GCC Configuration and Building

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Part 1

Configuration and Building

Configuring GCC

configure

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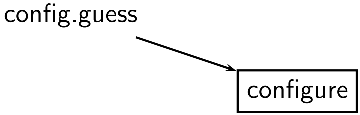

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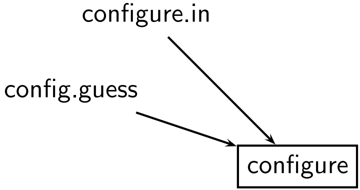

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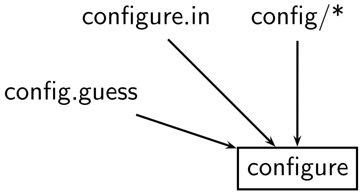

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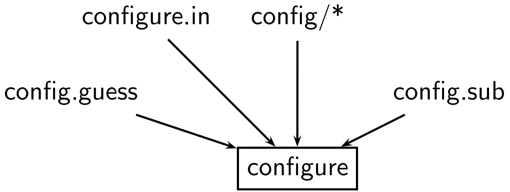

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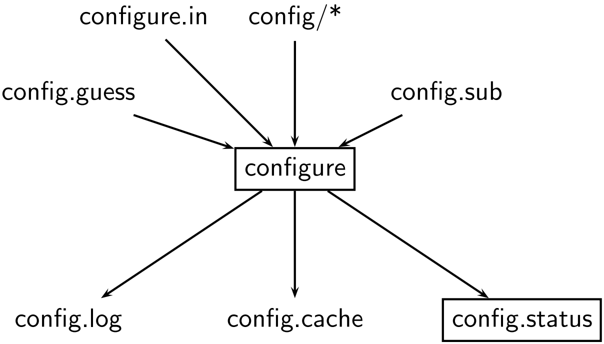

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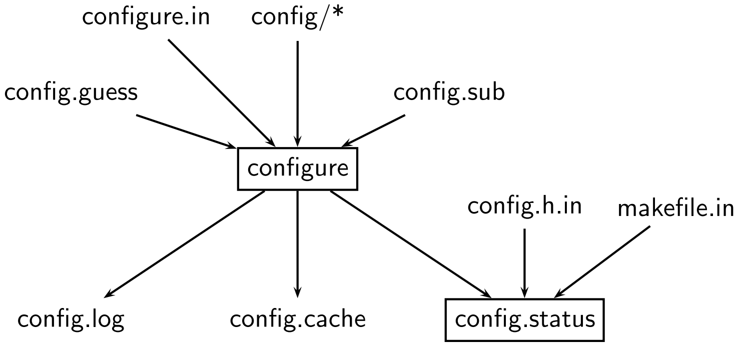

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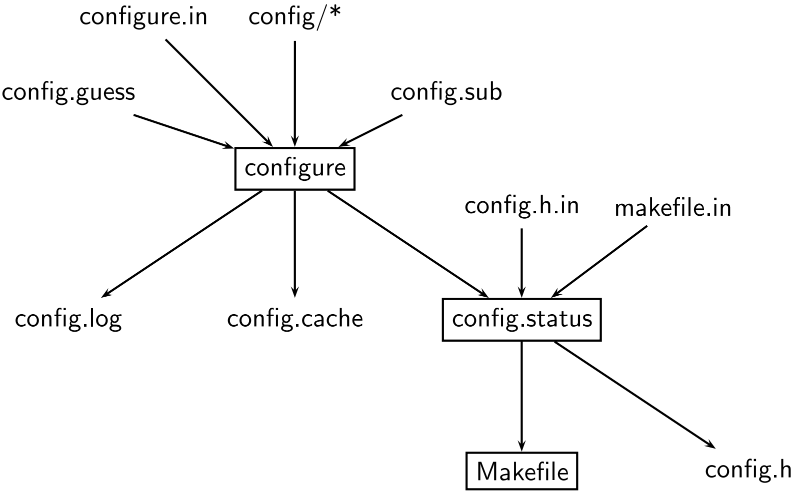
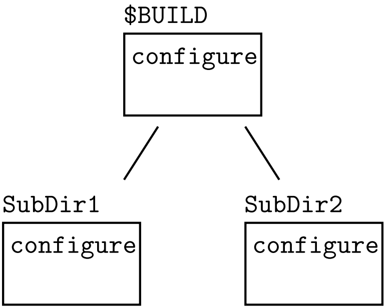


Alternatives in Configuration

GCC 3.3	
	

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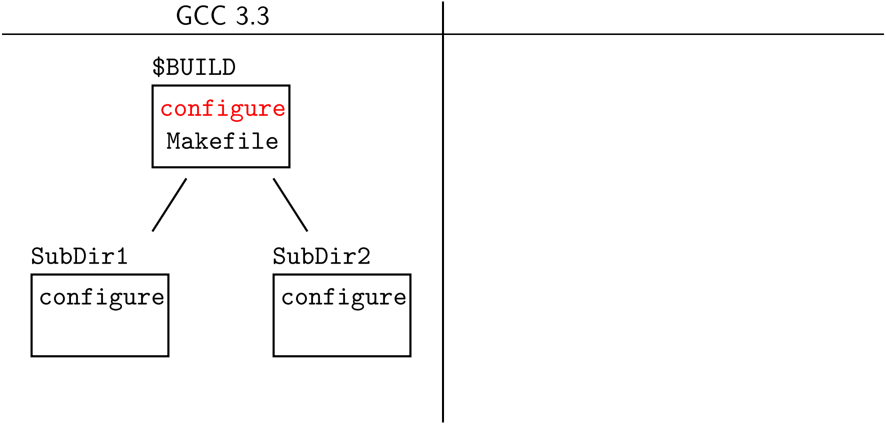

