

lualatex.dtx
(LuaTeX-specific support)

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*Significant portions of the code here are adapted/simplified from the packages `luatex` and `luatexbase` written by Heiko Oberdiek, Élie Roux, Manuel Pégourié-Gonnar and Philipp Gesang.

1 Overview

LuaTeX adds a number of engine-specific functions to TeX. Several of these require set up that is best done in the kernel or need related support functions. This file provides *basic* support for LuaTeX at the L^AT_εX kernel level plus as a loadable file which can be used with plain TeX and L^AT_εX.

This file contains code for both TeX (to be stored as part of the format) and Lua (to be loaded at the start of each job). In the Lua code, the kernel uses the namespace `luatexbase`.

The following `\count` registers are used here for register allocation:

```
\e@alloc@attribute@count Attributes (default 258)
\e@alloc@ccodetable@count Category code tables (default 259)
\e@alloc@luafunction@count Lua functions (default 260)
  \e@alloc@whatsit@count User whatsits (default 261)
  \e@alloc@bytecode@count Lua bytecodes (default 262)
  \e@alloc@luachunk@count Lua chunks (default 263)
```

(`\count 256` is used for `\newmarks` allocation and `\count 257` is used for `\newXeTeXintercharclass` with XeTeX, with code defined in `ltfinal.dtx`). With any L^AT_εX kernel from 2015 onward these registers are part of the block in the extended area reserved by the kernel (prior to 2015 the L^AT_εX kernel did not provide any functionality for the extended allocation area).

2 Core TeX functionality

The commands defined here are defined for possible inclusion in a future L^AT_εX format, however also extracted to the file `ltluatex.tex` which may be used with older L^AT_εX formats, and with plain TeX.

```
\newattribute \newattribute{attribute}
Defines a named \attribute, indexed from 1 (i.e. \attribute0 is never defined).
Attributes initially have the marker value -"7FFFFFFF ('unset') set by the engine.
\newcatcodetable \newcatcodetable{catcodetable}
Defines a named \catcodetable, indexed from 1 (\catcodetable0 is never assigned).
A new catcode table will be populated with exactly those values assigned by IniTeX (as described in the LuaTeX manual).
\newluafunction \newluafunction{function}
Defines a named \luafunction, indexed from 1. (Lua indexes tables from 1 so \luafunction0 is not available).
\newwhatsit \newwhatsit{whatsit}
Defines a custom \whatsit, indexed from 1.
\newluabytecode \newluabytecode{bytecode}
Allocates a number for Lua bytecode register, indexed from 1.
\newluachunkname newluachunkname{chunkname}
Allocates a number for Lua chunk register, indexed from 1. Also enters the name of the register (without backslash) into the lua.name table to be used in stack traces.
```

<code>\catcodetable@initex</code>	Predefined category code tables with the obvious assignments. Note that the
<code>\catcodetable@string</code>	<code>latex</code> and <code>atletter</code> tables set the full Unicode range to the codes predefined by
<code>\catcodetable@latex</code>	the kernel.
<code>\catcodetable@attribute</code>	<code>\setattribute{⟨attribute⟩}{⟨value⟩}</code>
<code>\unsetattribute</code>	<code>\unsetattribute{⟨attribute⟩}</code>

Set and unset attributes in a manner analogous to `\setlength`. Note that attributes take a marker value when unset so this operation is distinct from setting the value to zero.

3 Plain T_EX interface

The `ltluatex` interface may be used with plain T_EX using `\input{ltluatex}`. This inputs `ltluatex.tex` which inputs `etex.src` (or `etex.sty` if used with L^AT_EX) if it is not already input, and then defines some internal commands to allow the `ltluatex` interface to be defined.

The `luatexbase` package interface may also be used in plain T_EX, as before, by inputting the package `\input luatexbase.sty`. The new version of `luatexbase` is based on this `ltluatex` code but implements a compatibility layer providing the interface of the original package.

