

The l3build package

Checking and building packages

The L^AT_EX3 Project*

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1 The l3build system

1.1 Introduction

The l3build system is a Lua script for building T_EX packages, with particular emphasis on regression testing. It is written in cross-platform Lua code, so can be used by any modern T_EX distribution with the `texlua` interpreter. A package for building with l3build can be written in any T_EX dialect; its defaults are set up for L^AT_EX packages written in the DocStrip style. (Caveat: minimal testing has yet been performed for non-L^AT_EX packages.)

Test files are written as standalone T_EX documents using the `regression-test.tex` setup file; documentation on writing these tests is discussed in Section 2.

The `l3build.lua` script is not designed to be executed directly; each package will define its own `build.lua` script as a driver file which both sets variables (such as the name of the package) and then calls the main `l3build.lua` script internally.

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A standard package layout might look something like the following:

```
abc/
  abc.dtx
  abc.ins
  build.lua
  README.md
  support/
  testfiles/
```

Most of this should look fairly self-explanatory. The top level `support/` directory (optional) would contain any necessary files for compiling documentation, running regression tests, and so on.

The `l3build` system is also capable of building and checking *bundles* of packages. To avoid confusion, we refer to either a standalone package or a package within a bundle as a *module*.

For example, within the L^AT_EX3 project we have the `l3packages` bundle which contains the `xparse`, `xtemplate`, etc., modules. These are all built and distributed as one bundle for installation, distribution *via* CTAN and so forth.

Each module in a bundle will have its own build script, and a bundle build script brings them all together. A standard bundle layout would contain the following structure.

```
mybundle/
  build.lua
  support/
  yyy/
    build.lua
    README.md
    testfiles/
    yyy.dtx
    yyy.ins
  zoo/
    build.lua
    README.md
    testfiles/
    zoo.dtx
    zoo.ins
```

All modules within a bundle must use the same build script name.

In a small number of cases, the name used by CTAN for a module or bundle is different from that used in the installation tree. For example, the L^AT_EX 2_ε kernel is called `latex-base` by CTAN but is located inside `<texmf>/tex/latex/base`. This can be handled by using `ctanpkg` for the name required by CTAN to override the standard value.

The `testfiles/` folder is local to each module, and its layout consists of a series of regression tests with their outputs.

```
testfiles/
  test1.lvt
  test1.tlg
  ...
  support/
    my-test.cls
```

Again, the `support/` directory contains any files necessary to run some or all of these tests.

When the build system runs, it creates a directory `build/` for various unpacking, compilation, and testing purposes. For a module, this build folder can be in the main directory of the package itself, but for a bundle it should be common for the bundle itself and for all modules within that bundle. A `build/` folder can be safely deleted; all material within is re-generated for each command of the `l3build` system.

1.2 Main build commands

In the working directory of a bundle or module, the following commands can be executed:

- `check`
- `check` $\langle name(s) \rangle$
- `cmdcheck`
- `clean`
- `ctan`
- `doc` $\langle name(s) \rangle$
- `install`
- `save` $\langle name(s) \rangle$
- `setversion`
- `unpack`

These commands are described below.

As well as these commands, the system recognises the options

- `-date` (`-d`) Date to use when setting version data
- `-engine` (`-e`) Sets the engine to use for testing
- `-force` (`-f`) Force checks to run even if sanity checks fail, *e.g.* when `-engine` is not given in `{"pdftex", "xetex", "luatex"}`
- `-halt-on-error` (`-H`) Specifies that checks should stop as soon as possible, rather than running all requested tests; the difference file is printed in the terminal directly in the case of failure
- `-pdf` (`-p`) Test PDF file against a reference version rather than using a log comparison
- `-quiet` (`-q`) Suppresses output from unpacking
- `-textfiledir` (`-t`) Select a specific set of tests
- `-version` (`-v`) Version string to use when setting version data

```
$ texlua build.lua check
```

The `check` command runs the entire test suite. This involves iterating through each `.lvt` file in the test directory (specified by the `testfiledir` variable), compiling each test in a “sandbox” (a directory specified by `testdir`), and comparing the output against each matching predefined `.tlg` file.

If changes to the package or the typesetting environment have affected the results, the check for that file fails. A `diff` of the expected to actual output should then be inspected to determine the cause of the error; it is located in the `testdir` directory (default `maindir .. "/build/test"`).

On Windows, the `diff` program is not available and so `fc` is used instead (generating an `.fc` file). Setting the environmental variables `diffexe` and `diffext` can be used to adjust the choice of comparison made: the standard values are

Windows `diffext = fc, diffexe = fc /n`

*nix `diffext = diff, diffexe = diff -c --strip-trailing-cr`

The following files are moved into the “sandbox” for the `check` process:

- all `installfiles` after unpacking;
- all `checkfiles` after unpacking;
- any files in the directory `testsuppdir`;
- any files that match `checksuppfiles` in the `supportdir`.

This range of possibilities allow sensible defaults but significant flexibility for defining your own test setups.

Checking can be performed with any or all of the ‘engines’ `pdftex`, `xetex`, and `luatex`. By default, each test is executed with all three, being compared against the `.tlg` file produced from the `pdftex` engine (these defaults are controlled by the `checkengines` and `stdengine` variable respectively). The format used for tests can be altered by setting `checkformat`: the default setting `latex` means that tests are run using *e.g.* `pdflatex`, whereas setting to `plain` will run tests using *e.g.* `pdftex`. (Currently, this should be one of `latex` or `plain`.) To perform the check, the engine typesets each test `checkruns` times. More detail on this in the documentation on `save`. Options passed to the binary are defined in the variable `checkopts`.

By default, `texmf` trees are searched for input files when checking. This can be disabled by setting `checksearch` to `false`: isolation provides confidence that the tests cannot accidentally be running with incorrect files installed in the main distribution or `hometexmf`.

```
$ texlua build.lua check <name(s)>
```

Checks only the test `<name(s)>.lvt`. All engines specified by `checkengines` are tested unless the command line option `-engine` (or `-e`) has been given to limit testing to a single engine. Normally testing is preceded by unpacking source files and copying the result plus any additional support to the test directory: this may be skipped using the `-s` option.

```
$ texlua build.lua check -p
```

Rather than the log-based checking carried out by the standard `check` target, running with the `-p` option carries out a binary comparison of the PDF files produced by typesetting against those saved in `testfiledir`.