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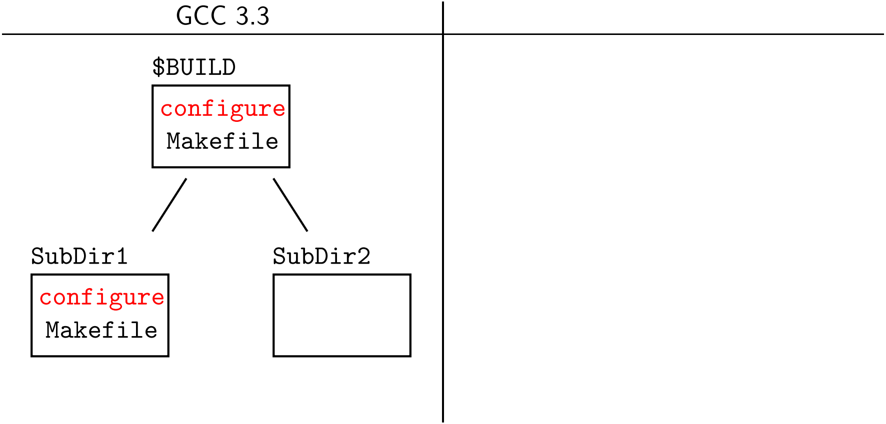

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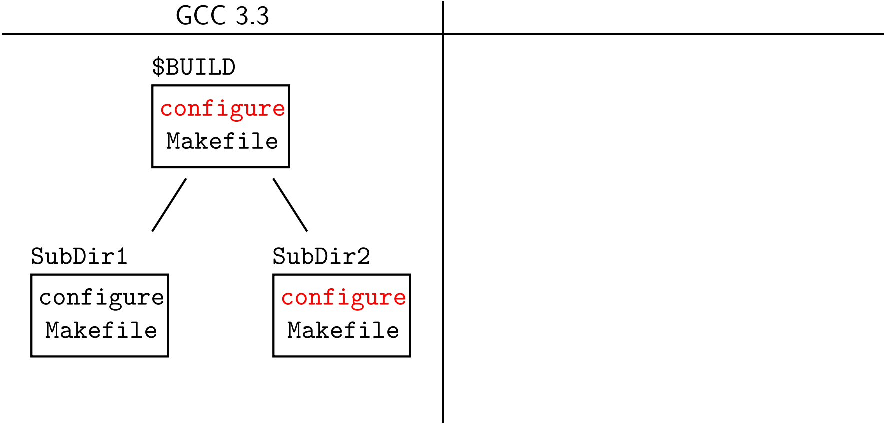

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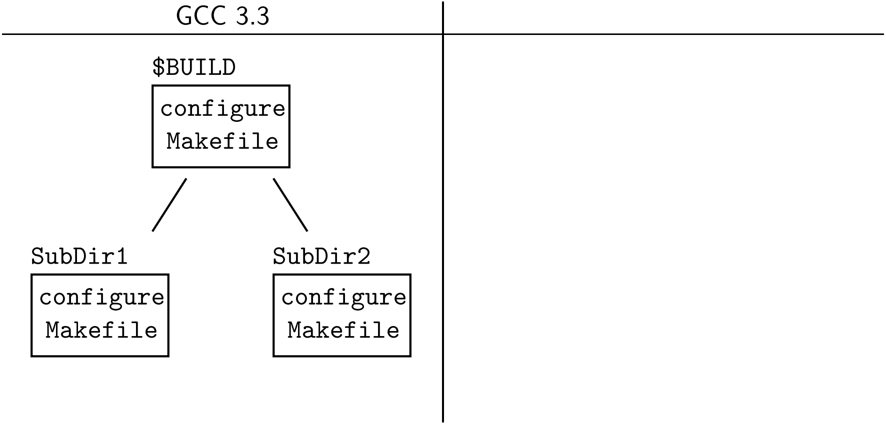

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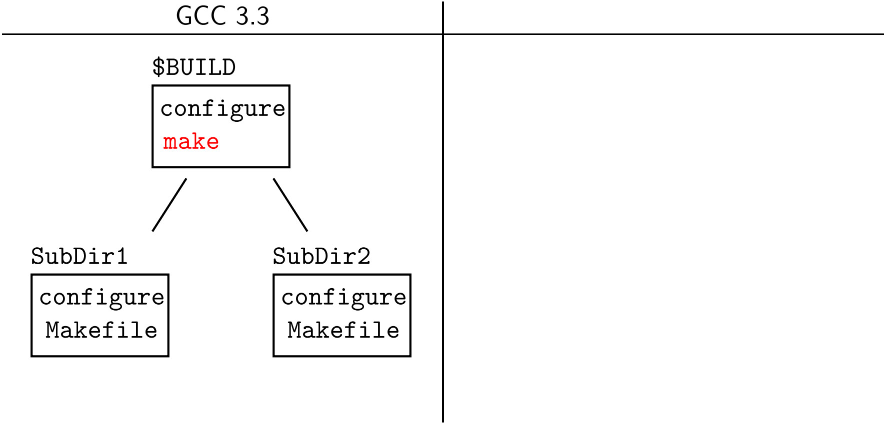

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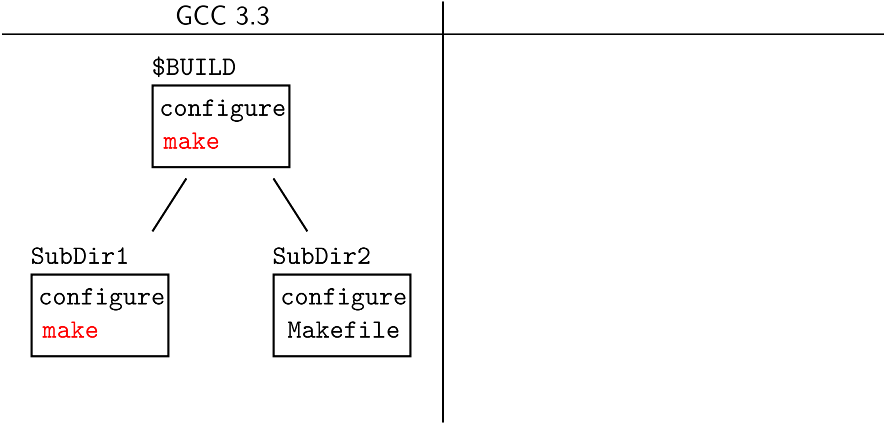

