

GODI User's Manual

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Preface

GODI is a programming environment for the computer language Objective Caml (O'Caml), a result of the research activities of the Cristal project at the INRIA institute in France.

From INRIA you can get the O'Caml compiler and runtime system, but this is usually not enough to develop applications. You also need libraries, and fortunately there are many developers all over the world providing them; you can go and pick them up. But it is a lot of work to build and install each of them.

GODI is a system that simplifies this task: It is a framework that automatically builds the O'Caml core system, and additionally installs a growing number of pre-packaged libraries. For a number of reasons GODI is a source-code based system, and there are no precompiled libraries, but it makes it very simple for everybody to compile them.

Features of GODI:

- Automatic installation of new libraries: GODI knows where a library can be downloaded, which prerequisites are needed to build it, and which commands must be invoked to compile and install it
- Complete package management of the installation: A library is installed as a package (a managed set of files), so it is possible to remove it later without any hassle.
- GODI implements the necessary logic to upgrade installations: Because of the way O'Caml works, all dependent libraries must be recompiled if a library is upgraded to a newer version. GODI automates this process.
- Integration with the operating system: If additional C libraries are needed to build an O'Caml library, and the operating system includes them, they will usually be automatically found and used. Non-standard locations can be configured (there is only one configuration file for the whole installation).
- GODI has a menu-based user interface that makes it simple to use even for beginners.
- GODI tries to standardize the directory layout of library installations, so it becomes simpler to find files of interest.

This manual is a mixture of a user's and developer's manual, and you find information at various levels of details.

Chapter 1

Getting and Installing GODI

GODI is an O’Caml distribution that is compiled and installed from sources. The main reason for this is that it simplifies the maintenance of the GODI system from the perspective of the developers. GODI has only very little central infrastructure, more or less it is only a file management and distribution service, and complicated installations like compile farms are not needed. Furthermore, GODI supports a wider range of operating systems than it would be possible for a binary distribution. Users will also note the advantage that software updates happen frequently, and the distributed software versions are usually the latest that are available.

Of course, there is also a downside, especially GODI users must do more than for distributions where the software is available in binary form. First, the basic «C toolchain» to build C programs must be already installed on the system, and it must work. Second, the development parts of the system libraries must be installed on the system, e.g. C header files. The users must also recognize by themselves when additional external libraries are required for certain GODI packages. Third, the users’ patience is sometimes stressed, as it takes a bit of time to build software. Fourth, the users should be prepared that sometimes things go wrong. The GODI developers cannot guarantee that the distributed build procedures work on every system. Sometimes they make too optimistic assumptions, for instance it is sometimes expected that the OS has features it actually does not have (e.g. that shell utilities have GNU extensions). Such errors happen from time to time, and the developers are glad when the users inform them about such mistakes. Of course, this would require that the users have some skills recognizing them. Summarised, the GODI users need some basic skills in system and software build management.

Resources

There are a number of on-line resources that are important for users. Links are available on the GODI homepage, <http://godi.ocaml-programming.de>:

- GODI mailing list
- GODI bug tracking system

- Subversion server
- Further documentation

1.1 Preparing your system

It is very likely that you must first install software because you can even start using GODI. This is the generic list for all OS:

- You need `gcc`, the GNU C compiler. Other compilers are not supported (but may work nevertheless). You need also the system header files, sometimes they are not installed by default (e.g. `glibc-dev` on many Linux distributions).
- You need GNU `make`.
- You need `gzip/gzcat`, `bzip2/bzcat`, and GNU `patch`
- It is an advantage to have GNU `nm` and GNU `objcopy` (enables `ocamlc -pack`), but they are not required
- You need the standard Unix shell and file manipulation tools. Sometimes `dc` (often bundled with `bc`), and `m4` are not installed by default.

Of course, these are only the requirements for the minimum GODI installation. Depending on which GODI packages are installed, further external software may be needed.

There is a more detailed list in the README file contained in the GODI bootstrap tarball. It depends on the OS which of the tools come with the OS and which must be additionally installed.

1.2 Bootstrapping

The bootstrap procedure installs the minimum GODI system. Currently, the bootstrap procedure has two stages that must be performed one after the other. Stage 1 installs basic tools written in the C language that are required for the GODI package system. This means, after stage 1 the installed software is managed in the form of packages. We will discuss later what a package really is, for now just think a package as a group of files that is added to the system as a whole, and that can also be removed from the system as a whole.

Stage 2 installs the minimum O'Caml environment, and further parts of GODI.

In order to bootstrap, you need the bootstrap tarball, see <http://godi.ocaml-programming.de> for where it can be downloaded. Basically, you execute the following steps:

1. Extract the bootstrap tarball:


```
gzip -d godi-bootstrap-<VERSION>.tar.gz
tar xf godi-bootstrap-<VERSION>.tar
cd godi-bootstrap-<VERSION>
```

2. Enter stage 1:
`./bootstrap --prefix <PREFIX>`
3. Adjust PATH, optionally edit `<PREFIX>/etc/godi.conf`:
`PATH=<PREFIX>/bin:<PREFIX>/sbin:$PATH`
`export PATH`
4. Enter stage 2 (a working Internet connection is required):
`./bootstrap_stage2`

The bootstrap procedure is discussed in more detail in the README file contained in the bootstrap tarball, especially what to do when things do not work as expected.

As `<PREFIX>`, you can choose any empty or not yet existing directory. It is not possible that `<PREFIX>` points to an already used directory like `/usr/local` as GODI needs its own private directory hierarchy.

It is not recommended to install GODI as super-user. Either install GODI privately under a non-privileged account, or create a special «godi» account for a shared installation.

Options

The bootstrap script (stage 1) has a number of command-line options (needed for adjustments in very special situations):

- `--section=3.08`: Installs O’Caml 3.08 instead of 3.09, the current default version.
- `--ftp=lukemftp`: Prefers the «lukemftp» utility to download files from the Internet
- `--ftp=tnftp`: Prefers the «tnftp» utility to download files from the Internet
- `--ftp=wget`: Prefers the «wget» utility to download files from the Internet. «wget» is not included in the bootstrap tarball like the other two utilities.
- `--append-path`: When looking up system utilities, first system-specific standard locations are tried, and after these, the directories enumerated in the PATH variable. This is the default.
- `--prepend-path`: When looking up system utilities, first the directories enumerated in the PATH variable are tried, and then system-specific standard locations.
- `--no-path`: When looking up system utilities, only the system-specific standard locations are tried.
- `--search-path <PATH>`: When looking up system utilities, only the directories enumerated in the `<PATH>` argument are tried.
- `--section <sect>`: Selects the release line of GODI to install. See section 4.5 for information about release lines. This option defaults to the newest regular release.

Environment

A number of environment variables are respected:

- `CC`: This variable selects the C compiler to use. Normally, `gcc` is preferred. This variable must not be set to an absolute path but just to the name of the compiler command. Note that it is very hard to change the C compiler at a later time.
- `http_proxy` and `ftp_proxy`: If you are connected to the Internet via a proxy, set these variables accordingly. For example, if the proxy is installed on `proxy.our.net` on port 8080, set both variables to `http://proxy.our.net:8080`

1.3 Installing packages with `godi_console`

After the bootstrap procedure has been finished successfully, a number of programs are installed in `<PREFIX>/bin` and `<PREFIX>/sbin`. The former directory contains applications that may be executed by everybody whereas the latter directory is reserved for administration programs. One of these is `godi_console` which serves as the central management tool. It goes into an interactive mode when called without arguments.

After starting `godi_console` type «2» to enter the menu «Select source packages». The list of available and installed packages appears (shown in figure 1.1). You can select (and deselect) packages by entering the number and typing «b» to build the package, «k» to keep the package as it is, or «r» to remove the package (in the corresponding submenu). Finally, press «s» to start the installation, a procedure comprising the following steps:

- `GODI` checks the package dependencies. Missing packages are implicitly selected for build. Furthermore, if a package is rebuilt, all installed packages are checked whether they are dependent on this package, and also rebuilt. The same «expansion» of the update plan is performed for the packages scheduled for removal.
- When the dependencies had to be corrected, the package list is displayed again, and the additionally affected packages are shown at the top of the list. In this case, type again «s» to restart the resolution of dependencies.
- Finally, the update plan is executed: Missing software is retrieved from the Internet. Old packages are removed. The new packages are extracted, built, and installed. These actions are always performed automatically, without any need for the users to gear into the running process.

This means, `godi_console` guides you through the build and installation processes, without having to enter commands. We do not discuss `godi_console` here in detail, as it is equipped with self-explanatory help texts.

A note for advanced users: `godi_console` also features a command-line mode which is useful for scripting purposes. There is a manual page for `godi_console` explaining this mode.


```

+----- GODI Console -----+

>>> Select Source Packages <<<

      FL NAME          INSTALLED  AVAILABLE  COMMENT
=====Packages available as source code:=====
[  1]  apps-camlmix      1.1        1.1        Processes macros written in pu
[  2]  apps-cduce       0.2.1      0.2.1      XML-oriented functional langua
[  3]  apps-cduce-cvs           20040829    XML-oriented functional langua
[  4]  apps-godiva      0.9.2      0.9.2      High-level tool for simplifyin
[  5]  apps-headache    1.03       1.03       Tool for managing headers in s
[  6]  apps-ledit       1.11       1.11       Line editor wrapper
[  7]  apps-schoca           0.2.0      Scheme interpreter written by
[  8]  apps-unison      2.10.2     2.10.2     File synchronizer
[  9]  base-curl        7.11.2#2   7.11.2#2   The version of CURL for GODI
[ 10]  base-expat       1.95.7#3   1.95.7#3   The version of expat for GODI
[ 11]  base-gdbm           1.8.3#4    The GNU database manager
[ 12]  base-pcre        4.5#1      4.5#1      The version of PCRE for GODI
[ 13]  base-subversion-c$           1.0.6      The subversion client allows d
[ 14]  conf-curl         3          3          Configures which curl library
[ 15]  conf-expat        6          6          Configures which expat library
[ 16]  conf-freetype2    1#1        1#1        Configures which freetype2 lib
-----
[more]-----
[p]rev [n]ext [u]pgrade all [s]tart/continue installation [h]elp e[x]it menu
>

```

Figure 1.1: Selecting source packages with godi_console

Warning: Avoid to install new packages when disk space is already tight. You may run into situations where it is hard to recover from. Furthermore, it is a bad idea to stop `godi_console` while a package installation is being performed.