This functionality requires T_EX Live 2016 or later as it needs support from the engines not available in earlier releases.

```
$ texlua build.lua cmdcheck
```

For l3doc-based sources, allows checking that the commands defined in the code part (by `cmdchkfiles`) are documented in the description part. This is performed by passing the `check` option to the l3doc class, typesetting the file(s) to check with engine `stdengine` with options `cmdchkopts`, and checking the resultant `.cmds` file(s). Dependencies are specified also with `checkdeps`.

```
$ texlua build.lua clean
```

This command removes all temporary files used for package bundling and regression testing. In the standard layout, these are all files within the directories defined by `localdir`,

`testdir`, `typesetdir` and `unpackdir`, as well as all files defined in the `cleanfiles` variable in the same directory as the script. The defaults are `.pdf` files from typesetting (`doc`) and `.zip` files from bundling (`ctan`).

```
$ texlua build.lua ctan
```

Creates an archive of the package and its documentation, suitable for uploading to CTAN. The archive is compiled in `distribdir`, and if the results are successful the resultant `.zip` file is moved into the same directory as the build script. If `packtdszip` is set true then the building process includes a `.tds.zip` file containing the ‘T_EX Directory Structure’ layout of the package or bundle. The archive therefore may contain two ‘views’ of the package:

```
abc.zip/
  abc/
    abc.dtx
    abc.ins
    abc.pdf
    README.md
  abc.tds.zip/
    doc/latex/abc/
      abc.pdf
      README.md
    source/latex/abc/
      abc.dtx
      abc.ins
    tex/latex/abc/
      abc.sty
```

The files copied into the archive are controlled by a number of variables. The ‘root’ of the TDS structure is defined by `tdsroot`, which is `"latex"` by default. Plain users would redefine this to `"plain"` (or perhaps `"generic"`), for example. The build process for a `.tds.zip` file currently assumes a ‘standard’ structure in which all extracted files should be placed inside the `tex` tree in a single directory, as shown above. If the module includes any BibT_EX or MakeIndex styles these will be placed in the appropriate subtrees.

The `doc` tree is constructed from:

- all files matched by `demofiles`,
- all files matched by `docfiles`,
- all files matched by `typesetfiles` with their extension replaced with `.pdf`,
- all files matched by `textfiles`,
- all files matched by `bibfiles`.

The `source` tree is constructed from all files matched by `typesetfiles` and `sourcefiles`. The `tex` tree from all files matched by `installfiles`.

Files that should always be excluded from the archive are matched against the `excludefiles` variable; by default this is `{"*~"}`, which match Emacs’ autosave files.

Binary files should be specified with the `binaryfiles` variable (default `{"*.pdf", "*.zip"}`); these are added to the zip archive without normalising line endings (text files are automatically converted to Unix-style line endings).

To create the archive, by default the binary `zipexe` is used ("zip") with options `zipopts (-v -r -X)`. The intermediate build directories `ctandir` and `tdsdir` are used to construct the archive.

```
$ texlua build.lua doc
```

Compiles documentation files in the `typesetdir` directory. In the absence of one or more file names, all documentation is typeset; a file list may be given at the command line for selective typesetting. If the compilation is successful the `.pdf` is moved back into the main directory.

The documentation compilation is performed with the `typesetexe` binary (default `pdflatex`), with options `typesetopts`. Additional T_EX material defined in `typesetcmds` is passed to the document (e.g., for writing `\PassOptionsToClass{13doc}{letterpaper}`), and so on—note that backslashes need to be escaped in Lua strings).

Files that match `typesetsupfiles` in the `support` directory (`supportdir`) are copied into the `build/local` directory (`localdir`) for the typesetting compilation process. Additional dependencies listed in the `typesetdeps` variable (empty by default) will also be installed.

Source files specified in `sourcefiles` and `typesetsourcefiles` are unpacked before the typesetting takes place. (In most cases `typesetsourcefiles` will be empty, but may be used where there are files to unpack *only* for typesetting.)

If `typesetsearch` is `true` (default), standard `texmf` search trees are used in the typesetting compilation. If set to false, *all* necessary files for compilation must be included in the `build/local` sandbox.

```
$ texlua build.lua doc <name(s)>
```

Typesets only the files with the `<name(s)>` given, which should be the root name without any extension.

```
$ texlua build.lua install
```

Copies all package files (defined by `installfiles`) into the user's home `texmf` tree in the form of the T_EX Directory Structure.

```
$ texlua build.lua save <name(s)>
```

This command runs through the same execution as `check` for a specific test(s) `<name(s)>.lvt`. This command saves the output of the test to a `.tlg` file. This file is then used in all subsequent checks against the `<name>.lvt` test.

If the `-engine` (or `-e`) is specified (one of `pdftex`, `xetex`, or `luatex`), the saved output is stored in `<name>.<engine>.tlg`. This is necessary if running the test through a different engine produces a different output. A normalisation process is performed when checking to avoid common differences such as register allocation; full details are listed in section 1.7.

If the `recordstatus` variable is set `true`, additional information will be added to the `.tlg` to record the “exit status” of the typesetting compilation of the `.lvt` file. If the typesetting compilation completed without throwing an error (due to T_EX programming errors, for example), the “exit status” is zero, else non-zero.

```
$ texlua build.lua save -p <name(s)>
```

This version of `save` will store the PDF files produced from `<name(s)>.lvt` in addition to the `.tlg` file, and thus allows binary comparison of the result of typesetting.

This functionality requires T_EX Live 2016 or later as it needs support from the engines not available in earlier releases.

```
$ texlua build.lua setversion
```

Modifies the content of files specified by **versionfiles** to allow automatic updating of the file date and version. The latter are specified using the **-d** and **-v** command line options and if not given will default to the current date in ISO format (YYYY-MM-DD) and **-1**, respectively. As detailed below, the standard set up has no search pattern defined for this target and so no action will be taken *unless* a version type for substitution is set up (using **versionform** or by defining a custom function).

```
$ texlua build.lua unpack
```

This is an internal target that is normally not needed on user level. It unpacks all files into the directory defined by **unpackdir**. This occurs before other build commands such as **doc**, **check**, etc.

