

Autoconf/Automake Basics

Speaker: Mark K. Kim

Linux Users' Group of Davis
March 2, 2004

Slide modified slightly after the talk to fix some errors
and add some minor information

The portability problem

- Hardware differences
 - Endian-ness
 - Word size
 - OS differences
 - Executable file names
 - Device file names
 - File name conventions
 - Compiler differences
 - Compiler name & arguments
 - Header file names & definitions
 - Keywords
-
-

Why use Autoconf/Automake?

- Portability
- Code reuse
- Professional look



What does it look like?

```
$ ./configure
checking for a BSD-compatible install... /usr/bin/install -c
checking whether build environment is sane... yes
checking for gawk... gawk
checking whether make sets ${MAKE}... yes
checking for gcc... gcc
...
$ make
make all-recursive
make[1]: Entering directory `/home/vindaci/orgs/lugod/20040302-autotools_talk/contrib/hello-2.1.1'
Making all in contrib
...
$ su
Password:
# make install
set fnord $MAKEFLAGS; amf=$2; \
dot_seen=no; \
target=`echo install-recursive | sed s/-recursive//`; \
list='contrib doc intl po src man m4 tests'; for subdir in $list; do \
...
#
```

Writing a C program – the code

```
/* hello.c: A standard "Hello, world!" program */  
  
#include <stdio.h>  
  
int main(int argc, char* argv[])  
{  
    printf("Hello, world!\n");  
  
    return 0;  
}
```

```
# Makefile: A standard Makefile for hello.c  
  
all: hello  
  
clean:  
    rm -f hello
```

Writing a C program – the execution

```
$ ls
Makefile  hello.c
$ make
cc      hello.c  -o hello
$ ls
Makefile  hello*  hello.c
$ ./hello
Hello, world!
$
```

Creating `configure` - The steps

- ``configure`` is created from “`configure.ac`” (using ``autoconf``)
- “`configure.ac`” can be created automatically (using ``autoscan``)



Creating `configure` - The first try (1/2)

```
$ ls
hello.c  Makefile
$ autoscan
$ ls
autoscan.log  configure.scan  hello.c  Makefile
$ mv configure.scan configure.ac
$ autoconf
$ ls
autom4te.cache/  configure*  hello.c
autoscan.log     configure.ac  Makefile
$
```


Creating `configure` - The first try (2/2)

```
$ ./configure
checking for gcc... gcc
checking for C compiler default output file name... a.out
checking whether the C compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ANSI C... none needed
configure: creating ./config.status
config.status: error: cannot find input file: Makefile.in
$
```

Creating `configure` - The first try (2/2)

```
$ ./configure
checking for gcc... gcc
checking for C compiler default output file name... a.out
checking whether the C compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ANSI C... none needed
configure: creating ./config.status
config.status: error: cannot find input file: Makefile.in
$ mv Makefile Makefile.in
$
```

Creating `configure` - The second try (1/2)

```
$ mv Makefile Makefile.in
$ ./configure
checking for gcc... gcc
checking for C compiler default output file name... a.out
checking whether the C compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ANSI C... none needed
configure: creating ./config.status
config.status: creating Makefile
config.status: creating config.h
config.status: error: cannot find input file: config.h.in
$
```

Creating `configure` - The second try (2/2)

```
$ ls
autom4te.cache/  config.status*  hello.c
autoscan.log    configure*      Makefile
config.log      configure.ac    Makefile.in
$ make
cc -s -O2 -Wall   hello.c  -o hello
$ ./hello
Hello, world!
$
```

Recap – Creating `configure`

- Creating `configure`:
 - 1) Prepare sources and the Makefile.in
 - 2) Run `autoscan`
 - 3) Rename `configure.scan` to `configure.ac`
 - 4) Run `autoconf`
 - 5) `./configure`
 - 6) `make`
 - Still to consider:
 - 1) Creating Makefile.in using Automake
 - 2) Creating config.h.in
 - 3) Using config.h to make our program portable
-
-