1.4 Configuring external libraries

Unfortunately, `godi_console` cannot build everything in an automatic way. Especially one point requires manual intervention from time to time: External C libraries.

Of course, it is required that these external libraries are installed before GODI can make use of them. For example, if you install the package `godi-zlib` it is a good idea to check whether the underlying C library `libz` is already present or not (don't forget to check that the C header files are also installed). Especially for non-free OS like Solaris there is no standard place to install such external libraries. Some admins put them into `/usr/local`, some into `/opt`, and a lot of further private locations are in use, too. For Linux and BSD, however, these libraries are often part of the OS, and can be found at known places in `/usr`.

The good news is that GODI is very flexible regarding these locations. There are two ways of telling GODI where to find libraries: By changing the global configuration, and by setting package-specific parameters.

The global parameter in question is `SEARCH_LIBS`: For example, when `libz` is installed in `/opt/phantasy` such that the library `libz.so` is located in `/opt/phantasy/lib` and the C headers are in `/opt/phantasy/include`, one can tell GODI this place by setting

```
SEARCH_LIBS += /opt/phantasy
```

in the global configuration file `<PREFIX>/etc/godi.conf`. This parameter is respected by most packages that need external libraries (but not by all, as there are other, incompatible methods of looking up libraries, see below).

GODI already knows a number of standard locations for libraries, i.e. directories where certain OS install libraries by default. For example, NetBSD usually installs add-on libraries in `/usr/pkg` which is already part of the built-in knowledge.

You may have already noticed that there are `conf-<NAME>` packages for a number of external libraries `<NAME>`. For example, there is a `conf-zlib` package. The role of these packages is to find and store the configuration where external libraries are expected to be found by GODI. By default, the `conf` packages iterate over the directories enumerated by `SEARCH_LIBS`, and look for the needed libraries in these places. Furthermore, a small test program is tried to build, just to see whether the found libraries really work.

Sometimes the library cannot be found, or additional compiler or linker flags must be set. The `conf` packages allow you to set the individual configuration parameters. Of course, the GODI user must already know which parameter must be set to which value – in other words, this is tweaking for experts. In `godi_console`, one can set the configuration parameters by going to the configuration screens of the `conf` packages. For example, `conf-zlib` has two such parameters:

GODI_ZLIB_INCDIR: The directory where the C header file `zlib.h` can be found

GODI_ZLIB_LIBDIR: The directory where the library file `libz.so` can be found

Some conf packages also allow you to set the flags for compiling and linking directly rather than setting directories. In any case, the individual configuration parameters override the search strategy followed by default.

Nowadays, libraries are more and more shipped with special configuration scripts. These scripts simply output the required compiler and linker flags. When available, GODI prefers these scripts, and sees them as a trusted source whose knowledge can be expected to be right. For example, the freetype library has such a script, `freetype-config`, and one can call it by `«freetype-config --cflags»` to get the compiler flags, and by `«freetype-config --libs»` to get the linker flags. The corresponding GODI configuration package is `conf-freetype2`. Instead of searching the library directly, it just looks for where this configuration script is installed. Normally, the locations in `SEARCH_LIBS` are checked (by looking into the `bin` subdirectories), and the directories in `PATH` are checked. If the script cannot be found, it is still possible to set the location directly with a configuration parameter:

GODI_FREETYPE2_CONFIG: The absolute path to the `freetype-config` script

When such a script is used, the configuration package does not support to specify the directories of the library directly, or to set the flags.

As pointed out, the output of the configuration scripts is simply trusted. If it happens that the obtained flags do not work, the script is wrong, and it is not possible to use the library from GODI.

Many OS now use the ELF file format for libraries (e.g. Linux, BSD, Solaris). ELF allows several ways of finding libraries at runtime, i.e. when the program using the library is started:

- The `LD_LIBRARY_PATH` variable may list directories where libraries are installed
- There is the `RPATH` (runtime path) entry in the executable using the library
- There is often a global configuration file (e.g. `ld.so.conf` for Linux) listing the default library directories of the OS

For a number of reasons, GODI never uses the `LD_LIBRARY_PATH` feature. This variable is more an ad-hoc solution to get misconfigured libraries working, but not the appropriate means for a permanent and professional environment like GODI.

GODI uses one of the other two options: First, it is checked whether the library can be found by keeping the default settings, and only if this does not work, the `RPATH` feature is enabled. Note that this automatism is not applied when a configuration script is used; in this case it is expected that this script already knows which way is the right one to find the library at runtime.

Important note: Currently, this approach is not put through at all places. This has the effect that there are usually more RPATH settings than needed. This is rarely problematic, but I already had the case that a system library was installed in two versions, and the RPATH setting was wrong. In particular, this library was libGL.so, and one version (in /usr/lib) was the MESA software 3D rendering version, and the other version (in /usr/X11R6/lib) was the hardware 3D rendering version. Because of implementation errors, stub libraries were installed with RPATHs for /usr/lib (which is totally useless), and my programs suddenly loaded the GL library for software rendering. The workaround in such cases is to byte-compile with -custom (or to use the ocaml-opt compiler), and to fix the RPATH with -cclib -Wl,-R/preferred/path. This GODI problem will not be fixed soon.

1.5 Using libraries from base packages

Usually, GODI does not include add-on C libraries like libz; it is expected that these are already available by the OS, or that the sysadmin has already installed them. Sometimes, however, GODI needs certain versions of the libraries, and it would be painful to require that the sysadmin updates the OS or other parts of the system only to make GODI happy. In these cases, GODI includes the libraries to install in the «base» series of packages, e.g. base-pcre includes the preferred version of the PCRE library.

These packages are not enabled by default, however. It is first checked whether the library version provided by the OS or the version found somewhere on the system is acceptable. If not, the conf package fails, but prints a hint that enabling the base package would be a simple solution for the problem. By setting a configuration parameter, the GODI user can do this. For example, the conf-pcre package can be made using the base-pcre package by setting

```
GODI_BASEPKG_PCRE=yes
```

The rest is again fully automatic.

Chapter 2

Using GODI

In this chapter, I would like to give some hints for O’Caml beginners, and explain where to find what in the GODI environment.

2.1 Starting the O’Caml toplevel

The O’Caml bytecode compiler can be called as a so-called toplevel: The user can enter declarations and expressions, and these are immediately compiled to bytecode, and immediately executed. The toplevel is very handy for coding attempts, and also an interesting debugging aid for larger programs (because one can load already compiled bytecode into the toplevel, too). One can invoke the toplevel with the command `ocaml`:

```
$ ocaml
Objective Caml version 3.08.1
#
```

For example, define the factorial function as (note that the `#` at the beginning of the line is the prompt symbol, and that the `;;` at the end of the line indicates the end of the user input):

```
# let rec fac n = if n <= 1 then 1 else n * fac(n-1);;
```

The toplevel answers with:

```
val fac : int -> int = <fun>
```

This means that `fac` is a function taking integers as input, and returning integers as results. Call the function as

```
# fac 10;;
```

and you get the result 3628800. Of course, we cannot give here an introduction into the O'Caml language, so we stop here. It is recommended to install the package `godi-ocaml-manual` which includes both introductory and reference documentation of the O'Caml language. The installed manual can be found in the directory `<PREFIX>/doc/godi-ocaml-manual`.

You can exit the toplevel by pressing CTRL-D or typing `#quit ; ;` (including the hash mark).

You may have noticed that the toplevel does not include a line editor. To get around this limitation, install the package `apps-ledit`, and call the toplevel by

```
$ ledit ocaml
```

This enables a number of keys (cursor keys, delete key, etc.).

2.2 A simple IDE: `ocamlbrowser`

The O'Caml core distribution includes a simple IDE that allows you to explore libraries, to edit O'Caml sources, and to run the toplevel: `ocamlbrowser`. As this program uses the Tk library for the GUI operations, it is not installed by the GODI bootstrap procedure (so it is not necessary to deal with the complications of finding external libraries already at this early stage). `ocamlbrowser` is contained in the `godi-ocaml-lablTk` package.

The program `ocamlbrowser` is invoked without argument, and pops up a new window with three columns. In the leftmost column, the modules of the standard library are listed. If you click at a module, the middle column shows the definitions of the module. The rightmost column is only used when nested modules occur (e.g. `MoreLabels.Set`).

If you click at a definition (`v=value`, `t=type`, `cn=exception`, `m=module`, ...) the contents of the definition are shown below the three columns. You can also view the interface and the implementation files, if available, by pressing the buttons «Intf» and «Impl», respectively.

The toplevel is invoked with the menu entry «File → Shell...». It works like the ordinary toplevel but also does syntax highlighting.

The editor is invoked with the menu entry «File → Editor...». It performs syntax highlighting, and you can even typecheck your definitions («Compiler → Typecheck»). As a special feature, you can query the types of subexpressions after a typecheck pass: Just put the cursor near the interesting symbol, or mark the expression, and press the right mouse key.

By selecting «Edit → To shell», the current definition (or the marked region) is copied over to the shell window (if open).

Although `ocamlbrowser` has some interesting features, it is still too limited in order to be useable as professional development environment.

2.3 Using `emacs/xemacs`

GODI does currently not include packages with the required `emacs` Lisp definitions.