The unpacking process is performed by executing the **unpackexe** (default **tex**) with options **unpackopts** on all files defined by the **unpackfiles** variable; by default, all files that match **{ "*.ins" }**.

If additional support files are required for the unpacking process, these can be enumerated in the **unpacksuppfiles** variable. Dependencies for unpacking are defined with **unpackdeps**.

By default this process allows files to be accessed in all standard **texmf** trees; this can be disabled by setting **unpacksearch** to **false**.

1.3 Example build scripts

An example of a standalone build script for a package that uses self-contained **.dtx** files is shown in Figure 1. Here, the **module** only is defined, and since it doesn't use **.ins** files so the variable **unpackfiles** is redefined to run **tex** on the **.dtx** files instead to generate the necessary **.sty** files. There are some PDFs in the repository that shouldn't be part of a CTAN submission, so they're explicitly excluded, and here unpacking is done 'quietly' to minimise console output when building the package. Finally, because this is a standalone package, we assume that **l3build** is installed in the main T_EX distribution and find the Lua script by searching for it.

An example of a bundle build script for **l3packages** is shown in Figure 2. Note for L^AT_EX3 we use a common file to set all build variables in one place, and the path to the **l3build.lua** script is hard-coded so we always use our own most recent version of the script. An example of an accompanying module build script is shown in Figure 3.

Under a Unix-like platform, you may wish to run **'chmod +x build.lua'** on these files, which allows a simpler command line use. Instead of writing

```
texlua build.lua check
```

for example, you would simply write

```
./build.lua check
```

instead. (Or even omit the **./** depending on your path settings.) Windows users can achieve a similar effect by creating a file **build.bat** as show in Figure 4.

1.4 Variables

This section lists all variables defined in the `l3build.lua` script that are available for customisation.

```
1 #!/usr/bin/env texlua
2
3 -- Build script for breqn
4
5 module = "breqn"
6
7 unpackfiles = {"*.dtx"}
8 excludefiles = {"*/breqn-abbr-test.pdf",
9                 "*/eqbreaks.pdf"}
10 unpackopts = "-interaction=batchmode"
11
12 kpse.set_program_name("kpsewhich")
13 dofile(kpse.lookup("l3build.lua"))
```

Figure 1: The build script for the `breqn` package.


```

1  #!/usr/bin/env texlua
2
3  -- Build script for LaTeX3 "l3packages" files
4
5  -- Identify the bundle: there is no module as this is the "driver"
6  bundle = "l3packages"
7
8  -- Location of main directory: use Unix-style path separators
9  maindir = ".."
10
11 -- Load the common build code: this is the one place that a path
12 -- needs to be hard-coded
13 dofile (maindir .. "/l3build/l3build-config.lua")
14 dofile (maindir .. "/l3build/l3build.lua")

```

Figure 2: The build script for the l3packages bundle.

```

1  #!/usr/bin/env texlua
2
3  -- Build script for LaTeX3 "xparse" files
4
5  -- Identify the bundle and module:
6  bundle = "l3packages"
7  module = "xparse"
8
9  -- Location of main directory: use Unix-style path separators
10 -- Should match that defined by the bundle.
11 maindir = "../.."
12
13 -- Load the common build code: this is the one place that a path
14 -- needs to be hard-coded
15 dofile (maindir .. "/l3build/l3build-config.lua")
16 dofile (maindir .. "/l3build/l3build.lua")

```

Figure 3: The build script for the xparse module.

```

1  @echo off
2  texlua build.lua %*

```

Figure 4: Windows batch file wrapper for running the build process.

Variable	Default	Description
<code>module</code>	<code>"</code>	The name of the module
<code>bundle</code>	<code>"</code>	The name of the bundle in which the module belongs (where relevant)
<code>ctanpkg</code>	<code>module/bundle</code>	Name of the CTAN package matching this module
<code>modules</code>	<code>{}</code>	The list of all modules in a bundle (when not auto-detecting)
<code>exclmodules</code>	<code>{}</code>	Directories to be excluded from automatic module detection
<code>maindir</code>	<code>"."</code>	Top level directory for the module/bundle
<code>docfiledir</code>	<code>maindir</code>	Directory containing documentation files
<code>supportdir</code>	<code>maindir .. "/support"</code>	Directory containing general support files
<code>testfiledir</code>	<code>maindir .. "/testfiles"</code>	Directory containing test files
<code>testsuppdir</code>	<code>testfiledir .. "/support"</code>	Directory containing test-specific support files
<code>distribdir</code>	<code>maindir .. "/build/distrib"</code>	Directory for generating distribution structure
<code>localdir</code>	<code>maindir .. "/build/local"</code>	Directory for extracted files in “sandboxed” \TeX runs
<code>testdir</code>	<code>maindir .. "/build/test"</code>	Directory for running tests
<code>typesetdir</code>	<code>maindir .. "/build/doc"</code>	Directory for building documentation
<code>unpackdir</code>	<code>maindir .. "/build/unpack"</code>	Directory for unpacking sources
<code>ctandir</code>	<code>distribdir .. "/ctan"</code>	Directory for organising files for CTAN
<code>tdsdir</code>	<code>distribdir .. "/tds"</code>	Directory for organised files into TDS structure
<code>tdsroot</code>	<code>"latex"</code>	Root directory of the TDS structure for the bundle/module to be installed into
<code>bibfiles</code>	<code>{"*.bib"}</code>	\BibTeX database files
<code>binaryfiles</code>	<code>{"*.pdf", "*.zip"}</code>	Files to be added in binary mode to zip files
<code>bstfiles</code>	<code>{"*.bst"}</code>	\BibTeX style files
<code>checkfiles</code>	<code>{ }</code>	Extra files unpacked purely for tests
<code>checksuppfiles</code>		Files needed for performing regression tests
<code>cmdchkfiles</code>	<code>{}</code>	Files need to perform command checking (l3doc-based documentation only)
<code>cleanfiles</code>	<code>{"*.log", "*.pdf", "*.zip"}</code>	Files to delete when cleaning
<code>demofiles</code>	<code>{}</code>	Files which show how to use a module
<code>docfiles</code>	<code>{}</code>	Files which are part of the documentation but should not be typeset
<code>excludefiles</code>	<code>{"*~"}</code>	Files to ignore entirely (default for Emacs backup files)
<code>installfiles</code>	<code>{"*.sty", "*.cls"}</code>	Files to install to the \TeX tree and similar task
<code>makeindexfiles</code>	<code>{"*.ist"}</code>	MakeIndex files to be included in a TDS-style zip
<code>sourcefiles</code>	<code>{"*.dtx", "*.ins"}</code>	Files to copy for unpacking
<code>textfiles</code>	<code>{"*.md", "*.txt"}</code>	Plain text files to send to CTAN as-is
<code>typesetdemofiles</code>	<code>{}</code>	Files to typeset before the documentation for inclusion in main documentation files
<code>typesetfiles</code>	<code>{"*.dtx"}</code>	Files to typeset for documentation
<code>typesetsuppfiles</code>	<code>{}</code>	Files needed to support typesetting when “sandboxed”
<code>typesetsourcefiles</code>	<code>{}</code>	Files to copy to unpacking when typesetting.
<code>unpackfiles</code>	<code>{"*.ins"}</code>	Files to run to perform unpacking.
<code>unpacksuppfiles</code>	<code>{}</code>	Files needed to support unpacking when “sandboxed”
<code>versionfiles</code>	<code>{"*.dtx"}</code>	Files for automatic version editing
<code>bakext</code>	<code>".bak"</code>	Extension of backup files

