Contents

1 Introduction ........................................... 2
   1.1 TeX Live and the TeX Collection ................ 2
   1.2 Operating system support ......................... 3
   1.3 Basic installation of TeX Live .................. 3
   1.4 Security considerations .......................... 3
   1.5 Getting help ..................................... 3

2 Overview of TeX Live ................................. 4
   2.1 The TeX Collection: TeX Live, proTeXt, MacTeX .... 4
   2.2 Top level TeX Live directories ................... 4
   2.3 Overview of the predefined texmf trees .......... 5
   2.4 Extensions to TeX ................................ 6
   2.5 Other notable programs in TeX Live .............. 6

3 Installation ........................................... 7
   3.1 Starting the installer ............................ 7
      3.1.1 Unix ....................................... 7
      3.1.2 MacOSX ..................................... 8
      3.1.3 Windows .................................... 8
      3.1.4 Cygwin ..................................... 8
      3.1.5 The text installer ........................... 8
      3.1.6 The graphical installer ..................... 9
      3.1.7 The legacy installers ....................... 9
   3.2 Running the installer ............................. 10
      3.2.1 Binary systems menu (Unix only) ............. 10
      3.2.2 Selecting what is to be installed .......... 11
      3.2.3 Directories ................................ 11
      3.2.4 Options .................................... 12
   3.3 Command-line install-tl options ................. 13
      3.3.1 The -repository option ..................... 14
   3.4 Post-install actions ............................. 14
      3.4.1 Environment variables for Unix ............... 14
      3.4.2 Environment variables: Global configuration ... 14
      3.4.3 Internet updates after DVD installation .... 15
      3.4.4 System font configuration for XeTeX and LuaTeX 15
      3.4.5 ConTeXt Mark IV ............................. 15
      3.4.6 Integrating local and personal macros ...... 15
      3.4.7 Integrating third-party fonts ............... 16
   3.5 Testing the installation ......................... 16
   3.6 Links for additional downloadable software ...... 18

4 Specialized installations .......................... 18
   4.1 Shared-user (or cross-machine) installations .... 18
   4.2 Portable (USB) installations .................... 19


1 Introduction

1.1 \TeX\ Live and the \TeX\ Collection

This document describes the main features of the \TeX\ Live software distribution—\TeX\ and related programs for GNU/Linux and other Unix flavors, Mac OS X, and Windows systems.

You may have acquired \TeX\ Live by downloading, or on the \TeX\ Collection DVD, which \TeX\ user groups distribute among their members, or in other ways. Section 2.1 briefly describes the contents of the DVD. Both \TeX\ Live and the \TeX\ Collection are cooperative efforts by the \TeX\ user groups. This document mainly describes \TeX\ Live itself.
TEX Live includes executables for \TeX, \LaTeX, \texttt{tex2\epsilon}, Con\TeX, \LaTeX2e, Metapost, \newfont{Bib}{}, and many other programs; an extensive collection of macros, fonts and documentation; and support for typesetting in many different scripts from around the world.

For a brief summary of the major changes in this edition of \TeX\ Live, see the end of the document, section 9 (p. 33).

1.2 Operating system support

\TeX\ Live contains binaries for many Unix-based platforms, including GNU/Linux, MacOSX, and Cygwin. The included sources can be compiled on platforms for which we do not provide binaries.

As to Windows: Windows 7 and later are supported. Windows Vista may still mostly work, but \TeX\ Live will no longer even install on Windows XP or earlier. There are no special 64-bit executables for Windows, but the 32-bit executables should run on 64-bit systems.

See section 2.1 for alternate solutions for Windows and MacOSX.

1.3 Basic installation of \TeX\ Live

You can install \TeX\ Live either from DVD or over the Internet (http://tug.org/texlive/acquire.html). The net installer itself is small, and downloads everything requested from the Internet.

The DVD installer lets you install to a local disk. You cannot run \TeX\ Live directly from the \TeX\ Collection DVD (or its .iso image), but you can prepare a runnable installation on, e.g., a USB stick (see section 4.2). Installation is described in later sections (p. 7), but here is a quick start:

- The installation script is named \texttt{install-tl}. It can operate in a “gui mode” given the option \texttt{-gui} (default for Windows and Mac OS X), a text mode given \texttt{-gui=text} (default for everything else). On Unix platforms, the former Perl/Tk and wizard modes are still available if Perl/Tk is installed; see section 3.1.3 for Windows.
- One of the installed items is the ‘\TeX\ Live Manager’ program, named \texttt{tlmgr}. Like the installer, it can be used in both GUI mode and in text mode. You can use it to install and uninstall packages and do various configuration tasks.

1.4 Security considerations

To the best of our knowledge, the core \TeX programs themselves are (and always have been) extremely robust. However, the contributed programs in \TeX\ Live may not reach the same level, despite everyone’s best efforts. As always, you should be careful when running programs on untrusted input; to improve safety, use a new subdirectory or chroot.

This need for care is especially urgent on Windows, since in general Windows finds programs in the current directory before anything else, regardless of the search path. This opens up a wide variety of possible attacks. We have closed many holes, but undoubtedly some remain, especially with third-party programs. Thus, we recommend checking for suspicious files in the current directory, especially executables (binaries or scripts). Ordinarily they should not be present, and definitely should not normally be created by merely processing a document.

Finally, \TeX\ (and its companion programs) are able to write files when processing documents, a feature that can also be abused in a wide variety of ways. Again, processing unknown documents in a new subdirectory is the safest bet.

1.5 Getting help

The \TeX\ community is active and friendly, and most serious questions end up getting answered. However, the support is informal, done by volunteers and casual users, so it’s especially important that you do your homework before asking. (If you prefer guaranteed commercial support, you can forgo \TeX\ Live completely and purchase a vendor’s system: http://tug.org/interest.html#vendors has a list.)

Here is a list of resources, approximately in the order we recommend using them:

Getting started If you are new to \TeX, the web page http://tug.org/begin.html gives a brief introduction to the system.

\TeX FAQ The \TeX FAQ is a huge compendium of answers to all sorts of questions, from the most basic to the most arcane. It is included on \TeX\ Live in \texttt{texmf-dist/doc/generic/FAQ-en/}, and is available on the Internet through http://www.tex.ac.uk/faq. Please check here first.
**TeX Catalogue** If you are looking for a particular package, font, program, etc., the TeX Catalogue is the place to look. It is a huge collection of all TeX-related items. See [http://ctan.org/pkg/catalogue/](http://ctan.org/pkg/catalogue/).

**TeX Web Resources** The web page [http://tug.org/interest.html](http://tug.org/interest.html) has many TeX-related links, in particular for numerous books, manuals, and articles on all aspects of the system.

**support archives** Principal support forums for TeX include the LaTeX community site at [http://latex-community.org/](http://latex-community.org/), the q&a site [http://tex.stackexchange.com](http://tex.stackexchange.com), the Usenet newsgroup [news:comp.text.tex](http://www.tug.org/interest.html), and the mailing list [texhax@tug.org](mailto:texhax@tug.org). Their archives have years of past questions and answers for your searching pleasure, via, for the latter two, [http://groups.google.com/group/comp.text.tex/topics](http://groups.google.com/group/comp.text.tex/topics) and [http://tug.org/mail-archives/texhax](http://tug.org/mail-archives/texhax). And a general web search, for example on [http://google.com](http://google.com), never hurts.

**asking questions** If you cannot find an answer, you can post to [http://latex-community.org/](http://latex-community.org/) and [http://tex.stackexchange.com](http://tex.stackexchange.com) through their web interfaces, to [comp.text.tex](http://www.tug.org/interest.html) through Google or your newsreader, or to [texhax@tug.org](mailto:texhax@tug.org) through email. But before you post anywhere, please read this FAQ entry, to maximize your chances of getting a useful answer: [http://www.tex.ac.uk/cgi-bin/texfaq2html?label=askquestion](http://www.tex.ac.uk/cgi-bin/texfaq2html?label=askquestion).

**TeX Live support** If you want to report a bug or have suggestions or comments on the TeX Live distribution, installation, or documentation, the mailing list is [tex-live@tug.org](mailto:tex-live@tug.org). However, if your question is about how to use a particular program included in TeX Live, please write to that program’s maintainer or mailing list. Often running a program with the `--help` option will provide a bug reporting address.

The other side of the coin is helping others who have questions. All the above resources are open to anyone, so feel free to join, start reading, and help out where you can.

### 2 Overview of TeX Live

This section describes the contents of TeX Live and the TeX Collection of which it is a part.

#### 2.1 The TeX Collection: TeX Live, proTeXt, MacTeX

The TeX Collection DVD comprises the following:

**TeX Live** A complete TeX system to be installed to disk. Home page: [http://tug.org/texlive/](http://tug.org/texlive/).

**MacTeX** for MacOSX (currently named macOS by Apple, but we continue to use the older name in this document), this adds a native MacOSX installer and other Mac applications to TeX Live. Home page: [http://tug.org/mactex/](http://tug.org/mactex/).

**proTeXt** An enhancement of the MiKTeX distribution for Windows, proTeXt adds a few extra tools to MiKTeX, and simplifies installation. It is entirely independent of TeX Live, and has its own installation instructions. Home page: [http://tug.org/protext/](http://tug.org/protext/).

**CTAN** A snapshot of the CTAN repository ([http://www.ctan.org/](http://www.ctan.org/)).

CTAN and protext do not follow the same copying conditions as TeX Live, so be careful when redistributing or modifying.

#### 2.2 Top level TeX Live directories

Here is a brief listing and description of the top level directories in a TeX Live installation.

- **bin** The TeX system programs, arranged by platform.
- **readme-*.dir** Quick overview and useful links for TeX Live, in various languages, in both HTML and plain text.
- **source** The source to all included programs, including the main Web2C-based TeX distributions.
- **texmf-dist** The principal tree; see TEXMFDIST below.
tlpkg  Scripts, programs and data for managing the installation, and special support for Windows.

In addition to the directories above, the installation scripts and README files (in various languages) are at the top level of the distribution.

For documentation, the comprehensive links in the top-level file doc.html may be helpful. The documentation for nearly everything (packages, formats, fonts, program manuals, man pages, Info files) is in texmf-dist/doc. You can use the texdoc program to find documentation wherever it is located.

This \TeX\ Live documentation itself is in texmf-dist/doc/texlive, available in several languages:

- Czech/Slovak: texmf-dist/doc/texlive/texlive-cz
- German: texmf-dist/doc/texlive/texlive-de
- English: texmf-dist/doc/texlive/texlive-en
- French: texmf-dist/doc/texlive/texlive-fr
- Italian: texmf-dist/doc/texlive/texlive-it
- Polish: texmf-dist/doc/texlive/texlive-pl
- Russian: texmf-dist/doc/texlive/texlive-ru
- Serbian: texmf-dist/doc/texlive/texlive-sr
- Simplified Chinese: texmf-dist/doc/texlive/texlive-zh-cn

2.3 Overview of the predefined texmf trees

This section lists the predefined variables specifying the texmf trees used by the system, and their intended purpose, and the default layout of \TeX\ Live. The command tlmgr conf shows the values of these variables, so that you can easily find out how they map to particular directories in your installation.

All of the trees, including the personal ones, should follow the \TeX\ Directory Structure (TDS, http://tug.org/tds), with all its myriad subdirectories, or files may not be found. Section 3.4.6 (p.15) describes this in more detail. The order here is the reverse order in which the trees are searched, that is, later trees in the list override earlier ones.

TEXMFDIST  The tree which holds nearly all of the files in the original distribution—configuration files, scripts, packages, fonts, etc. (The main exception are the per-platform executables, which are stored in a sibling directory bin/.)

TEXMFSYSSYSVAR  The (site-wide) tree used by texconfig-sys, updmap-sys and fmtutil-sys, and also by tlmgr, to store (cached) runtime data such as format files and generated map files.

TEXMFSYSCONFIG  The (site-wide) tree used by the utilities texconfig-sys, updmap-sys, and fmtutil-sys to store modified configuration data.

TEXMFLLOCAL  The tree which administrators can use for system-wide installation of additional or updated macros, fonts, etc.

TEXMFHOME  The tree which users can use for their own individual installations of additional or updated macros, fonts, etc. The expansion of this variable dynamically adjusts for each user to their own individual directory.

TEXMFVAR  The (personal) tree used by texconfig, updmap and fmtutil to store (cached) runtime data such as format files and generated map files.

TEXMFCONFIG  The (personal) tree used by the utilities texconfig, updmap, and fmtutil to store modified configuration data.

TEXMFCACHE  The tree(s) used by Con\TeX\ MkIV and Lua\TeX\ to store (cached) runtime data; defaults to TEXMFSYSSYSVAR, or (if that’s not writable), TEXMFVAR.

The default layout is:

**system-wide root** can span multiple \TeX\ Live releases (/usr/local/texlive by default on Unix):

- 2018 A previous release.
- 2019 The current release.

```
bin
  i386-linux GNU/Linux binaries (32-bit)
  ...
  x86_64-darwin Mac OS X binaries
  x86_64-linux GNU/Linux binaries (64-bit)
```
2 OVERVIEW OF TeX LIVE

win32 Windows binaries

\texttt{texmf-dist} TEXMFDIST and TEXMFMAIN
\texttt{texmf-var} TEXMFSYSVAR, TEXMFCACHE
\texttt{texmf-config} TEXMFCONFIG
\texttt{texmf-local} TEXMFLOCAL, intended to be retained from release to release.

user’s home directory ($\texttt{HOME}$ or $\%USERPROFILE\%$)

\texttt{.texlive2018} Privately generated and configuration data for a previous release.
\texttt{.texlive2019} Privately generated and configuration data for the current release.
\texttt{texmf-var} TEXMFVAR, TEXMFCACHE
\texttt{texmf-config} TEXMFCONFIG
\texttt{texmf} TEXMFHOME Personal macros, etc.