2.4 The O’Caml compilers and tools

The O’Caml core distribution includes:

- `ocaml`: The toplevel (see above)
- `ocamlc`: The bytecode compiler, available for all platforms. For example, to compile the file `sample.ml` to the program `sample`, call it as
`ocamlc -o sample sample.ml`
- `ocamlopt`: The native code compiler, available for most platforms. The command-line options are almost the same as for `ocamlc`.
- `ocamlc.opt` and `ocamlopt.opt`: These are versions of `ocamlc` and `ocamlopt` that are compiled with the native code compiler, and are much faster than `ocamlc` and `ocamlopt`. The function is exactly the same.
- `ocamlcp` and `ocamlprof`: The bytecode compiler with profiling instrumentation, and the corresponding analysis tool
- `ocamlmktop`: A special version of the bytecode compiler to create toplevels with custom functionality
- `ocamldep`: The dependency generator
- `ocamllex(.opt)` and `ocamlyacc`: Lexer and parser generators
- `ocamldebug`: The replay debugger
- `ocamlmklib`: A tool to create stub libraries
- `ocamlrun`: The bytecode interpreter. There is normally no need to call it directly.
- `camlp4`, `camlp4o(.opt)`, `camlp4r(.opt)`, `mkcamlp4`, `ocpp`: The configurable pre-processor
- `ocamldoc`: The documentation generator

These tools are all described in the O’Caml manual. The native-code compiler is not available for all platforms, as well as the `.opt` versions of the tools.

The GODI version of `ocamlmklib` is a wrapper script around the real `ocamlmklib.bin` tool that adds a number of default options that should be present in a GODI environment.

In addition to these official tools, some less official tools are also installed:

- `addlabels` and `scrapelabels`: These tools rewrite O’Caml programs from the old, unlabeled style to the new, labeled style, and vice versa.
- `objinfo`: Outputs valuable information about bytecode files (`cmo` and `cma`), for example which module versions must be loaded as prerequisites
- `dumpapprox`: Outputs valuable information about native-code files (`cmx`), for instance whether a function is enabled for inlining.

2.5 Using add-on libraries with findlib/ocamlfind

Unfortunately, the O’Caml core distribution handles libraries in a rather low-level way, and the user of the libraries must know the directories where these are installed. Furthermore, the dependencies between the libraries must be manually resolved. This style is similar to the way libraries are handled in the C language.

The findlib library (and the command-line frontend `ocamlfind`) try to bridge the gap between the user’s needs and the low-level but robust approach of the O’Caml core. GODI equips all libraries with the necessary meta information findlib needs to process the libraries, and to make them available in a user-friendlier manner.

In the toplevel, findlib can be enabled by the directive (also type the hash mark):

```
#use "topfind" ;;
```

This installs a number of additional toplevel directives:

- `#require "<LIBNAME>":` Loads the library `<LIBNAME>` into the toplevel (unless it is already loaded), including all required prerequisites
- `#list:` Lists the available libraries
- `#camlp4o:` Enables the `camlp4` preprocessor with standard syntax. This should be the first directive after loading `topfind`.
- `#camlp4r:` Enables the `camlp4` preprocessor with revised syntax. This should be the first directive after loading `topfind`.

For example, a single

```
#require "pxp" ;;
```

loads the XML parser PXP into the toplevel, including all predecessor libraries PXP is dependent on.

Unfortunately, some platforms cannot load libraries into the toplevel that depend on external C libraries. For example, Cygwin and NetBSD are such platforms. When you try to load such libraries, these platforms output the error

```
Cannot load required shared library:  
dynamic loading not supported on this platform.
```

The workaround is to create a custom toplevel that statically links the needed libraries. For example, to create a custom toplevel with support for PXP, run the command

```
$ocamlfind ocamlmktop -o mytop -package pxp,findlib -linkpkg
```


which creates a toplevel program called `mytop` which can be used instead of the pre-built toplevel `ocaml`. Note that `findlib` must always be mentioned as package. The toplevel `mytop` has already built-in support for `findlib`, so you need not to «`#use`» `topfind` at the beginning of every session. The «`#require`» directive for PXP is still necessary, however.

In order to call the standalone compilers `ocamlc` and `ocamlopt`, the tool `ocamlfind` should be used. This is a wrapper program around the compilers that adds a number of additional command-line options. For example, to compile the module `sample.ml` that calls functions of PXP, use

```
$ ocamlfind ocamlc -c sample.ml -package pxp
```

When linking executables, the option `-linkpkg` must be passed to indicate that the libraries must be linked, too:

```
$ ocamlfind ocamlc -o sample sample.cmo -package pxp  
-linkpkg
```

The tool `ocamlfind` can also be used as wrapper for `ocamlcp`, `ocamlopt`, `ocamlmktop`, `ocamldep`, `ocamldoc`, and `ocamlbrowser`. The latter is very convenient to browse the interfaces of add-on libraries, e.g. to view the definitions of PXP, run

```
$ ocamlfind ocamlbrowser -package pxp-engine
```

(Note that we refer to `pxp-engine`, and not `pxp`, as the latter is only an empty pseudo package, and the `ocamlbrowser` call does not resolve dependencies.)

A special feature of `findlib` is that it simplifies the usage of `camlp4` enormously, the grammar-level preprocessor for O'Caml. In order to enable `camlp4`, set the `-syntax` option:

```
$ ocamlfind ocamlc ... -syntax camlp4o
```

This enables `camlp4` with standard syntax. Replace `camlp4r` for `camlp4o` to get the revised syntax. The interesting feature of `ocamlfind` is that one can easily specify `camlp4` extensions. For example, to get the `xstrp4` extension, just use

```
$ ocamlfind ocamlc ... -syntax camlp4o -package xstrp4
```

i.e. add such extensions simply to the list of included packages.

The `findlib` library is available as GODI package `godi-findlib`. It is installed as part of the bootstrap procedure. There is, however, a small but useful option that is not enabled by default, and requires a recompilation of `findlib`: The Makefile wizard. This is a GUI to create `findlib`-aware Makefiles with a few clicks.

To get it: Start `godi_console`, select the `godi-findlib` package, and enter the configuration menu. Set the parameter

```
GODI_FINDLIB_TOOLBOX = yes
```

and rebuild findlib. You will also need `godi-ocaml-labltk` (and thus `tcl/tk`) in order to build this special version of findlib (which is the reason why this option is disabled by default). The result is that the «Makefile wizard» is included in the findlib package. Call the wizard with

```
$ ocamlfind findlib/make_wizard
```

and follow the instructions in the new window that pops up.

There would be a lot more to say about findlib. As part of the package, the findlib manual is also installed, so please look there for more information.

A final note on the syntax «-I +pkgname» the O’Caml compilers implement themselves. It was introduced as simple mechanism to locate add-on libraries. For GODI, this kind of referring to libraries should be regarded as deprecated legacy mechanism. The point is that this syntax is much less flexible than findlib, and that it is also dictates the directory where the library must be installed (which is not acceptable).

2.6 Finding package documentation

The documentation for package `P` can be found in `<PREFIX>/doc/P`. The preferred format is HTML.

There is also a small CGI that can display library interfaces: `godi-findlib-browser`. It can be found in `<PREFIX>/doc/cgi-bin/browser.cgi` after installation. One can easily view all interfaces (but w/o formatting), and there is also a full-text search option. In order to activate this CGI, you need a properly configured web server. For Apache, the widely used web server, it is usually sufficient to include the directives

```
ScriptAlias /godi-bin <PREFIX>/doc/cgi-bin
<directory <PREFIX>/doc/cgi-bin>
  AllowOverride None
  Options ExecCGI
  Order allow,deny
  Allow from all
</directory>
```

into the configuration file `httpd.conf`, and to restart the web server. The CGI becomes visible under the URL `http://servername/godi-bin/browser.cgi`. There are also other ways of configuring Apache for this purpose.

2.7 Key packages

Some packages play a special role in the package system:

- The O'Caml core distribution is the union of the packages:
godι-ocaml: Compilers and runtime environment
godι-ocaml-src: Sources of the core distribution
godι-ocaml-dbm: NDBM access (module Dbm)
godι-ocaml-graphics: Simple graphics (module Graphics)
godι-ocaml-labltk: GUIs with Tk

This means that the O'Caml source tarball, as it can be obtained from the INRIA FTP server, is split up into five packages. The reason is that external libraries are needed for some parts of the O'Caml core, and this can be easier handled when packaged separately. In addition to this, there is also the O'Caml manual:

godι-ocaml-manual

You can select all of these packages by

godι-ocaml-all

which exists for convenience only (meta package).

The package `godι-ocaml-src` is very special, because it contains the already configured but not yet compiled source tree of O'Caml. It is the logical predecessor of the other O'Caml core packages, which all extract and build parts of this tree. The idea of this package is also to simplify patching the O'Caml compiler. There is one disadvantage of this construction: In order to force a rebuild of the whole O'Caml system when newer sources are available, one must select *both* `godι-ocaml` and `godι-ocaml-src`. If only the former were rebuilt, the old, wrong sources would be taken, and if only the latter were rebuilt, only the sources would be updated without compiling them.

- The software GODI consists of is itself packaged:
godι-core-digest: Helper program to compute file digests
godι-core-ftp: Helper program to download files from the Internet
godι-core-make: The BSD «make» utility
godι-core-pax: Archive tools (tar, pax) with special features for the package system
godι-core-pkgtools: The utilities to add and delete binary packages
godι-core-mk: The build framework (a set of «make» rules) to compile and install packages from sources
godι-tools: The higher-level tools, currently only `godι_console`

Note that some of these packages have a special status, as they are part of the GODI system, and not every operation is permitted. For example, it is not allowed to delete `godι-core-pkgtools`, because there would not be any way to recover from the resulting situation. Furthermore, you will notice that `godι_console` lists some of them under the section «Installed packages not available as source code». This only means that there are no newer sources to update them. Actually, the bootstrap tarball contains the source code these packages were initially built from.

- GODIVA is an associated project to simplify the creation of GODI packages. In order to create GODI packages with GODIVA, you need `apps-godiva`. This tool is not needed to process the generated packages, though.

- As already pointed out, findlib is supported by all libraries in GODI, and thus `godi-findlib` is also a key package.

Chapter 3

The Architecture of GODI

In this chapter, we look at the various parts of GODI, and how they are related to each other. It should become clearer how GODI works, and what one can expect from it.