Variable	Default	Description
dviext	".dvi"	Extension of DVI files
lvtext	".lvt"	Extension of test files
tlgext	".tlg"	Extension of test file output
lveext	".lve"	Extension of auto-generating test file output
logext	".log"	Extension of checking output, before processing it into a .tlg
pdfext	".pdf"	Extension of PDF file for checking and saving
psext	".ps"	Extension of PostScript files
checkdeps	{}	List of dependencies for running checks
typesetdeps	{}	List of dependencies for typesetting docs
unpackdeps	{}	List of dependencies for unpacking
checkengines	{"pdftex", "xetex", "luatex"}	Engines to check with check by default
stdengine	"pdftex"	Engine to generate .tlg file from
checkformat	"latex"	Format to use for tests
typesetexe	"pdflatex"	Executable for compiling doc(s)
unpackexe	"tex"	Executable for running unpack
zipexe	"zip"	Executable for creating archive with ctan
checkopts	"-interaction=nonstopmode"	Options based to engine when running checks.
cmdchkopts	"-interaction=batchmode"	Options based to engine when running command checks.
typesetopts	"-interaction=nonstopmode"	Options based to engine when typesetting.
unpackopts	""	Options based to engine when unpacking.
zipopts	"-v -r -X"	Options based to zip program.
checksearch	true	Switch to search the system texmf for during checking
typesetsearch	true	Switch to search the system texmf for during typesetting
unpacksearch	true	Switch to search the system texmf for during unpacking
glossarystyle	"gglo.ist"	MakeIndex style file for glossary/changes creation
indexstyle	"gind.ist"	MakeIndex style for index creation
biberexe	"biber"	Biber executable
biberopts	""	Biber options
bibtexexe	"bibtex8"	BIB _T E _X executable
bibtexopts	"-w"	BIB _T E _X options
makeindexexe	"makeindex"	MakeIndex executable
makeindexopts	""	MakeIndex options
forcecheckepoch	"true"	Force epoch when running tests
forcedoepoch	"false"	Force epoch when typesetting
asciengines	{"pdftex"}	Engines which should log as sure ASCII
checkruns	1	Number of runs to complete for a test before comparing the log
epoch	1463734800	Epoch (Unix date) to set for test runs
maxprintline	79	Length of line to use in log files
packtdszip	false	Switch to build a TDS-style zip file for CTAN
scriptname	"build.lua"	Name of script used in dependencies
typesetcmds	""	Instructions to be passed to T _E X when doing typesetting.
typsetcycles	3	Number of cycles of typesetting to carry out.

```

1 -- Special config for these tests
2 checksearch = true
3 checkengines = {"xetex", "luatex"}

```

Figure 5: The build script for the `xparse` module.

Variable	Default	Description
<code>versionform</code>	<code>""</code>	Nature of version strings for auto-replacement.
<code>recordstatus</code>	<code>false</code>	Switch to include error level from test runs in <code>.tlg</code> files

1.5 Multiple sets of tests

In most cases, a single set of tests will be appropriate for the module, with a common set of configuration settings applying. However, there are situations where you may need entirely independent sets of tests which have different setting values, for example using different formats or where the entire set will be engine-dependent. To support this, `l3build` offers the `--testfiledir` (`-t`) command line option. When this is given with a directory argument it overrides the `testfiledir` variable. Moreover, before the tests are run, `l3build` will read `config.lua` within the directory (if available). This should comprise a list of settings which apply to the tests in place of those in the main build script.

For example, for the core $\text{\LaTeX}2_{\epsilon}$ tests the main test files are contained in a directory `testfiles` and have `checksearch` set `false`. To test font loading for \XeTeX and \LuaTeX there are a second set of tests in `testfiles-TU` which use the short `config.lua` file shown in Figure 5. These additional tests are then run using `texlua build.lua check --testfiledir=testfiles-TU`.

1.6 Dependencies

If you have multiple packages that are developed separately but still interact in some way, it's often desirable to integrate them when performing regression tests. For $\text{\LaTeX}3$, for example, when we make changes to `l3kernel` it's important to check that the tests for `l3packages` still run correctly, so it's necessary to include the `l3kernel` files in the build process for `l3packages`.

In other words, `l3packages` is *dependent* on `l3kernel`, and this is specified in `l3build` by setting appropriately the variables `checkdeps`, `typesetdeps`, and `unpackdeps`. The relevant parts of the $\text{\LaTeX}3$ repository is structured as the following.

```

l3/
  l3kernel/
    build.lua
    expl3.dtx
    expl3.ins
    ...
    testfiles/
  l3packages/
    build.lua
    xparse/
      build.lua

```

```

testfiles/
xparse.dtx
xparse.ins

support/

```

For L^AT_EX3 build files, `maindir` is defined as top level folder `l3`, so all support files are located here, and the build directories will be created there. To set `l3kernel` as a dependency of `l3package`, within `l3packages/xparse/build.lua` the equivalent of the following is set:

```

maindir = "../.."
checkdeps = {maindir .. "/l3kernel"}

```

This ensures that the `l3kernel` code is included in all processes involved in unpacking and checking and so on. The name of the script file in the dependency is set with the `scriptname` variable; by default these are `"build.lua"`.