2.4 Extensions to TeX

Knuth’s original TeX itself is frozen, apart from rare bug fixes. It is present in TeX Live as the program \texttt{tex}, and will remain so for the foreseeable future. TeX Live also contains several extended versions of TeX (also known as TeX engines):

$\varepsilon$-TeX adds a set of new primitives (related to macro expansion, character scanning, classes of marks, additional debugging features, and more) and the TeX--XeT extensions for bidirectional typesetting. In default mode, $\varepsilon$-TeX is 100% compatible with ordinary TeX. See texmf-dist/doc/etex/base/etex_man.pdf.

pdfTeX builds on the $\varepsilon$-TeX extensions, adding support for writing PDF output as well as DVI, and many non-output-related extensions. This is the program invoked for most formats, e.g., \texttt{etex}, \texttt{latex}, \texttt{pdflatex}. Its web site is \url{http://www.pdftex.org/}. See texmf-dist/doc/pdftex/manual/pdfTeX-a.pdf for the manual, and texmf-dist/doc/pdftex/manual/samplepdf/samplepdf.tex for example usage of some of its features.

LuaTeX is the designated successor of pdfTeX, and is mostly (but not entirely) backward-compatible. It is also intended to be a functional superset of Aleph (see below), though perfect compatibility is not intended. The incorporated Lua interpreter (\url{http://www.lua.org/}) enables elegant solutions for many thorny TeX problems. When called as \texttt{texlua}, it functions as a standalone Lua interpreter, and is used as such within TeX Live. Its web site is \url{http://www.luaTeX.org/}, and the reference manual is texmf-dist/doc/luatex/base/luatex.pdf.

XeTeX adds support for Unicode input and OpenType- and system fonts, implemented using standard third-party libraries. See \url{http://tug.org/xetex}.

$\Omega$ (Omega) is based on Unicode (16-bit characters), thus supports working with almost all the world’s scripts simultaneously. It also supports so-called ‘$\Omega$ Translation Processes’ (OTPs), for performing complex transformations on arbitrary input. Omega is no longer included in TeX Live as a separate program; only Aleph is provided:

Aleph combines the $\Omega$ and $\varepsilon$-TeX extensions. See texmf-dist/doc/aleph/base.

2.5 Other notable programs in TeX Live

Here are a few other commonly-used programs included in TeX Live:

\texttt{bibtex}, \texttt{biber} bibliography support.
\texttt{makeindex}, \texttt{xindy} index support.
\texttt{dvips} convert DVI to PostScript.
\texttt{xdvi} DVI previewer for the X Window System.
\texttt{dviconcat}, \texttt{dviselect} cut and paste pages from DVI files.
\texttt{dvipdfmx} convert DVI to PDF, an alternative approach to pdfTeX (mentioned above).
\texttt{psselect}, \texttt{psnup}, … PostScript utilities.
\texttt{pdfjam}, \texttt{pdfjoin}, … PDF utilities.
\texttt{context}, \texttt{mtxrun} ConTeXt and PDF processor.
\texttt{htlatex}, … \texttt{tex4ht}: (La)TeX to HTML (and XML and more) converter.
3 Installation

3.1 Starting the installer

To begin, get the \TeX{} Collection DVD or download the \TeX{} Live net installer. See \url{http://tug.org/texlive/acquire.html} for more information and other methods of getting the software.

\textbf{Net installer, .zip or .tar.gz:} Download from CTAN, under systems/texlive/tlnet; the url \url{http://mirror.ctan.org/systems/texlive/tlnet} should redirect to a nearby, up-to-date, mirror. You can retrieve either \texttt{install-tl.zip} which can be used under Unix and Windows, or the considerably smaller \texttt{install-unx.tar.gz} for Unix only. After unpacking, \texttt{install-tl} and \texttt{install-tl-windows.bat} will be in the \texttt{install-tl} subdirectory.

\textbf{Net installer, Windows .exe:} Download from CTAN as above, and double-click. This starts up a first-stage installer and unpacker; see figure 1. It gives two choices: “Install” and “Unpack only”.

\textbf{\TeX{} Collection DVD:} go to the DVD’s texlive subdirectory. Under Windows, the installer normally starts automatically when you insert the DVD. You can get the DVD by becoming a member of a \TeX{} user group (highly recommended, \url{http://tug.org/usergroups.html}), or purchasing it separately (\url{http://tug.org/store}), or burning your own from the ISO image. You can also mount the ISO directly on most systems. After installing from DVD or ISO, if you want to get continuing updates from the Internet, please see 3.4.3.

The same installer program is run, whatever the source. The most visible difference between the two is that with the net installer, what you end up with is the packages that are currently available. This is in contrast to the DVD and ISO images, which are not updated between the major public releases.

If you need to download through proxies, use a \texttt{~/.wgetrc} file or environment variables with the proxy settings for Wget (\url{http://www.gnu.org/software/wget/manual/html_node/Proxies.html}), or the equivalent for whatever download program you are using. This does not matter if you are installing from the DVD or ISO image.

The following sections explain installer start-up in more detail.

3.1.1 Unix

Below, $>$ denotes the shell prompt; user input is \textbf{bold}. The script \texttt{install-tl} is a Perl script. The simplest way to start it on a Unix-compatible system is as follows:

```
$ perl /path/to/installer/install-tl
```

(Or you can invoke \texttt{/path/to/installer/install-tl} if it stayed executable, or \texttt{cd} to the directory first, etc.; we won’t repeat all the variations.) You may have to enlarge your terminal window so that it shows the full text installer screen (figure 2).

To install in GUI mode (figure 4), you’ll need to have Tcl/Tk installed. Given that, you can run:
> perl install-tl -gui

The old wizard and perl/tk/expert options are still available. These require the Perl::Tk module compiled with XFT support, which is generally no problem with GNU/Linux, but often is with other systems. For a complete listing of the various options:

> perl install-tl -help

About Unix permissions: Your umask at the time of installation will be respected by the TeX Live installer. Therefore, if you want your installation to be usable by users other than you, make sure your setting is sufficiently permissive, for instance, umask 002. For more information about umask, consult your system documentation.

Special considerations for Cygwin: Unlike other Unix-compatible systems, Cygwin does not by default include all of the prerequisite programs needed by the TeX Live installer. See section 3.1.4.

3.1.2 Mac OS X

As mentioned in section 2.1, a separate distribution is prepared for Mac OS X, named MacTeX (http://tug.org/mactex). We recommend using the native MacTeX installer instead of the TeX Live installer on Mac OS X, because the native installer makes a few Mac-specific adjustments, in particular to allow easily switching between the various TeX distributions for Mac OS X (MacTeX, Fink, MacPorts, ...) using the so-called TeX Dist data structure.

MacTeX is firmly based on TeX Live, and the main TeX trees and binaries are precisely the same. It adds a few extra folders with Mac-specific documentation and applications.

3.1.3 Windows

If you are using the unpacked downloaded zip file, or the DVD installer failed to start automatically, double-click install-tl-windows.bat.

You can also start the installer from the command-prompt. Below, > denotes the prompt; user input is bold. If you are in the installer directory, run just:

> install-tl-windows

Or you can invoke it with an absolute location, such as:

> D:\texlive\install-tl-windows

for the TeX Collection DVD, supposing that D: is the optical drive. Figure 3 displays the initial basic screen of the GUI installer, which is the default for Windows.

To install in text mode, use:

> install-tl-windows -no-gui

For a complete listing of the various options:

> install-tl-windows -help

3.1.4 Cygwin

Before beginning the installation, use Cygwin's setup.exe program to install the perl and wget packages if you have not already done so. The following additional packages are recommended:

- fontconfig [needed by XeTeX and LuaTeX]
- ghostscript [needed by various utilities]
- libXaw7 [needed by xdvi]
- ncurses [provides the clear command used by the installer]

3.1.5 The text installer

Figure 2 displays the main text mode screen under Unix. The text installer is the default on Unix.

This is only a command-line installer; there is no cursor support at all. For instance, you cannot tab around checkboxes or input fields. You just type something (case-sensitive) at the prompt and press the Enter key, and then the entire terminal screen will be rewritten, with adjusted content.

The text installer interface is this primitive in order to make it run on as many platforms as possible, even with a minimal Perl.
3 INSTALLATION

Installing TeX Live 2019 from: ...
Platform: x86_64-linux => 'GNU/Linux on x86_64'
Distribution: inst (compressed)
Directory for temporary files: /tmp

Detected platform: GNU/Linux on Intel x86_64

<.install> binary platforms: 1 out of 16
<setup> set installation scheme: scheme-full
<customize> customizing installation collections
  40 collections out of 41, disk space required: 5829 MB
<dir> directories:
  TEXDIR (the main TeX directory):
    /usr/local/texlive/2019
  ...
<opt> options:
  [ ] use letter size instead of A4 by default
  ...
<portable> set up for portable installation

Actions:
<install> start installation to hard disk
<profile> save installation profile to ‘texlive.profile’ and exit
<help> help
<quit> quit

3.1.6 The graphical installer

The default graphical installer starts out simple, with just a few options; see figure 3. It can be started with

> install-tl -gui

The Advanced button gives access to most of the options of the text installer; see figure 4.

3.1.7 The legacy installers

The perltk/expert and wizard modes are still available for systems with have Perl/Tk installed. These can be specified with -gui=perltk and -gui=wizard arguments respectively.
3 INSTALLATION

3.2 Running the installer

The installer is intended to be mostly self-explanatory, but following are a few notes about the various options and submenus.

3.2.1 Binary systems menu (Unix only)

Figure 5 displays the text mode binaries menu. By default, only the binaries for your current platform will be installed. From this menu, you can select installation of binaries for other platforms as well. This can be useful if you are sharing a TeX tree across a network of heterogeneous machines, or for a dual-boot system.
3.2.2 Selecting what is to be installed

<table>
<thead>
<tr>
<th>Select scheme:</th>
</tr>
</thead>
<tbody>
<tr>
<td>a [X] full scheme (everything)</td>
</tr>
<tr>
<td>b [ ] medium scheme (small + more packages and languages)</td>
</tr>
<tr>
<td>c [ ] small scheme (basic + xetex, metapost, a few languages)</td>
</tr>
<tr>
<td>d [ ] basic scheme (plain and latex)</td>
</tr>
<tr>
<td>e [ ] minimal scheme (plain only)</td>
</tr>
<tr>
<td>f [ ] ConTeXt scheme</td>
</tr>
<tr>
<td>g [ ] GUST TeX Live scheme</td>
</tr>
<tr>
<td>h [ ] infrastructure-only scheme (no TeX at all)</td>
</tr>
<tr>
<td>i [ ] teTeX scheme (more than medium, but nowhere near full)</td>
</tr>
<tr>
<td>j [ ] custom selection of collections</td>
</tr>
</tbody>
</table>

Figure 6: Scheme menu

Figure 6 displays the TeX Live scheme menu; from here, you choose a “scheme”, which is an overall set of package collections. The default full scheme installs everything available. This is recommended, but you can also choose the basic scheme for just plain and LaTeX, small for a few more programs (equivalent to the so-called Basic TeX installation of MacTeX), minimal for testing purposes, and medium or teTeX to get something in between. There are also various specialized and country-specific schemes.

You can refine your scheme selection with the ‘collections’ menu (figure 7, shown in GUI mode for a change).

Collections are one level more detailed than schemes—in essence, a scheme consists of several collections, a collection consists of one or more packages, and a package (the lowest level grouping in TeX Live) contains the actual TeX macro files, font files, and so on.

If you want more control than the collection menus provide, you can use the TeX Live Manager (tlmgr) program after installation (see section 5); using that, you can control the installation at the package level.

3.2.3 Directories

The default layout is described in section 2.3, p. 5. The default installation directory is /usr/local/texlive/2019 on Unix and %SystemDrive%\texlive\2019 on Windows. This arrangement enables having many parallel TeX Live installations, such as one for each release (typically by year, as here), and you can switch between them merely by altering your search path.

That installation directory can be overridden by setting the so-called TEXDIR in the installer. The GUI screen for this and other options is shown in figure 4. The most common reasons to change it are either lacking enough disk space in that partition (the full TeX Live needs several gigabytes), or lacking write permission for the default location (you don’t have to be root or administrator to install TeX Live, but you do need write access to the target directory).

The installation directories can also be changed by setting a variety of environment variables before running the installer (most likely, TEXLIVE_INSTALL_PREFIX or TEXLIVE_INSTALL_TEXDIR); see the documentation from install-tl --help (available online at http://tug.org/texlive/doc/install-tl.html) for the full list and more details.

A reasonable alternative destination is a directory under your home, especially if you will be the sole user. Use ‘~’ to indicate this, as in ‘~/texlive/2019’.

We recommend including the year in the name, to enable keeping different releases of TeX Live side by side. (You may wish to also maintain a version-independent name, such as /usr/local/texlive-cur, via a symbolic link, which you can then repoint after testing the new release.)

Changing TEXDIR in the installer will also change TEXMFLOCAL, TEXMFSDKVAR and TEXMFSDKSCONFIG. TEXMFHOME is the recommended location for personal macro files or packages. The default value is ~/Library/texmf on Macs. In contrast to TEXDIR, here a ‘~’ is preserved in the newly-written configuration files, since it usefully refers to the home directory of the user running TeX. It expands to $HOME on Unix and %USERPROFILE% on Windows. Special redundant note: TEXMFHOME, like all trees, must be organized according to the TDS, or files may not be found.

TEXMFVAR is the location for storing most cached runtime data specific to each user. TEXMFVAR is the variable name used for that purpose by LuaLaTeX and ConTeXt MkIV (see section 3.4.5, p. 15); its default value is TEXMFSDKVAR, or (if that’s not writable), TEXMFVAR.
3.2.4 Options

Figure 8 shows the text mode options menu. More info on each:

**use letter size instead of A4 by default:** The default paper size selection. Of course, individual documents can and should specify a specific paper size, if desired.

**execution of restricted list of programs:** As of TeX Live 2010, execution of a few external programs is allowed by default. The (very short) list of allowed programs is given in the `texmf.cnf`. See the 2010 news (section 9.1.7) for more details.

**create format files:** Although unnecessary format files take time to generate and disk space to store, it is still recommended to leave this option checked: if you don’t, then format files will be generated in people’s private `TEXMFVAR` tree as they are needed. In that location, they will not be updated automatically if (say) binaries or hyphenation patterns are updated in the installation, and thus you could end up with incompatible format files.

**install font/macro ... tree:** Download/install the documentation and source files included in most packages. Unchecking is not recommended.