4 Lua functionality

4.1 Allocators in Lua

<code>new_attribute</code>	<code>luatexbase.new_attribute(⟨attribute⟩)</code> Returns an allocation number for the <code>⟨attribute⟩</code> , indexed from 1. The attribute will be initialised with the marker value <code>-"7FFFFFFF</code> ('unset'). The attribute allocation sequence is shared with the T _E X code but this function does <i>not</i> define a token using <code>\attributedef</code> . The attribute name is recorded in the <code>attributes</code> table. A metatable is provided so that the table syntax can be used consistently for attributes declared in T _E X or Lua.
<code>new_whatsit</code>	<code>luatexbase.new_whatsit(⟨whatsit⟩)</code> Returns an allocation number for the custom <code>⟨whatsit⟩</code> , indexed from 1.
<code>new_bytecode</code>	<code>luatexbase.new_bytecode(⟨bytecode⟩)</code> Returns an allocation number for a bytecode register, indexed from 1. The optional <code>⟨name⟩</code> argument is just used for logging.
<code>new_chunkname</code>	<code>luatexbase.new_chunkname(⟨chunkname⟩)</code> Returns an allocation number for a Lua chunk name for use with <code>\directlua</code> and <code>\latelua</code> , indexed from 1. The number is returned and also <code>⟨name⟩</code> argument is added to the <code>lua.name</code> array at that index.
<code>new_luafunction</code>	<code>luatexbase.new_luafunction(⟨functionname⟩)</code> Returns an allocation number for a lua function for use with <code>\luafunction</code> , <code>\lateluafunction</code> , and <code>\luadef</code> , indexed from 1. The optional <code>⟨functionname⟩</code> argument is just used for logging.

These functions all require access to a named T_EX count register to manage their allocations. The standard names are those defined above for access from T_EX, *e.g.* `"e@alloc@attribute@count`, but these can be adjusted by defining the variable `⟨type⟩_count_name` before loading `ltluatex.lua`, for example

```
local attribute_count_name = "attributetracker"
require("lualuatex")
```

would use a TeX `\count` (`\countdef`'d token) called `attributetracker` in place of `"e@alloc@attribute@count"`.

4.2 Lua access to TeX register numbers

`registernumber` `luatexbase.registernumber(<name>)`

Sometimes (notably in the case of Lua attributes) it is necessary to access a register *by number* that has been allocated by TeX. This package provides a function to look up the relevant number using LuaTeX's internal tables. After for example `\newattribute\myattrib`, `\myattrib` would be defined by (say) `\myattrib=\attribute15`. `luatexbase.registernumber("myattrib")` would then return the register number, 15 in this case. If the string passed as argument does not correspond to a token defined by `\attributedef`, `\countdef` or similar commands, the Lua value `false` is returned.

As an example, consider the input:

```
\newcommand\test[1]{%
\typeout{#1: \expandafter\meaning\csname#1\endcsname^^J
\space\space\space\space
\directlua{tex.write(luatexbase.registernumber("#1") or "bad input")}%
}}

\test{undefinedrubbish}

\test{space}

\test{hbox}

\test{@MM}

\test{@tempdima}
\test{@tempdimb}

\test{strutbox}

\test{sixt@@n}

\attributedef\myattr=12
\myattr=200
\test{myattr}
```

If the demonstration code is processed with LuaLaTeX then the following would be produced in the log and terminal output.

```
undefinedrubbish: \relax
bad input
space: macro:->
bad input
hbox: \hbox
```

```

        bad input
@MM: \mathchar"4E20
    20000
@tempdima: \dimen14
    14
@tempdimb: \dimen15
    15
strutbox: \char"B
    11
sixt@n: \char"10
    16
myattr: \attribute12
    12

```

Notice how undefined commands, or commands unrelated to registers do not produce an error, just return `false` and so print `bad input` here. Note also that commands defined by `\newbox` work and return the number of the box register even though the actual command holding this number is a `\chardef` defined token (there is no `\boxdef`).

4.3 Module utilities

`provides_module` `luatexbase.provides_module(<info>)`
This function is used by modules to identify themselves; the `info` should be a table containing information about the module. The required field `name` must contain the name of the module. It is recommended to provide a field `date` in the usual L^AT_EX format `yyyy/mm/dd`. Optional fields `version` (a string) and `description` may be used if present. This information will be recorded in the log. Other fields are ignored.