1.7 Output normalisation

To allow test files to be used between different systems (*e.g.* when multiple developers are involved in a project), the log files are normalised before comparison during checking. This removes some system-dependent data but also some variations due to different engines. This normalisation consists of two parts: removing (“ignoring”) some lines and modifying others to give consistent test. Currently, the following types of line are ignored:

- Lines before the `\START`, after the `\END` and within `\OMIT`/`\TIMO` blocks
- Entirely blank lines, including those consisting only of spaces.
- Lines containing file dates in format `<yyyy>/<mm>/<dd>`.
- Lines starting `\openin` or `\openout`.

Modifications made in lines are:

- Removal spaces at the start of lines.
- Removal of `./` at start of file names.
- Standardisation of the list of units known to T_EX (pdfT_EX and LuaT_EX add a small number of additional units which are not known to T_EX90 or X_ƎT_EX).
- Standardisation of `\csname\endcsnamel` to `\csname\endcsname` (the former is formally correct, but the latter was produced for many years due to a T_EX bug).
- Conversion of `on line <number>` to `on line ...` to allow flexibility in changes to test files.
- Conversion of register numbers in assignment lines `\<register>=\<type><number>` to `\<type><...>`
- Conversion of box numbers in `\show lines > \box<number>=` to `> \box...=`

LuaTeX makes several additional changes to the log file. As normalising these may not be desirable in all cases, they are handled separately. When creating LuaTeX-specific test files (either with LuaTeX as the standard engine or saving a LuaTeX-specific `.tlg` file) no further normalisation is undertaken. On the other hand, for cross-engine comparison the following normalisation is applied:

- Removal of additional (unused) `\discretionary` points.
- Normalisation of some `\discretionary` data to a TeX90 form.
- Removal of `U+...` notation for missing characters.
- Removal of `display` for display math boxes (included by TeX90/pdfTeX/X_ƎTeX).
- Removal of Omega-like `direction` TLT information.
- Removal of additional whatsit containing local paragraph information (`\localinterlinepenalty`, *etc.*).
- Rounding of glue set to four decimal places (glue set may be slightly different in LuaTeX compared to other engines).
- Conversion of low chars (0 to 31) to `^^` notation.

When making comparisons between 8-bit and Unicode engines it is useful to format the top half of the 8-bit range such that it appears in the log as `^^⟨char⟩` (the exact nature of the 8-bit output is otherwise dependent on the active code page). This may be controlled using the `asciiengines` option. Any engines named here will use a `.tcx` file to produce only ASCII chars in the log output, whilst for other engines normalisation is carried out from UTF-8 to ASCII. If the option is set to an empty table the latter process is skipped: suitable for cases where only Unicode engines are in use.

2 Writing test files

Test files are written in a TeX dialect using the support file `regression-test.tex`, which should be `\input` at the very beginning of each test. Additional customisations to this driver can be included in a local `regression-test.cfg` file, which will be loaded automatically if found.

The macros loaded by `regression-test.tex` set up the test system and provide a number of commands to aid the production of a structured test suite. The basis of the test suite is to output material into the `.log` file, from which a normalised test output (`.tlg`) file is produced by the build command `save`. A number of commands are provided for this; they are all written in uppercase to help avoid possible conflicts with other package commands.

2.1 Metadata and structural commands

Any commands that write content to the `.log` file that should be ignored can be surrounded by `\OMIT ... \TIMO`. At the appropriate location in the document where the `.log` comparisons should start (say, after `\begin{document}`), the test suite must contain the `\START` macro. The test should then include `\AUTHOR{⟨authors details⟩}` in case a test file fails in the future and needs to be re-analysed.

Some additional diagnostic information can then be included as metadata for the conditions of the test. The desired format can be indicated with `\FORMAT{<format name>}`, and any packages or classes loaded can be indicated with

```
\CLASS[<options>]{<class name, version>}
\PACKAGE[<options>]{<package name, version>}
```

These do not provide information that is useful for automated checking; after all, packages change their version numbers frequently. Rather, including this information in a test indicates the conditions under which the test was definitely known to pass at a certain time in the past.

The `\END` command signals the end of the test (but read on). Some additional diagnostic information is printed at this time to debug if the test did not complete ‘properly’ in terms of mismatched brace groups or `\if... \fi` groups.

In a \LaTeX document, `\end{document}` will implicitly call `\END` at the very end of the compilation process. If `\END` is used directly (replacing `\end{document}` in the test), the compilation will halt almost immediately, and various tasks that `\end{document}` usually performs will not occur (such as potentially writing to the various `.toc` files, and so on). This can be an advantage if there is additional material printed to the log file in this stage that you wish to ignore, but it is a disadvantage if the test relies on various auxiliary data for a subsequent typesetting run. (See the `checkruns` variable for how these tests would be test up.)

2.2 Commands to help write tests

A simple command `\CHECKCOMMAND<macro>` is provided to check whether a particular `<macro>` is defined, undefined, or equivalent to `\relax`. This is useful to flag either that internal macros are remaining local to their definitions, or that defined commands definitely are defined, or even as a reminder that commands you intend to define in a future package need to be tested once they appear.

`\TYPE` is used to write material to the `.log` file, like \LaTeX ’s `\typeout`, but it allows ‘long’ input. The following commands are defined to use `\TYPE` to output strings to the `.log` file.

