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GNU gcj

Tom Tromey

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For the GCC-3.0 Version*

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Introduction

This manual describes how to use `gcj`, the GNU compiler for the Java programming language. `gcj` can generate both '`.class`' files and object files, and it can read both Java source code and '`.class`' files.

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1 Invoking gcj

As `gcj` is just another front end to `gcc`, it supports many of the same options as gcc. See section "Option Summary" in *Using the GNU Compiler Collection*. This manual only documents the options specific to `gcj`.

1.1 Input and output files

A `gcj` command is like a `gcc` command, in that it consists of a number of options and file names. The following kinds of input file names are supported:

file`.java` Java source files.

file`.class` Java bytecode files.

file`.zip`
file`.jar` An archive containing one or more `.class` files, all of which are compiled. The archive may be compressed.

`@`*file* A file containing a whitespace-separated list of input file names. (Currently, these must all be `.java` source files, but that may change.) Each named file is compiled, just as if it had been on the command line.

library`.a`
library`.so`
`-l`*libname* Libraries to use when linking. See the `gcc` manual.

You can specify more than one input file on the `gcj` command line, in which case they will all be compiled. If you specify a `-o` *FILENAME* option, all the input files will be compiled together, producing a single output file, named *FILENAME*. This is allowed even when using `-S` or `-c`, but not when using `-C`. (This is an extension beyond the what plain `gcc` allows.) (If more than one input file is specified, all must currently be `.java` files, though we hope to fix this.)

1.2 Input Options

`gcj` has options to control where it looks to find files it needs. For instance, `gcj` might need to load a class that is referenced by the file it has been asked to compile. Like other compilers for the Java language, `gcj` has a notion of a *class path*. There are several options and environment variables which can be used to manipulate the class path. When `gcj` looks for a given class, it searches the class path looking for matching '`.class`' or '`.java`' file. `gcj` comes with a built-in class path which points at the installed '`libgcj.jar`', a file which contains all the standard classes.

In the below, a directory or path component can refer either to an actual directory on the filesystem, or to a '`.zip`' or '`.jar`' file, which `gcj` will search as if it is a directory.

`-I`*dir* All directories specified by `-I` are kept in order and prepended to the class path constructed from all the other options. Unless compatibility with tools like `javac` is imported, we recommend always using `-I` instead of the other options for manipulating the class path.

`--classpath=`*path*
: This sets the class path to *path*, a colon-separated list of paths (on Windows-based systems, a semicolon-separate list of paths).

`--CLASSPATH=`*path*
: This sets the class path to *path*, a colon-separated list of paths (on Windows-based systems, a semicolon-separate list of paths). This differs from the `--classpath` option in that it also suppresses the built-in system path.

`CLASSPATH`
: This is an environment variable which holds a list of paths.

The final class path is constructed like so:

- First come all directories specified via `-I`.
- If `--classpath` is specified, its value is appended and processing stops. That is, `--classpath` suppresses all the options mentioned later in this list.
- If `--CLASSPATH` is specified, its value is appended and the `CLASSPATH` environment variable is suppressed.
- If the `CLASSPATH` environment variable is specified (and was not suppressed by `--CLASSPATH`), then its value is appended.
- Finally, the built-in system directory, '`libgcj.jar`', is appended.

The classfile built by `gcj` for the class `java.lang.Object` (and placed in `libgcj.jar`) contains a special zero length attribute `gnu.gcj.gcj-compiled`. The compiler looks for this attribute when loading `java.lang.Object` and will report an error if it isn't found, unless it compiles to bytecode (the option `-fforce-classes-archive-check` can be used to overide this behavior in this particular case.)

`-fforce-classes-archive-check`
: This forces the compiler to always check for the special zero length attribute `gnu.gcj.gcj-compiled` in `java.lang.Object` and issue an error if it isn't found.

1.3 Encodings

The Java programming language uses Unicode throughout. In an effort to integrate well with other locales, `gcj` allows '`.java`' files to be written using almost any encoding. `gcj` knows how to convert these encodings into its internal encoding at compile time.

You can use the `--encoding=`*NAME* option to specify an encoding (of a particular character set) to use for source files. If this is not specified, the default encoding comes from your current locale. If your host system has insufficient locale support, then `gcj` assumes the default encoding to be the '`UTF-8`' encoding of Unicode.