**create symlinks in standard directories:** This option (Unix only) bypasses the need to change environment variables. Without this option, TeX Live directories usually have to be added to `PATH`, `MANPATH` and `INFOPATH`. You will need write permissions to the target directories. This option is intended for accessing the TeX system through directories that are already known to users, such as `/usr/local/bin`, which don’t already contain any TeX files. Do not overwrite existing files on your system with this option, e.g., by specifying system directories. The safest and recommended approach is to leave the option uncheck.
after installation ... CTAN: When installing from DVD, this option is enabled by default, since usually one wants to take any subsequent package updates from the CTAN area that is updated throughout the year. The only likely reason to disable it is if you install only a subset from the DVD and plan to augment the installation later. In any case, the package repository for the installer, and for updates after installation, can be set independently as needed; see section 3.3.1 and section 3.4.3.

Windows-specific options, as displayed in the advanced Perl/Tk interface:

adjust PATH setting in registry This ensures that all programs will see the TeX Live binary directory on their search path.

add menu shortcuts If set, there will be a TeX Live submenu of the Start menu. There is a third option ‘Launcher entry’ besides ‘TeX Live menu’ and ‘No shortcuts’. This option is described in section 4.1.

change file associations The options are ‘Only new’ (create file associations, but do not overwrite existing ones), ‘All’ and ‘None’.

install TeXworks front end

When all the settings are to your liking, you can type ‘I’ in the text interface, or press the ‘Install TeX Live’ button in the Perl/Tk GUI, to start the installation process. When it is done, skip to section 3.4 to read what else needs to be done, if anything.

3.3 Command-line install-tl options

Type

> install-tl -help

for a listing of command-line options. Either - or -- can be used to introduce option names. These are the most common ones:

- gui Use the GUI installer if possible. This requires Tcl/Tk version 8.5 or higher. This is the case on Mac OS X and is distributed with TeX Live on Windows. The legacy options - gui=perlTk and - gui=wizard are still available and require the Perl/Tk module (http://tug.org/texlive/distro.html#perlTk) compiled with XFT support; if Tcl/Tk and Perl/Tk are not available, installation continues in text mode.

- no-gui Force using the text mode installer.

- lang LL Specify the installer interface language as a standard (usually two-letter) code. The installer tries to automatically determine the right language but if it fails, or if the right language is not available, then it uses English as a fallback. Run install-tl -- help to get the list of available languages.

- portable Install for portable use on, e.g., a USB stick. Also selectable from within the text installer with the V command, and from the GUI installer. See section 4.2.

- profile file Load the installation profile file and do the installation with no user interaction. The installer always writes a file texlive.profile to the tlpkg subdirectory of your installation. That file can be given as the argument to redo the exact same installation on a different system, for example. Alternatively, you can use a custom profile, most easily created by starting from a generated one and changing values, or an empty file, which will take all the defaults.

- repository url-or-directory Specify package repository from which to install; see following.

- in-place (Documented only for completeness: Do not use this unless you know what you are doing.) If you already have an rsync, svn, or other copy of TeX Live (see http://tug.org/texlive/acquire-mirror.html) then this option will use what you’ve got, as-is, and do only the necessary post-install. Be warned that the file tlpkg/texlive.tlpdb may be overwritten; saving it is your responsibility. Also, package removal has to be done manually. This option cannot be toggled via the installer interface.
3.3.1 The -repository option

The default network package repository is a CTAN mirror chosen automatically via http://mirror.ctan.org.

If you want to override that, the location value can be a url starting with ftp:, http:, or a plain directory path. (When giving an http: or ftp: location, trailing ‘/’ characters and/or a trailing ‘/tlpkg’ component are ignored.)

For example, you could choose a particular CTAN mirror with something like: http://ctan.example.org/tex-archive/systems/texlive/tlnet/, substituting a real hostname and its particular top-level CTAN path for ctan.example.org/tex-archive. The list of CTAN mirrors is maintained at http://ctan.org/mirrors.

If the given argument is local (either a path or a file:// url), compressed files in an archive subdirectory of the repository path are used (even if uncompressed files are available as well).

3.4 Post-install actions

Some post-installation may be required.

3.4.1 Environment variables for Unix

If you elected to create symlinks in standard directories (described in section 3.2.4), then there is no need to edit environment variables. Otherwise, on Unix systems, the directory of the binaries for your platform must be added to the search path. (On Windows, the installer takes care of this.)

Each supported platform has its own subdirectory under TEXDIR/bin. See figure 5 for the list of subdirectories and corresponding platforms.

Optionally, you can also add the documentation man and Info directories to their respective search paths, if you want the system tools to find them. The man pages might be found automatically after the addition to PATH.

For Bourne-compatible shells such as bash, and using Intel x86 GNU/Linux and a default directory setup as an example, the file to edit might be $HOME/.profile (or another file sourced by .profile, and the lines to add would look like this:

PATH=/usr/local/texlive/2019/bin/x86_64-linux:$PATH; export PATH
MANPATH=/usr/local/texlive/2019/texmf-dist/doc/man:$MANPATH; export MANPATH
INFOPATH=/usr/local/texlive/2019/texmf-dist/doc/info:$INFOPATH; export INFOPATH

For csh or tcsh, the file to edit is typically $HOME/.cshrc, and the lines to add might look like:

setenv PATH /usr/local/texlive/2019/bin/x86_64-linux:$PATH
setenv MANPATH /usr/local/texlive/2019/texmf-dist/doc/man:$MANPATH
setenv INFOPATH /usr/local/texlive/2019/texmf-dist/doc/info:$INFOPATH

If you already have settings somewhere in your “dot” files, naturally the T\eX Live directories should be merged in as appropriate.

3.4.2 Environment variables: Global configuration

If you want to make these changes globally, or for a user newly added to the system, then you are on your own; there is just too much variation between systems in how and where these things are configured.

Our two hints are: 1) you may want to check for a file /etc/manpath.config and, if present, add lines such as

MANPATH_MAP /usr/local/texlive/2019/bin/x86_64-linux / 
/usr/local/texlive/2019/texmf-dist/doc/man

And 2) check for a file /etc/environment which may define the search path and other default environment variables.

In each (Unix) binary directory, we also create a symbolic link named man to the directory texmf-dist/doc/man. Some man programs, such as the standard MacOSX man, will automatically find that, obviating the need for any man page setup.
3.4.3 Internet updates after DVD installation

If you installed TeX Live from DVD and then wish to get updates from the Internet, you need to run this command—after you’ve updated your search path (as described in the previous section):

```
> tlmgr option repository http://mirror.ctan.org/systems/texlive/tlnet
```

This tells `tlmgr` to use a nearby CTAN mirror for future updates. This is done by default when installing from DVD, via the option described in section 3.2.4.

If there are problems with the automatic mirror selection, you can specify a particular CTAN mirror from the list at [http://ctan.org/mirrors](http://ctan.org/mirrors). Use the exact path to the `tlnet` subdir on that mirror, as shown above.

3.4.4 System font configuration for XeTeX and LuaTeX

XeTeX and LuaTeX can use any font installed on the system, not just those in the TeX trees. They do these via related but not identical methods.

On Windows, fonts shipped with TeX Live are automatically made available to XeTeX by font name. On MacOSX, supporting font name lookups requires additional steps; please see the MacTeX web pages ([http://tug.org/mactex](http://tug.org/mactex)). For other Unix systems, the procedure to be able to find the fonts shipped with TeX Live via font name follows.

To facilitate this, when the `xetex` package is installed (either at initial installation or later), the necessary configuration file is created in `TEXMFSYSVAR/fonts/conf/texlive-fontconfig.conf`.

To set up the TeX Live fonts for system-wide use (assuming you have suitable privileges), proceed as follows:

2. Run `fc-cache -fsv`.

If you do not have sufficient privileges to carry out the steps above, or if you want to make the TeX Live fonts available to only one user, you can do the following:

1. Copy the `texlive-fontconfig.conf` file to `~/.fonts.conf`, where ~ is your home directory.
2. Run `fc-cache -fv`.

You can run `fc-list` to see the names of the system fonts. The incantation `fc-list : family style file spacing` (all arguments are literal strings) shows some generally interesting information.

3.4.5 ConTeXt Mark IV

Both the ‘old’ ConTeXt (Mark II) and the ‘new’ ConTeXt (Mark IV) should run out of the box after TeX Live installation, and should need no special attention as long as you stick to using `tlmgr` for updates.

However, because ConTeXt MkIV does not use the kpathsea library, some setup will be required whenever you install new files manually (without using `tlmgr`). After each such installation, each MkIV user must run:

```
context --generate
```

to refresh the ConTeXt disk cache data. The resulting files are stored under `TEXMFCACHE`, whose default value in TeX Live is `TEXMFSYSVAR;TEXMFVAR`.

ConTeXt MkIV will read from all paths mentioned in `TEXMFCACHE`, and write to the first path that is writable. While reading, the last found match will take precedence in the case of duplicated cache data.

For more information, see [http://wiki.contextgarden.net/Running_Mark_IV](http://wiki.contextgarden.net/Running_Mark_IV).

3.4.6 Integrating local and personal macros

This is already mentioned implicitly in section 2.3: `TEXMFLOCAL` (by default, `/usr/local/texlive/texmf-local` or `%SystemDrive%\texlive\texmf-local` on Windows) is intended for system-wide local fonts and macros; and `TEXMFHOME` (by default, `$HOME/texmf` or `%USERPROFILE%\texmf`), is for personal fonts and macros. These directories are intended to stick around from release to release, and have their content seen automatically by a new TeX Live release. Therefore, it is best to refrain from changing
the definition of `TEXMFLocal` to be too far away from the main \TeX\ Live directory, or you will need to manually change future releases.

For both trees, files should be placed in their proper \TeX\ Directory Structure (TDS) subdirectories; see \url{http://tug.org/tds} or consult `texmf-dist/web2c/texmf.cnf`. For instance, a \ETeX\ class file or package should be placed in `TEXMFLocal/tex/latex` or `TEXMFHOME/tex/latex`, or a subdirectory thereof.

`TEXMFLocal` requires an up-to-date filename database, or files will not be found. You can update it with the command `mktexlsr` or use the ‘Reinit file database’ button on the configuration tab of the \TeX\ Live Manager GUI.

By default, each of these variables is defined to be a single directory, as shown. This is not a hard-and-fast requirement. If you need to easily switch back and forth between different versions of large packages, for example, you can maintain multiple trees for your own purposes. This is done by setting `TEXMFHOME` to the list of directories, within braces, separated by commas:

```
TEXMFHOME = {/my/dir1,/mydir2,/a/third/dir}
```

Section 7.1.5 describes brace expansion further.

### 3.4.7 Integrating third-party fonts

This is unfortunately a messy topic. Forget about it unless you want to delve into many details of the \TeX\ installation. Many fonts are included in \TeX\ Live already, so take a look if you don’t already know that what you want isn’t there.

A possible alternative is to use Xe\TeX\ or Lua\TeX\ (see section 2.4), which let you use operating system fonts without any installation in \TeX\.

If you do need to do this, see \url{http://tug.org/fonts/fontinstall.html} for our best effort at describing the procedure.

### 3.5 Testing the installation

After installing \TeX\ Live, you naturally want to test it out, so you can start creating beautiful documents and/or fonts.

One thing you may immediately be looking for is a front-end with which to edit files. \TeX\ Live installs \TeX\works\ (\url{http://tug.org/teXworks}) on Windows (only), and Mac\TeX\ installs TeXShop (\url{http://pages.uoregon.edu/koch/texshop}). On other Unix systems, it’s left up to you to choose an editor. There are many choices available, some of which are listed in the next section; see also \url{http://tug.org/interest.html#editors}. Any plain text editor will work; something \TeX\-specific is not required.

The rest of this section gives some basic procedures for testing that the new system is functional. We give Unix commands here; under MacOSX and Windows, you’re more likely to run the tests through a graphical interface, but the principles are the same.

1. Make sure that you can run the `tex` program in the first place:

   ```
   > tex --version
   TeX 3.14159265 (\TeX\ Live ...)
   Copyright ... D.E. Knuth.
   ...
   ```

   If this comes back with ‘command not found’ instead of version and copyright information, or with an older version, most likely you don’t have the correct `bin` subdirectory in your `PATH`. See the environment-setting information on p. 14.

2. Process a basic \ETeX\ file:

   ```
   > latex sample2e.tex
   This is pdfTeX 3.14...
   ...
   Output written on sample2e.dvi (3 pages, 7484 bytes).
   Transcript written on sample2e.log.
   ```
3 INSTALLATION

If this fails to find sample2e.tex or other files, most likely you have interference from old environment variables or configuration files; we recommend unset all TEX-related environment variables for a start. (For a deep analysis, you can ask \TeX{} to report on exactly what it is searching for, and finding; see “Debugging actions” on page 30.)

3. Preview the result online:

\>
\> xdvi sample2e.dvi \# Unix
\> dviout sample2e.dvi \# Windows

You should see a new window with a nice document explaining some of the basics of \TeX{}. (Well worth reading, by the way, if you’re new to \TeX{}.) You do have to be running under X for xdvi to work; if you’re not, or your DISPLAY environment variable is set incorrectly, you’ll get an error ‘Can’t open display’.

4. Create a PostScript file for printing or display:

\>
\> dvips sample2e.dvi -o sample2e.ps

5. Create a PDF file instead of DVI; this processes the .tex file and writes PDF directly:

\>
\> pdflatex sample2e.tex

6. Preview the PDF file:

\>
\> gv sample2e.pdf
\>
\> xpdf sample2e.pdf

Neither gv nor xpdf are included in \TeX{} Live, so you must install them separately. See http://www.gnu.org/software/gv and http://www.foolabs.com/xpdf, respectively. There are plenty of other PDF viewers, too. For Windows, we recommend trying Sumatra PDF (https://www.sumatrapdfreader.org/free-pdf-reader.html).

7. Standard test files you may find useful in addition to sample2e.tex:

small2e.tex A simpler document than sample2e, to reduce the input size if you’re having troubles.
testpage.tex Test if your printer introduces any offsets.
nfssfont.tex For printing font tables and tests.
testfont.tex Also for font tables, but using plain \TeX{}.
story.tex The most canonical (plain) \TeX{} test file of all. You must type ‘\bye’ to the * prompt after ‘tex story.tex’.