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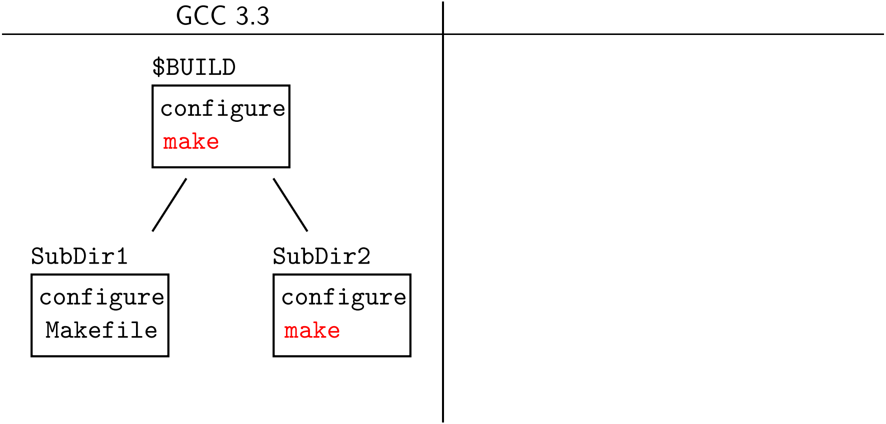

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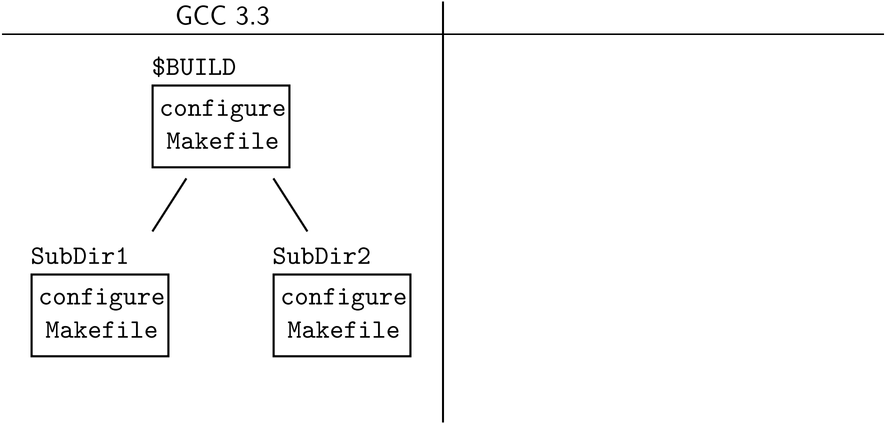

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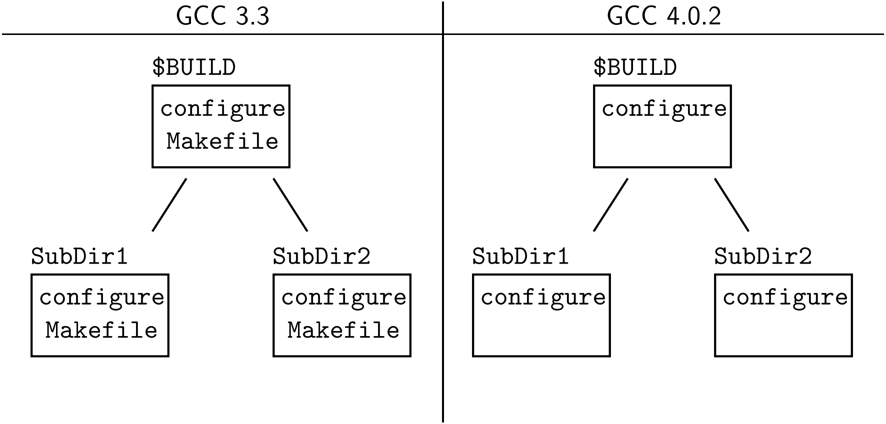

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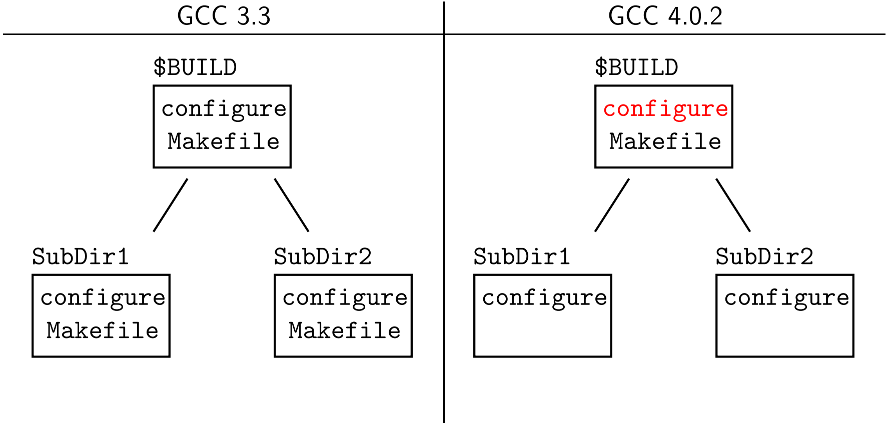