- `\SEPARATOR` inserts a long line of = symbols to break up the log output.
- `\NEWLINE` inserts a linebreak into the log file.
- `\TRUE`, `\FALSE`, `\YES`, `\NO` output those strings to the log file.
- `\ERROR` is *not* defined but is commonly used to indicate a code path that should never be reached.
- The `\TEST{<title>}{<contents>}` command surrounds its `<contents>` with some `\SEPARATORS` and a `<title>`.
- `\TESTEXP` surrounds its contents with `\TYPE` and formatting to match `\TEST`; this can be used as a shorthand to test expandable commands.
- TODO: would a `\TESTFEXP` command (based on `\romannumeral` expansion) be useful as well?
- `\BEGINTEST{<title>} ... \ENDTEST` is an environment form of `\TEST`, allowing verbatim material, *etc.* to appear.

An example of some of these commands is shown following.

```
\TEST{bool_set,~lazy~evaluation}
{
  \bool_set:Nn \l_tmpa_bool
  {
    \int_compare_p:nNn 1=1
    && \bool_lazy_any_p:n
    {
      { \int_compare_p:nNn 2=3 }
      { \int_compare_p:nNn 4=4 }
      { \int_compare_p:nNn 1=\ERROR } % is skipped
    }
    && \int_compare_p:nNn 2=2
  }
  \bool_if:NTF \l_tmpa_bool \TRUE \FALSE
}
```

This test will produce the following in the output.

```
=====
TEST 8: bool_set, lazy evaluation
=====
TRUE
=====
```

(Only if it's the eighth test in the file of course, and assuming `expl3` coding conventions are active.)

2.3 Showing box content

The commands introduced above are only useful for checking algorithmic or logical correctness. Many packages should be tested based on their typeset output instead; `TeX` provides a mechanism for this by printing the contents of a box to the log file. The `regression-test.tex` driver file sets up the relevant `TeX` parameters to produce as much output as possible when showing box output.

A plain `TeX` example of showing box content follows.

```
\input regression-test.tex\relax
\START
\setbox0=\hbox{\rm hello \it world $a=b+c$}
\showbox0
\END
```

This produces the output shown in Figure 6 (left side). It is clear that if the definitions used to typeset the material in the box changes, the log output will differ and the test will no longer pass.

The equivalent test in `LATEX 2ε` using `expl3` is similar.

```
\input{regression-test.tex}
\documentclass{article}
\usepackage{expl3}
```



```

\START
\ExplSyntaxOn
\box_new:N \l_tmp_box
\hbox_set:Nn \l_tmp_box {hello~ \emph{world}~ $a=b+c$}
\box_show:N \l_tmp_box
\ExplSyntaxOff
\END

```

The output from this test is shown in Figure 6 (right side). There is marginal difference (mostly related to font selection and different logging settings in L^AT_EX) between the plain and expl3 versions.

When examples are not self-contained enough to be typeset into boxes, it is possible to ask T_EX to output the entire contents of a page. Insert `\showoutput` for L^AT_EX or set `\tracingoutput` positive for plain T_EX; ensure that the test ends with `\newpage` or equivalent because T_EX waits until the entire page is finished before outputting it.

TODO: should we add something like `\TRACEPAGES` to be format-agnostic here? Should this perhaps even be active by default?

2.4 Testing entire pages

There may be occasions where creating entire test pages is necessary to observe the test output required. That is best achieved by applying `\showoutput` and forcing a complete page to be produced, for example

```

\input{regression-test.tex}
\documentclass{article}
\usepackage{expl3}
\START
\showoutput
% Test content here
\vfil\break
\END

```

2.5 Additional test tasks

A standard test will run the file `<name>.lvt` using one or more engines, but will not carry out any additional processing. For some tests, for example bibliography generation, it may be desirable to call one or more tools in addition to the engine. This can be arranged by defining `runtest_tasks`, a function taking one argument, the name of the current test (this is equivalent to T_EX's `\jobname`, *i.e.* it lacks an extension). The function `runtest_tasks` is is into a call to the system to run the engine. As such, it should take return a string with the appropriate command(s) and option(s). If more than one task is required, these should be separated by use of `os_concat`, a string variable defined by `l3build` as the correct concatenation marker for the system. An example of `runtest_tasks` suitable for calling Biber is shown in Listing 7.

2.6 Epoch setting

To produce predictable output when suing dates, the test system offers the ability to set the epoch to a known value. The `1463734800` variable may be given as a raw value

<pre> > \box0= \hbox(6.94444+0.83333)x90.56589 .\tenrm h .\tenrm e .\tenrm l .\tenrm l .\tenrm o .\glue 3.33333 plus 1.66666 minus 1.11111 .\tenit w .\tenit o .\tenit r .\tenit l .\tenit d .\glue 3.57774 plus 1.53333 minus 1.0222 .\mathon .\teni a .\glue(\thickmuskip) 2.77771 plus 2.77771 .\tenrm = .\glue(\thickmuskip) 2.77771 plus 2.77771 .\teni b .\glue(\medmuskip) 2.22217 plus 1.11108 minus 2.22217 .\tenrm + .\glue(\medmuskip) 2.22217 plus 1.11108 minus 2.22217 .\teni c .\mathoff ! OK. 1.9 \showbox0 </pre>	<pre> > \box71= \hbox(6.94444+0.83333)x91.35481 .\OT1/cmr/m/n/10 h .\OT1/cmr/m/n/10 e .\OT1/cmr/m/n/10 l .\OT1/cmr/m/n/10 l .\OT1/cmr/m/n/10 o .\glue 3.33333 plus 1.66666 minus 1.11111 .\OT1/cmr/m/it/10 w .\OT1/cmr/m/it/10 o .\OT1/cmr/m/it/10 r .\OT1/cmr/m/it/10 l .\OT1/cmr/m/it/10 d .\kern 1.03334 .\glue 3.33333 plus 1.66666 minus 1.11111 .\mathon .\OML/cmm/m/it/10 a .\glue(\thickmuskip) 2.77771 plus 2.77771 .\OT1/cmr/m/n/10 = .\glue(\thickmuskip) 2.77771 plus 2.77771 .\OML/cmm/m/it/10 b .\glue(\medmuskip) 2.22217 plus 1.11108 minus 2.22217 .\OT1/cmr/m/n/10 + .\glue(\medmuskip) 2.22217 plus 1.11108 minus 2.22217 .\OML/cmm/m/it/10 c .\mathoff ! OK. <argument> \l_tmp_box 1.12 \box_show:N \l_tmp_box </pre>
---	--

Figure 6: Output from displaying the contents of a simple box to the log file, using plain \TeX (left) and expl3 (right). Some blank lines have been added to the plain \TeX version to help with the comparison.

```

1 function runtest_tasks(name)
2   return "biber_" .. name
3 end

```

Figure 7: Example `runtest_tasks` function.

```

1 \input regression-test.tex\relax
2 \START
3 \TEST{counter-math}{
4 %<*test>
5   \OMIT
6   \newcounter{numbers}
7   \setcounter{numbers}{2}
8   \addtocounter{numbers}{2}
9   \stepcounter{numbers}
10  \TIMO
11  \typeout{\arabic{numbers}}
12 %</test>
13 %<expect> \typeout{5}
14 }
15 \END

```

Figure 8: Test and expectation can be specified side-by-side in a single `.dtx` file.