To implement `--encoding`, `gcj` simply uses the host platform's `iconv` conversion routine. This means that in practice `gcj` is limited by the capabilities of the host platform.

The names allowed for the argument `--encoding` vary from platform to platform (since they are not standardized anywhere). However, `gcj` implements the encoding named '`UTF-8`' internally, so if you choose to use this for your source files you can be assured that it will work on every host.

1.4 Warnings

`gcj` implements several warnings. As with other generic `gcc` warnings, if an option of the form `-Wfoo` enables a warning, then `-Wno-foo` will disable it. Here we've chosen to document the form of the warning which will have an effect – the default being the opposite of what is listed.

`-Wredundant-modifiers`
: With this flag, `gcj` will warn about redundant modifiers. For instance, it will warn if an interface method is declared `public`.

`-Wextraneous-semicolon`
: This causes `gcj` to warn about empty statements. Empty statements have been deprecated.

`-Wno-out-of-date`
: This option will cause `gcj` not to warn when a source file is newer than its matching class file. By default `gcj` will warn about this.

`-Wunused`
: This is the same as `gcc`'s `-Wunused`.

`-Wall`
: This is the same as `-Wredundant-modifiers -Wextraneous-semicolon -Wunused`.

1.5 Code Generation

In addition to the many `gcc` options controlling code generation, `gcj` has several options specific to itself.

`--main=`*CLASSNAME*
: This option is used when linking to specify the name of the class whose `main` method should be invoked when the resulting executable is run.[1]

`-D`*name*`[=`*value*`]`
: This option can only be used with `--main`. It defines a system property named *name* with value *value*. If *value* is not specified then it defaults to the empty string. These system properties are initialized at the program's startup and can be retrieved at runtime using the `java.lang.System.getProperty` method.

`-C`
: This option is used to tell `gcj` to generate bytecode ('`.class`' files) rather than object code.

`-d` *directory*
: When used with `-C`, this causes all generated '`.class`' files to be put in the appropriate subdirectory of *directory*. By default they will be put in subdirectories of the current working directory.

`-fno-bounds-check`
: By default, `gcj` generates code which checks the bounds of all array indexing operations. With this option, these checks are omitted. Note that this can

[1] The linker by default looks for a global function named `main`. Since Java does not have global functions, and a collection of Java classes may have more than one class with a `main` method, you need to let the linker know which of those `main` methods it should invoke when starting the application.

result in unpredictable behavior if the code in question actually does violate array bounds constraints.

`-fjni` With `gcj` there are two options for writing native methods: CNI and JNI. By default `gcj` assumes you are using CNI. If you are compiling a class with native methods, and these methods are implemented using JNI, then you must use `-fjni`. This option causes `gcj` to generate stubs which will invoke the underlying JNI methods.

1.6 Configure-time Options

Some `gcj` code generations options affect the resulting ABI, and so can only be meaningfully given when `libgcj`, the runtime package, is configured. `libgcj` puts the appropriate options from this group into a '`spec`' file which is read by `gcj`. These options are listed here for completeness; if you are using `libgcj` then you won't want to touch these options.

`-fuse-boehm-gc`
: This enables the use of the Boehm GC bitmap marking code. In particular this causes `gcj` to put an object marking descriptor into each vtable.

`-fhash-synchronization`
: By default, synchronization data (the data used for `synchronize`, `wait`, and `notify`) is pointed to by a word in each object. With this option `gcj` assumes that this information is stored in a hash table and not in the object itself.

`-fuse-divide-subroutine`
: On some systems, a library routine is called to perform integer division. This is required to get exception handling correct when dividing by zero.

2 Compatibility with the Java Platform

As we believe it is important that the Java platform not be fragmented, `gcj` and `libgcj` try to conform to the relevant Java specifications. However, limited manpower and incomplete and unclear documentation work against us. So, there are caveats to using `gcj`.

This list of compatibility issues is by no means complete.

- `gcj` implements the JDK 1.1 language. It supports inner classes, though these are known to still be buggy. It does not yet support the Java 2 `strictfp` keyword (it recognizes the keyword but ignores it).
- `libgcj` is largely compatible with the JDK 1.2 libraries. However, `libgcj` is missing many packages, most notably `java.awt`. There are also individual missing classes and methods. We currently do not have a list showing differences between `libgcj` and the Java 2 platform.
- Sometimes the `libgcj` implementation of a method or class differs from the JDK implementation. This is not always a bug. Still, if it affects you, it probably makes sense to report it so that we can discuss the appropriate response.