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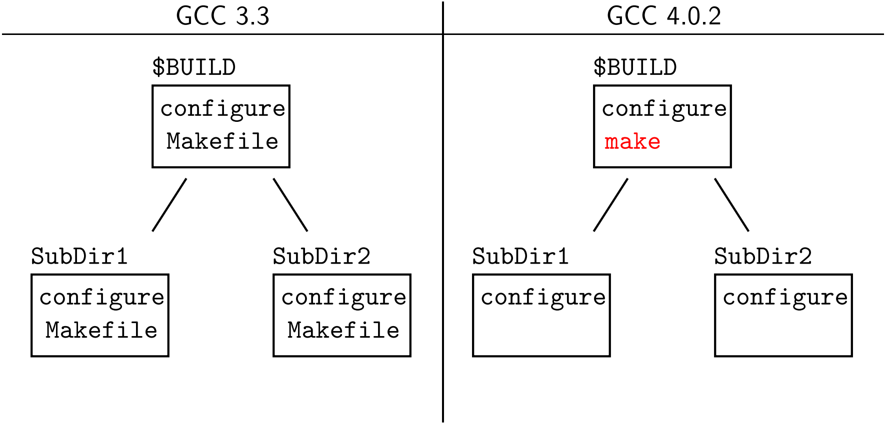

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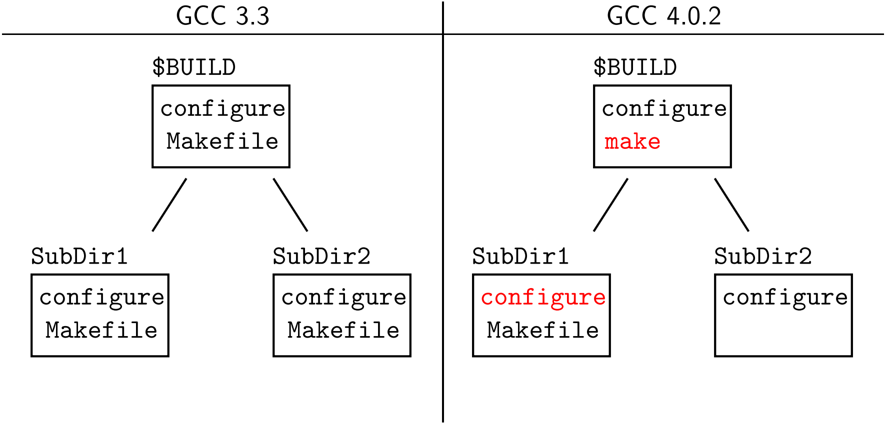

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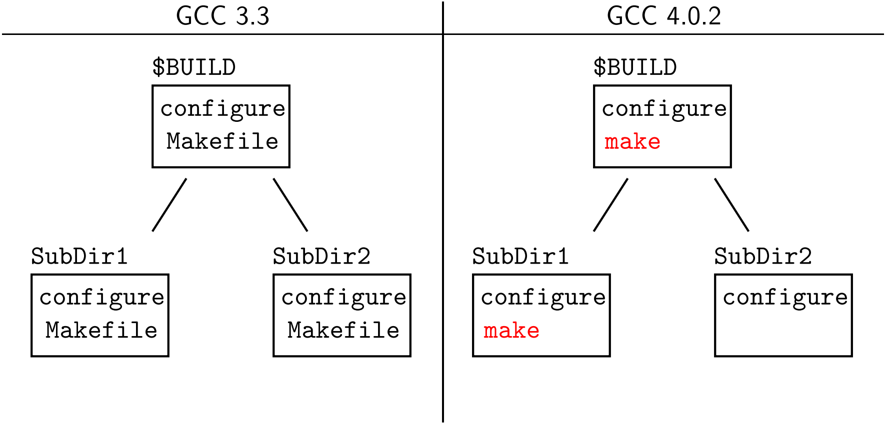

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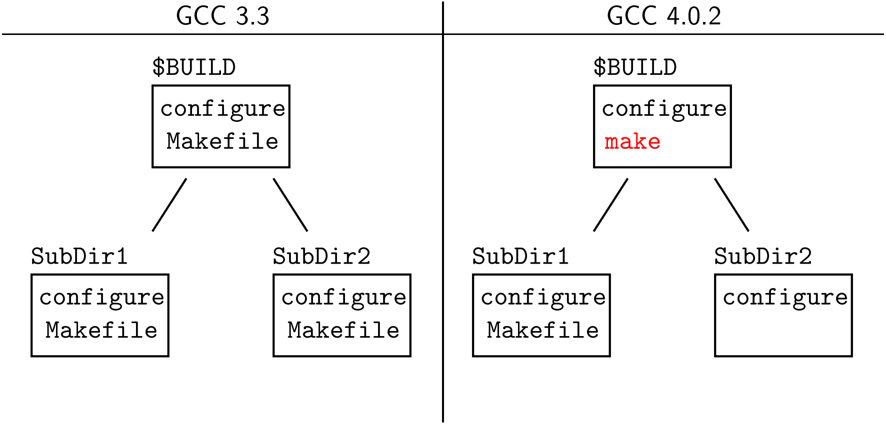

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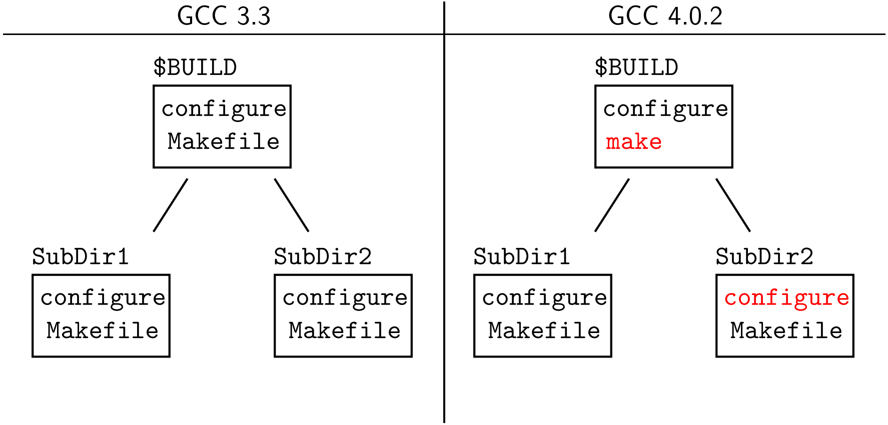

