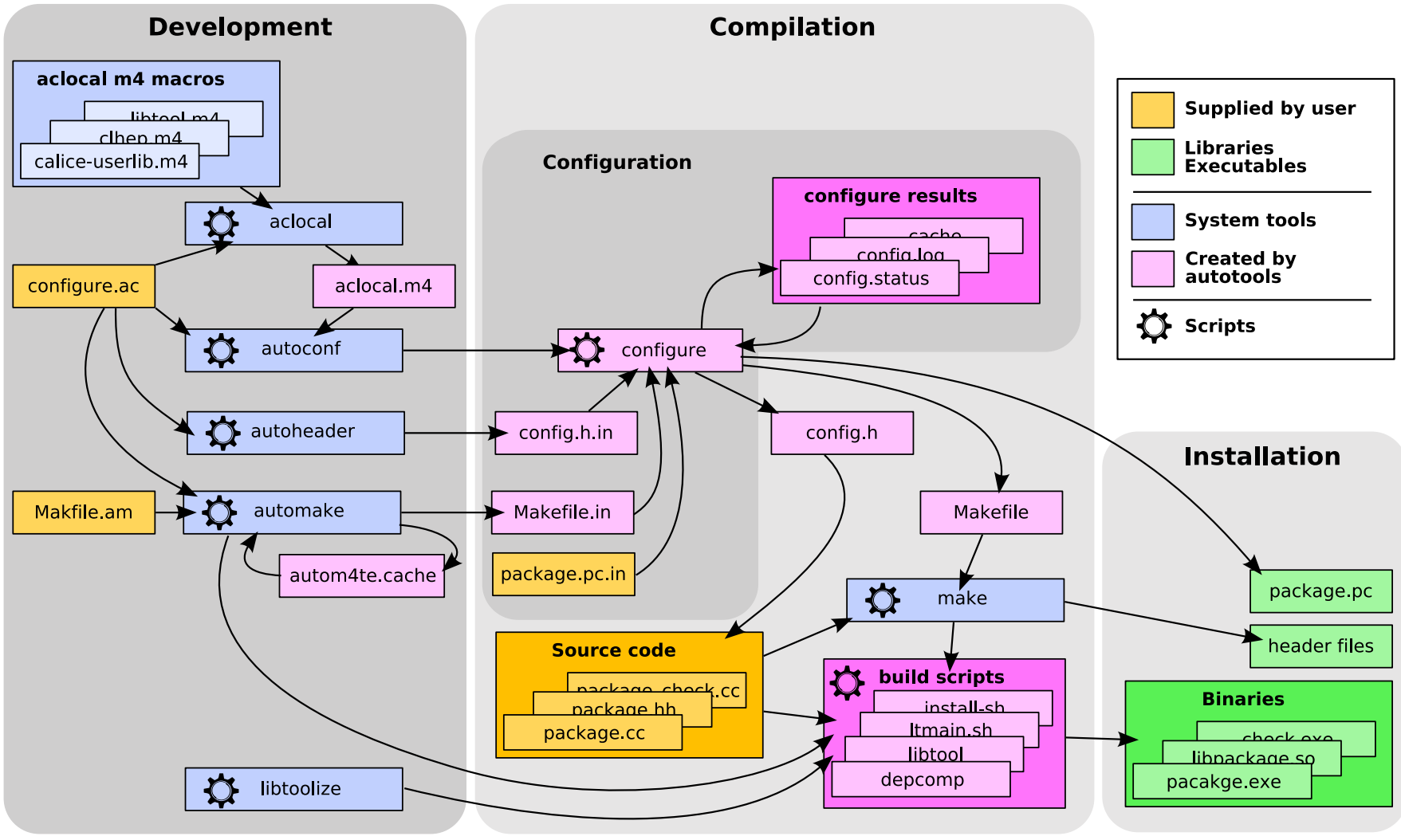

Finally, make is used to compile, install etc.