3.1 GODI servers and clients

In principle, GODI is a kind of client/server system. This aspect is usually overlooked, although it is one of the most important properties. The GODI system, as it was installed in chapter 1, consists only of the client part that controls the locally installed packages. In addition to this, there is also a GODI server that provides the necessary information which packages exist and what the packages contain. The GODI client (e.g. `godi_console`) may contact the server to update the list of packages. In `godi_console` you can trigger this by selecting the menu item «Update the list of available packages».

The GODI server is mainly a Subversion repository where the files are stored that make up the various packages. This repository is maintained by the GODI developers in a collaborative effort. You can view this repository under the URL <https://gps.dynxs.de>.

The `godi-build` directory contains the packages, whereas `godi-bootstrap` contains the base software including the bootstrap script (from which it derives its name). (The other directories contain software not related to GODI, although some of the libraries are available as GODI packages.)

More precisely, the `godi-build` directory on the GODI server only provides the *build instructions*, i.e. the set of rules that control the build and installation procedures. The GODI server does not store the *distribution files*, i.e. the tarballs made and distributed by the authors of the software packages. These are downloaded from the primary http or ftp servers. (To be even more exact, the GODI server keeps copies of the distribution files, but these are only used when the primary servers are not reachable.) For example, the package `godi-ocamlnet` in version 0.98 has the following build instructions and distribution files:

- <http://www.ocaml-programming.de/godi-build/3.08/godi-ocamlnet-0.98.build.tgz> is the URL where the build instructions can be obtained. These are created by the GODI developers. This tarball contains the files:

DESCR: Just a text file with a description of the package

distinfo: Contains checksum for distribution files

Makefile: The rules to build and install the package

PLIST.godi: The package list, i.e. it is described which files are part of the package

- <http://aleron.dl.sourceforge.net/sourceforge/ocamlnet/ocamlnet-0.98.tar.gz> is the URL where the single distribution file can be obtained. This is the file distributed by the author of the software.

The build instructions also contain dependency information. For this reason, it is necessary that the build instructions of all packages must be available at any time, and because of this, `godi_console` updates them in a single step. The distribution files, on the contrary, are only downloaded when the corresponding package is built.

3.2 Local directory layout

The GODI directory hierarchy follows Unix conventions with some additions:

- `<PREFIX>/bin`: Binaries
- `<PREFIX>/sbin`: Binaries for GODI administration
- `<PREFIX>/etc`: Configuration files. Especially, you find here `godi.conf`, the global configuration file for GODI, and `ld.conf`, the global configuration file for dynamic stub libraries
- `<PREFIX>/man`: Manual pages
- `<PREFIX>/share`: Platform-independent files (in subdirectories)
- `<PREFIX>/lib`: C libraries and, in subdirectories, platform-dependent files
- `<PREFIX>/lib/godi`: Generated configuration files
- `<PREFIX>/lib/ocaml/std-lib`: OCaml standard library
- `<PREFIX>/lib/ocaml/compiler-lib`: Additional OCaml interface files
- `<PREFIX>/lib/ocaml/pkg-lib`: Add-on OCaml libraries
- `<PREFIX>/lib/ocaml/site-lib`: User-installed (non-packaged) add-on OCaml libraries
- `<PREFIX>/build`: GODI build system
- `<PREFIX>/build/buildfiles`: Contains the `build.tgz` files with the build instructions (for archive purposes only)
- `<PREFIX>/build/distfiles`: Contains distribution files

- `<PREFIX>/build/packages`: Contains binary packages (in `All`)
- `<PREFIX>/build/mk`: Global GODI build rules
- `<PREFIX>/build/<CATEGORY>/<PACKAGE>`: These directories contain the unpacked `build.tgz` files
- `<PREFIX>/db`: The directory containing the package database

3.3 Packages

We already said that a package is a group of files that is installed as a whole. This is a simplified definition, and when one looks in detail at the package concept, it becomes clear that the same package may exist in three ways:

- As «source package»: The build instructions plus the distribution files may be viewed as source packages. It is important to remember, however, that there is no single file bundle containing the files to build the software (like SRPMs). The concept is rather that the package metainformation are obtained from the GODI server in the form of the mentioned build instructions, and that the raw sources of the software are directly retrieved from the original file servers where the software authors distribute them (the distribution files).
- As installed package: These are the installed files. GODI remembers which files belong to which packages, and stores these data in the *package database* which can be usually found at `<PREFIX>/db`.
- As binary package: This is an archive file containing the files to install (together with a subset of the metainformation). These archive files can be found under `<PREFIX>/build/packages/All`, and they are automatically created when a package is built from sources.

The metainformation includes:

- The package name: The name is derived from the original name under which the author distributes the software. GODI prefixes this name with a category indicator («base», «conf», «apps», «godi»):

base:	This is software outside of GODI's scope, but required for GODI. Often, the base software is part of the OS. In the case it is not available, or only in the wrong version, the «base» packages may be used as replacement.
conf:	The configuration packages represent the knowledge about software outside of GODI that is used by GODI. For example, the configuration packages for external libraries remember where these libraries are located, and how these must be linked to programs created with GODI. The source package usually only consists of build instructions, but not of distribution files. The instructions include a script that systematically guesses facts

about the external software to configure, and checks these assumptions by tests (autoconfiguration). See also section 1.4 for an explanation from the user's point of view. The result of the script is usually stored in a file, and this file is the only content of the installed/binary package. For example, the package `conf-zlib` remembers the configuration parameters in `<PREFIX>/lib/godi/conf-zlib.mk`. See the section 6.1 for a detailed discussion.

apps: These are applications (end-user software).

godi: This is software to build applications, i.e. libraries, meta-programming (generators, compilers, ...), and development tools.

Sometimes, software falling into the «godi» category has also parts that could be seen as applications. In such cases, «godi» is preferred over «apps».

Libraries sometimes also have a runtime part, and this means they are needed to run the applications. In the O'Caml world, this does not happen very often, because most libraries are statically linked. Nevertheless, it might be necessary to create another category for run-time files, but this makes only sense when the run-time part of libraries is separated from the build-time part.

- The version of the package: The version string has two parts. The first part is the «dotted» sequence of decimal numbers one usually associates with a version string. It is the version the author of the software announces (but see below). The second part is the package revision number. Sometimes the first attempt of the package has errors, and to distinguish improved versions of the package from the previous ones, the revision number is incremented. The revision number is a natural number. In the version string, the revision number is separated from the primary version by the keyword «godi». For example, in «1.2godi2», the primary version, as announced by the author, is «1.2», and the GODI revision number is 2. When the «godi» suffix is missing, the revision number is 0 by definition. Sometimes, the character «#» is used as separator instead of «godi», but this is only an abbreviation and does not have any meaning.

Usually, the primary version number consists of natural numbers separated by dots. The syntax of the version numbers allows a few further elements. GODI restricts the syntax because it must always be possible to compare two version numbers, and to decide which one must be sorted before the other (linear ordering). Of course, this can only be ensured when it is known how the version numbers are constructed.

In addition to the dotted decimals, one can also include letters. These are compared lexicographically, e.g. «1.1ab» < «1.1ac». One can also use the characters «+» and «_» as separators, but they have lower weight than the dot, e.g. «foo3.07+1» < «foo3.07.1». There are a few further keywords: «test», «alpha», «beta», «pre», «rc», «pl» which are also recognised as separators. The first five of these have the special property that they *decrease* the weight, for example «1.1test1» < «1.1». The separator «test» decreases the most, the separator «rc» (release candidate) decreases the least. For instance, «1.1test1» < «1.1beta1». The separator «pl» (patch level) has again positive weight, but less than

all other separators. Other characters than the mentioned ones are not allowed in version strings.

Of course, the authors of software do not always use versioning schemes that are compatible with the one GODI applies. In this case, the packager should try to port the original version numbers as closely as possible to the GODI scheme. It is essential, however, that the order of the numbers is correctly represented, otherwise it might happen that a newer version of the software is available, but GODI does not recognise that. An example illustrates that: Some authors make both development snapshots and regular releases available. For the former, date strings are used, e.g. `foo-20040921`. For the latter, classic dotted numbers are used, e.g. `foo-3.2`. GODI can process both formats, and the sorting order for each format is properly represented. It is not possible, however, to mix both formats. Because «20040921» is just a big number, it is higher than «3.2», even if it was released before «3.2». The moral of the story: Use either date strings, or dotted numbers, but do not alternate between them.

A final clarification about the revision numbers: They distinguish between several editions of the build instructions. They do not distinguish between different versions of binary packages that are made from the same sources and the same build instructions, but with a different equipment of predecessor packages. For example, if `foo-4.4` is once built with `bar-1` and once built with `bar-2` as predecessors, the *same* version string (and thus the same file name) will be used for both binary packages that result from the build. (Maybe we will have a mechanism to handle this some day.)

- Source: The package has fields that describe where the distribution files can be downloaded, and where more information can be obtained.
- Description: The package has a short, one-line description («comment»), and a longer description that may even consist of several paragraphs.
- Dependencies: The package may require that other packages are already installed. This is called a package dependency. There are two kinds of dependencies (for the moment, further types are discussed in `godi-list`): Build dependencies demand that the predecessor packages must be installed at build time, and strict (runtime) dependencies express the requirement that the predecessor packages must be installed both at build and at run time.

Furthermore, dependencies are handled differently for source packages, and for installed/binary packages. One difference is clear: For the latter type of package, there are no build dependencies, because they are already built. The other differences have to do with the handling of the transitivity of the dependency relation, and the meaning of version conditions.

For source packages, it is not necessary to state indirect predecessors. For example, if `foo` requires `bar`, and `bar` requires `baz`, GODI concludes that `foo` also requires `baz` indirectly. GODI finds this out automatically. In contrast to this, installed and binary packages must list all predecessors explicitly, even indirect ones, so `bar` has to demand `baz`. Fortunately, GODI users never have to resolve such dependencies, as this is done internally by GODI, so this is a detail users rarely see. (The transitive closure is taken for several reasons. During compilation of software it may happen that indirect predecessors influence the current build. The cross-module inlining feature of OCaml is

an example of this. Of course, such effects must be represented by the dependency relation. Furthermore, the closure eases the distribution of binary packages.)