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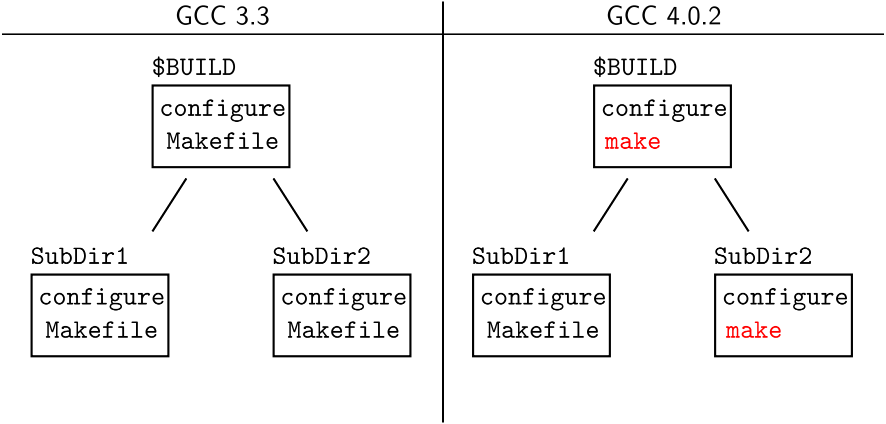

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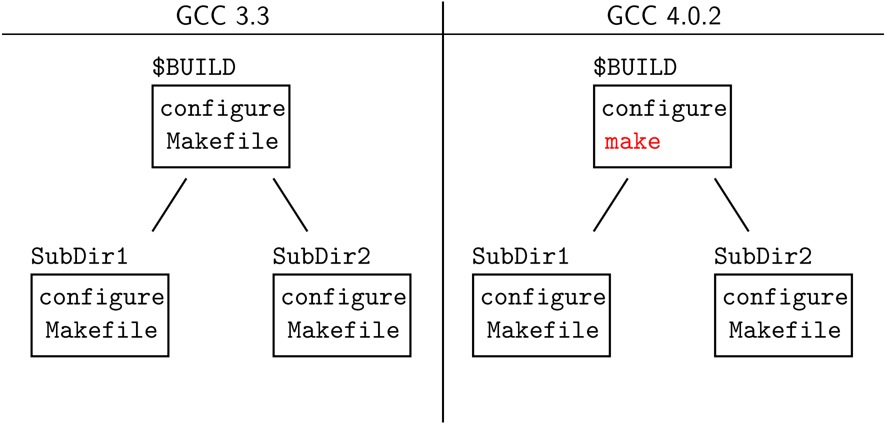

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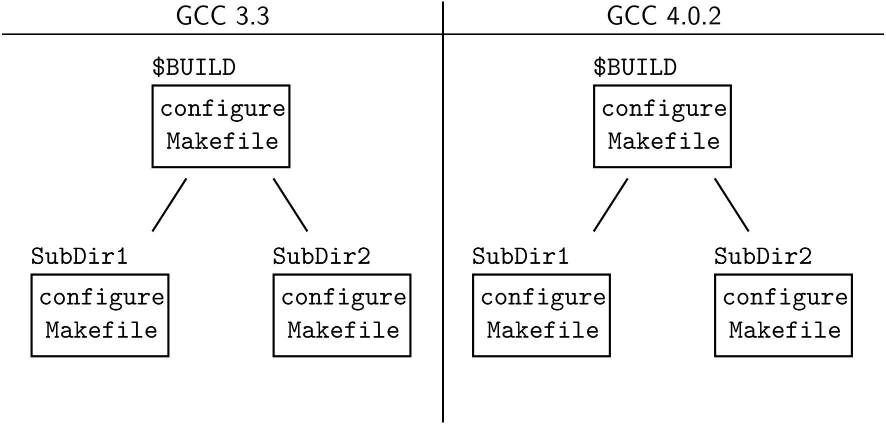

Steps in Configuration and Building

Usual Steps	
• Download and untar the source	

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GCC generates a large part of source code during configuration!

Some Interesting Facts about GCC 4.0.2

Pristine compiler sources (downloaded tarball)

Lines of C code	1098306
Lines of MD code	217888
Lines of total code	1316194
Total Authors (approx)	63
Backend directories	34

For the targetted (= pristine + generated) C compiler

Total lines of code	810827
Total lines of pure code	606980
Total pure code WITHOUT #includes	602351
Total number of #include directives	4629
Total #included files	336

Some Interesting i386 MD Facts

General information

Number of .md files	8
Number of C files	72

Realistic code size information (excludes comments)

Total lines of code	47290
Total lines of .md code	23566
Total lines of header code	9986
Total lines of C code	16961

Other Facts about the Size of GCC

	GCC 4.0.2	GCC 4.3.0
Compressed tar file (.tar.bz2)	30.3 MB	6.6 MB
Uncompressed source	378 MB	511 MB

The size of $BUILD directory is usually larger than $SOURCE and depends on the target specification.

Building a Compiler: General issues I

Some Terminology

- The sources of a compiler are compiled (i.e. built) on machine X
  X is called as the Build system
- The built compiler runs on machine Y
  Y is called as the Host system
- The compiler compiles code for target Z
  Z is called as the Target system
- Note: The built compiler itself runs on the Host machine and generates executables that run on Target machine!!!