8. If you have installed the \textsf{xetex} package, you can test its access to system fonts as follows:

\> xetex opentype-info.tex
This is Xe\TeX{}, Version 3.14...
...
Output written on opentype-info.pdf (1 page).
Transcript written on opentype-info.log.

If you get an error message saying “Invalid fontname ‘Latin Modern Roman/ICU’”, then you need to configure your system so that the fonts shipped with \TeX{} Live can be found. See section 3.4.4.
3.6 Links for additional downloadable software

If you are new to \TeX, or otherwise need help with actually writing \TeX or \LaTeX documents, please visit \url{http://tug.org/begin.html} for some introductory resources.

Links for some other tools you may consider installing:

- **Ghostscript** \url{https://ghostscript.com/}
- **Perl** \url{http://www.perl.org/} with supplementary packages from CPAN, \url{http://www.cpan.org/}
- **ImageMagic** \url{http://www.imagemagick.com}, for graphics processing and conversion
- **NetPBM** \url{http://netpbm.sourceforge.net/}, also for graphics.

**\TeX-oriented editors** There is a wide choice, and it is a matter of the user’s taste. Here is a selection in alphabetical order (a few here are for Windows only).

- **GNU Emacs** is also available natively under Windows, see \url{http://www.gnu.org/software/emacs/emacs.html}.
- **Emacs with AuCTeX** for Windows is available from CTAN. The AuCTeX home page is \url{http://www.gnu.org/software/auctex}.
- **SciTE** is available from \url{http://www.scintilla.org/SciTE.html}.
- **TeXmaker** is free software, available from \url{http://www.xmlmath.net/texmaker}.
- **TeXstudio** started out as a fork of TeXmaker with additional features; \url{http://texstudio.org}.
- **TeXnicCenter** is free software, available from \url{http://www.texniccenter.org} and in the pro\TeXXt distribution.
- **TeXworks** is free software, available from \url{http://tug.org/texworks} and as part of \TeX Live for Windows (only).
- **Vim** is free software, available from \url{http://www.vim.org}.
- **WinEdt** is shareware available though \url{http://tug.org/winedt} or \url{http://www.winedt.com}.
- **WinShell** is available from \url{http://www.winshell.de}.

For a much longer list of packages and programs, see \url{http://tug.org/interest.html}.

4 Specialized installations

The previous sections described the basic installation process. Here we turn to some specialized cases.

4.1 Shared-user (or cross-machine) installations

\TeX Live has been designed to be shared between different systems on a network. With a standard directory layout, no hard paths are configured: the locations for files needed by \TeX Live programs are found relative to the programs. You can see this in the principal configuration file \$TEXMFDIST/web2c/texmf.cnf, which contains lines such as

```
TEXMFROOT = $SELFAUTOPARENT
...
TEXMFDIST = $TEXMFROOT/texmf-dist
...
TEXMFLocal = $SELFAUTOPARENT/texmf-local
```

This means that adding the directory for \TeX Live executables for their platform to their search path is sufficient to get a working setup.

By the same token, you can also install \TeX Live locally and then move the entire hierarchy afterwards to a network location.

For Windows, \TeX Live includes a launcher \texttt{tlaunch}. Its main window contains menu entries and buttons for various \TeX-related programs and documentation, customizable via an ini file. On first use, it replicates the usual Windows-specific post-install, \textit{i.e.}, search path modification and file associations, but only for the current user. Therefore, workstations with access to \TeX Live on the local network only need a menu shortcut for the launcher. See the \texttt{tlaunch} manual (\texttt{texdoc tlaunch}, or \url{https://ctan.org/pkg/tlaunch}).
4.2 Portable (USB) installations

The \texttt{-portable} installer option (or \texttt{V} command in the text installer or corresponding GUI option) creates a completely self-contained \TeX{} Live installation under a common root and forgoes system integration. You can create such an installation directly on a USB stick, or copy it to a USB stick afterwards.

To run \TeX{} using this portable installation, you need to add the appropriate binary directory to the search path during your terminal session, as usual.

On Windows, you can double-click \texttt{tl-tray-menu} at the root of the installation and create a temporary ‘tray menu’ offering a choice of a few common tasks, as shown in this screenshot:

![TLMGR GUI]

The ‘More…’ entry explains how you can customize this menu.

5 \texttt{tlmgr}: Managing your installation

\TeX{} Live includes a program named \texttt{tlmgr} for managing \TeX{} Live after the initial installation. Its capabilities include:

\begin{itemize}
  \item installing, updating, backing up, restoring, and uninstalling individual packages, optionally taking dependencies into account;
  \item searching for and listing packages and their descriptions;
  \item listing, adding, and removing platforms;
  \item changing installation options such as paper size and source location (see section 3.3.1).
\end{itemize}

\texttt{tlmgr}'s functionality completely subsumes the \texttt{texconfig} program. We still distribute and maintain \texttt{texconfig} for the sake of anyone used to its interface, but we recommend using \texttt{tlmgr} nowadays.

5.1 Current GUI interfaces for \texttt{tlmgr}

\TeX{} Live contains several GUIs for \texttt{tlmgr}. Figure 9 shows \texttt{tshell}, which is written in Tcl/Tk and works out of the box under Windows and MacOSX. Figure 10 shows \texttt{tlcockpit}, which requires Java version 8...
or higher and JavaFX. Both are separate packages.

tlmgr itself can also be run in GUI mode (figure 11) with

> tlmgr -gui

This GUI extension requires Perl/Tk, which module is no longer included in \TeX\ Live’s Perl distribution for Windows.

### 5.2 Sample tlmgr command-line invocations

After the initial installation, you can update your system to the latest versions available with:

> tlmgr update -all

If this makes you nervous, first try

> tlmgr update -all -dry-run

or (less verbose):

> tlmgr update -list

This more complex example adds a collection, for the engine Xe\TeX, from a local directory:

> tlmgr -repository /local/mirror/tlnet install collection-xetex

It generates the following output (abridged):

```bash
install: collection-xetex
install: arabxetex
... install: xetex
install: xetexconfig
install: xetex.1386-linux
running post install action for xetex
install: xetex-def
... running mkteklr
... running fmtutil-sys --missing
... Transcript written on xelatex.log.
```
As you can see, \texttt{tlmgr} installs dependencies, and takes care of any necessary post-install actions, including updating the filename database and (re)generating formats. In the above, we generated new formats for Xe\TeX.  

To describe a package (or collection or scheme):

\texttt{> tlmgr show collection-latexextra}

which produces output like this:

\begin{verbatim}  
package: collection-latexextra  
category: Collection  
shortdesc: LaTeX supplementary packages  
longdesc: A very large collection of add-on packages for LaTeX.  
installed: Yes  
revision: 46963  
sizes: 657941k
\end{verbatim}

Last and most important, for full documentation see \url{http://tug.org/texlive/tlmgr.html}, or:

\texttt{> tlmgr -help}
6 Notes on Windows

6.1 Windows-specific features

Under Windows, the installer does some extra things:

Menus and shortcuts. A new ‘T\TeX Live’ submenu of the Start menu is installed, which contains entries for some GUI programs (tlmgr, texdoctk, the PS_View (psv) PostScript previewer) and some documentation.

File associations. If enabled, Texworks, Dviout and PS_view become either the default program for their respective filetypes, or get an entry in the ‘Open with’ right-click menus of those filetypes.

Bitmap to eps converter. Various bitmapped formats get an entry \texttt{bitmap2eps} in their ‘Open with’ right-click menu. Bitmap2eps is a simple script which lets \texttt{sam2p} or \texttt{bmeps} do the real work.

Automatic path adjustment. No manual configuration steps are required.

Uninstaller. The installer creates an entry under ‘Add/Remove Programs’ for T\TeX Live. The uninstall tab of the T\TeX Live Manager GUI refers to this. For a single-user install, the installer also creates an uninstall entry under the Start menu.

Write-protect. For an admin install, the T\TeX Live directories are write-protected, at least if T\TeX Live is installed on a normal NTFS-formatted non-removable disk.

Also, have a look at tlaunch, described in section 4.1, for a different approach.

6.2 Additional software included on Windows

To be complete, a T\TeX Live installation needs support packages that are not commonly found on a Windows machine. T\TeX Live provides the missing pieces. These programs are all installed as part of T\TeX Live only on Windows.

Perl and Ghostscript. Because of the importance of Perl and Ghostscript, T\TeX Live includes ‘hidden’ copies of these programs. T\TeX Live programs that need them know where to find them, but they don’t betray their presence through environment variables or registry settings. They aren’t full-scale installations, and shouldn’t interfere with any system installations of Perl or Ghostscript.

PS_View. Also installed is PS_View, a PostScript and PDF viewer; see figure 12.
dviout. Also installed is dviout, a DVI viewer. At first, when you preview files with dviout, it will create fonts, because screen fonts were not installed. After a while, you will have created most of the fonts you use, and you will rarely see the font-creation window. More information can be found in the (highly recommended) on-line help.

\TeX\works. \TeX\works is a \TeX-oriented editor with an integrated PDF viewer.

Command-line tools. A number of Windows ports of common Unix command-line programs are installed along with the usual \TeX\ Live binaries. These include gzip, zip, unzip, and the utilities from the poppler suite (pdfinfo, pdffonts, . . . ); no standalone PDF viewer for Windows is included. One option for that is the Sumatra PDF viewer, available from \url{https://sumatrapdfreader.org/}.

\texttt{fc-list}, \texttt{fc-cache}, . . . The tools from the fontconfig library allow Xe\TeX to handle system fonts on Windows. You can use \texttt{fc-list} to determine the font names to pass to \TeX\ Live's extended \texttt{\font} command. If necessary, run \texttt{fc-cache} first to update font information.

6.3 User Profile is Home

The Windows counterpart of a Unix home directory is the \texttt{%USERPROFILE%} directory. Under Windows Vista and later it is \texttt{C:\Users\<username>}. In the \texttt{texmf.cnf} file, and Kpathsea in general, - will expand appropriately on both Windows and Unix.

6.4 The Windows registry

Windows stores nearly all configuration data in its registry. The registry contains a set of hierarchically organized keys, with several root keys. The most important ones for installation programs are HKEY_CURRENT_USER and HKEY_LOCAL_MACHINE, HKCU and HKLM in short. The HKCU part of the registry is in the user's home directory (see section 6.3). HKLM is normally in a subdirectory of the Windows directory.

In some cases, system information could be obtained from environment variables but for other information, for example the location of shortcuts, it is necessary to consult the registry. Setting environment variables permanently also requires registry access.

6.5 Windows permissions

In later versions of Windows, a distinction is made between regular users and administrators, where only the latter have free access to the entire operating system. We have made an effort to make \TeX\ Live installable without administrative privileges.

If the installer is started with administrative permissions, there is an option to install for all users. If this option is chosen, shortcuts are created for all users, and the system search path is modified. Otherwise, shortcuts and menu entries are created for the current user, and the user search path is modified.

Regardless of administrator status, the default root of \TeX\ Live proposed by the installer is always under \texttt{%SystemDrive%}. The installer always tests whether the root is writable for the current user.

A problem may arise if the user is not an administrator and \TeX\ Live already exists in the search path. Since the effective search path consists of the system search path followed by the user search path, the new \TeX\ Live would never get precedence. As a safeguard, the installer creates a shortcut to the command-prompt in which the new \TeX\ Live binary directory is prepended to the local search path. The new \TeX\ Live will be always usable from within such a command-prompt. The shortcut for \TeX\works, if installed, also prepends \TeX\ Live to the search path, so it should also be immune to this path problem.

You should be aware that even if you are logged in as administrator, you need to explicitly ask for administrator privileges. In fact, there is not much point in logging in as administrator. Instead, right-clicking on the program or shortcut that you want to run usually gives you a choice ‘Run as administrator’.

6.6 Increasing maximum memory on Windows and Cygwin

Windows and Cygwin (see section 3.1.4 for Cygwin installation specifics) users may find that they run out of memory when running some of the programs shipped with \TeX\ Live. For example, \texttt{asy} might run out of memory if you try to allocate an array of 25,000,000 reals, and Lua\TeX might run out of memory if you try to process a document with a lot of big fonts.
For Cygwin, you can increase the amount of available memory by following the instructions in the Cygwin User’s Guide (http://www.cygwin.com/cygwin-ug-net/setup-maxmem.html).

For Windows, you have to create a file, say moremem.reg, with these four lines:

```plaintext
Windows Registry Editor Version 5.00

[HKEY_LOCAL_MACHINE\Software\Cygwin]
"heap_chunk_in_mb"=dword:fffffff00
```
and then execute the command `regedit /s moremem.reg` as administrator. (If you want to change memory only for the current user instead of system-wide, use HKEY_CURRENT_USER.)

## 7 A user’s guide to Web2C

Web2C is an integrated collection of \TeX-related programs: \TeX\ itself, \METAFONT, MetaPost, B\TeX, etc. It is the heart of \TeX\ Live. The home page for Web2C, with the current manual and more, is http://tug.org/web2c.

A bit of history: The original implementation was by Tomas Rokicki who, in 1987, developed a first \TeX-to-C system based on change files under Unix, which were primarily the original work of Howard Trickey and Pavel Curtis. Tim Morgan became the maintainer of the system, and during this period the name changed to Web-to-C. In 1990, Karl Berry took over the work, assisted by dozens of additional contributors, and in 1997 he handed the baton to Olaf Weber, who returned it to Karl in 2006.

The Web2C system runs on Unix, 32-bit Windows systems, MacOSX, and other operating systems. It uses Knuth’s original sources for \TeX\ and other basic programs written in the \WEB\ literate programming system and translates them into C source code. The core \TeX\ programs handled in this way are:

- **bibtex** Maintaining bibliographies.
- **dvicopy** Expands virtual font references in DVI files.
- **dvitomp** DVI to MPX (MetaPost pictures).
- **dvitype** DVI to human-readable text.
- **gftodvi** Generic font proofsheets.
- **gftopk** Generic to packed fonts.
- **gftype** GF to human-readable text.
- **mf** Creating typeface families.
- **mft** Prettyprinting \METAFONT\ source.
- **mpost** Creating technical diagrams.
- **patgen** Creating hyphenation patterns.
- **pktogf** Packed to generic fonts.
- **pktype** PK to human-readable text.
- **pltotf** Plain text property list to TFM.
- **pooltype** Display \WEB\ pool files.
- **tangle** \WEB\ to Pascal.
- **tex** Typesetting.
- **tftopl** TFM to plain text property list.
- **vftovp** Virtual font to virtual property list.
- **vptovf** Virtual property list to virtual font.
- **weave** \WEB\ to \TeX.