(a simple integer) or as a date in ISO format. The two flags "`true`" and "`false`" then determine whether this is applied in testing and typesetting, respectively.

The epoch may also be given as a command line option, `-E`, which again takes either a date or raw epoch. When given, this will automatically activate forcing of the epoch in both testing and typesetting.

3 Alternative test formats

3.1 Generating test files with DocStrip

It is possible to pack tests inside source files. Tests generated during the unpacking process will be available to the `check` and `save` commands as if they were stored in the `testfiledir`. Any explicit test files inside `testfiledir` take priority over generated ones with the same names.

3.2 Specifying expectations

Regression tests check whether changes introduced in the code modify the test output. Especially while developing a complex package there is not yet a baseline to save a test goal with. It might then be easier to formulate the expected effects and outputs of tests directly. To achieve this, you may create an `.lve` instead of a `.tlg` file.¹ It is processed exactly like the `.lvt` to generate the expected outcome. The test fails when both differ.

Combining both features enables contrasting the test with its expected outcome in a compact format. Listing 8 exemplary tests `TEX`s counters. Listing 9 shows the relevant part of an `.ins` file to generate it.

¹Mnemonic: `lvt`: test, `lve`: expectation

```

1 \generate{\file{\jobname.lvt}{\from{\jobname.dtx}{test}}
2 \file{\jobname.lve}{\from{\jobname.dtx}{expect}}}

```

Figure 9: Test and expectation are generated from a .dtx file of the same name.

4 Release-focussed features

4.1 Automatic version modification

As detailed above, the `setversion` target will automatically edit source files to modify date and version. This behaviour is governed by variable `versionform`. As standard, no automatic replacement takes place, but setting `versionform` will allow this to happen, with options

- `ProvidesPackage` — Searches for lines using the $\text{\LaTeX}2_{\epsilon}$ `\ProvidesPackage`, `\ProvidesClass` and `\ProvidesFile` identifiers (as a whole line).
- `ProvidesExplPackage` — Searches for lines using the `expl3` `\ProvidesExplPackage`, `\ProvidesExplClass` and `\ProvidesExplFile` identifiers (at the start of a line).
- `filename` — Searches for lines using `\def\filename`, `\def\filedate`, ..., formulation.
- `ExplFileDate` — Searches for lines using `\def\ExplFileDate`, ..., formulation.

For more complex cases, the programmer may directly define the Lua function `setversion_update_line()`, which takes as arguments the line of the source, the supplied date and the supplied version. It should return a (possibly unmodified) line and may use one, both or neither of the date and version to update the line. Typically, `setversion_update_line` should match to the exact pattern used by the programmer in the source files. For example, for code using macros for the date and version a suitable function might read as shown in Figure 10.

4.2 Typesetting documentation

As part of the overall build process, `l3build` will create PDF documentation as described earlier. The standard build process for PDFs will attempt to run `Biber`, `BiBTeX` and `MakeIndex` as appropriate (the exact binaries used are defined by `"biber"`, `"bibtex8"` and `"makeindex"`). However, there is no attempt to create an entire PDF creation system in the style of `latexmk` or similar.

For package authors who have more complex requirements than those covered by the standard set up, the Lua script offers the possibility for customisation. The Lua function `typeset` may be defined before reading `l3build.lua` and should take one argument, the name of the file to be typeset. Within this function, the auxiliary Lua functions `biber`, `bibtex`, `makeindex` and `tex` can be used, along with custom code, to define a PDF typesetting pathway. The functions `biber` and `bibtex` take a single argument: the name of the file to work with *minus* any extension. The `tex` takes as an argument the full name of the file. The most complex function `makeindex` requires the name, input extension, output extension, log extension and style name. For example, Figure 11 shows a simple script which might apply to a case where multiple `BiBTeX` runs are needed (perhaps where citations can appear within other references).

```

1 function setversion_update_line(line, date, version)
2   -- No real regex so do it one type at a time
3   for _,i in pairs({"Class", "File", "Package"}) do
4     if string.match(
5       line,
6       "^\\Provides" .. i .. "[a-zA-Z0-9%~+}%][[~]]*%]" .. "$"
7     ) then
8       line = string.gsub(line, "[%d%d%d%d/%d%d/%d%d]", "["
9         .. string.gsub(date, "%-", "/")
10       line = string.gsub(
11         line, "(%[d%d%d%d/%d%d/%d%d)_[^_]*", "%1_" .. version
12       )
13       break
14     end
15   end
16   return line
17 end

```

Figure 10: Example setversion_update_line function.

```

1 #!/usr/bin/env texlua
2
3 -- Build script with custom PDF route
4
5 module = "mymodule"
6
7 function typeset(file)
8   local name = jobname(file)
9   local errorlevel = tex (file)
10   if errorlevel == 0 then
11     -- Return a non-zero errorlevel if anything goes wrong
12     errorlevel =(
13       bibtex(name) +
14       tex(file)      +
15       bibtex(name) +
16       tex(file)      +
17       tex(file)
18     )
19   end
20   return errorlevel
21 end
22
23 kpse.set_program_name("kpsewhich")
24 dofile(kpse.lookup("l3build.lua"))

```

Figure 11: A customised PDF creation script.

5 Lua interfaces

Whilst for the majority of users the simple variable-based control methods outlined above will suffice, for more advanced applications there will be a need to adjust behavior by using interfaces within the Lua code. This section details the global variables and functions provided.