What is “configure.ac”?

```
#                                     -*- Autoconf -*-
# Process this file with autoconf to produce a configure script.

AC_PREREQ(2.59)
AC_INIT(FULL-PACKAGE-NAME, VERSION, BUG-REPORT-ADDRESS)
AC_CONFIG_SRCDIR([hello.c])
AC_CONFIG_HEADER([config.h])

# Checks for programs.
AC_PROG_CC

# Checks for libraries.

# Checks for header files.

# Checks for typedefs, structures, and compiler characteristics.

# Checks for library functions.

AC_CONFIG_FILES([Makefile])
AC_OUTPUT
```

What is “configure”?

```
#!/bin/sh
# Guess values for system-dependent variables and create Makefiles.
# Generated by GNU Autoconf 2.59 for FULL-PACKAGE-NAME VERSION.
#
# Report bugs to <BUG-REPORT-ADDRESS>.
#
# Copyright (C) 2003 Free Software Foundation, Inc.
# This configure script is free software; the Free Software Foundation
# gives unlimited permission to copy, distribute and modify it.
## ----- ##
## M4sh Initialization. ##
## ----- ##

# Be Bourne compatible
if test -n "${ZSH_VERSION+set}" && (emulate sh) >/dev/null 2>&1; then
  emulate sh
  NULLCMD=:
  # Zsh 3.x and 4.x performs word splitting on ${1+"$@"}, which
  # is contrary to our usage.  Disable this feature.
  alias -g ' ${1+"$@" } '=' "$@ '
elif test -n "${BASH_VERSION+set}" && (set -o posix) >/dev/null 2>&1; then
  set -o posix
fi
DUALCASE=1; export DUALCASE # for MKS sh
```

An example program – the code

```
/* epoch.c: A program to show the time since the Epoch */  
  
#include <stdio.h>  
#include <sys/time.h>  
  
int main(int argc, char* argv[])  
{  
    double sec;  
    struct timeval tv;  
  
    gettimeofday(&tv, NULL);  
    sec = tv.tv_sec;  
    sec += tv.tv_usec / 1000000.0;  
  
    printf("%f\n", sec);  
  
    return 0;  
}
```


Example program – the execution

```
# Makefile: A standard Makefile for epoch.c

all: epoch

clean:
    rm -f epoch
```

```
$ ls
epoch.c  Makefile
$ make
cc -s -O2 -Wall    epoch.c    -o epoch
$ ./epoch
1077857890.903839
$
```

Portability problem!

gettimeofday() is not available on all systems!

```
GETTIMEOFDAY(2)                Linux Programmers Manual                GETTIMEOFDAY(2)

NAME
    gettimeofday, settimeofday - get / set time

SYNOPSIS
.....

CONFORMING TO
    SVr4, BSD 4.3. POSIX 1003.12001 describes gettimeofday() but not set
   timeofday().

SEE ALSO
```



Potential solution: Use time()

```
TIME(2)                                     Linux Programmers Manual                                     TIME(2)

NAME
    time - get time in seconds

SYNOPSIS
    #include <time.h>

    time_t time(time_t *t);

DESCRIPTION
    time returns the time since the Epoch (00:00:00 UTC, January 1, 1970),
    measured in seconds.

.....

CONFORMING TO
    SVr4, SVID, POSIX, X/OPEN, BSD 4.3
    Under BSD 4.3, this call is obsoleted by gettimeofday(2).  POSIX does
    not specify any error conditions.

SEE ALSO
```

Better Solution

- Use `gettimeofday()` if available.
- Fall back on `time()` if `gettimeofday()` is not available.