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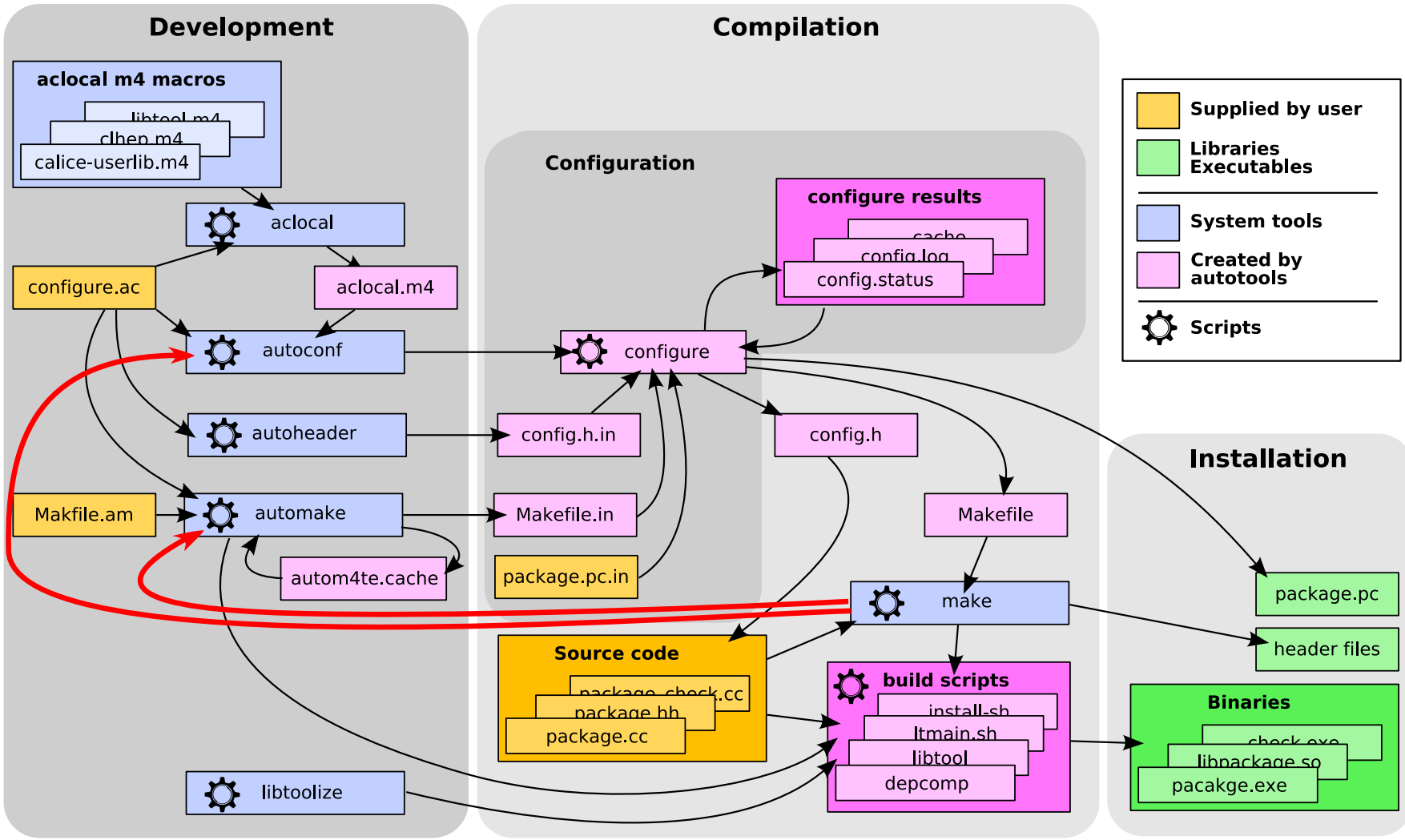

Once the Makefiles are created:

make will call autoconf, automake whenever necessary.