Dependencies may carry a version condition, for example `foo` may require `bar` in version ≥ 3.2 . For source packages, these conditions are just handled as constraints. For installed and binary packages, however, these conditions are transformed into exact version requirements. For example, if the user happens to have version 3.3 of `bar` installed, this is acceptable when `foo` is built, because $3.3 \geq 3.2$. The resulting binary package lists the dependency `bar == 3.3`, i.e. the actually found version is taken as fixed version. The reason for this is that O’Caml libraries (and most dependencies are about libraries) are very sensitive to changes, and it is unlikely that any other version works than the one found at build time.

- **Maintainer:** The person who is responsible for maintaining the package as part of GODI.

3.4 Libraries

As already pointed out, the O’Caml libraries always support `findlib` in the GODI system. This is not a very hard requirement, and it is usually simple to even add such support to libraries where the author does not do this. `Findlib` bases only on a few concepts, and complicated situations cannot arise.

The key ideas are that libraries are stored in known directories (directory convention), and that there is a file with meta-information about libraries (called «META»). The directory convention is as follows (here shown in the way GODI realises it):

- `<PREFIX>/lib/ocaml/pkg-lib/<NAME>`: This directory contains all code files for the library `<NAME>`, except DLLs. By «code files» we mean compiled interfaces (suffix `cmi`), compiled modules (suffixes `cmo`, `cmx`, `o`), and library archives (suffixes `cma`, `cmxa`, `a`). It is also a good idea to put the source interfaces here (suffix `mli`), for better documentation.

Files of other kind can go elsewhere, e.g. into `<PREFIX>/lib/<NAME>`, this is out of the scope of `findlib`.

The code directory must not have subdirectories.

- `<PREFIX>/lib/ocaml/pkg-lib/stublibs`: This directory contains the DLLs for all `findlib` libraries that are installed below `pkg-lib`. The DLLs are simple to recognise, because their name begins with the prefix «dll», and has an OS-dependent suffix (e.g. «.so» for Linux, «.dylib» for MacOS, etc.). `Findlib` also puts for every DLL a second file into this directory, with the suffix «.owner», e.g. «dllfoo.so.owner» for the DLL «dllfoo.so». This file indicates to which library the DLL belongs (the name is stored in the file).

This `stublibs` directory is already configured in `ld.conf`, the DLL configuration file of O’Caml, so one need not to care about this detail.

If the OS does not support DLLs, the directory remains empty.

- `<PREFIX>/lib/ocaml/site-lib/<NAME>`: This is another directory for the library `<NAME>`. In the `site-lib` hierarchy user additions are stored, whereas the `pkg-lib` hierarchy is reserved for libraries installed by GODI packages.

By a trick it is achieved that the command «`ocamlfind install ...`» automatically installs the library into `site-lib` when it is executed outside of a GODI build, but into `pkg-lib` when executed within a GODI build. So the libraries automatically end in `site-lib` when GODI users build and install libraries manually.

- `<PREFIX>/lib/ocaml/site-lib/stublibs`: The DLL directory for libraries in the `site-lib` hierarchy.

Of course, it is possible that the same library is installed under both `pkg-lib` and `site-lib`. In this case, `site-lib` has precedence. Anyway, it is a bad idea to do so, because this may break GODI's build system. In general, it is ok to have libraries in `site-lib` that depend on libraries in `pkg-lib`, but not vice versa.

In addition to the directory convention, `findlib` manages libraries also by storing meta-information about the libraries. These are put into files with the name `META`, and the `META` files are contained in the code directories of the libraries. `META` has usually only a few lines, e.g.

```
description = "The library foo"
version = "1.0"
archive(byte) = "foo.cma"
archive(native) = "foo.cmxa"
```

and is seldom more complicated.

`Findlib` can also express dependencies (library X depends on library Y = library X uses features of Y). This mechanism is different from the GODI package dependencies, and there is no strict need that the dependencies of `findlib` and GODI correspond to each other, although this is usually the case for obvious reasons.

O'Caml libraries linked with external C libraries are a special case. In principal, there is an O'Caml part, and a C part. As shown in section 1.4, it is required that the GODI user can configure where the C library is located. The configuration data are contained in the configuration package `conf-foo` for the external C library `foo`. The whole story is as follows:

- The O'Caml library (e.g. `foo.cma`) is linked with a small stub library (e.g. `libfoo_stubs`), which is also written in C, and whose purpose is to translate the O'Caml conventions for data and function representation into the C conventions, and vice versa.
- The stub library is linked with the external C library.

The O'Caml library and the stub library are part of the GODI package `godi-foo`. The location of the external C library is specified by `conf-foo`. It is now possible that the C library is located outside of GODI, or that the C library is available as GODI package, too.

In the latter case, the package is called `base-foo`, and it is required that the C library is installed in the directory `<PREFIX>/lib`.

Note that although the information where the external C library resides is specified in `conf-foo`, these locations are also entered into the O’Caml library as part of the build process, so that they are also available in `godi-foo`. At runtime, `conf-foo` is no longer needed. Furthermore, if the user wants to change the configuration, it is not only required to build `conf-foo` again, but also `godi-foo`, and GODI does not remind you of that.

Some platforms allow that C libraries are dynamically loaded into the running bytecode interpreter, but in general this cannot be assumed. Of course, the C libraries must be available as DLLs (or DSOs in Unix terms) in order to be dynamically loadable. When the platform does not support this technique, however, there is no advantage to have C libraries in DLL form, as O’Caml links statically anyway.

Linking with C libraries is really complicated, and there are a number of details that must be handled differently for the various platforms. It is currently not clear which facts about linking are important for GODI users, and which are really technical details only experts need to know.

Chapter 4

Managing a GODI Installation

4.1 What can be done with `godi_console`

The following tasks can be easily carried out with the help of `godi_console`:

- Updating the source packages: `godi_console` retrieves a new package list from the GODI server, and gets the updated build instructions for all packages with a newer version string.

Instructions:

1. Select: Main menu → Update the list of available packages
2. Wait until the system responds with a success message
3. Press «x» to exit from the dialogue

- Building additional packages from source: By selecting a package for build, `godi_console` downloads the distribution files, compiles and installs the package. Furthermore, a binary package is created.

If necessary, `godi_console` also builds predecessor packages automatically, for both build and strict dependencies.

Instructions:

1. Select: Main menu → Select source packages
2. Scroll up/down by pressing «p» and «n» (or use PageUp/PageDown keys). Finally enter the number of the package to build, and press Enter
3. The detailed description of the package appears. Press «b» to select it for build. Press «x» to exit from the dialogue
4. It may happen that now the configuration dialogue appears. In this case, you can set configuration parameters by entering their number, and changing their value. If done, press again «x»
5. The package list is again shown. Press «s» to start the installation process.

6. It may happen that further (predecessor) packages are also selected for build, and the package list is only updated to reflect this. Press again «s» in this case.
7. GODI now asks whether it is ok to start the installation. Press «o» to confirm this, or «x» to cancel.
8. The installation process begins and runs fully automatic. (Actually, there is one exception from the latter: When `godi_console` updates itself, the user must confirm this step, because it is very critical.)
9. When the installation process prints a success message, it is done. Press «x» to exit.

- Updating packages by rebuilding them from source: By selecting an already installed package for build, `godi_console` performs all necessary steps to upgrade the package to the new version. First, the old version of the package is removed, and then, the new distribution files are downloaded, built, and installed.

The dependencies are checked in two directions: Missing predecessor packages are installed. This can happen when the new version requires additional prerequisites. Furthermore, the successor packages are also handled in a special way, because the strict successors are updated, too, or at least rebuilt if no newer version is available.

Instructions: Updating packages works like building packages for the first time.

- Removing installed packages: By selecting an installed package for removal, `godi_console` deletes the package and all strict successors from the system.

Instructions:

1. Select: Main menu → Select source packages
2. Scroll up/down by pressing «p» and «n» (or use PageUp/PageDown keys). Finally enter the number of the package to remove, and press Enter
3. The detailed description of the package appears. Press «r» to select it for removal. Press «x» to exit from the dialogue
4. The package list is again shown. Press «s» to start the installation process.
5. It may happen that further (successor) packages are also selected for removal, and the package list is only updated to reflect this. Press again «s» in this case.
6. GODI now asks whether it is ok to start the installation. Press «o» to confirm this, or «x» to cancel.
7. The installation process begins and runs fully automatic.
8. When the installation process prints a success message, it is done. Press «x» to exit.

It is recommended to check whether enough disk space is available before installing packages. One can get into problematic situations when the disk becomes full in the wrong moment, and it is difficult to recover from this. Furthermore, it is a bad idea to stop `godi_console` in the wrong moment (CTRL-C) because of the same reasons. The critical step begins when `godi_console` prints that it is installing a package («===> Installing for package»), and ends after the installation has been registered («===> Registering installation for package»).

4.2 Installed packages

The command `godi_info` may be used to get detailed information about installed packages:

- `godi_info <NAME>`: Prints the comment, the description, strict dependencies (both predecessors and successors are output), and the homepage of the software.
- `godi_info -L <NAME>`: Prints the files the package consists of.

Note that `godi_info -F` does not work (looking up the package by file name), because the needed reverse index is not available.

The command `godi_delete` may be used to remove a package from a system (you can also do this with `godi_console`). Give the `-r` option to delete the package and all successor packages.

4.3 Binary packages

As mentioned earlier in this manual, the binary package file is put into the directory `<PREFIX>/build/packages/All` after the build of a package has succeeded. This means that this directory always contains a complete copy of the current installation plus a lot of history information.