Better epoch.c – The code

```
/* epoch.c: A program to show the time since the Epoch */

#include <stdio.h>
#include <sys/time.h>
#include <time.h>

#include "config.h"

int main(int argc, char* argv[])
{
    printf("%f\n", get_epoch());

    return 0;
}

double get_epoch()
{
    double sec;

#ifdef HAVE_GETTIMEOFDAY
    struct timeval tv;

    gettimeofday(&tv, NULL);
    sec = tv.tv_sec;
    sec += tv.tv_usec / 1000000.0;
#else
    sec = time(NULL);
#endif

    return sec;
}
```

Generating config.h

- `config.h` is created by ``configure`` from `“config.h.in”`
- `“config.h.in”` is created by ``autoheader`` from the C sources and headers.



Sample session

```
$ ls
epoch.c Makefile
$ autoscan
$ ls
autoscan.log configure.scan epoch.c Makefile
$ mv configure.scan configure.ac
$ ls
autoscan.log configure.ac epoch.c Makefile
$ autoheader
$ ls
autom4te.cache/ config.h.in epoch.c
autoscan.log configure.ac Makefile
$ mv Makefile Makefile.in
$ autoconf
$ ls
autom4te.cache/ config.h.in configure.ac Makefile.in
autoscan.log configure* epoch.c
$ ./configure
checking for gcc... gcc
checking for C compiler default output file name.. a.out
checking whether the C compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ANSI C... none needed
checking how to run the C preprocessor... gcc -E
checking for egrep... grep -E
checking for ANSI C header files... yes
checking for sys/types.h... yes
checking for sys/stat.h... yes
checking for stdlib.h... yes
checking for string.h... yes
checking for memory.h... yes
checking for strings.h... yes
checking for inttypes.h... yes
checking for stdint.h... yes
checking for unistd.h... yes
checking sys/time.h usability... yes
checking sys/time.h presence... yes
checking for sys/time.h... yes
checking whether time.h and sys/time.h may both be
included... yes
checking for gettimeofday... yes
configure: creating ./config.status
config.status: creating Makefile
config.status: creating config.h
$ ls
autom4te.cache/ config.h.in configure* Makefile
autoscan.log config.log configure.ac Makefile.in
config.h config.status* epoch.c
$ make
cc -s -O2 -Wall epoch.c -o epoch
$ ls
autom4te.cache/ config.h.in configure* epoch.c
autoscan.log config.log configure.ac Makefile
config.h config.status* epoch* Makefile.in
$ ./epoch
1077873582.855393
$
```

What is “config.h”?

```
/* config.h. Generated by configure. */
/* config.h.in. Generated from configure.ac by autoheader. */

/* Define to 1 if you have the `gettimeofday' function. */
#define HAVE_GETTIMEOFDAY 1

/* Define to 1 if you have the <inttypes.h> header file. */
#define HAVE_INTTYPES_H 1

/* Define to 1 if you have the <memory.h> header file. */
#define HAVE_MEMORY_H 1

/* Define to 1 if you have the <stdint.h> header file. */
#define HAVE_STDINT_H 1

/* Define to 1 if you have the <stdlib.h> header file. */
#define HAVE_STDLIB_H 1

/* Define to 1 if you have the <strings.h> header file. */
#define HAVE_STRINGS_H 1

/* Define to 1 if you have the <string.h> header file. */
#define HAVE_STRING_H 1

/* Define to 1 if you have the <sys/stat.h> header file. */
#define HAVE_SYS_STAT_H 1

/* Define to 1 if you have the <sys/time.h> header file. */
#define HAVE_SYS_TIME_H 1

/* Define to 1 if you have the <sys/types.h> header file. */
#define HAVE_SYS_TYPES_H 1

/* Define to 1 if you have the <unistd.h> header file. */
#define HAVE_UNISTD_H 1

/* Define to the address where bug reports for this package
should be sent. */
#define PACKAGE_BUGREPORT "BUG-REPORT-ADDRESS"

/* Define to the full name of this package. */
#define PACKAGE_NAME "FULL-PACKAGE-NAME"

/* Define to the full name and version of this package. */
#define PACKAGE_STRING "FULL-PACKAGE-NAME VERSION"

/* Define to the one symbol short name of this package. */
#define PACKAGE_TARNAME "full-package-name"

/* Define to the version of this package. */
#define PACKAGE_VERSION "VERSION"

/* Define to 1 if you have the ANSI C header files. */
#define STDC_HEADERS 1

/* Define to 1 if you can safely include both <sys/time.h> and
<time.h>. */
#define TIME_WITH_SYS_TIME 1
```


Recap thus far...