The precise functions and syntax of these programs are described in the documentation of the individual packages and of Web2C itself. However, knowing a few principles governing the whole family of programs will help you take advantage of your Web2C installation.

All programs honor these standard GNU options:
--help print basic usage summary.
--verbose print detailed progress report.
--version print version information, then exit.

For locating files the Web2C programs use the path searching library Kpathsea (http://tug.org/kpathsea). This library uses a combination of environment variables and configuration files to optimize searching the (huge) collection of TeX files. Web2C can look at many directory trees simultaneously, which is useful in maintaining TeX's standard distribution and local and personal extensions in distinct trees. To speed up file searches, the root of each tree has a file `ls-R`, containing an entry showing the name and relative pathname for all files under that root.

### 7.1 Kpathsea path searching

Let us first describe the generic path searching mechanism of the Kpathsea library.

We call a search path a colon- or semicolon-separated list of path elements, which are basically directory names. A search path can come from (a combination of) many sources. To look up a file `my-file` along a path `./dir`, Kpathsea checks each element of the path in turn: first `./my-file`, then `/dir/my-file`, returning the first match (or possibly all matches).

In order to adapt optimally to all operating systems' conventions, on non-Unix systems Kpathsea can use filename separators different from colon (`:`) and slash (`/`).

To check a particular path element `p`, Kpathsea first checks if a prebuilt database (see “Filename database” on page 27) applies to `p`, i.e., if the database is in a directory that is a prefix of `p`. If so, the path specification is matched against the contents of the database.

Although the simplest and most common path element is a directory name, Kpathsea supports additional features in search paths: layered default values, environment variable names, config file values, users’ home directories, and recursive subdirectory searching. Thus, we say that Kpathsea expands a path element, meaning it transforms all the specifications into basic directory name or names. This is described in the following sections in the same order as it takes place.

Note that if the filename being searched for is absolute or explicitly relative, i.e., starts with `/' or `../`, Kpathsea simply checks if that file exists.

#### 7.1.1 Path sources

A search path can come from many sources. In the order in which Kpathsea uses them:

1. A user-set environment variable, for instance, `TEXINPUTS`. Environment variables with a period and a program name appended override; e.g., if `latex` is the name of the program being run, then `TEXINPUTS.latex` will override `TEXINPUTS`.

2. A program-specific configuration file, for example, a line `S /a:/b` in `dvips’s config.ps`.

3. A Kpathsea configuration file `texmf.cnf`, containing a line like `TEXINPUTS=/c:/d` (see below).

4. The compile-time default.

You can see each of these values for a given search path by using the debugging options (see “Debugging actions” on page 30).

#### 7.1.2 Config files

Kpathsea reads runtime configuration files named `texmf.cnf` for search path and other definitions. The search path used to look for these files is named `TEXMFCNF`, but we do not recommend setting this (or any) environment variable.

Instead, normal installation results in a file `.../2019/texmf.cnf`. If you must make changes to the defaults (not normally necessary), this is the place to put them. The main configuration file is in `.../2019/texmf-dist/web2c/texmf.cnf`. You should not edit this latter file, as your changes will be lost when the distributed version is updated.

All `texmf.cnf` files in the search path will be read and definitions in earlier files override those in later files. For example, with a search path of `.:$TEXMF`, values from `./texmf.cnf` override those from `$TEXMF/texmf.cnf`.

- Comments start with `%` and continue to the end of the line.
• Blank lines are ignored.
• A \ at the end of a line acts as a continuation character, i.e., the next line is appended. Whitespace at the beginning of continuation lines is not ignored.
• Each remaining line has the form:

  variable [.progname] [=] value

where the ‘=’ and surrounding whitespace are optional.
• The variable name may contain any character other than whitespace, ‘=’, or ‘.’, but sticking to ‘A-Za-z_’ is safest.
• If ‘.progname’ is present, the definition only applies if the program that is running is named progname or progname.exe. This allows different flavors of \TeX{} to have different search paths, for example.
• value may contain any characters except % and @'. The $var.prog feature is not available on the right-hand side; instead, you must use an additional variable. A ‘;’ in value is translated to ‘:\’ if running under Unix; this is useful to be able to have a single texmf.cnf for Unix, MS-DOS and Windows systems.
• All definitions are read before anything is expanded, so variables can be referenced before they are defined.

A configuration file fragment illustrating most of these points is shown below:

```
TEXMF = {$TEXMFLOCAL,!!$TEXMFMAIN}
TEXINPUTS.latex = .;$TEXMF/tex/{latex,generic;}//
TEXINPUTS.fontinst = .;$TEXMF/tex//;$TEXMF/fonts/afm//
% e-\TeX\ related files
TEXINPUTS.elatex = .;$TEXMF/{etex,tex}/{latex,generic;}//
TEXINPUTS.etex = .;$TEXMF/{etex,tex}/{eplain,plain,generic;}//
```

### 7.1.3 Path expansion

Kpathsea recognizes certain special characters and constructions in search paths, similar to those available in Unix shells. As a general example, the complex path, `$HOME/\bar{a}/\bar{b}$/baz' expands to all subdirectories under directories \bar{a} and \bar{b} in \$HOME’s home directory that contain a directory or file baz. These expansions are explained in the sections below.

### 7.1.4 Default expansion

If the highest-priority search path (see “Path sources” on page 25) contains an extra colon (i.e., leading, trailing, or doubled), Kpathsea inserts at that point the next-highest-priority search path that is defined. If that inserted path has an extra colon, the same happens with the next highest. For example, given an environment variable setting

```
> setenv TEXINPUTS /home/karl:
```

and a TEXINPUTS value from texmf.cnf of

```
.:$TEXMF//tx
```

then the final value used for searching will be:

```
/home/karl.:.:$TEXMF//tx
```

Since it would be useless to insert the default value in more than one place, Kpathsea changes only one extra ‘:’ and leaves any others in place. It checks first for a leading ‘:’, then a trailing ‘:’, then a doubled ‘:’.

### 7.1.5 Brace expansion

A useful feature is brace expansion, which means that, for instance, v{a,b}w expands to vaw:vbw. Nesting is allowed. This is used to implement multiple \TeX{} hierarchies, by assigning a brace list to $TEXMF. For example, in texmf.cnf, a definition like this (simplified for this example) is made:

```
TEXMF = {$(TEXMFVAR,$TEXMFHOME,!!$TEXMFLOCAL,!!$TEXMFDIST}
```

We can then use this to define, for example, the \TeX{} input path:
TEXINPUTS = .;$TEXMF/tex/
which means that, after looking in the current directory, the $TEXMFVAR/tex, $TEXMFHOME/tex, $TEXMFLOCAL/tex and $TEXMFDIST/tex trees only will be searched (the last two using \ls-R data base files). It is a convenient way for running two parallel \TeX structures, one “frozen” (on a CD, for instance) and the other being continuously updated with new versions as they become available. By using the $TEXMF variable in all definitions, one is sure to always search the up-to-date tree first.

7.1.6 Subdirectory expansion

Two or more consecutive slashes in a path element following a directory \textit{d} is replaced by all subdirectories of \textit{d}: first those subdirectories directly under \textit{d}, then the subsubdirectories under those, and so on. At each level, the order in which the directories are searched is \textit{unspecified}.

If you specify any filename components after the ‘//’, only subdirectories with matching components are included. For example, ‘/a//b’ expands into directories /a/1/b, /a/2/b, /a/1/1/b, and so on, but not /a/b/c or /a/1.

Multiple ‘//’ constructs in a path are possible, but ‘//’ at the beginning of a path is ignored.

7.1.7 List of special characters and their meaning: a summary

The following list summarizes the special characters in Kpathsea configuration files.

- : Separator in path specification; at the beginning or the end of a path it substitutes the default path expansion.
- ; Separator on non-Unix systems (acts like :).
- $ Variable expansion.
- ~ Represents the user’s home directory.
- \{...\} Brace expansion.
- // Subdirectory expansion (can occur anywhere in a path, except at its beginning).
- % Start of comment.
- \ Continuation character (allows multi-line entries).
- !! Search only database to locate file, do not search the disk.

7.2 Filename databases

Kpathsea goes to some lengths to minimize disk accesses for searches. Nevertheless, at installations with enough directories, searching each possible directory for a given file can take an excessively long time (this is especially true if many hundreds of font directories have to be traversed.) Therefore, Kpathsea can use an externally-built plain text “database” file named \ls-R that maps files to directories, thus avoiding the need to exhaustively search the disk.

A second database file \textit{aliases} allows you to give additional names to the files listed in \ls-R. This can be helpful to confirm to DOS 8.3 filename conventions in source files.

7.2.1 The filename database

As explained above, the name of the main filename database must be \ls-R. You can put one at the root of each \TeX hierarchy in your installation that you wish to be searched ($TEXMF by default). Kpathsea looks for \ls-R files along the \TEXMFDBS path.

The recommended way to create and maintain \ls-R is to run the \texttt{mktexlsr} script included with the distribution. It is invoked by the various \texttt{mktex}... scripts. In principle, this script just runs the command

```
cd /your/texmf/root && \ls -1LAR ./ >ls-R
```

assuming your system’s \ls produces the right output format (GNU \ls is all right). To ensure that the database is always up-to-date, it is easiest to rebuild it regularly via \texttt{cron}, so that it is automatically updated when the installed files change, such as after installing or updating a \LaTeX\ package.

If a file is not found in the database, by default Kpathsea goes ahead and searches the disk. If a particular path element begins with ‘!!’, however, \textit{only} the database will be searched for that element, never the disk.
7.2.2 kpsewhich: Standalone path searching

The kpsewhich program exercises path searching independent of any particular application. This can be useful as a sort of find program to locate files in TeX hierarchies (this is used heavily in the distributed ‘mktex’... scripts).

> kpsewhich option... filename...

The options specified in option start with either ‘-’ or ‘--’, and any unambiguous abbreviation is accepted.

Kpathsea looks up each non-option argument on the command line as a filename, and returns the first file found. There is no option to return all the files with a particular name (you can run the Unix ‘find’ utility for that).

The most common options are described next.

--dpi=num Set the resolution to num; this only affects ‘gf’ and ‘pk’ lookups. ‘-D’ is a synonym, for compatibility with dvips. Default is 600.

--format=name Set the format for lookup to name. By default, the format is guessed from the filename. For formats which do not have an associated unambiguous suffix, such as MetaPost support files and dvips configuration files, you have to specify the name as known to Kpathsea, such as tex or enc files. Run kpsewhich --help for a list.

--mode=string Set the mode name to string; this only affects ‘gf’ and ‘pk’ lookups. No default: any mode will be found.

--must-exist Do everything possible to find the files, notably including searching the disk. By default, only the ls-R database is checked, in the interest of efficiency.

--path=string Search along the path string (colon-separated as usual), instead of guessing the search path from the filename. ‘/’ and all the usual expansions are supported. The options ‘--path’ and ‘--format’ are mutually exclusive.

--progname=name Set the program name to name. This can affect the search paths via the .progs feature. The default is kpsewhich.

--show-path=name shows the path used for file lookups of file type name. Either a filename extension (.pk, .vf, etc.) or a name can be used, just as with ‘--format’ option.

--debug=num sets the debugging options to num.

7.2.3 Examples of use

Let us now have a look at Kpathsea in action. Here’s a straightforward search:

> kpsewhich article.cls
/usr/local/texmf-dist/tex/latex/base/article.cls

We are looking for the file article.cls. Since the ‘.cls’ suffix is unambiguous we do not need to specify that we want to look for a file of type tex (TeX source file directories). We find it in the subdirectory tex/latex/base below the ‘texmf-dist’ TeX Live directory. Similarly, all of the following are found without problems thanks to their unambiguous suffix.

> kpsewhich array.sty
/usr/local/texmf-dist/tex/latex/tools/array.sty

> kpsewhich latin1.def
/usr/local/texmf-dist/tex/latex/base/latin1.def

> kpsewhich size10.clo
/usr/local/texmf-dist/tex/latex/base/size10.clo

> kpsewhich small2e.tex
By the way, that last is a Bib\TeX{} bibliography database for TUGboat articles.

> kpsewhich cmr10.pk

Font bitmap glyph files of type .pk are used by display programs like dvips and xdvi. Nothing is returned in this case since there are no pre-generated Computer Modern `.pk' files in \TeX{} Live—\textit{the Type 1 variants are used by default}.

> kpsewhich wsui10.pk

For these fonts (a phonetic alphabet from the University of Washington) we had to generate `.pk' files, and since the default METAFONT mode on our installation is ljfour with a base resolution of 600dpi (dots per inch), this instantiation is returned.

> kpsewhich --dpi=300 wsui10.pk

In this case, when specifying that we are interested in a resolution of 300dpi (~dpi=300) we see that no such font is available on the system. A program like dvips or xdvi would go off and actually build the required .pk files using the script mktexpk.

Next we turn our attention to dvips's header and configuration files. We first look at one of the commonly used files, the general prologue \texttt{tex.pro} for \TeX{} support, before turning our attention to the generic configuration file (config.ps) and the PostScript font map \texttt{psfonts.map}—as of 2004, map and encoding files have their own search paths and new location in \texttt{texmf} trees. As the `.ps' suffix is ambiguous we have to specify explicitly which type we are considering (dvips config) for the file config.ps.

> kpsewhich --format="dvips config" config.utm

The contents of that file is

p +utm.map

which points to the file utm.map, which we want to locate next.

> kpsewhich utm.map

This map file defines the file names of the Type 1 PostScript fonts in the URW collection. Its contents look like (we only show part of the lines):

utmb8r NimbusRomNo9L-Medi ... <utmb8a.pfb
utmib8r NimbusRomNo9L-MediItal ... <utmib8a.pfb
utm8r NimbusRomNo9L-Regu ... <utm8a.pfb
utmri8r NimbusRomNo9L-ReguItal ... <utmri8a.pfb
utmb8r NimbusRomNo9L-Medi ... <utmb8a.pfb
utmro8r NimbusRomNo9L-Regu ... <utm8a.pfb

Let us, for instance, take the Times Roman instance utmr8a.pfb and find its position in the \texttt{texmf} directory tree with a search for Type 1 font files:
It should be evident from these examples how you can easily locate the whereabouts of a given file. This is especially important if you suspect that the wrong version of a file is picked up somehow, since kpsewhich will show you the first file encountered.