`module_info` `luatexbase.module_info(<module>, <text>)`
`module_warning` `luatexbase.module_warning(<module>, <text>)`
`module_error` `luatexbase.module_error(<module>, <text>)`

These functions are similar to L^AT_EX's `\PackageError`, `\PackageWarning` and `\PackageInfo` in the way they format the output. No automatic line breaking is done, you may still use `\n` as usual for that, and the name of the package will be prepended to each output line.

Note that `luatexbase.module_error` raises an actual Lua error with `error()`, which currently means a call stack will be dumped. While this may not look pretty, at least it provides useful information for tracking the error down.

4.4 Callback management

`add_to_callback` `luatexbase.add_to_callback(<callback>, <function>, <description>)` Registers the `<function>` into the `<callback>` with a textual `<description>` of the function. Functions are inserted into the callback in the order loaded.

`remove_from_callback` `luatexbase.remove_from_callback(<callback>, <description>)` Removes the callback function with `<description>` from the `<callback>`. The removed function and its description are returned as the results of this function.

`in_callback` `luatexbase.in_callback(<callback>, <description>)` Checks if the `<description>` matches one of the functions added to the list for the `<callback>`, returning a boolean value.

<code>disable_callback</code>	<code>luatexbase.disable_callback(<callback>)</code> Sets the <code><callback></code> to <code>false</code> as described in the LuaTeX manual for the underlying <code>callback.register</code> built-in. Callbacks will only be set to <code>false</code> (and thus be skipped entirely) if there are no functions registered using the callback.
<code>callback_descriptions</code>	A list of the descriptions of functions registered to the specified callback is returned. <code>{}</code> is returned if there are no functions registered.
<code>create_callback</code>	<code>luatexbase.create_callback(<name>,metatype,<default>)</code> Defines a user defined callback. The last argument is a default function or <code>false</code> .
<code>call_callback</code>	<code>luatexbase.call_callback(<name>,...)</code> Calls a user defined callback with the supplied arguments.

5 Implementation

```

1 <*2ekernel | tex | latexrelease>
2 <2ekernel | latexrelease>\ifx\directlua\undefined\else

```

5.1 Minimum LuaTeX version

LuaTeX has changed a lot over time. In the kernel support for ancient versions is not provided: trying to build a format with a very old binary therefore gives some information in the log and loading stops. The cut-off selected here relates to the tree-searching behaviour of `require()`: from version 0.60, LuaTeX will correctly find Lua files in the `texmf` tree without ‘help’.

```

3 <latexrelease>\IncludeInRelease{2015/10/01}
4 <latexrelease>          {\newluafunction}{LuaTeX}%
5 \ifnum\luatexversion<60 %
6   \wlog{*****}
7   \wlog{* LuaTeX version too old for ltuatex support *}
8   \wlog{*****}
9   \expandafter\endinput
10 \fi

```

Two simple L^AT_EX macros from `ltdfn.s.dtx` have to be defined here because `ltdfn.s.dtx` is not loaded yet when `ltluatex.dtx` is executed.

```

11 \long\def@gobble#1{}
12 \long\def@firstofone#1{#1}

```

5.2 Older L^AT_EX/Plain T_EX setup

```

13 <*tex>

```

Older L^AT_EX formats don’t have the primitives with ‘native’ names: sort that out. If they already exist this will still be safe.

```

14 \directlua{tex.enableprimitives("",tex.extraprimitives("luatex"))}
15 \ifx\@alloc\undefined

```

In pre-2014 L^AT_EX, or plain T_EX, load `etex.{sty,src}`.

```

16 \ifx\documentclass\undefined
17   \ifx\loccount\undefined
18     \input{etex.src}%
19   \fi
20   \catcode'\@=11 %
21   \outer\expandafter\def\csname newfam\endcsname

```

```

22                                     {\alloc@8\fam\chardef\et@xmaxfam}
23 \else
24   \RequirePackage{etex}
25   \expandafter\def\csname newfam\endcsname
26     {\alloc@8\fam\chardef\et@xmaxfam}
27   \expandafter\let\expandafter\new@mathgroup\csname newfam\endcsname
28   \fi

```

5.2.1 Fixes to etex.src/etex.sty

These could and probably should be made directly in an update to `etex.src` which already has some Lua_T_E_X-specific code, but does not define the correct range for Lua_T_E_X.