5.1 Global variables

options

The **options** table holds the values passed to **l3build** at the command line. The possible entries in the table are given in the table below.

Entry	Type
date	String
engine	Table
files	Table
force	Boolean
halt	Boolean
help	Boolean
pdf	Boolean
quiet	Boolean
rerun	Boolean
testfiledir	Table
version	String

5.2 Utility functions

The utility functions are largely focussed on file operations, though a small number of others are provided. File paths should be given in Unix style (using / as a path separator). File operations take place relative to the path from which **l3build** is called. File operation syntax is largely modelled on Unix command line commands but reflect the need to work on Windows in a flexible way.

abspath()

abspath()(*<target>*)

Returns a string which gives the absolute location of the *<target>* directory.

dirname()

dirname()(*<file>*)

Returns a string comprising the path to a *<file>* with the name removed (*i.e.* up to the last /). Where the *<file>* has no path data, "." is returned.

basename()

basename()(*<file>*)

Returns a string comprising the full name of the *<file>* with the path removed (*i.e.* from the last / onward).

cleandir()

cleandir()(*<dir>*)

Removes any content within the *<dir>*; returns an error level.

<u>cp()</u>	<code>cp(<glob>, <source>, <destination>)</code> Copies files matching the <glob> from the <source> directory to the <destination>; returns an error level.
<u>direxists()</u>	<code>direxists(<dir>)</code> Tests if the <dir> exists; returns a boolean value.
<u>fileexists()</u>	<code>fileexists(<file>)</code> Tests if the <file> exists; returns a boolean value.
<u>filelist()</u>	<code>filelist(<path>, [<glob>])</code> Returns a table containing all of the files with the <path> which match the <glob>; if the latter is absent returns a list of all files in the <path>.
<u>jobname()</u>	<code>jobname(<file>)</code> Returns a string comprising the jobname of the file with the path and extension removed (<i>i.e.</i> from the last / up to the last .).
<u>mkdir()</u>	<code>mkdir(<dir>)</code> Creates the <dir>; returns an error level.
<u>ren()</u>	<code>ren(<dir>, <source>, <destination>)</code> Renames the <source> file to the <destination> name within the <dir>; returns an error level.
<u>rm()</u>	<code>rm(<dir>, <glob>)</code> Removes files in the <dir> matching the <glob>; returns an error level.
<u>run()</u>	<code>run(<dir>, <cmd>)</code> Executes the <cmd>, starting it in the <dir>; returns an error level.
<u>splitpath()</u>	<code>splitpath(<file>)</code> Returns two strings split at the last /: the <code>dirname()</code> and the <code>basename()</code> .
<u>unix_to_win()</u>	<code>unix_to_win(<path>)</code> Returns a string comprising the <path> with / characters replaced by \\ and thus suitable for use with Windows-specific commands which require this form of path.

5.3 System-dependent strings

To support creation of additional functionality, the following low-level strings are exposed by `l3build`: these all have system-dependent definitions and avoid the need to test `os.type` during the construction of system calls.

<u><code>os_concat</code></u>	The concatenation operation for using multiple commands in one system call, <i>e.g.</i> <code>os.execute("tex " .. file .. os_concat .. "tex " .. file)</code>
<u><code>os_null</code></u>	The location to redirect commands which should produce no output at the terminal: almost always used preceded by <code>></code> , <i>e.g.</i> <code>os.execute("tex " .. file .. " > " .. os_null)</code>
<u><code>os_pathsep</code></u>	The separator used when setting an environment variable to multiple paths, <i>e.g.</i> <code>os.execute(os_setenv .. " PATH=../a" .. os_pathsep .. "../b")</code>
<u><code>os_setenv</code></u>	The command to set an environmental variable, <i>e.g.</i> <code>os.execute(os_setenv .. " PATH=../a")</code>
<u><code>os_yes</code></u>	A command to generate a series of 200 lines each containing the character <code>y</code> : this is useful as the Unix <code>yes</code> command cannot be used inside <code>os.execute</code> (it does not terminate).

5.4 Components of `l3build`

<u><code>call()</code></u>	<code>call(<dirs>, <target>, [<options>])</code> Runs the <code>l3build</code> <code><target></code> (a string) for each directory in the <code><dirs></code> (a table). This will pass command line options for the parent script to the child processes. The <code><options></code> table should take the same form as the global <code><options></code> , described above. If it is absent then the global list is used. Note that any entry for the <code>target</code> in this table is ignored.
----------------------------	--

Index

The italic numbers denote the pages where the corresponding entry is described, numbers underlined point to the definition, all others indicate the places where it is used.

Symbols		A
<code>\<macro></code>	<i>15</i>	<code>abspath()</code> <i>22</i>
<code>\<register></code>	<i>13</i>	<code>\AUTHOR</code> <i>14</i>
<code>\<type></code>	<i>13</i>	
		B
		<code>basename()</code> <i>22</i>

\BEGINTESTF	15	os commands:	
\box	13	os_concat	24
C		os_null	24
call()	24	os_pathsep	24
\CHECKCOMMAND	15	os_setenv	24
\CLASS	15	os_yes	24
cleandir()	22	P	
cp()	23	\PACKAGE	15
D		\ProvidesClass	20
direxists()	23	\ProvidesExplClass	20
dirname()	22	\ProvidesExplFile	20
E		\ProvidesExplPackage	20
\END	13	\ProvidesFile	20
\ENDTESTF	15	\ProvidesPackage	20
\ERROR	15	R	
F		\relax	15
\FALSE	15	ren()	23
\fi	15	rm()	23
fileexists()	23	\romannumeral	15
filelist()	23	run()	23
\FORMATF	15	S	
I		\SEPARATOR	15
\if	15	\showoutput	17
J		splitpath()	23
\jobname	17	\STARTF	13
jobname()	23	T	
M		\TESTEXP	15
mkdir()	23	\TESTF	15
N		\TESTFEXP	15
\NEWLINE	15	\TIMO	13
\newpage	17	\TRACEPAGES	17
\NO	15	\tracingoutput	17
O		\TRUE	15
\OMITF	13	\TYPE	15
\openin	13	\typeout	15
\openout	13	U	
options	22	unix commands:	
		unix_to_win()	23
		Y	
		\YES	15