7.2.4 Debugging actions

Sometimes it is necessary to investigate how a program resolves file references. To make this practical, Kpathsea offers various levels of debugging output:

1 stat calls (disk lookups). When running with an up-to-date ls-R database this should almost give no output.
2 References to hash tables (such as ls-R databases, map files, configuration files).
4 File open and close operations.
8 General path information for file types searched by Kpathsea. This is useful to find out where a particular path for the file was defined.
16 Directory list for each path element (only relevant for searches on disk).
32 File searches.
64 Variable values.

A value of -1 will set all the above options; in practice, this is usually the most convenient.

Similarly, with the dvips program, by setting a combination of debug switches, one can follow in detail where files are being picked up from. Alternatively, when a file is not found, the debug trace shows in which directories the program looks for the given file, so that one can get an indication what the problem is.

Generally speaking, as most programs call the Kpathsea library internally, one can select a debug option by using the KPATHSEA_DEBUG environment variable, and setting it to (a combination of) values as described in the above list.

(For Windows users: it is not easy to redirect all messages to a file in this system. For diagnostic purposes you can temporarily SET KPATHSEA_DEBUG_OUTPUT=err.log).

Let us consider, as an example, a small \LaTeX{} source file, hello-world.tex, which contains the following input.

\documentclass{article}
\begin{document}
Hello World!
\end{document}

This little file only uses the font cmr10, so let us look at how dvips prepares the PostScript file (we want to use the Type 1 version of the Computer Modern fonts, hence the option -Pcms).

> dvips -d4100 hello-world -Pcms -o

In this case we have combined dvips's debug class 4 (font paths) with Kpathsea's path element expansion (see the dvips reference manual). The output (slightly rearranged) appears in Figure 13.

dvips starts by locating its working files. First, texmf.cnf is found, which gives the definitions of the search paths for the other files, then the file database ls-R (to optimize file searching) and the file aliases, which makes it possible to declare several names (e.g., a short DOS-like 8.3 and a more natural longer version) for the same file. Then dvips goes on to find the generic configuration file config.ps before looking for the customization file .dvipsrc (which, in this case is not found). Finally, dvips locates the config file for the Computer Modern PostScript fonts config.cms (this was initiated with the -Pcms option on the dvips command). This file contains the list of the map files which define the relation between the \TeX, PostScript and file system names of the fonts.

> more /usr/local/texmf/dvips/cms/config.cms
  p +ams.map
  p +cms.map
  p +cmbkm.map
  p +amsbkm.map
dvips thus goes on to find all these files, plus the generic map file \texttt{psfonts.map}, which is always loaded (it contains declarations for commonly used PostScript fonts; see the last part of section 7.2.3 for more details about PostScript map file handling).

At this point \texttt{dvips} identifies itself to the user:

\begin{verbatim}
This is dvips(k) 5.92b Copyright 2002 Radical Eye Software (www.radicaleye.com)
\end{verbatim}

Then it goes on to look for the prolog file \texttt{texc.pro}:

\begin{verbatim}
kd debug:start search(file=texc.pro, must_exist=0, find_all=0, path=./tex/dvips/:./usr/local/texmf/dvips/\).
k debug:start search(file=texc.pro, must_exist=0, find_all=0, path=./tex/dvips/:./usr/local/texmf/dvips/\).
\end{verbatim}

After having found the file in question, \texttt{dvips} outputs the date and time, and informs us that it will generate the file \texttt{hello-world.ps}, then that it needs the font file \texttt{cmr10}, and that the latter is declared as “resident” (no bitmaps needed):

\begin{verbatim}
TeX output 1998.02.26:1204' -> hello-world.ps
Defining font () cmr10 at 10.0pt
Font cmr10 <CMR10> is resident.
\end{verbatim}

Now the search is on for the file \texttt{cmr10.tfm}, which is found, then a few more prolog files (not shown) are referenced, and finally the Type 1 instance \texttt{cmr10.pfb} of the font is located and included in the output file (see last line).

\begin{verbatim}
k debug:start search(file=cmr10.pfb, must_exist=0, find_all=0, path=./tex/dvips/:./usr/local/texmf/dvips/\).
k debug:start search(file=cmr10.pfb, must_exist=0, find_all=0, path=./tex/dvips/:./usr/local/texmf/dvips/\).
<cmr10.pfb>[1]}

Figure 13: Finding configuration files
7.3 Runtime options

Another useful feature of Web2C is its possibility to control a number of memory parameters (in particular, array sizes) via the runtime file `texmf.cnf` read by Kpathsea. The memory settings can be found in Part 3 of that file in the TeX Live distribution. The more important are:

- **main_memory** Total words of memory available, for TeX, METAfont and MetaPost. You must make a new format file for each different setting. For instance, you could generate a “huge” version of TeX, and call the format file `hugetex.fmt`. Using the standard way of specifying the program name used by Kpathsea, the particular value of the `main_memory` variable will then be read from `texmf.cnf`.

- **extra_mem_bot** Extra space for “large” TeX data structures: boxes, glue, breakpoints, etc. Especially useful if you use `PCTeX`.

- **font_mem_size** Number of words for font information available for TeX. This is more or less the total size of all TFM files read.

- **hash_extra** Additional space for the hash table of control sequence names. Only $\approx 10,000$ control sequences can be stored in the main hash table; if you have a large book with numerous cross-references, this might not be enough. The default value of `hash_extra` is 50000.

Of course, this facility is no substitute for truly dynamic arrays and memory allocation, but since these are extremely difficult to implement in the present TeX source, these runtime parameters provide a practical compromise allowing some flexibility.

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Builders of the binaries: Marc Baudoin (amd64-netbsd, i386-netbsd), Ken Brown (i386-cygwin, x86_64-cygwin), Simon Dales (armhf-linux), Johannes Hielscher (aarch64-linux), Akira Kakuto (win32), Dick Koch (x86_64-darwin), Nikola Lečić (amd64-freebsd, i386-freebsd), Henri Menke (x86_64-linuxarm), Mojca Miklavc (i386-linux, x86_64-darwinlegacy, i386-solaris, x86_64-solaris, sparc-solaris), Norbert Preining (x86_64-linux). For information on the TeX Live build process, see http://tug.org/texlive/build.html.

Translators of this manual: Denis Bitouzé & Patrick Bideault (French), Carlos Enriquez Figueras (Spanish), Jigod Jiang, Jinsong Zhao, Yue Wang, & Helin Gai (Chinese), Nikola Lečić (Serbian), Marco Pallante & Carla Maggi (Italian), Petr Sojka & Jan Busa (Czech/Slovak), Boris Veytsman (Russian), Zofia Walczak (Polish), Uwe Ziegenhagen (German). The TeX Live documentation web page is http://tug.org/texlive/doc.html.

Of course the most important acknowledgement must go to Donald Knuth, first for inventing TeX, and then for giving it to the world.

9 Release history

9.1 Past

Discussion began in late 1993 when the Dutch TeX Users Group was starting work on its 4AllTeX CD for MS-DOS users, and it was hoped at that time to issue a single, rational, CD for all systems. This was too ambitious a target for the time, but it did spawn not only the very successful 4AllTeX CD, but also the TUG Technical Council working group on a TeX Directory Structure (http://tug.org/tds), which specified how to create consistent and manageable collections of TeX support files. A complete draft of the TDS was published in the December 1995 issue of TUGboat, and it was clear from an early
stage that one desirable product would be a model structure on CD. The distribution you now have
is a very direct result of the working group’s deliberations. It was also clear that the success of the
4AllTEX CD showed that Unix users would benefit from a similarly easy system, and this is the other
main strand of TEX Live.

We first undertook to make a new Unix-based TDS CD in the autumn of 1995, and quickly identified
Thomas Esser’s teTEX as the ideal setup, as it already had multi-platform support and was built with
portability across file systems in mind. Thomas agreed to help, and work began seriously at the start
of 1996. The first edition was released in May 1996. At the start of 1997, Karl Berry completed a
major new release of Web2c, which included nearly all the features which Thomas Esser had added in
teTEX, and we decided to base the 2nd edition of the CD on the standard Web2C, with the addition
of teTEX’s texconfig script. The 3rd edition of the CD was based on a major revision of Web2C, 7.2,
by Olaf Weber; at the same time, a new revision of teTEX was being made, and TeX Live included
almost all of its features. The 4th edition followed the same pattern, using a new version of teTEX, and
a new release of Web2C (7.3). The system now included a complete Windows setup, thanks to Fabrice
Popineau.

For the 5th edition (March 2000) many parts of the CD were revised and checked, updating hundreds
of packages. Package details were stored in XML files. But the major change for TeX Live 5 was that
all non-free software was removed. Everything in TeX Live is now intended to be compatible with
the Debian Free Software Guidelines (http://www.debian.org/intro/free); we have done our best
to check the license conditions of all packages, but we would very much appreciate hearing of any
mistakes.

The 6th edition (July 2001) had much more material updated. The major change was a new install
concept: the user could select a more exact set of needed collections. Language-related collections were
completely reorganized, so selecting any of them installs not only macros, fonts, etc., but also prepares
an appropriate language.dat.

The 7th edition of 2002 had the notable addition of MacOSX support, and the usual myriad of
updates to all sorts of packages and programs. An important goal was integration of the source back
with TeX, to correct the drift apart in versions 5 and 6.

9.1.1 2003

In 2003, with the continuing flood of updates and additions, we found that TeX Live had grown so
large it could no longer be contained on a single CD, so we split it into three different distributions (see
section 2.1, p. 4). In addition:

- At the request of the IETEX team, we changed the standard latex and pdflatex commands to now use ε-TEx (see p. 6).
- The new Latin Modern fonts were included (and are recommended).
- Support for Alpha OSF was removed (HPUX support was removed previously), since no one had
  (or volunteered) hardware available on which to compile new binaries.
- Windows setup was substantially changed; for the first time an integrated environment based on
  XEmacs was introduced.
- Important supplementary programs for Windows (Perl, Ghostscript, ImageMagick, Ispell) are
  now installed in the TeX Live installation directory.
- Font map files used by dvips, dviupd and pdftex are now generated by the new program updmap
  and installed into texmf/fonts/map.
- TeX, METAFONT, and MetaPost now, by default, output most input characters (32 and above)
  as themselves in output (e.g., \write) files, log files, and the terminal, i.e., not translated using
  the "^" notation. In TeX Live 7, this translation was dependent on the system locale settings;
  now, locale settings do not influence the TeX programs’ behavior. If for some reason you need
  the "^" output, rename the file teXmf/web2c/cp8bit.tcx. (Future releases will have cleaner ways
  to control this.)
- This documentation was substantially revised.
- Finally, since the edition numbers had grown unwieldy, the version is now simply identified by
  the year: TeX Live 2003.

9.1.2 2004

2004 saw many changes:
• If you have locally-installed fonts which use their own .map or (much less likely) .enc support files, you may need to move those support files. .map files are now searched for in subdirectories of fonts/map only (in each texmf tree), along the TEXFONTSMAPS path. Similarly, .enc files are now searched for in subdirectories of fonts/enc only, along the ENCFONTS path. updmap will attempt to warn about problematic files. For methods of handling this and other information, please see http:// tug.org/texlive/mapenc.html.

• The TeX Collection has been expanded with the addition of a MiKTeX-based installable CD, for those who prefer that implementation to Web2C. See section 2 (p.4).

• Within TeX Live, the single large texmf tree of previous releases has been replaced by three: texmf, texmf-dist, and texmf-doc. See section 2.2 (p.4), and the README files for each.

• All TeX-related input files are now collected in the tex subdirectory of texmf* trees, rather than having separate sibling directories tex, etex, pdfTeX, pdfetex, etc. See texmf-dist/doc/generic/tds/tds.html#Extensions.

• Helper scripts (not meant to be invoked by users) are now located in a new scripts subdirectory of texmf* trees, and can be searched for via kpsewhich -format=texmfscripts. So if you have programs which call such scripts, they'll need to be adjusted. See texmf-dist/doc/generic/tds/tds.html#Scripts.

• Almost all formats leave most characters printable as themselves via the “translation file” cp227. tcx, instead of translating them with the ^^ notation. Specifically, characters at positions 32–256, plus tab, vertical tab, and form feed are considered printable and not translated. The exceptions are plain TeX (only 32–126 printable), ConTeXt (0–255 printable), and the Ω-related formats. This default behavior is almost the same as in TeX Live 2003, but it's implemented more cleanly, with more possibilities for customization. See texmf-dist/doc/web2c/web2c.html#TCX-files. (By the way, with Unicode input, TeX may output partial character sequences when showing error contexts, since it is byte-oriented.)

• pdfTeX is now the default engine for all formats except (plain) tex itself. (Of course it generates DVI when run as latex, etc.) This means, among other things, that the microtypographic features of pdfTeX are available in BiTEx, ConTeXt, etc., as well as the ε-TeX features (texmf-dist/doc/etex/base/).

It also means it’s more important than ever to use the ifpdf package (works with both plain and BiTEx) or equivalent code, because simply testing whether \pdfoutput or some other primitive is defined is not a reliable way to determine if PDF output is being generated. We made this backward compatible as best we could this year, but next year, \pdfoutput may be defined even when DVI is being written.

• pdfTEX (http://pdftex.org) has many new features:
  - \pdfmapfile and \pdfmapline provide font map support from within a document. Microtypographic font expansion can be used more easily. http://www.ntg.nl/pipermail/ntg-pdfTeX/2004-May/000504.html
  - All parameters previously set through the special configuration file pdfTeX.cfg must now be set through primitives, typically in pdfTeXconfig.tex: pdfTeX.cfg is no longer supported. Any extant .fmt files must be redumped when pdfTeXconfig.tex is changed. See the pdfTEX manual for more: texmf-dist/doc/pdftex/manual/pdftex-a.pdf.