- `autoscan`
 - Rename “`configure.scan`” to “`configure.ac`”
 - `autoheader`
 - Rename “`Makefile`” to “`Makefile.in`”
 - `autoconf`
 - `./configure`
 - `make`
-
-

Creating “Makefile.in” – The steps

- Create “Makefile.am” by hand
- Run `automake`



What is “Makefile.am”?

```
# Makefile.am for epoch.c
```

```
bin_PROGRAMS=epoch
```

```
epoch_SOURCES=epoch.c
```

Creating “Makefile.in” – The first try

```
$ ls
epoch.c  Makefile.am
$ autoscan
$ mv configure.scan configure.ac
$ autoheader
$ automake
configure.ac: no proper invocation of AM_INIT_AUTOMAKE was found.
configure.ac: You should verify that configure.ac invokes AM_INIT_AUTOMAKE,
configure.ac: that aclocal.m4 is present in the top-level directory,
configure.ac: and that aclocal.m4 was recently regenerated (using aclocal).
configure.ac: required file `./install-sh' not found
configure.ac: required file `./mkinstalldirs' not found
configure.ac: required file `./missing' not found
Makefile.am: required file `./COPYING' not found
Makefile.am: required file `./INSTALL' not found
Makefile.am: required file `./NEWS' not found
Makefile.am: required file `./README' not found
Makefile.am: required file `./AUTHORS' not found
Makefile.am: required file `./ChangeLog' not found
Makefile.am: required file `./depcomp' not found
/usr/share/automake-1.7/am/depend2.am: am__fastdepCC does not appear in AM_CONDITIONAL
/usr/share/automake-1.7/am/depend2.am: AMDEP does not appear in AM_CONDITIONAL
$
```

What is “AM_INIT_AUTOMAKE”?

File: automake-1.7.info, Node: Complete, Next: Hello, Prev: Examples, Up: E\

A simple example, start to finish
=====

Let's suppose you just finished writing `zardoz', a program to make your head float from vortex to vortex. You've been using Autoconf to provide a portability framework, but your `Makefile.in's have been ad-hoc. You want to make them bulletproof, so you turn to Automake.

The first step is to update your `configure.in' to include the commands that `automake' needs. The way to do this is to add an `AM_INIT_AUTOMAKE' call just after `AC_INIT':

```
AC_INIT(zardoz, 1.0)  
AM_INIT_AUTOMAKE  
...
```

Since your program doesn't have any complicating factors (e.g., it doesn't use `gettext', it doesn't want to build a shared library), you're done with this part. That was easy!

--zz-Info: (automake-1.7.info.gz)Complete, 52 lines --Top-----

Dealing with AM_INIT_AUTOMAKE

1) Edit “configure.ac”

2) Run `aclocal`

3) automake

4) autoconf



Editing configure.ac

```
#                                     -*- Autoconf -*-
# Process this file with autoconf to produce a configure script.

AC_PREREQ(2.59)
AC_INIT(FULL-PACKAGE-NAME, VERSION, BUG-REPORT-ADDRESS)
AM_INIT_AUTOMAKE
AC_CONFIG_SRCDIR([epoch.c])
AC_CONFIG_HEADER([config.h])

# Checks for programs.
AC_PROG_CC

# Checks for libraries.

# Checks for header files.
AC_CHECK_HEADERS([sys/time.h])

# Checks for typedefs, structures, and compiler characteristics.
AC_HEADER_TIME

# Checks for library functions.
AC_CHECK_FUNCS([gettimeofday])

AC_CONFIG_FILES([Makefile])
AC_OUTPUT
```