When a package is updated to a new version, the binary package file of the old version is not deleted. In principle, this allows you to go back, and to restore the old package. However, the history function is limited by the fact that often package files are overwritten when a package is rebuilt for a different equipment of predecessor packages, but for the same version of the software. For example, consider that there is a package `foo` in version 1, and a package `bar` in version 1. Furthermore, `bar` is dependent on `foo`. When a new version of `foo` is released, e.g. version 2, and the GODI user updates the package, *both* packages are built again, `foo` in version 2, and `bar` in version 1. The result is that a new binary package file is created for `foo`, namely `foo-2.tgz`, but that the old package file for `bar` is overwritten, because it is still called `bar-1.tgz`.

The main purpose of the binary packages is to simplify the distribution of software in LANs. One can copy the packages from one system to another, and install them, which is a lot simpler than to build the software on every system from source.

Tasks related to binary packages:

- Getting information: The `godi_info` command can also deal with package files. Just pass the name of the file as argument, and the output of the command refers to the file instead of the installed package. Example:

```
godi_info <PREFIX>/build/packages/All/godi-ocaml-3.08.1.tgz
```

- Installing an additional package: This is performed by `godi_add`. By default, it is not allowed to overwrite the package if it is already installed. Example:

```
godi_add <PREFIX>/build/packages/All/godi-ocaml-3.08.1.tgz
```

You can also mention several package names on the command line to install several packages at once. When predecessor packages are missing, they are searched in the same directory the original package is taken from. When the predecessor packages exist, but in the wrong version, the installation fails.

- Replacing a package: This can be done with `godi_add`, too, when the `-u` option is given. In principle, it is not necessary to delete the successor packages first, as the package can be in-line replaced by a different version if the version conditions of the dependent packages permit it. However, this is normally not the case.

Predecessor packages are not updated, however, even if this first enabled the installation of the original package. `godi_add` is simply not intelligent enough for this operation.

The package replacement even works if an older version is to be installed (downgrade).

- Cleaning the package directory: Of course, you can delete the files in `<PREFIX>/build/packages/All` when you are sure you do not need them anymore. Note that there also symlinks in the neighbour directories that should be deleted, too.

4.4 Restoring old packages

In principle, one can restore binary packages (i.e. install the old binary package file again), and one can recover source packages (i.e. go back to an old version of the source package, and build it again).

4.4.1 Restoring an old binary package

In principle, you can restore an old binary package by calling `godi_add -u` for it:

```
cd <PREFIX>/build/packages/All
godi_add -u <NAME>.tgz
```

Sometimes this does not work, however, because the old package is not compatible with the current set of predecessor or successor packages (`godi_add` reports a conflict). You can try to replace the problematic packages by historic versions, too, but this is a very complex task, and it is even unclear whether it is possible at all. As explained in section 4.3, package files may be overwritten in certain circumstances, and this means that the required old files might be lost.

In general, it is better to build the old version of the package from source, see the next section for instructions.

4.4.2 Building an old version of a package

This way of restoration is usually possible. In `<PREFIX>/build/buildfiles`, GODI stores the build instructions of all package versions that were ever downloaded. In `<PREFIX>/build/distfiles`, GODI stores the distribution files of all package versions that were ever built.

Follow these steps to install the package corresponding to the build instructions in `<CAT>-<NAME>-<VERSION>.build.tgz`:

1. Change the directory:

```
cd <PREFIX>/build/<CAT>
```

2. Delete the current build instructions (if present):

```
rm -rf <NAME>
```

3. Extract the old build.tgz archive:

```
godi_tar xzf ../buildfiles/<CAT>-<NAME>-<VERSION>.build.tgz
```

4. Start `godi_console` and build the package again (see above). It might happen that the distribution files do not exist locally in the `distfiles` directory, because the package was never built before. In this case, `godi_console` tries to download them from the Internet. There is no guarantee, however, that historic distribution files remain available forever.

Of course, `godi_console` may want to rebuild other packages, too. This is just the same mechanism as building new packages. It may happen, however, that the already installed packages are too modern for the new package. This is not detected by GODI in advance because this kind of information is not available. The most likely symptom is that the build fails with a compiler error.

In order to keep this possibility, it is strongly discouraged to delete the files in the `buildfiles` and `distfiles` directories.

4.5 Distribution upgrades

There are usually several «release lines» of GODI, i.e. several completely independent series of packages. When you perform the bootstrap procedure, one of the release lines is automatically selected and installed (there is always one release line reflecting the most up-to-date state). Up to now, the following types of release lines are in use:

- For every major version of the O’Caml compiler a new release line is started. For example, there are releases for the O’Caml 3.07 and the O’Caml 3.08 systems. Minor updates (bug fixes) of the compiler are usually handled within the existing release line, e.g. the 3.07 compiler was updated to 3.07pl2 after a while in the existing 3.07 line.

The reason for this is that the version of the O’Caml compiler is a major determinant of all software covered by GODI. Often, software must be explicitly ported to a new O’Caml compiler release, because the new version introduces almost always incompatibilities with the previous version.

- For certain development purposes, special release lines are started. These are often experimental, and include features that are not yet ready for the stable GODI system.

Currently, the existing release lines of the first type are «3.07» and «3.08». The release lines of the second type are announced in `godi-list`.

The release line GODI uses is determined by the variable `GODI_SECTION` that can be set in the file `<PREFIX>/etc/godi.conf`. After changing this variable, please note that GODI does not really detect that a different distribution is selected, it just retrieves the package from the newly selected release. This means:

- If the new release has packages with newer versions, these are recognised as being new, and the build instructions are downloaded when the package list is updated.
- If the new release has packages with older versions, these are recognised as being older than the available ones, and the build instructions of the new release are ignored.

The consequence is that the change of the release line works only correctly when this implies an upgrade, i.e. the packages of the new release are newer. If you really want to change to an older release, you must first delete all extracted build instructions:

```
cd <PREFIX>/build
rm -rf apps/* base/* conf/* godi/*
```

After that, at least the build instructions of the older release are downloaded, and you can start to build packages. You might still encounter strange effects, though, because package downgrades are a somewhat hairy operation, as necessary information about compatibility between old and new packages are missing.

4.6 Scripting GODI

The program `godi_console` cannot only be used in an interactive way, but also in scripts. Call `godi_console -help` to see the possibilities. It is beyond this manual to describe the command fully. See the manual page for «`godi_console`» for more information.

It should also be mentioned that `godi_add` and `godi_delete` just call `godi_console`.

The command «`godi_console make`» is currently not used - however, in future versions of GODI it is planned that `godi_make` will just call this command.

Chapter 5

Packaging Software

This chapter explains the core method of packaging software. GODIVA is another method with a simpler package specification file. GODIVA processes this file, and generates build instructions according to the core method, so GODIVA should be regarded as a higher layer that works on top of the core layer.

The question is whether to use GODIVA, or to manually apply the core method. There is no simple answer, but the following criteria may help:

- GODIVA requires that the software to be packaged follows certain rules, e.g. that there are certain «make» targets, that \$PREFIX is honoured, etc. Normally, the build scripts coming with a software distribution do not match exactly with the requirements (although they come quite close). If you package your own software, this is not a big problem, just change the build scripts such that the GODIVA requirements are fulfilled. If you package third-party software, it may become necessary to apply patches such that GODIVA and the build scripts play nicely together.
- GODIVA does not support configuration options.
- GODIVA does not support the inclusion of library flags from conf-* packages. This makes it a bad choice for software that provides bindings for C libraries.

Some of the limitations can be worked around by patching the result of the generated build instructions, however.

If you think you may want to try GODIVA, just install the apps-godiva package, and read more on the homepage: <http://projects.phauna.org/godiva>. The following information may be still of interest, however.

5.1 The build directory

The build instructions for a package are stored in the build directory:

```
<PREFIX>/build/<CAT>/<CAT>--<NAME>
```

You find here the following files and directories:

- `Makefile` (mandatory): This `Makefile` controls the overall build process. It does not directly invoke compilers, but it calls the `Makefile` of the software to build as sub process. This `Makefile` has a certain structure, see below.
- `distinfo` (mandatory): This file contains checksums of the distribution files, and of patches.
- `DESCR` (mandatory): The long description of the package. Free ASCII text.
- `BUILDMSG` (optional): This message describes configuration options. Free ASCII text.
- `MESSAGE` (optional): A message to be displayed when the package is finally installed (e.g. from a binary archive). Free ASCII text.
- `PLIST` or `PLIST.godi` (mandatory): The file describes which files are installed by the package, and are owned by the package. The name «`PLIST.godi`» should no longer be used. `PLIST` can include a number of directives, and is explained below in detail.
- `CONFOPTS` (optional): The list of configuration options (just one option per line).
- `patches` (optional): This directory contains patches to be applied to the unpacked software before the build starts. Patches are automatically applied by the build framework. Note, however, that patches are only applied when they also occur in `distinfo`, otherwise an error is indicated.
- `files` (optional): Additional files to be added to the software. There is no automatism, the commands performing the addition must be programmed in `Makefile`.

Usually, one needs only `Makefile`, `DESCR`, and `PLIST` (`distinfo` is generated, see below).

There may be the directory `work` as well. It contains the unpacked software, and this is the place where the build process really happens. By deleting `work`, one can reset the build process to the beginning. Note that it is possible to configure a different place for `work` (e.g. somewhere in `/tmp`).

5.2 Stages

The build process is structured into several stages. A certain stage can only be reached from the immediately preceding stage (but there is some shortcut logic, see below). The stages are:

- `fetch`: This stage ensures that the distribution files are in `<PREFIX>/build/distfiles`. If not, the files are downloaded.
- `extract`: Unpacks the distribution files into `work`.
- `patch`: Applies the patches to `work`

- `configure`: Configures the software (usually by calling a configure script)
- `build`: Compiles the software
- `install`: Installs the software
- `package`: Creates the binary package from the installed image

Normally, the build process just «climbs» the stages one after the other. The build process remembers the already reached stages by placing invisible files into `work`, e.g. `work/.install_done` indicates that build has completed the install stage.

When developing a package, it is possible to go to a certain stage, and to check whether everything has been done right (in `godi_console`, the stages are simply iterated, and one does not have the chance to stop and to check what is going on). This is done by calling `godi_make`, and passing the name of the stage, e.g.

```
godi_make configure
```

continues the build process until at least the `configure` stage is reached.