• The \input primitive in tex (and mf and mpost) now accepts double quotes containing spaces and other special characters. Typical examples:
  \input "filename with spaces" % plain
  \input("filename with spaces") % latex

See the Web2C manual for more: texmf-dist/doc/web2c.

• encTeX support is now included within Web2C and consequently all TeX programs, via the -enc option — only when formats are built. encTeX supports general re-encoding of input and output, enabling full support of Unicode (in UTF-8). See texmf-dist/doc/generic/encTeX/ and http://www.olsak.net/encTeX.html.
Aleph, a new engine combining \text NiX and \text Omega, is available. A little information is available in \texttt{texmf-dist/doc/aleph/base} and \url{http://www.tex.ac.uk/cgi-bin/texfaq2html?label=aleph}. The \text NiX-based format for Aleph is named \texttt{lamed}.

The latest \text NiX release has a new version of the LPPL — now officially a Debian-approved license. Assorted other updates, see the \texttt{ltnews} files in \texttt{texmf-dist/doc/latex/base}.

dvipng, a new program for converting DVI to PNG image files, is included. See \url{http://www.ctan.org/pkg/dvipng}.

We reduced the cbgreek package to a “medium” sized set of fonts, with the assent and advice of the author (Claudio Beccari). The excised fonts are the invisible, outline, and transparency ones, which are relatively rarely used, and we needed the space. The full set is of course available from CTAN (\url{http://mirror.ctan.org/tex-archive/fonts/greek/cbfonts}).

\texttt{oxdvi} has been removed; just use \texttt{xdvi}.

The \texttt{ini} and \texttt{vir} commands (links) for \texttt{tex}, \texttt{mf}, and \texttt{mpost} are no longer created, such as \texttt{initex}. The \texttt{ini} functionality has been available through the command-line option \texttt{-ini} for years now.

\texttt{i386-openbsd} platform support was removed. Since the tetex package in the BSD Ports system is available, and GNU/Linux and FreeBSD binaries were available, it seemed volunteer time could be better spent elsewhere.

On \texttt{sparc-solaris} (at least), you may have to set the \texttt{LD_LIBRARY_PATH} environment variable to run the \texttt{t1utils} programs. This is because they are compiled with C++, and there is no standard location for the runtime libraries. (This is not new in 2004, but wasn’t previously documented.) Similarly, on \texttt{mips-irix}, the MIPSpro 7.4 runtimes are required.

9.1.3 2005

2005 saw the usual huge number of updates to packages and programs. The infrastructure stayed relatively stable from 2004, but inevitably there were some changes there as well:

- New scripts \texttt{texconfig-sys}, \texttt{updmap-sys}, and \texttt{fmtutil-sys} were introduced, which modify the configuration in the system trees. The \texttt{texconfig}, \texttt{updmap}, and \texttt{fmtutil} scripts now modify user-specific files, under \texttt{$HOME/.texlive2005}.

- Corresponding new variables \texttt{TEXMFCONFIG} and \texttt{TEXMFSYSCONFIG} to specify the trees where configuration files (user or system, respectively) are found. Thus, you may need to move personal versions of \texttt{fmtutil.cnf} and \texttt{updmap.cfg} to these places; another option is to redefine \texttt{TEXMFCONFIG} or \texttt{TEXMFSYSCONFIG} in \texttt{texmf.cnf}. In any case the real location of these files and the values of \texttt{TEXMFCONFIG} and \texttt{TEXMFSYSCONFIG} must agree. See section 2.3, p.5.

- Last year, we kept \texttt{\pdfoutput} and other primitives undefined for DVI output, even though the pdfetex program was being used. This year, as promised, we undid that compatibility measure. So if your document uses \texttt{\ifpdfoutput\undefined} to test if PDF is being output, it will need to be changed. You can use the package \texttt{ifpdf.sty} (which works under both plain \text NiX and \text NiX) to do this, or steal its logic.

- Last year, we changed most formats to output (8-bit) characters as themselves (see previous section). The new TCX file \texttt{empty.tcx} now provides an easier way to get the original \texttt{^^} notation if you so desire, as in:

\begin{verbatim}
latex --translate-file=empty.tcx yourfile.tex
\end{verbatim}

- The new program \texttt{dvipdfmx} is included for translation of DVI to PDF; this is an actively maintained update of \texttt{dvipdfm} (which is also still available for now, though no longer recommended).

- The new programs \texttt{pdfopen} and \texttt{pdfclose} are included to allow reloading of PDF files in the Adobe Acrobat Reader without restarting the program. (Other PDF readers, notably \texttt{xdpdf}, \texttt{gv}, and \texttt{gsview}, have never suffered from this problem.)

- For consistency, the variables \texttt{HOMETEXMF} and \texttt{VARTEXMF} have been renamed to \texttt{TEXMFHOME} and \texttt{TEXMFSYSVAR}, respectively. There is also \texttt{TEXMFVAR}, which is by default user-specific. See the first point above.
9.1.4 2006–2007

In 2006–2007, the major new addition to TeX Live was the XeTeX program, available as the xetex and xelatex programs; see http://scripts.sil.org/xetex.

MetaPost also received a notable update, with more planned for the future (http://tug.org/metapost/articles). The TeX .fmt (high-speed format) and the similar files for MetaPost and METAFONT are now stored in subdirectories of texmf/web2c, instead of in the directory itself (although the directory is still searched, for the sake of existing .fmt’s). The subdirectories are named for the ‘engine’ in use, such as tex or pdftex or xetex. This change should be invisible in normal use.

The (plain) tex program no longer reads %& first lines to determine what format to run; it is the pure Knuthian TeX. (LaTeX and everything else do still read %& lines).

Of course the year also saw (the usual) hundreds of other updates to packages and programs. As usual, please check CTAN (http://mirror.ctan.org) for updates.

Internally, the source tree is now stored in Subversion, with a standard web interface for viewing the tree, as linked from our home page. Although not visible in the final distribution, we expect this will provide a stable development foundation for future years.

Finally, in May 2006 Thomas Esser announced that he would no longer be updating teTeX (http://tug.org/tetex). As a result, there was a surge of interest in TeX Live, especially among GNU/Linux distributors. (There is a new tetex installation scheme in TeX Live, which provides an approximate equivalent.) We hope this will eventually translate to improvements in the TeX environment for everyone.

9.1.5 2008

In 2008, the entire TeX Live infrastructure was redesigned and reimplemented. Complete information about an installation is now stored in a plain text file tlpkg/texlive.tlpdb.

Among other things, this finally makes possible upgrading a TeX Live installation over the Internet after the initial installation, a feature MiKTeX has provided for many years. We expect to regularly update new packages as they are released to CTAN.

The major new engine LuaTeX (http://luatex.org) is included; besides a new level of flexibility in typesetting, this provides an excellent scripting language for use both inside and outside of TeX documents.

Support among Windows and the Unix-based platforms is now much more uniform. In particular, most Perl and Lua scripts are now available on Windows, using the Perl internally distributed with TeX Live.

The new tmgr script (section 5) is the general interface for managing TeX Live after the initial installation. It handles package updates and consequent regeneration of formats, map files, and language files, optionally including local additions.

With the advent of tmgr, the texconfig actions to edit the format and hyphenation configuration files are now disabled.

The xindy indexing program (http://xindy.sourceforge.net/) is now included on most platforms.

The kpsewhich tool can now report all matches for a given file (option –all) and limit matches to a given subdirectory (option –subdir).

The dvipdfmx program now includes functionality to extract bounding box information, via the command name extractbb; this was one of the last features provided by dvipdfm not in dvipdfmx.

The font aliases Times-Roman, Helvetica, and so on have been removed. Different packages expected them to behave differently (in particular, to have different encodings), and there was no good way to resolve this.

The platex format has been removed, to resolve a name conflict with a completely different Japanese platex; the polski package is now the main Polish support.

Internally, the WEB string pool files are now compiled into the binaries, to ease upgrades.

Finally, the changes made by Donald Knuth in his ‘TeX tuneup of 2008’ are included in this release. See http://tug.org/TUGboat/Articles/tb29-2/tb92kmut.pdf.

9.1.6 2009

In 2009, the default output format for Lua(La)TeX is now PDF, to take advantage of LuaTeX’s OpenType support, et al. New executables named dviluatex and dvilualatex run LuaTeX with DVI output. The LuaTeX home page is http://luatex.org.
The original Omega engine and Lambda format have been excised, after discussions with the Omega authors. The updated Aleph and Lamed remain, as do the Omega utilities.

A new release of the AMS Type 1 fonts is included, including Computer Modern: a few shape changes made over the years by Knuth in the Metafont sources have been integrated, and the hinting has been updated. The Euler fonts have been thoroughly reshaped by Hermann Zapf (see http://tug.org/TUGboat/Articles/tb29-2/tb92hagen-euler.pdf). In all cases, the metrics remain unchanged. The AMS fonts home page is http://www.ams.org/tx/amsfonts.html.

The new GUI front end TeXworks is included for Windows, and also in MacTeX. For other platforms, and more information, see the TeXworks home page, http://tug.org/texworks. It is a cross-platform front end inspired by the Mac OS X TeXShop editor, aiming at ease-of-use.

The graphics program Asymptote is included for several platforms. This implements a text-based graphics description language vaguely akin to MetaPost, but with advanced 3D support and other features. Its home page is http://asymptote.sourceforge.net.

The separate dvipdfmx program has been replaced by dvipdfmx, which operates in a special compatibility mode under that name. dvipdfmx includes CJK support and has accumulated many other fixes over the years since the last dvipdfm release.

Executables for the cygwin and i386-netbsd platforms are now included, while we were advised that OpenBSD users get TeX through their package systems, plus there were difficulties in making binaries that have a chance of working on more than one version.

A miscellany of smaller changes: we now use xx compression, the stable replacement for lzo (http://tukaani.org/xz/); a literal $ is allowed in filenames when it does not introduce a known variable name; the Kpathsea library is now multi-threaded (made use of in MetaPost); the entire TeX Live build is now based on Automake.

Final note on the past: all releases of TeX Live, along with ancillary material such as CD labels, are available at ftp://tug.org/historic/systems/texlive.

9.1.7 2010

In 2010, the default version for PDF output is now 1.5, enabling more compression. This applies to all the TeX engines when used to produce PDF and to dvipdfmx. Loading the pdf14 filter package changes back to PDF 1.4, or set \pdfminorversion=4.

pdf(∂)/TeX now automatically converts a requested Encapsulated PostScript (EPS) file to PDF, via the epstopdf package, when and if the primitive graphics.cfg configuration file is loaded, and PDF is being output. The default options are intended to eliminate any chance of hand-created PDF files being overwritten, but you can also prevent epstopdf from being loaded at all by putting \newcommand{\DoNotLoadEpstopdf}{\null} before the \documentclass declaration. It is also not loaded if the pst-pdf package is used. For more details, see the epstopdf package documentation (http://ctan.org/pkg/epstopdf-pkg).

A related change is that execution of a very few external commands from TeX, via the \write18 feature, is now enabled by default. This applies to \repstyldef, \makeindex, \ps2eps, \bibtex, and \bibtex8; the list is defined in texmf.cnf. Environments which must disallow all such external commands can deselect this option in the installer (see section 3.2.4), or override the value after installation by running \texttt{tlmgr conf texmf shell_escape 0}.

Yet another related change is that Bib\TeX and Makeindex now refuse to write their output files to an arbitrary directory (like TeX itself), by default. This is so they can now be enabled for use by the restricted \write18. To change this, the \TEXMFOUTPUT environment variable can be set, or the \texttt{openout_any} setting changed.

Xe\TeX now supports margin kerning along the same lines as pdf\TeX. (Font expansion is not presently supported.)

By default, tlmgr now saves one backup of each package updated (\texttt{tlmgr option autobackup 1}), so broken package updates can be easily reverted with \texttt{tlmgr restore}. If you do post-install updates, and don’t have the disk space for the backups, run \texttt{tlmgr option autobackup 0}.

New programs included: the \texttt{pTeX} engine and related utilities for typesetting Japanese; the Bib\TeX/U program for Unicode-enabled Bib\TeX; the chktex utility (http://baruch.ev-en.org/proj/chktex) for checking (\LaTeX) TeX documents; the dvipsfmt (http://dvipsfm.sourceforge.net) DVI-to-SVG translator.

Executables for these new platforms are now included: amd64-freebsd, amd64-kfreebsd, i386-freebsd, i386-kfreebsd, x86_64-darwin, x86_64-solaris.

A change in \TeX Live 2009 that we failed to note: numerous \TeX4ht-related executables (http://tug.org/tex4ht) were removed from the binary directories. The generic \texttt{mk4ht} program can be used as a replacement.

Final note on the past: all releases of TeX Live, along with ancillary material such as CD labels, are available at ftp://tug.org/historic/systems/texlive.
to run any of the various tex4ht combinations.

Finally, the \TeX{} Live release on the \TeX{} Collection DVD can no longer be run live (oddly enough). A single DVD no longer has enough room. One beneficial side effect is that installation from the physical DVD is much faster.

9.1.8 2011

The Mac OS X binaries (universal-darwin and x86_64-darwin) now work only on Leopard or later; Panther and Tiger are no longer supported.

The \texttt{biber} program for bibliography processing is included on common platforms. Its development is closely coupled with the \texttt{biblatex} package, which completely reimplements the bibliographical facilities provided by \LaTeX{}.

The MetaPost (\texttt{mpost}) program no longer creates or uses \texttt{.mem} files. The needed files, such as \texttt{plain.mp}, are simply read on every run. This is related to supporting MetaPost as a library, which is another significant though not user-visible change.

The \texttt{updmap} implementation in Perl, previously used only on Windows, has been revamped and is now used on all platforms. There shouldn’t be any user-visible changes as a result, except that it runs much faster.

The \texttt{initex} and \texttt{inimf} programs were restored (but no other ini* variants).

9.1.9 2012

tlmgr supports updates from multiple network repositories. The section on multiple repositories in the \texttt{tlmgr help} output has more.

The parameter \texttt{XeTeXdashbreakstate} is set to 1 by default, for both \texttt{xetex} and \texttt{xelatex}. This allows line breaks after em-dashes and en-dashes, which has always been the behavior of plain \TeX{}, \LaTeX{}, Lua\TeX{}, etc. Existing Xe\TeX{} documents which must retain perfect line-break compatibility will need to set \texttt{XeTeXdashbreakstate} to 0 explicitly.