Automake – Sample session

```
$ ls
epoch.c  Makefile.am
$ autoscan
$ mv configure.scan configure.ac
$ autoheader
$ vi configure.ac
$ aclocal
$ automake --add-missing --copy
configure.ac: installing `./install-sh'
configure.ac: installing `./mkinstalldirs'
configure.ac: installing `./missing'
Makefile.am: installing `./COPYING'
Makefile.am: installing `./INSTALL'
Makefile.am: required file `./NEWS' not found
Makefile.am: required file `./README' not found
Makefile.am: required file `./AUTHORS' not found
Makefile.am: required file `./ChangeLog' not found
Makefile.am: installing `./depcomp'
$ autoconf
$ ls
aclocal.m4          config.h.in      COPYING          INSTALL          Makefile.in
autom4te.cache/    configure*      depcomp*        install-sh*      missing*
autoscan.log       configure.ac     epoch.c         Makefile.am      mkinstalldirs*
$
```


What is “Makefile.in”?

```
# Makefile.in generated by automake 1.7.9 from Makefile.am.
# @configure_input@

# Copyright 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003
# Free Software Foundation, Inc.
# This Makefile.in is free software; the Free Software Foundation
# gives unlimited permission to copy and/or distribute it,
# with or without modifications, as long as this notice is preserved.

# This program is distributed in the hope that it will be useful,
# but WITHOUT ANY WARRANTY, to the extent permitted by law; without
# even the implied warranty of MERCHANTABILITY or FITNESS FOR A
# PARTICULAR PURPOSE.

@SET_MAKE@

srcdir = @srcdir@
top_srcdir = @top_srcdir@
VPATH = @srcdir@
pkgdatadir = $(datadir)/@PACKAGE@
pkglibdir = $(libdir)/@PACKAGE@
pkgincludedir = $(includedir)/@PACKAGE@
top_builddir = .

am__cd = CDPATH="$${ZSH_VERSION+.}$(PATH_SEPARATOR)" && cd
INSTALL = @INSTALL@
install_sh_DATA = $(install_sh) -c -m 644
install_sh_PROGRAM = $(install_sh) -c
```

./configure

```
$ ls
aclocal.m4      config.h.in    COPYING       INSTALL       Makefile.in
autom4te.cache/ configure*     depcomp*     install-sh*   missing*
autoscan.log   configure.ac   epoch.c      Makefile.am   mkinstalldirs*
$ ./configure
checking for a BSD-compatible install... /usr/bin/install -c
checking whether build environment is sane... yes
checking for gawk... gawk
checking whether make sets $(MAKE)... yes
checking for gcc... gcc
...
checking sys/time.h usability... yes
checking sys/time.h presence... yes
checking for sys/time.h... yes
checking whether time.h and sys/time.h may both be included... yes
checking for gettimeofday... yes
configure: creating ./config.status
config.status: creating Makefile
config.status: creating config.h
config.status: executing depfiles commands
$ ls
aclocal.m4      config.h.in    configure.ac   INSTALL       Makefile.in
autom4te.cache/ config.log     COPYING       install-sh*   missing*
autoscan.log   config.status* depcomp*     Makefile     mkinstalldirs*
config.h       configure*     epoch.c      Makefile.am   stamp-h1
$
```