There are defined actions that are carried out for every stage. These actions can be configured by setting variables in Makefile (explained below). In addition to this, one can define pre and post actions for every stage by adding rules to Makefile, e.g.

```
pre-configure:
    <commands>
```

causes that these commands are executed before the predefined actions of the `configure` stage. In the same way, a `post-configure` rule would be executed after the predefined actions of the `configure` stage.

5.3 The Makefile

The minimum Makefile looks as follows:

```
.include "../..mk/bsd.prefs.mk"
VERSION= ...
PKGNAME= ...-${VERSION}
PKGREVISION= ...
DISTNAME=...
DISTFILES=....tar.gz
CATEGORIES=...
MASTER_SITES= ...
MAINTAINER=...
HOMEPAGE=...
COMMENT=...
.include "../..mk/bsd.pkg.mk"
```

Of course, this is only rarely enough, but often only a few additions are needed. We will discuss possible additions below. The «include» directives are mandatory, and load the rest of the build framework. The variables have this meaning:

- **VERSION:** This is the version string of the package, without revision suffix («godi» plus revision number)
- **PKGNAME:** The package name, including the version string at the end (as defined by **VERSION**).
- **PKGVERSION:** The revision number. This is a natural number ≥ 0 . If omitted, the revision number is assumed to be 0 which is the same as not specifying a number.
- **DISTNAME:** The name of the directory below **work** into which the distribution files are unpacked, i.e. the name of the topmost directory of the distribution tarball. This is usually the name of the package, optionally including the version string.
- **DISTFILES:** The names of the distribution files. This can be any number of files (even zero); the names are separated by spaces. These files are downloaded from **MASTER_SITES**, stored into the **distfiles** directory, and finally unpacked in **work**. If omitted, **DISTFILES** is tried to be derived from **DISTNAMES** by appending **EXTRACT_SUFFIX**, usually «tar.gz».
- **CATEGORIES:** This should be the category prefix of **PKGNAME**, i.e. **apps**, **conf**, **godi**, or **base**. In the future it will be possible to assign a package to several categories, and the categorization will be visible in the user interface.
- **MASTER_SITES:** A list of URLs where the **DISTFILES** can be downloaded. The URLs are tried in turn, so you can mention mirror sites in addition to the primary site. The URLs must end with a slash (or more precisely, with the separator character to which the file name can be appended). Currently, only «http» and «ftp» URLs are allowed. There is special support for common download sites like Sourceforge, e.g. one can define

```
MASTER_SITES=${MASTER_SITE_SOURCEFORGE:=path/}
```

where **path** is the part to append to the master URL. (This strange syntax is needed because **MASTER_SITE_SOURCEFORGE** expands to a list of URLs!)
The **GODI** backup URL is implicitly added to **MASTER_SITES**, and when neither of the URLs work, the **GODI** backup server is tried in a final attempt.
- **MAINTAINER:** The name of the package maintainer, including email address
- **HOMEPAGE:** The homepage of the packaged software
- **COMMENT:** The short, one-line description of the package

With only these variables, the stage actions are defined as follows:

- **fetch:** The **DISTFILES** are downloaded from the **MASTER_SITES**.

- `extract`: The `DISTFILES` are unpacked into `work`.
- `patch`: Applies the patches to `work`
- `configure`: Does nothing, the default is that there is no configuration script
- `build`: Changes to the subdirectory of `work` containing the unpacked sources, and tries to build the target «all»
- `install`: Changes to the subdirectory of `work` containing the unpacked sources, and tries to build the target «install»
- `package`: Creates the binary package from the installed image

We will now discuss how to define a number of frequent variations of this default. As most configurations can be done by setting further variables, the reference document of the variables is quite important: The file `makevar-ref.txt` describes the variables. It is usually installed in `<PREFIX>/doc/GODI/project-doc`.

5.3.1 Customising the «extract» stage

There are not really many ways for this type of customisation. If only some `DISTFILES` need to be unpacked, one can set

- `EXTRACT_ONLY`: Enumerates the file names to extract. This should be a subset of `DISTFILES`.

5.3.2 Customising the «patch» stage

Patches need not to be declared in `Makefile` (only in `distfiles`). The patches must be put into the `patches` directory. Usually, the file names of patches have the convention

```
patch-<letter><letter>-<info>
```

where the two letters define the order in which the patches are applied. The info suffix is just a descriptive string, e.g. one can mention the patched file (if it is only one file).

Patches are applied relative to the toplevel directory of the unpacked sources. The patch format should be «unified» patches. It is not allowed that files are created or deleted by patching; in the first case one must copy the files from the `files` directory to the source tree, and in the latter case one must delete the files by a script.

How to create patches

In this example we create a patch for the file `foo.txt` which is part of the `bar-3.14` package.

1. Copy the original version of the file:

```
cd work/bar-3.14
cp foo.txt foo.txt.orig
```
2. Modify `foo.txt` as required
3. Create the diff file (current directory is still `work/bar-3.14`):

```
diff -au foo.txt.orig foo.txt >../../patches/patch-aa-foo.txt
```

If the file to patch is located in a subdirectory, do not change to this subdirectory! Create the difference always from the toplevel directory of the unpacked sources.

Finally, you should also update `distfiles`, see below how to do this.

5.3.3 Customising the «configure» stage

As mentioned, the default is not to configure the software. The following variables enable this:

- `HAS_CONFIGURE=yes`: Enables to call a configuration script.
- `CONFIGURE_SCRIPT`: The name of the script to call. This defaults to «configure».
- `CONFIGURE_ARGS`: The arguments to be passed to the script. By default empty. Note that the arguments are in shell syntax, i.e. separated by spaces, and if necessary, quoted. E.g.

```
CONFIGURE_ARGS="word1 word2" word3
```

passes two arguments to the script where the first one is composed of two words.

If you just want to pass Makefile variables, the «Q» modifier is useful. It quotes automatically, e.g.

```
CONFIGURE_ARGS=-prefix ${LOCALBASE:Q}
```

so `LOCALBASE` is here always an argument of its own.

As with many other «plural» variables that have a list of arguments as values, it is common to use the «+=» operator to add arguments, e.g.

```
CONFIGURE_ARGS+=-prefix ${LOCALBASE:Q}
CONFIGURE_ARGS+=-with-foo
```


This operator appends the new value to the already existing list, and ensures that there is a space character as separator.

- `CONFIGURE_ENV`: Environment variables to be passed to the script. A number of variables are already passed by default (see reference). The syntax is simply:

```
CONFIGURE_ENV+=var=value
```

where `var` is the name of the variable, and `value` the new value.

- `CONFIGURE_DIRS`: Lists the directories where to invoke the configure script. By default, this is only done in the toplevel directory of the source tree.

5.3.4 Customising the «build» stage

One can set a number of variables, and there are also some typical «code snippets».

- `USE_GMAKE=yes`: Effects that GNU make is used to build the software. By default, `godi_make` is used (which is a BSD-type make utility).
- `MAKEFILE`: The name of the invoked Makefile of the source tree. Defaults to «Makefile».
- `ALL_TARGET`: The target(s) to pass to «make» to build the software. Defaults to «all». See below for a discussion.
- `MAKE_FLAGS`: Further arguments to pass to «make». Especially, it is possible to override variables of the invoked Makefile by passing «name=value» arguments. The arguments are again in shell syntax.

Pitfall: There is also a variable `MAKEFLAGS`, without underscore. This variable has a different meaning, as it is used to pass flags to recursive invocations of `godi_make`. Don't touch it!

- `MAKE_ENV`: Environment variables to be passed to «make». A number of variables are already passed by default (see reference). The syntax is simply:

```
MAKE_ENV+=var=value
```

where `var` is the name of the variable, and `value` the new value.

- `BUILD_DIRS`: Lists the directories where «make» is invoked to build the software. By default, it is only invoked in the toplevel directory of the source tree. By setting this variable to the empty string, the default action for the «build» stage is completely disabled.

Often, OCaml software must be built with «make all» to get the bytecode version, and «make opt» compiles to the native code version (if supported). This is usually expressed by this code snippet

```
.if ${GODI_HAVE_OCAMLLOPT} == "yes"
ALL_TARGET= all opt
.else
ALL_TARGET= all
.endif
```

(or some variation). The variable `GODI_HAVE_OCAMLLOPT` expands to `yes` when the `ocaml-opt` compiler is available, and to `no` otherwise. (Note that there are some more variables that describe the properties of the O’Caml core, see the variable reference.)

When `findlib` is used by the software, a special configuration must be enforced. This configuration sets a different lookup path for libraries such that the GODI-managed libraries have precedence. To get it, put this line into Makefile:

```
MAKE_ENV+= ${BUILD_OCAMLFIND_ENV}
```

If forgotten, it may happen that the build fails because a required library is not found, or in the wrong version.

5.3.5 Customising the «install» stage

Many of the «build» variables are also applied in the «install» stage, namely `USE_GMAKE`, `MAKEFILE`, `MAKE_FLAGS`, `MAKE_ENV`. The following variables are specific for «install»:

- `INSTALL_TARGET`: The target(s) to pass to «make» to install the software. Defaults to «install».
- `INSTALL_DIRS`: Lists the directories where «make» is invoked to install the software. By default, it is invoked in the same directories as for the «build» stage. By setting this variable to the empty string, the default action for the «install» stage is completely disabled.

It is quite common to add post-install actions to Makefile, because often documentation files are not installed by the installation procedure defined by the packaged software. An example for such an action is:

```
post-install:
    ${MKDIR} ${PREFIX}/doc/godi-getopt
    ${CP} ${WRKSRC}/README ${WRKSRC}/COPYING \
        ${PREFIX}/doc/godi-getopt
```

There are a number of further variables here:

- `PREFIX`: This is the base directory where packages are installed. The variable `LOCALBASE` has usually the same value, but for a number of reasons `PREFIX` should be preferred when files are installed, and `LOCALBASE` should be preferred when files are looked up (owned by other packages that are already installed)

- `WRKSR`: This is the toplevel directory of the source tree, as absolute path.
- `MKDIR`, `CP`: These are *defined* commands. Of course, one could also directly call `mkdir` and `cp`, but there are systems where there are several versions of various commands (e.g. a BSD version and a System V version), and the GODI framework has selected one that can be called through the mentioned variables.

