



**The Abdus Salam  
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Scientific Environment: with case studies from Environmental  
Monitoring**

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**Advanced Linux**

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# *make*

- 'make' is a **command generator**.
- From a **description file** and **general templates** it creates **commands for the shell**.
- 'make' sorts out **dependencies** among files.

# *make* *continue..*

A program often consists of several source files, header files, libraries.

When one of these is modified, you must rebuild the program, by re-compiling some of the files, but not necessarily all, and then re-linking the object files.

'make' decides what must be done, basing itself on the dependencies and the last modification date/time of each file.

If file A depends on file B and B was modified after A had been built, then A must be re-built:  
compiled, linked, edited, substituted in a library or what have you.

# *make* *continue..*

Generally you invoke 'make' by typing:

```
make myprogram
```

'myprogram' is the target, it is built from one or more files, the 'prerequisites' or 'dependencies'.

The dependencies are specified in a description file (Makefile or makefile), together with the commands to be executed to build the target.

# *make* *continue..*

## Example of a Makefile:

```
program : main.o iodat.o dorun.o lo.o /usr/lib/crtn.a
    cc -o program main.o iodat.o dorun.o lo.o /usr/lib/crtn.a

main.o : main.c
    cc -c main.c

iodat.o : iodat.c
    cc -c iodat.c

dorun.o : dorun.c
    cc -c dorun.c

lo.o : lo.s
    as -o lo.o lo.s
```

Note that there are **dependency lines** or rule lines containing a ':' and command lines, starting with a 'tab' character.

# *make* *continue..*

The example is rather clumsy, repetitive. Things become simpler by using macros and by exploiting the suffix rules.

A macro is defined as:

name = "a text string" ('quoted' if necessary).

You refer to a macro with:

$\$(name)$  or  $\${name}$

# *make continue..*

## Example:

LIB = -lX11

objs = drawable.o plot\_points.o root\_data.o

CC = /usr/bin/gcc

23 = "This is the 23rd run"

OPT = # empty now, use later

DB = -g

BINDIR = /usr/local/bin

plot : \${objs}

    \${CC} -o plot \${DB} \${OPT} \${objs} \${LIB}

    mv plot \${BINDIR}

# *make continue..*

When you now type: *make plot* the shell will receive the following commands:

```
/usr/bin/gcc -o plot -g drawable.o plot_points.o  
root_data.o -lX11
```

```
mv plot /usr/local/bin
```

## *make continue..*

Macros can be nested. The order of definition is immaterial. 'make' has also macros defined internally.

Shell environment variables can be used as macros in a Makefile. So, if you have a shell environment variable:

DIR = /usr/proj

and you have 'exported' it:

export DIR (for bash) or:

setenv DIR /usr/proj (for tcsh)

*make* *continue..*

then you may use  $\${DIR}$  in your Makefile:

```
SRC =  $\${DIR}$ /src
```

```
myprog : ....
```

```
    cd  $\${SRC}$ 
```

# *make* continue..

These are the very essentials only of 'make'. For the details (many!), see the *man pages* or the book by A.Oram and S.Talbott, *Managing projects with make*. The examples were taken from this book.

'make' is absolutely essential for developing software of some complexity, especially if done by a team of programmers.

# gcc

gcc stands for "GNU Compiler Collection."  
It contains compilers for C, C++, Objective C,  
Fortran, Java and a few more.

## *gcc continue..*

Usually the compiler chain is invoked with:

```
gcc [-options] -o Prog file1.c file2.c...filek.s
```

(or something similar), where **Prog** is the name of the executable file that is to be produced as the end product.

# *gcc continue..*

C compiler consists of a chain of programs:

- **preprocessor (cpp)** transforms the '.c' program into a '.i' file, using the '.h' files.
- **compiler (cc1)** does the real job:  
translates C code into assembly code ('.s' file)
- **assembler (as)** translates the '.s' file into object code ('.o' file)
- **linker (ld)** 'glues' all '.o' files together and includes functions from libraries.

A cross-compiler has an overall wrapper program, usually called **xgcc**.

# *gcc continue..*

The most important options are:

- **-g** produce information for the debugger.
- **-I incdir** include '.h' files from 'incdir'.
- **-L libdir** search 'libdir' for libraries.
- **-l libname** search the library 'libname' for functions to 'link' in.
- **-o prog** name the executable: 'prog'.
- **-S** produce only '.s' file(s). Don't assemble.
- **-c** produce object ('.o') files. Don't call the linker to produce an executable.
- **-Wall** give all possible warnings.
- **-O2** optimize the code produced.
- **-v** verbose mode (I find it useful).

# *gcc continue..*

Normally, you will wisely specify the options to use in your *Makefile*.

# ***gdb***

**gdb** is a symbolic debugger, which means that you can use line numbers and names of variables and functions as defined in the C source code.

The executable to be debugged must have been compiled using the '-g' option of gcc.

## *What Next?*

Finally, after this workshop those who are new to linux and windows users can continue to work in a linux environment such as:

- cygwin can be use to run unix commands and applications in windows. Can also be use to connect to linux remotely. <http://www.cygwin.com>
- There are projects like Ubuntu, knoppix etc for those who are new to linux. They are easy to install and work with.

<http://www.ubuntulinux.org/>

<http://www.knoppix.org/>

## *What Next? continue...*

- Small linux - Damn Small Linux(DSL) and Puppy Linux. These are fully functional linux that can fit on a small CD or jumpdrive between 50-70Meg.

<http://www.damnsmalllinux.org/>

<http://www.puppyos.com/>

For the various distributions of linux, try:

<http://distrowatch.com>

More information about linux from:

<http://www.linux.org>