Building a Compiler: General issues II

Some Definitions

Note: The built compiler itself runs on the Host machine and generates executables that run on Target machine!!!

A few interesting permutations of X, Y and Z are:

$X = Y = Z$	Native build
$X = Y \neq Z$	Cross compiler
$X \neq Y \neq Z$	Canadian Cross compiler

Example

Native i386: built on i386, hosted on i386, produces i386 code.
Sparc cross on i386: built on i386, hosted on i386, produces Sparc code.

Building a Compiler

Bootstrapping

A compiler is just another program

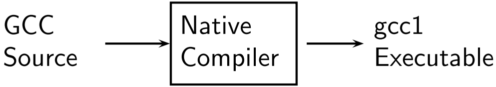
It is improved, bugs are fixed and newer versions are released

To build a new version given a built old version:

1. Stage 1: Build the new compiler using the old compiler
2. Stage 2: Build another new compiler using compiler from stage 1
3. Stage 3: Build another new compiler using compiler from stage 2
   Stage 2 and stage 3 builds must result in identical compilers

⇒ Building cross compilers stops after Stage 1!

A Native Build



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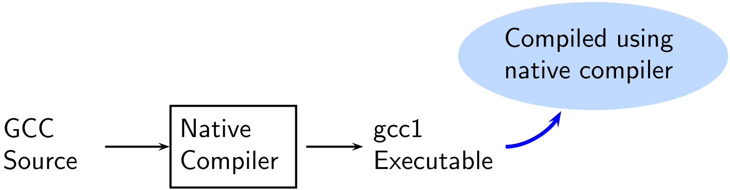

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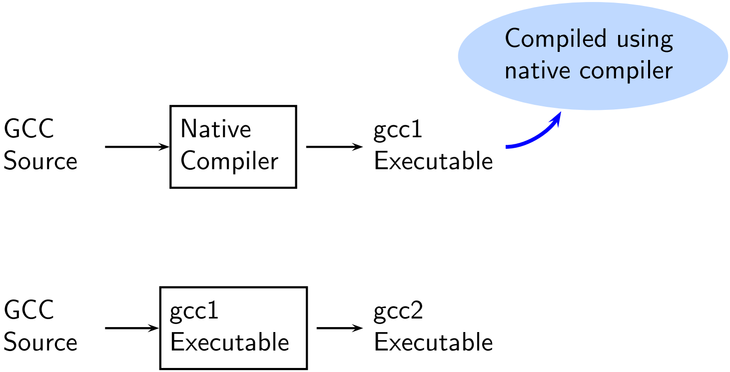

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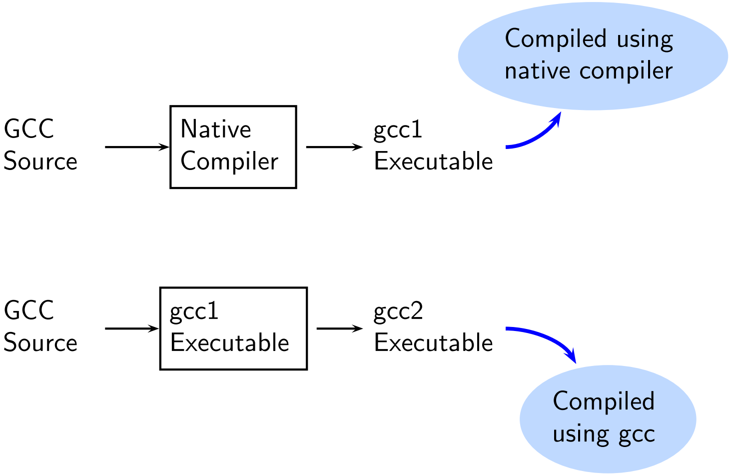

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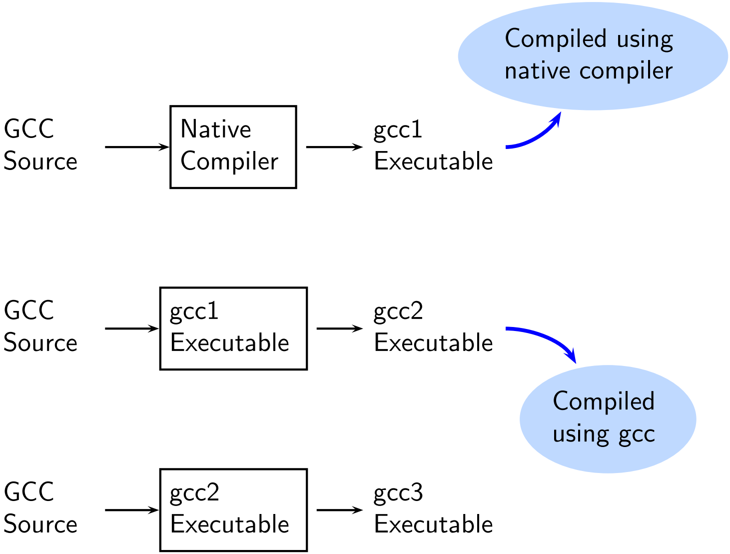