What is in the Makefile?

```
# Makefile.in generated by automake 1.7.9 from Makefile.am.
# Makefile.  Generated from Makefile.in by configure.

# Copyright 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003
# Free Software Foundation, Inc.
# This Makefile.in is free software; the Free Software Foundation
# gives unlimited permission to copy and/or distribute it,
# with or without modifications, as long as this notice is preserved.

# This program is distributed in the hope that it will be useful,
# but WITHOUT ANY WARRANTY, to the extent permitted by law; without
# even the implied warranty of MERCHANTABILITY or FITNESS FOR A
# PARTICULAR PURPOSE.

srcdir = .
top_srcdir = .

pkgdatadir = $(datadir)/full-package-name
pkglibdir = $(libdir)/full-package-name
pkgincludedir = $(includedir)/full-package-name
top_builddir = .

am__cd = CDPATH="$$ZSH_VERSION+."$(PATH_SEPARATOR)" && cd
INSTALL = /usr/bin/install -c
install_sh_DATA = $(install_sh) -c -m 644
install_sh_PROGRAM = $(install_sh) -c
```

make and make install

```
$ make
cd . && /bin/sh /home/vindaci/orgs/lugod/20040302-
autotools_talk/examples/complete/missing --run
autoheader
touch ./config.h.in
cd . && /bin/sh ./config.status config.h
config.status: creating config.h
make all-am
make[1]: Entering directory
~/home/vindaci/orgs/lugod/20040302-
autotools_talk/examples/complete'
if gcc -DHAVE_CONFIG_H -I. -I. -I. -s -O2 -Wall
-MT epoch.o -MD -MP -MF ".deps/epoch.Tpo" \
-c -o epoch.o `test -f 'epoch.c' || echo
'./`epoch.c; \
then mv -f ".deps/epoch.Tpo" ".deps/epoch.Po"; \
else rm -f ".deps/epoch.Tpo"; exit 1; \
fi
gcc -s -O2 -Wall -o epoch epoch.o
make[1]: Leaving directory
~/home/vindaci/orgs/lugod/20040302-
autotools_talk/examples/complete'
$ make install --dry-run
make install-exec-am install-data-am
make[1]: Entering directory
~/home/vindaci/orgs/lugod/20040302-
autotools_talk/examples/complete'
:
/bin/sh ./mkinstalldirs /usr/local/bin
list='epoch'; for p in $list; do \
  pl=`echo $p|sed 's/$//'\`; \
  if test -f $p \
  ; then \
    f=`echo "$pl" | sed 's,^.*/,/,s,x,x,s/$//'\`; \
    echo " /usr/bin/install -c $p /usr/local/bin/$f"; \
    /usr/bin/install -c $p /usr/local/bin/$f || exit 1; \
  else ;; fi; \
done
make[1]: Nothing to be done for `install-data-am'.
make[1]: Leaving directory
~/home/vindaci/orgs/lugod/20040302-
autotools_talk/examples/complete'
$ ls
aclocal.m4          config.log          epoch*             Makefile.am
autom4te.cache/    config.status*     epoch.c           Makefile.in
autoscan.log       configure*         epoch.o           missing*
config.h           configure.ac       INSTALL          mkinstalldirs*
config.h.in        COPYING           install-sh*      stamp-h1
config.h.in~      depcomp*          Makefile
$ ./epoch
1077932918.501751
$
```

The Ultimate Summary

- 1) Create sources, "Makefile.am"
 - 2) `autoscan`
 - 3) Rename "configure.scan" to "configure.ac"
 - 4) `autoheader`
 - 5) Add `AM_INIT_AUTOMAKE` to "configure.ac"
 - 6) `aclocal`
 - 7) `automake --add-missing --copy`
 - 8) `autoconf`
 - 9) `./configure`
 - 10) `make`
 - 11) `make install`
-
-

If you modify your source...

1) Run ``autoscan`` again

2) Compare `configure.scan` with `configure.ac`

- Update `configure.ac`

3) Run ``autoreconf``



Things to know...

- Autoconf/Automake doesn't make a program portable – *YOU DO!*
- Your program evolves to be more portable.
- You can add or write your own tests in m4.
(Place them in “acinclude.m4”)



Resources

- GNU Autoconf, Automake, and Libtool:
 - <http://sources.redhat.com/autobook/>
 - The GNU Autoconf Macro archive
 - <http://www.gnu.org/software/ac-archive/>
 - Autotools Tutorial for Beginners
 - <http://www.cbreak.org/>
-
-