The output files generated by \texttt{pdftex} and \texttt{dvips}, among others, can now exceed 2 gigabytes.

The 35 standard PostScript fonts are included in the output of \texttt{dvips} by default, since so many different versions of them are extant.

In the restricted \texttt{\write18} execution mode, set by default, \texttt{mpost} is now an allowed program.

A \texttt{texmf.cnf} file is also found in \texttt{./texmf-local}, e.g., \texttt{/usr/local/texlive/texmf-local/web2c/texmf.cnf}, if it exists.

The \texttt{updmap} script reads a per-tree \texttt{updmap.cfg} instead of one global config. This change should be invisible, unless you edited your \texttt{updmap.cfg}'s directly. The \texttt{updmap --help} output has more.

Platforms: armel-linux and mipsel-linux added; sparc-linux and i386-netbsd are no longer in the main distribution.

9.1.10 2013

Distribution layout: the top-level \texttt{texmf/} directory has been merged into \texttt{texmf-dist/}, for simplicity.

Both the \texttt{TEXMFSMAIN} and \texttt{TEXMFDIST} Kpathsea variables now point to \texttt{texmf-dist}.

Many small language collections have been merged together, to simplify installation.

MetaPost: native support for PNG output and floating-point (IEEE double) has been added.

Lu\TeX{}: updated to Lua 5.2, and includes a new library (\texttt{pdfscanner}) to process external PDF page content, among much else (see its web pages).

Xe\TeX{} (also see its web pages for more):

- The HarfBuzz library is now used for font layout instead of ICU. (ICU is still used to support input encodings, bidirectionality, and the optional Unicode line breaking.)
- Graphite2 and HarfBuzz are used instead of SilGraphite for Graphite layout.
- On Macs, Core Text is used instead of the (deprecated) ATSUI.
- Prefer TrueType/OpenType fonts to Type1 when the names are the same.
- Fix occasional mismatch in font finding between Xe\TeX{} and xdvipdfmx.
- Support OpenType math cut-ins.

\texttt{xdvi}: now uses FreeType instead of \texttt{t1lib} for rendering.

\texttt{microtype.sty}: some support for Xe\TeX{} (protrusion) and Lua\TeX{} (protrusion, font expansion, tracking), among other enhancements.
9.1.11 2014

2014 saw another \TeX\ tune-up from Knuth; this affected all engines, but the only visible change likely is the restoration of the \texttt{preloaded format} string on the banner line. Per Knuth, this now reflects the format that \texttt{would} be loaded by default, rather than an undumped format that is actually preloaded in the binary; it may be overridden in various ways.

pdf\TeX: new warning-suppression parameter \texttt{\pdfsuppresswarningpagegroup}; new primitives for fake interword spaces to help with PDF text reflowing: \texttt{\pdfinterwordspaceon}, \texttt{\pdfinterwordspaceoff}, \texttt{\pdffakespace}.

Lua\TeX: Notable changes and fixes were made to font loading and hyphenation. The biggest addition is a new engine variant, \texttt{luajittex} (\url{http://foundry.supelec.fr/projects/luajittex}) and its siblings \texttt{texluajit} and \texttt{texluajitc}. This uses a just-in-time Lua compiler (detailed \texttt{TUGboat} article at \url{http://tug.org/TUGboat/tb34-1/tb106scarso.pdf}). \texttt{luajittex} is still in development, is not available on all platforms, and is considerably less stable than \texttt{luatex}. Neither we nor its developers recommend using it except for the specific purpose of experimenting with jit on Lua code.

Xe\TeX: The same image formats are now supported on all platforms (including Mac); avoid Unicode compatibility decomposition fallback (but not other variants); prefer OpenType to Graphite fonts, for compatibility with previous Xe\TeX\ versions.

MetaPost: A new \texttt{numbersystem decimal} is supported, along with a companion internal \texttt{numberprecision}; a new definition of \texttt{drawdot} in \texttt{plain.mp}, per Knuth; bug fixes in SVG and PNG output, among others.

The \texttt{pstopdf} Con\TeX\ utility will be removed as a standalone command at some point after the release, due to conflicts with OS utilities of the same name. It can still (and now) be invoked as \texttt{mtxrun -script pstopdf}.

\texttt{psutils} has been substantially revised by a new maintainer. As a result, several seldom-used utilities (\texttt{fix*}, \texttt{getafm}, \texttt{psmerge}, \texttt{showchar}) are now only in the \texttt{scripts/} directory rather than being user-level executables (this can be reversed if it turns out to be problematic). A new script, \texttt{psjoin}, has been added.

The Mac\TeX\ redistribution of \TeX\ Live (section 3.1.2) no longer includes the optional Mac-only packages for the Latin Modern and \TeX\ Gyre fonts, since it is easy enough for individual users to make them available to the system. The \texttt{convert} program from ImageMagick has also been excised, since \TeX\ X4ht (specifically \texttt{tex4ht.env}) now uses Ghostscript directly.

The \texttt{langcjk} collection for Chinese, Japanese, and Korean support has been split into individual language collections for the sake of more moderate sizes.

Platforms: \texttt{x86_64-cygwin} added, \texttt{mips-irix} removed; Microsoft no longer supports Windows XP, so our programs may start failing there at any time.

9.1.12 2015

\LaTeX2ε now incorporates, by default, changes previously included only by explicitly loading the \texttt{fixdtx2e} package, which is now a no-op. A new \texttt{latexrelease} package and other mechanisms allow for controlling what is done. The included \LaTeX\ News #22 and “\LaTeX\ changes” documents have details. Incidentally, the \texttt{babel} and \texttt{psnffs} packages, while core parts of \LaTeX, are maintained separately and are not affected by these changes (and should still work).

Internally, \LaTeX2ε now includes Unicode-related engine configuration (what characters are letters, naming of primitives, etc.) which was previously part of \TeX\ Live. This change is intended to be invisible to users; a few low-level internal control sequences have been renamed or removed, but the behavior should be just the same.

pdf\TeX: Support JPEG Exif as well as JFIF; do not emit a warning if \texttt{pdfinclusionerrorlevel} is negative; sync with \texttt{xdpdf} 3.04.

Lua\TeX: New library \texttt{newtokenlib} for scanning tokens; bug fixes in the \texttt{normal} random number generator and other places.

Xe\TeX: Image handling fixes; \texttt{xdvipdfmx} binary looked for first as a sibling to \texttt{xetex}; internal \texttt{XDV} opcodes changed.
9.1.13 2016

Lua\TeX: Sweeping changes to primitives, both renames and removals, along with some node structure rearrangements. The changes are summarized in an article by Hans Hagen, “Lua\TeX 0.90 backend changes for PDF and more” (http://tug.org/TUGboat/tb37-1/tb115hagen-pdf.pdf); for all the details, see the Lua\TeX manual, texmf-dist/doc/luatex/base/luatex.pdf.

Metafont: New highly experimental sibling programs MFlua and MFluajit, integrating Lua with METAFONT, for trial testing purposes.

MetaPost: Bug fixes and internal preparations for MetaPost 2.0.

\SOURCE_DATE_EPOCH support in all engines except Lua\TeX (which will come in the next release) and original \text{} (intentionally omitted): if the environment variable \SOURCE_DATE_EPOCH is set, its value is used for timestamps in the PDF output. If \SOURCE_DATE_EPOCH_TEX_PRIMITIVES is also set, the \SOURCE_DATE_EPOCH value is used to initialize the \TeX primitives \texttt{\year, \month, \day, \time}. The pdf\TeX regular manual has examples and details.

pdf\TeX: new primitives \texttt{\pdfinfoomiodate, \pdftrailerrid, \pdfsuppresptexinfo, to control values appearing in the output which normally change with each run. These features are for PDF output only, not DVI.

\XeTeX: New primitives \texttt{\texttt{\XeTeXhyphenatablelength, \XeTeXgenerateactualtext, \XeTeXinterwordspaceshaping, \mdfivesum; character class limit increased to 4096; DVI id byte incremented.

Other utilities:

- \texttt{gregorio} is a new program, part of the \texttt{gregoriotex} package for typesetting Gregorian chant scores; it is included in shell_escape_commands by default.
- \texttt{upmendex} is an index creation program, mostly compatible with makeindex, with support for Unicode sorting, among other changes.
- \texttt{afm2tfm} now makes only accent-based height adjustments upward; a new option \texttt{-a} omits all adjustments.
- \texttt{ps2pk} can handle extended PK/GF fonts.

Mac\TeX: The \TeX Distribution Preference Pane is gone; its functionality is now in TeX Live Utility; bundled GUI applications upgraded; new script cjk-gs-integrate to be run by users who wish to incorporate various CJK fonts into Ghostscript.

Infrastructure: System-level tlmgr configuration file supported; verify package checksums; if GPG is available, verify signature of network updates. These checks happen with both the installer and tlmgr. (If GPG is not available, updates proceed as usual.)

Platforms: \texttt{alpha-linux} and \texttt{mipsel-linux} removed.

9.1.14 2017

Lua\TeX: More callbacks, more typesetting control, more access to internals; \texttt{ffi} library for dynamic code loading added on some platforms.

pdf\TeX: Environment variable \texttt{\SOURCE_DATE_EPOCH_TEX_PRIMITIVES} from last year renamed to \texttt{FORCE\SOURCE_DATE}, with no changes in functionality; if the \texttt{\pdfpageattr} token list contains the string \texttt{/MediaBox}, omit output of the default \texttt{/MediaBox}.

\XeTeX: Unicode/OpenType math now based on HarfBuzz's MATH table support; some bug fixes.

Dvips: Make the last paper size special win, for consistency with dvipdfmx and package expectations; the \texttt{-L0} option (L0 config setting) restores the previous behavior of the first special winning.
epTeX, eupTeX: New primitives \pdfuniformdeviate, \pdfnormaldeviate, \pdfrandomseed, \pdfsetrandomseed, \pdflapsedtime, \pdfresettimer, from pdfTeX.

MacTeX: As of this year, only Mac OS X releases for which Apple still releases security patches will be supported in MacTeX, under the platform name x86_64-darwin; currently this means Yosemite, El Capitan, and Sierra (10.10 and newer). Binaries for older Mac OS X versions are not included in MacTeX, but are still available in TeX Live (x86_64-darwinlegacy, i386-darwin, powerpc-darwin).

Infrastructure: The TEXMFLOCAL tree is now searched before TEXMFSYSTEM and TEXMFsysvar (by default); the hope is that this will better match expectations of local files overriding system files. Also, tlmgr has a new mode shell for interactive and scripted use, and a new action conf auxtrees to easily add and remove extra trees.

 updmap and fmtutil: These scripts now give a warning when invoked without explicitly specifying either so-called system mode ( updmap-sys, fmtutil-sys, or option -sys), or user mode ( updmap-user, fmtutil-user, or option -user). The hope is that this will reduce the perennial problem of invoking user mode by accident and thus losing future system updates. See http://tug.org/texlive/scripts-sys-user.html for details.

install-tl: Personal paths such as TEXMFHOME are now set to MacTeX values (~ /Library/...) by default on Macs. New option -init-from-profile to start an installation with the values from a given profile; new command P to explicitly save a profile; new profile variable names (but previous ones are still accepted).

SyncTeX: the name of the temporary file now looks like foo.synctex(busy), instead of foo.synctex.gz(busy) (no .gz). Front ends and build systems that want to remove temp files may need adjusting.

 Other utilities: texosquery-jre8 is a new cross-platform program for retrieving locale and other OS information from a TeX document; it is included in shell_escape_commands by default for restricted shell execution. (Older JRE versions are supported by texosquery, but cannot be enabled in restricted mode, as they are no longer supported by Oracle, even for security issues.)

Platforms: See MacTeX entry above; no other changes.

9.1.15 2018

Kpathsea: Case-insensitive filename matching now done by default in non-system directories; set texmf.cnf or environment variable texmf_casefold_search to 0 to disable. Full details in the Kpathsea manual (http://tug.org/kpathsea).

epTeX, eupTeX: New primitive \epTeXversion.

LuaTeX: Preparation for moving to Lua 5.3 in 2019: a binary luatex53 is available on most platforms, but must be renamed to luatex to be effective. Or use the ConTeXt Garden (http://wiki.contextgarden.net) files; more information there.

 MetaPost: Fixes for wrong path directions, TFM and PNG output.

pdfTeX: Allow encoding vectors for bitmap fonts; current directory not hashed into PDF ID; bug fixes for pdfprimitives and related.

XeTeX: Support /Rotate in PDF image inclusion; exit nonzero if the output driver fails; various obscure UTF-8 and other primitive fixes.

MacTeX: See version support changes below. In addition, the files installed in /Applications/TeX/ by MacTeX have been reorganized for greater clarity; now this location contains four GUI programs (BibDesk, LaToXiT, ToX Live Utility, and ToXShop) at the top level and folders with additional utilities and documentation.

 tlmgr: new front-ends tlshell (Tcl/Tk) and tlcockpit (Java); JSON output; uninstall now a synonym for remove; new action/option print-platform-info.

Platforms:

- Removed: armel-linux, powerpc-linux.
- x86_64-darwin supports 10.10–10.13 (Yosemite, El Capitan, Sierra, and High Sierra).
- x86_64-darwinlegacy supports 10.6–10.10 (though x86_64-darwin is preferred for 10.10). All support for 10.5 (Leopard) is gone, that is, both the powerpc-darwin and i386-darwin platforms have been removed.
- Windows: XP is no longer supported.

9.2 Present: 2019

Kpathsea: More consistent brace expansion and path splitting; new variable TEXMFHOME instead of hard-coded ~ in paths allows for easily searching additional or sub-directories (see comments in
9.3 Future

\TeX\ Live is not perfect, and never will be. We intend to continue to release new versions, and would like to provide more documentation, more programs, an ever-improved and better-checked tree of macros and fonts, and anything else \TeX\ Live. This work is all done by volunteers in their spare time, and so there is always more to do. Please see http://tug.org/texlive/contribute.html.

Please send corrections, suggestions, and offers of help to:

\texttt{tex-live@tug.org}
\texttt{http://tug.org/texlive}

\textit{Happy \TeX\Xing!}