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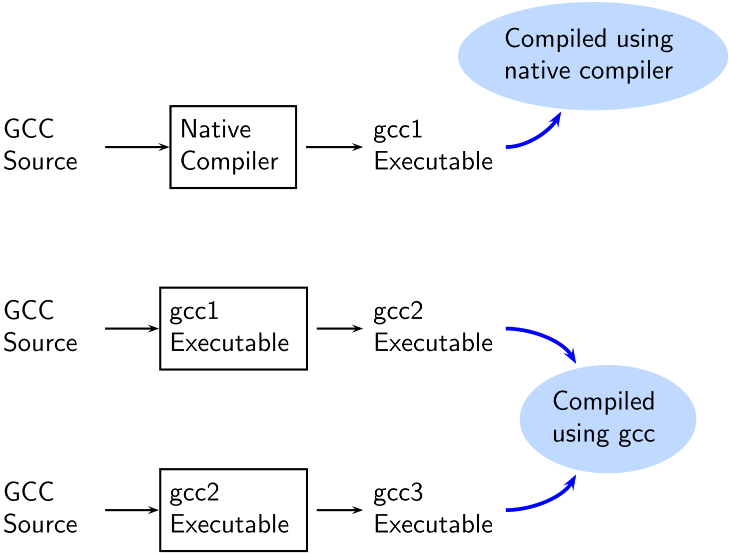
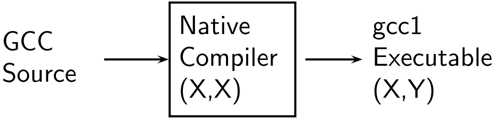


A Cross Build

Let Host = Build = X and Target = Y



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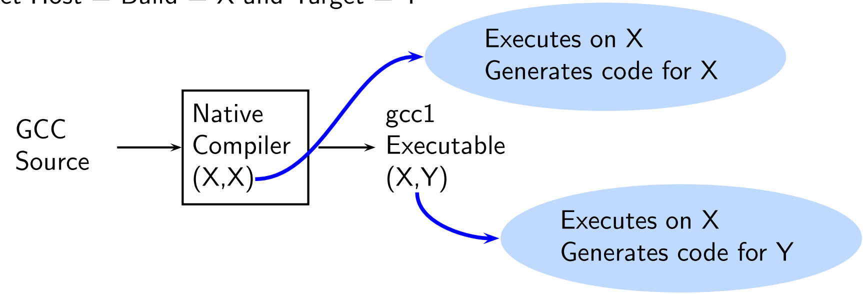

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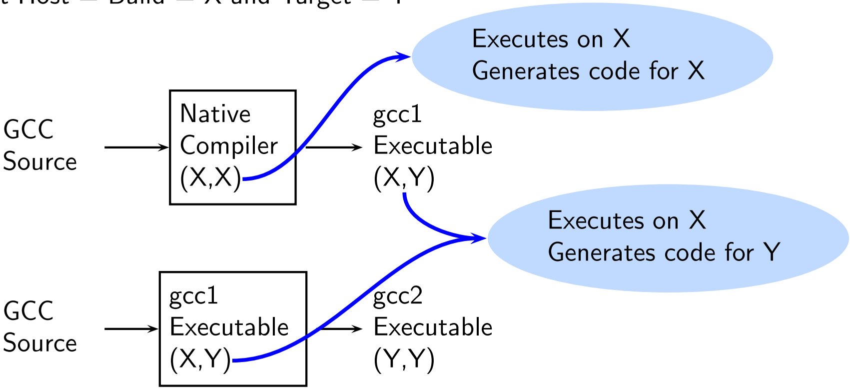

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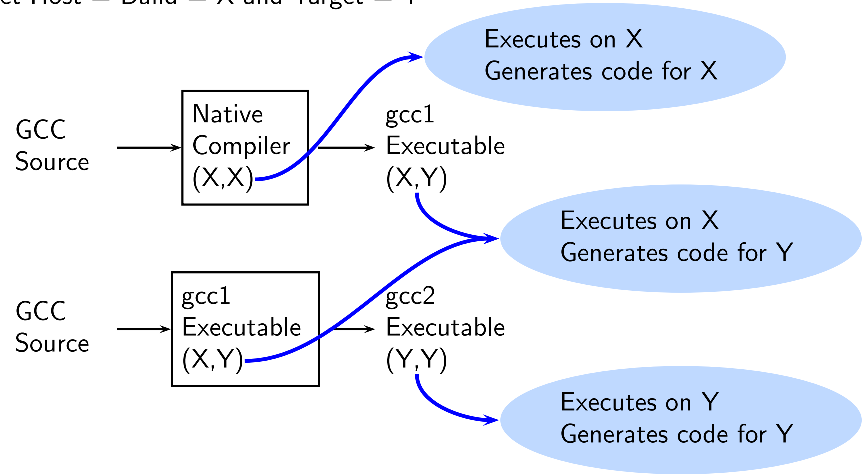

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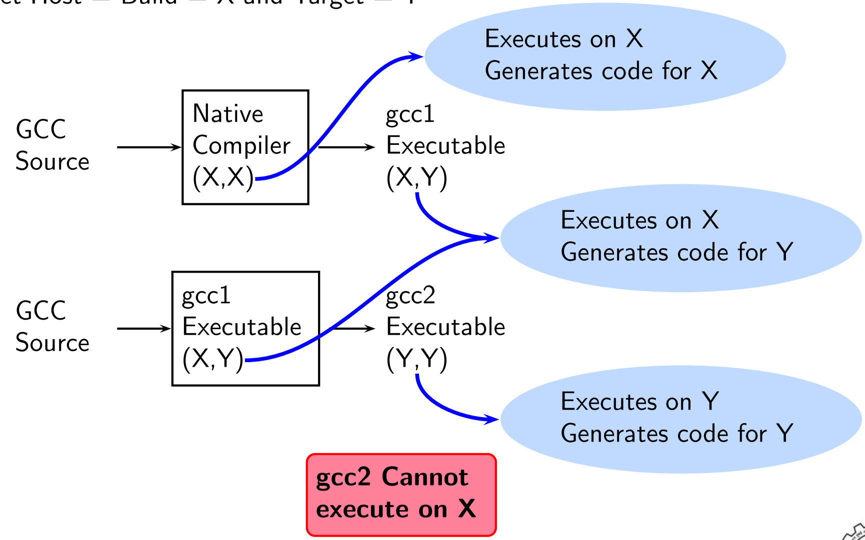