5.3.6 Dependencies

In Makefile one can also declare dependencies on other packages. The variables are:

- `DEPENDS`: Lists strict dependencies for build and runtime
- `BUILD_DEPENDS`: Lists build-time-only dependencies

The syntax for the expressions one can use in these variables:

- `<BASENAME> <OPERATOR> <VERSION> : <PATH>`

where `<BASENAME>` is the name of the package without version string, `<OPERATOR>` is one of `=`, `>`, `<`, `!`, and `<VERSION>` is the version string the operator refers to. Note that package revisions in `<VERSION>` (i.e. any «godi» suffixes) are ignored, and one cannot enforce a certain revision.

The `<PATH>` is (almost) a legacy component of the dependency expressions, i.e. it is ignored by `godi_console`, but there are still some scripts that need it. The `<PATH>` must be set to

```
../..<CATEGORY>/<BASENAME>
```

where `<CATEGORY>` is the category prefix of `<BASENAME>` (apps, godi, etc.). The `<PATH>` is the relative path where to find the build directory of the package one refers to.

Examples for package dependencies:

- `DEPENDS+=godi-ocaml>=3.07:../..<godi>/godi-ocaml`
- `BUILD_DEPENDS+=conf-zlib>=0:../..<conf>/conf-zlib`

The comparison «`>=0`» should be read as «any version is accepted». There is also the legacy syntax «`-*`» or even «`-[0-9]*`» for the same purpose, e.g. «`conf-zlib-*`», but it should no longer be used in new packages.

Selecting the kind of dependency

`BUILD_DEPENDS` should only be used when it can be ensured that the referred package is only needed at build time, *and in all other cases `DEPENDS` must be used*. Examples when build-time dependencies are sufficient:

- A generator or other build-time tool is required, and the other package includes it. For instance, `godi-findlib` is usually a build-time dependency because of this rule.
- The other package configures the build. All `conf-*` packages can be referred to by build-time dependencies.
- An application program is built, and all executables are either created with `ocamlc -custom`, or `ocamlopt`. In this case, the used libraries are not necessary at runtime, and the corresponding packages can be listed in `BUILD_DEPENDS`.

Note, however, that there are exceptions from this rule. For example, `godi-ocamlnet` also includes runtime files that are required even when the application is completely statically linked.

In general, when a library is linked into a program, or a library is the antecedent for another library, the dependency is of the runtime type.

Magic dependencies

There are dependencies that need normally not to be listed, because it is impossible to even start the build process without a certain minimum equipment. These dependencies include:

- `godi-tools`: This is the package including `godi_console`.
- `godi-core-mk`: This package contains the build framework.

One can, however, demand certain minimum versions for these packages. This is sometimes useful when one needs a special feature that was only recently introduced into the packaging system.

5.3.7 Legacy expressions

In the past, it was necessary to put a number of expressions into Makefile to get a certain behaviour, but due to improvements this is no longer required:

- `GODI_PLIST`: When set to «yes», the file `PLIST.godi` is used instead of `PLIST`
- `.include "../mk/godi.pkg.mk"`: This is now an empty file
- `PATH:=${LOCALBASE}/bin:${PATH}`: This is now always done

If you find that in existing packages, don't copy it to new packages.

5.4 Packing lists

The file PLIST describes the installed files, so GODI knows which files are owned by the package, and the files are removed when the package is deleted.

In general, the «install» stage must already have arranged that the files are installed in the right directories. Often, this is done by passing PREFIX to the configure script, but there is no general technique how this can be achieved. In doubt, read the documentation coming with the software, and, of course, the Makefiles and other build scripts included in the software distribution.

The PLIST file is needed first when the «install» stage is entered. Before this stage, the PLIST file can be omitted.

If you don't know the software you are packaging, it is sometimes difficult to find out which files are actually installed. As mentioned, the PLIST file is needed *before* the installation is done (at the beginning of the «install» stage), so you cannot just install and see what has been installed. See below for a discussion how to cope with this problem.

In the simplest form, PLIST just lists the files that have been installed, plus a number of directives how to deal with directories. For example:

```
bin/foo
```

This one-liner means that the package consists only of the executable `bin/foo`. Filenames are relative to the installation prefix of GODI, and it is an error to use absolute path names.

In general, directories need not to be mentioned in PLIST. Directories are automatically created, and they are automatically removed when they become empty. Note: In previous versions of GODI, the `@dirrm` directives controlled the handling of directories in more detail. This has been found as too complicated by the GODI developers, and has been removed from the GODI packaging system.

As it is quite error-prone to enumerate files, there are a number of abbreviations and special notations. We explain here only the most useful ones, for a complete reference see the file `plist-ref.txt` (usually installed in `<PREFIX>/doc/GODI/project-doc`).

- `@deepdir <dir>`: The mentioned directory and its contents (including subdirectories) are declared to be owned by the package.
- `@findlib <name>`: The named findlib library is declared to be owned by the package. When the library includes DLLs, these are ignored, however.
- `@dllfindlib <name>`: The named findlib library and the included DLLs are declared to be owned by the package. (Note: The ownership of the DLLs is only recognised when there are `.owner` files. This is the case when the library was installed with `ocamlfind`, but is usually not the case when another method was used.)
- `@optional <directive>`: The files covered by the `<directive>` are only installed in certain configurations, and may be missing in other configurations. E.g. `@optional @findlib <name>` means that the library is only optionally installed.

In most cases, these four directives are sufficient.

There is still the problem how to figure out which files are installed. A simple method:

1. Begin with an empty PLIST, and do `godi_make install`
2. Get the installed files by calling `godi_make print-installed`. Note, however, that there is no guarantee that this list is complete, the «print-installed» script checks the timestamps of all files in the GODI installation. This may go wrong, especially on systems where the «find» command does not support the comparison of the ctime field of the timestamp (which is less problematic than the mtime field).
3. Write the PLIST according to the output of «print-installed». One should keep in mind that some files are only installed for certain system configurations, so just copying the list may not be enough.
4. Now remove the package, and the files (so the package database is clean again):
`godi_delete <packagename>`
`godi_make print-installed | (cd <PREFIX>; xargs rm -f)`
5. Remove these files, and install the package again:
`rm work/.install_done work/.PLIST`

5.5 An Example

Here the Makefile of `godi-xstr` (slightly updated):

```
.include "../../mk/bsd.prefs.mk"
VERSION=          0.2.1
PKGNAME=          godi-xstr-${VERSION}
DISTNAME=         xstr
DISTFILES=        xstr-${VERSION}.tar.gz
CATEGORIES=       godi
MASTER_SITES=     http://ocaml-programming.de/packages/
MAINTAINER=       gerd@gerd-stolpmann.de
HOMEPAGE=         http://ocaml-programming.de
COMMENT=          additional string functions
DEPENDS+=         godi-ocaml>=3.06:../../godi/godi-ocaml
BUILD_DEPENDS+=   godi-findlib>=0.8.1:../../godi/godi-findlib
MAKE_ENV+=        ${BUILD_OCAMLFIND_ENV}
USE_GMAKE=        yes
ALL_TARGET=       all
.if ${GODI_HAVE_OCAMLOPT} == "yes"
ALL_TARGET+=      opt
.endif
```

```

post-install:
    ${MKDIR} ${LOCALBASE}/doc/godi-xstr
.    for F in README LICENSE
        ${CP} ${WRKSRC}/${F} ${LOCALBASE}/doc/godi-xstr
.    endfor
.include "../../mk/bsd.pkg.mk"

```

The corresponding PLIST file:

```

@findlib xstr
doc/godi-xstr/README
doc/godi-xstr/LICENSE

```

5.6 Further targets for godi_make

The following targets have relevance:

- `clean`: Deletes the «work» directory, and resets the build process to a clean, initial state.
- `print-installed`: Prints a list of files that have been installed (created or modified) since the last time the package was unpacked. The underlying method is not fully reliable.
- `makesum`: Creates the `distinfo` file, and puts entries for all `DISTFILES` into it.
- `makepatchsum`: Adds checksums for patches to an already existing `distinfo` file.

5.7 Testing packages

One of the basic properties every package must have is that one can delete it. So the most primitive test checks this:

1. Install the package with `godi_make install`
2. Delete the package with `godi_delete`, check that there are no error messages.
3. Check that `godi_make print-installed` does not output anything!

5.8 The package repository

The package repository is realised with Subversion. Everybody can check it out:

```
svn checkout https://gps.dynxs.de/svn/godi-build
```

Of course, you need an account to modify any of the files. If you had one, you could do the following:

- Copy your new package into the checked-out directory hierarchy. Normally, the right directory is `godi-build/trunk` plus the relative path of the package directory.
- Add the package to the repository: run «`svn add`», and commit it: «`svn commit`».
- Ask other developers to check the package out, and to test it
- Release the package: Add the right line to `godi-build/pack/release.<SECTION>.map`, invoke the web application called «Release Tool», and do the release.

I have prepared more detailed instructions how to perform these actions for everybody who wants to have an account on the GODI server. (You get these instructions together with the account data.)

5.9 Check list

- Can the package be cleanly deleted?
- Does the package also work for other types of systems than your own one? Not every system supports DLLs, for example. Not every system has the `ocamlpt` compiler.
- Are all dependencies declared?
- Are the descriptions in `DESCR`, and optionally `BUILDMSG` up to date?
- Is the documentation installed? As bare minimum, there should be a file clarifying the license conditions.
- Are the examples installed? These are part of the documentation.
- Are all references to external C libraries covered by `conf` packages? There should also be `conf` packages for other unusual equipment that is not part of GODI.

(to be extended...)

Chapter 6

External Dependencies

The autoconf nightmare.

6.1 Configuration packages

6.2 The policy for library lookup

6.3 Using `godi_script` to create configuration packages