2015-07-13 higher range in luatex.

```

29 \edef \et@xmaxregs {\ifx\directlua\@undefined 32768\else 65536\fi}

```

luatex/xetex also allow more math fam.

```

30 \edef \et@xmaxfam {\ifx\Umathcode\@undefined\sixt@n\else\@cclvi\fi}
31 \count 270=\et@xmaxregs % locally allocates \count registers
32 \count 271=\et@xmaxregs % ditto for \dimen registers
33 \count 272=\et@xmaxregs % ditto for \skip registers
34 \count 273=\et@xmaxregs % ditto for \muskip registers
35 \count 274=\et@xmaxregs % ditto for \box registers
36 \count 275=\et@xmaxregs % ditto for \toks registers
37 \count 276=\et@xmaxregs % ditto for \marks classes

```

and 256 or 16 fam. (Done above due to plain/L_AT_EX differences in l_Tuatex.)

```

38 % \outer\def\newfam{\alloc@8\fam\chardef\et@xmaxfam}

```

End of proposed changes to `etex.src`

5.2.2 luatex specific settings

Switch to global cf `luatex.sty` to leave room for inserts not really needed for luatex but possibly most compatible with existing use.

```

39 \expandafter\let\csname newcount\expandafter\expandafter\endcsname
40   \csname globcount\endcsname
41 \expandafter\let\csname newdimen\expandafter\expandafter\endcsname
42   \csname globdimen\endcsname
43 \expandafter\let\csname newskip\expandafter\expandafter\endcsname
44   \csname globskip\endcsname
45 \expandafter\let\csname newbox\expandafter\expandafter\endcsname
46   \csname globbox\endcsname

```

Define `\e@alloc` as in latex (the existing macros in `etex.src` hard to extend to further register types as they assume specific 26x and 27x count range. For compatibility the existing register allocation is not changed.

```

47 \chardef\e@alloc@top=65535
48 \let\e@alloc\chardef\chardef
49 \def\e@alloc#1#2#3#4#5#6{%
50   \global\advance#3\@ne
51   \e@ch@ck{#3}{#4}{#5}#1%
52   \allocationnumber#3\relax
53   \global#2#6\allocationnumber
54   \wlog{\string#6=\string#1\the\allocationnumber}}%

```

```

55 \gdef\ech@ck#1#2#3#4{%
56   \ifnum#1<#2\else
57     \ifnum#1=#2\relax
58       #1\@cclvi
59       \ifx\count#4\advance#1 10 \fi
60     \fi
61     \ifnum#1<#3\relax
62     \else
63       \errmessage{No room for a new \string#4}%
64     \fi
65   \fi}%

```

Fix up allocations not to clash with `etex.src`.

```

66 \expandafter\csname newcount\endcsname\@alloc@attribute@count
67 \expandafter\csname newcount\endcsname\@alloc@ccodetable@count
68 \expandafter\csname newcount\endcsname\@alloc@luafunction@count
69 \expandafter\csname newcount\endcsname\@alloc@whatsit@count
70 \expandafter\csname newcount\endcsname\@alloc@bytecode@count
71 \expandafter\csname newcount\endcsname\@alloc@luachunk@count

```

End of conditional setup for plain TeX / old L^AT_EX.

```

72 \fi
73 </tex>

```

5.3 Attributes

`\newattribute` As is generally the case for the LuaTeX registers we start here from 1. Notably, some code assumes that `\attribute0` is never used so this is important in this case.

```

74 \ifx\@alloc@attribute@count\undefined
75   \countdef\@alloc@attribute@count=258
76   \e@alloc@attribute@count=\z@
77 \fi
78 \def\newattribute#1{%
79   \e@alloc\attribute\attributedef
80   \e@alloc@attribute@count\m@ne\@alloc@top#1%
81 }

```

`\setattribute` Handy utilities.

```

\unsetattribute 82 \def\setattribute#1#2{#1=\numexpr#2\relax}
83 \def\unsetattribute#1{#1=-"7FFFFFFF\relax}

```

5.4 Category code tables

`\newcatcodetable` Category code tables are allocated with a limit half of that used by LuaTeX for everything else. At the end of allocation there needs to be an initialisation step. Table 0 is already taken (it's the global one for current use) so the allocation starts at 1.

```

84 \ifx\@alloc@ccodetable@count\undefined
85   \countdef\@alloc@ccodetable@count=259
86   \e@alloc@ccodetable@count=\z@
87 \fi
88 \def\newcatcodetable#1{%