GCC Code Organization Overview

Logical parts are:

- Build configuration files
- Compiler sources
- Emulation libraries
  `libgcc` $\longrightarrow$ emulate operations not supported on the target
  `real.c` $\longrightarrow$ floating point
- Language Libraries (except C)
- Support software (e.g. garbage collector)

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Our conventions

GCC source directory : `$(GCCHOME)`
GCC build directory : `$(GCCBUILD)`
GCC install directory : `$(GCCINSTALL)`
`$(GCCHOME)` $\neq$ `$(GCCBUILD)` $\neq$ `$(GCCBUILD)`

Organization of the Front End Code

- Source language dir: `$(GCCHOME)/<lang dir>`
- Source language dir contains
  - Parsing code
    either hand written or parser generator input
  - Additional AST/Generic nodes, if any
  - Interface to Generic creation

Except for C – which is the "native" language of the compiler

C front end code in: `$(GCCHOME)/gcc`

GCC Backend Organization

- `$(GCCHOME)/gcc/config/<target dir>/`
  Directory containing backend code
- Two main files: `<target>.h` and `<target>.md`,
  e.g. for an `i386` target, we have
  `$(GCCHOME)/gcc/config/i386/i386.md` and
  `$(GCCHOME)/gcc/config/i386/i386.h`
- Usually, also `<target>.c` for additional processing code
  (e.g. `$(GCCHOME)/gcc/config/i386/i386.c`)
- Some additional files

The GCC Build System I

Some Information

- Build-Host-Target systems inferred for native builds
- Specify Target system for cross builds
  Build $\equiv$ Host systems: inferred
- Build-Host-Target systems can be explicitly specified too
- For GCC: A "system" = three entities
  - "cpu"
  - "vendor"
  - "os"

e.g. `sparc-sun-sunos`, `i386-unknown-linux`, `i386-gcc-linux`

The GCC Build System II

Basic GCC Building How To

- `prompt$ cd $GCCBUILD`
- `prompt$ $GCCHOME configure <options>`
  - Specify target: optional for native builds, necessary for others (option `--target=<host-cpu-vendor string>`)
  - Choose source languages (option `--enable-languages=<CSV lang list (c,java)`)
  - Specify the installation directory (option `--prefix=<absolute path of $(GCCBUILD)>`)

  ⇒ `configure` output: customized `Makefile`
- `prompt$ make 2> make.err > make.log`
- `prompt$ make install 2> install.err > install.log`

Adding a New MD

To add a new backend to GCC

- Define a new system name, typically a triple.
  e.g. `spim-gnu-linux`
- Edit `$GCCHOME/config.sub` to recognize the triple
- Edit `$GCCHOME/gcc/config.gcc` to define
  - any backend specific variables
  - any backend specific files
  - `$GCCHOME/gcc/config/<cpu>` is used as the backend directory

  for recognized system names.

Tip

Read comments in `$GCCHOME/config.sub` & `$GCCHOME/gcc/config/<cpu>`.

The GCC Build Process I

GCC builds in two main phases:

- Adapt the compiler source for the specified build/host/target systems
  Consider a cross compiler:
  - Find the target MD in the source tree
  - "Include" MD info into the sources
    (details follow)
- Compile the adapted sources
- NOTE:
  - Incomplete MD specifications ⇒ Unsuccessful build
  - Incorrect MD specification ⇒ Run time failures/crashes
    (either ICE or `SIGSEGV`)

The GCC Build Process

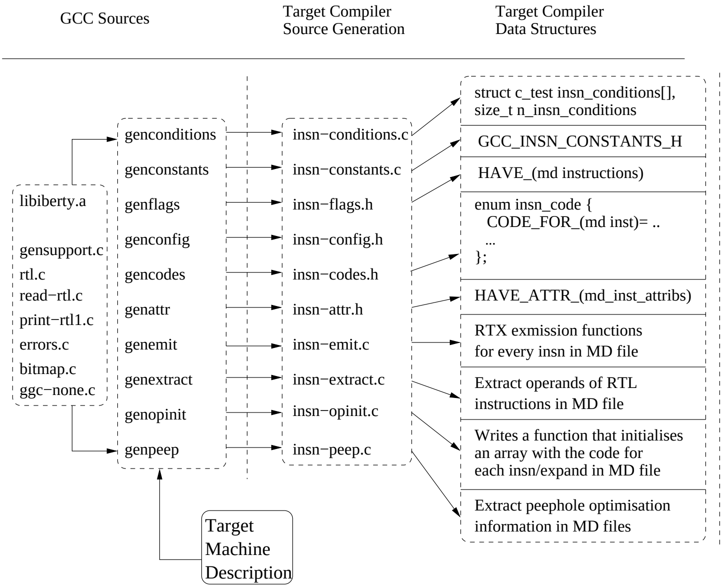
- make first compiles and runs a series of programs that process the target MD
- Typically, the program source file names are prefixed with gen
- The $GCCHOME/gcc/gen*.c programs
  - read the target MD files, and
  - extract info to create & populate the main GCC data structures

Example

Consider genconstants.c:

- <target>.md may define UNSPEC_* constants.
- genconstants.c – reads UNSPEC_* constants
- genconstants.c – generates corresponding #defines
- Collect then into the insn-constants.h
- #include "insn-constants.h" in the main GCC sources

The GCC Build Process



Building GCC – Summary

- Choose the source language: C
  (`--enable-languages=c`)
- Choose installation directory:
  (`--prefix=<absolute path>`)
- Choose the target for non native builds:
  (`--target=sparc-sunos-sun`)
- Run: `configure` with above choices
- Run: `make` to
  - generate target specific part of the compiler
  - build the entire compiler
- Run: `make install` to install the compiler

Tip

Redirect all the outputs:

```
$ make > make.log 2> make.err
```