The GNU Autotools – From User Perspective

To build a package on an arbitrary host:

```
tar -xzf package-1.0.tar.gz
./configure
make
make install
```

- Fetch package, unpack it.
- Configure package for target system,
- compile and
- install the package in default location (/usr/local).

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The GNU Autotools – From Developer Perspective

To participate in development process (or if checked out from CVS), need to bootstrap first:
(i.e. create configure script, Makefile templates etc.)

```
sh ./autogen.sh
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Which runs:

```
libtoolize
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The autoconf input file - configure.ac

Tests are activated by high level macros mixed with korn shell scripts:

```
...

AC_CXX_NAMESPACES(, [config_error=yes])

if test x$config_error = xyes; then
  AC_MSG_ERROR([Need compiler with namespace...])
fi

AC_CXX_HAVE_STL([have_stl=yes],[have_stl=no])
AM_CONDITIONAL(USE_STL, test x$have_stl = xyes)

...
```

Automake – Makefile,am

Simple Makefile.am to create shared/static libraries:
`libpackage.so/.a` and `libpackage_ext.so/.a`

```
nobase_pkginclude_HEADERS=pacakge.hh

lib_LTLIBRARIES = libpackage.la \
                  libpackage_ext.la

libpackage_la_SOURCES = package_0.cc

if USE_STL
  libpackage_la_SOURCES += package_1.cc
endif

libpackage_ext_la_SOURCES = package_ext.cc
```

Automake – Makefile,am

to create executables:

```
...

bin_PROGRAMS = exe

exe_LDFLAGS = libpackage.la
exe_SOURCES =  main.cc

...
```

or process a subdirectory:

```
...

SUBDIRS=auxlib

...
```

Automake – Makefile.am

or to build unit tests:
(programs which are not installed to test e.g. libraries):

```
...

check_PROGRAMS = test_pacakge
test_package_LDFLAGS = libpackage.la
test_package_SOURCES = test_paclage.cc

...
```

Looks complicated - Why should I use this crap ?

Steep learning curve – But once learned:

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Aren't there less complicated alternatives ?

Alternatives, yes. Replacements for make and autotools:

- ant/maven – java based.
  No out of the box C, C++, F77 support.
- SCons – python based.
  Already mature ? Maintainable ?.
- CMake.
  ?

But: autotools widely adopted standard:

xorg, GNOME, MySQL, CLHEP, ...

$\longrightarrow$ good support.

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Automatised solutions do a poor job if libraries etc. are not installed in default locations.

Way out:

- Provide pkg-config files and collect them in one location.
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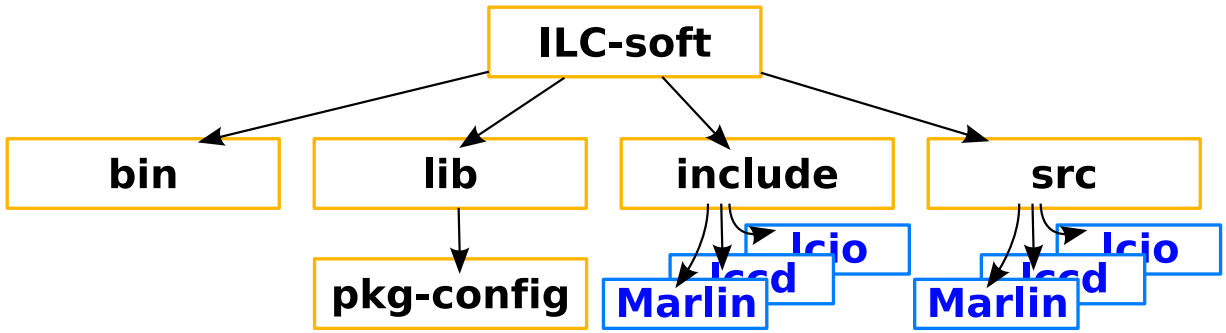

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- I would encourage the usage of the GNU autotools.
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- I think a UNIX like organisation of ILC-soft libraries and header files would be a good idea.
  (Easier to find libraries, header files, less configuration effort.)
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