3 Invoking gcjh

The `gcjh` program is used to generate header files from class files. It can generate both CNI and JNI header files, as well as stub implementation files which can be used as a basis for implementing the required native methods.

`-stubs` This causes `gcjh` to generate stub files instead of header files. By default the stub file will be named after the class, with a suffix of '`.cc`'. In JNI mode, the default output file will have the suffix '`.c`'.

`-jni` This tells `gcjh` to generate a JNI header or stub. By default, CNI headers are generated.

`-add` *text* Inserts *text* into the class body. This is ignored in JNI mode.

`-append` *text*
Inserts *text* into the header file after the class declaration. This is ignored in JNI mode.

`-friend` *text*
Inserts *text* into the class as a `friend` declaration. This is ignored in JNI mode.

`-prepend` *text*
Inserts *text* into the header file before the class declaration. This is ignored in JNI mode.

`--classpath=`*path*
`--CLASSPATH=`*path*
`-I`*directory*
`-d` *directory*
`-o` *file* These options are all identical to the corresponding `gcj` options.

`-o` *file* Sets the output file name. This cannot be used if there is more than one class on the command line.

`-td` *directory*
Sets the name of the directory to use for temporary files.

`--help` Print help about `gcjh` and exit. No further processing is done.

`--version`
Print version information for `gcjh` and exit. No further processing is done.

All remaining options are considered to be names of classes.

4 Invoking jv-scan

The `jv-scan` program can be used to print information about a Java source file ('`.java`' file).

`--complexity`
: This prints a complexity measure, related to cyclomatic complexity, for each input file.

`--encoding=`*name*
: This works like the corresponding `gcj` option.

`--print-main`
: This prints the name of the class in this file containing a `main` method.

`--list-class`
: This lists the names of all classes defined in the input files.

`--list-filename`
: If `--list-class` is given, this option causes `jv-scan` to also print the name of the file in which each class was found.

`-o` *file*
: Print output to the named file.

5 Invoking jcf-dump

This is a class file examiner, similar to `javap`. It will print information about a number of classes, which are specifed by class name or file name.

`-c` Disassemble method bodies. By default method bodies are not printed.

`--javap` Generate output in `javap` format. The implementation of this feature is very incomplete.

`--classpath=`*path*
`--CLASSPATH=`*path*
`-I`*directory*
`-o` *file* These options as the same as the corresponding `gcj` options.

6 Invoking gij

`gij` is a Java bytecode interpreter included with `libgcj`. `gij` is not available on every platform; porting it requires a small amount of assembly programming which has not been done for all the targets supported by `gcj`.

The primary argument to `gij` is the name of a class or, with `-jar`, a jar file. Options before this argument are interpreted by `gij`; remaining options are passed to the interpreted program.

If a class name is specified and this class does not have a `main` method with the appropriate signature (a `static void` method with a `String[]` as its sole argument), then `gij` will print an error and exit.

If a jar file is specified then `gij` will use information in it to determine which class' `main` method will be invoked.

`gij` will invoke the `main` method with all the remaining command-line options.

Note that `gij` is not limited to interpreting code. Because `libgcj` includes a class loader which can dynamically load shared objects, it is possible to give `gij` the name of a class which has been compiled and put into a shared library on the class path.

`-D`*name*`[=`*value*`]`
: This defines a system property named *name* with value *value*. If *value* is not specified then it defaults to the empty string. These system properties are initialized at the program's startup and can be retrieved at runtime using the `java.lang.System.getProperty` method.

`-ms=`*number*
: This sets the initial heap size

`-mx=`*number*
: This sets the maximum heap size.

`-jar`
: This indicates that the name passed to `gij` should be interpreted as the name of a jar file, not a class.

7 Resources

While writing `gcj` and `libgcj` we have, of course, relied heavily on documentation from Sun Microsystems. In particular we have used The Java Language Specification (both first and second editions), the Java Class Libraries (volumes one and two), and the Java Virtual Machine Specification. In addition we've used the online documentation at `http://java.sun.com/`.

The current `gcj` home page is `http://gcc.gnu.org/java/`.

For more information on gcc, see `http://gcc.gnu.org/`.

Some `libgcj` testing is done using the Mauve test suite. This is a free software Java class library test suite which is being written because the JCK is not free. See `http://sources.redhat.com/mauve/` for more information.