```



```

89 \e@alloc\catcodetable\chardef
90 \e@alloc\ccodetable@count\m@ne{"8000}#1%
91 \initcatcodetable\allocationnumber
92 }

```

\catcodetable@initex Save a small set of standard tables. The Unicode data is read here in using a parser
\catcodetable@string simplified from that in load-unicode-data: only the nature of letters needs to
\catcodetable@latex be detected.

```

\catcodetable@atletter 93 \newcatcodetable\catcodetable@initex
94 \newcatcodetable\catcodetable@string
95 \begingroup
96 \def\setrange#1#2#3{%
97 \ifnum#1>#2 %
98 \expandafter\@gobble
99 \else
100 \expandafter\@firstofone
101 \fi
102 {%
103 \catcode#1=#3 %
104 \expandafter\setrange#1#2#3\expandafter
105 {\number\numexpr#1 + 1\relax}{#2}{#3}
106 }%
107 }
108 \@firstofone{%
109 \catcodetable\catcodetable@initex
110 \catcode0=12 %
111 \catcode13=12 %
112 \catcode37=12 %
113 \setrange#1#2#3\relax%
114 \setrange#1#2#3\relax%
115 \catcode92=12 %
116 \catcode127=12 %
117 \savecatcodetable\catcodetable@string
118 \endgroup
119 }%
120 \newcatcodetable\catcodetable@latex
121 \newcatcodetable\catcodetable@atletter
122 \begingroup
123 \def\parseunicodedataI#1;#2;#3;#4\relax{%
124 \parseunicodedataII#1;#3;#2 First>\relax
125 }%
126 \def\parseunicodedataII#1;#2;#3 First>#4\relax{%
127 \ifx\relax#4\relax
128 \expandafter\parseunicodedataIII
129 \else
130 \expandafter\parseunicodedataIV
131 \fi
132 {#1}#2\relax%
133 }%
134 \def\parseunicodedataIII#1#2#3\relax{%
135 \ifnum 0%
136 \if L#21\fi
137 \if M#21\fi
138 >0 %

```

```

139     \catcode"#1=11 %
140     \fi
141 }%
142 \def\parseunicodedataIV#1#2#3\relax{%
143   \read\unicoderead to \unicodedataline
144   \if L#2%
145     \count0="#1 %
146     \expandafter\parseunicodedataV\unicodedataline\relax
147   \fi
148 }%
149 \def\parseunicodedataV#1;#2\relax{%
150   \loop
151     \unless\ifnum\count0>"#1 %
152       \catcode\count0=11 %
153       \advance\count0 by 1 %
154   \repeat
155 }%
156 \def\storedpar{\par}%
157 \chardef\unicoderead=\numexpr\count16 + 1\relax
158 \openin\unicoderead=UnicodeData.txt %
159 \loop\unless\ifeof\unicoderead %
160   \read\unicoderead to \unicodedataline
161   \unless\ifx\unicodedataline\storedpar
162     \expandafter\parseunicodedataI\unicodedataline\relax
163   \fi
164 \repeat
165 \closein\unicoderead
166 \@firstofone{%
167   \catcode64=12 %
168   \savecatcodetable\catcodetable@latex
169   \catcode64=11 %
170   \savecatcodetable\catcodetable@atletter
171 }
172 \endgroup

```

5.5 Named Lua functions

`\newluafunction` Much the same story for allocating Lua_{TEX} functions except here they are just numbers so they are allocated in the same way as boxes. Lua indexes from 1 so once again slot 0 is skipped.

```

173 \ifx\e@alloc@luafunction@count\@undefined
174   \countdef\e@alloc@luafunction@count=260
175   \e@alloc@luafunction@count=\z@
176 \fi
177 \def\newluafunction{%
178   \e@alloc@luafunction\e@alloc@chardef
179   \e@alloc@luafunction@count\m@ne\e@alloc@top
180 }

```

5.6 Custom whatsits

`\newwhatsit` These are only settable from Lua but for consistency are definable here.

```

181 \ifx\e@alloc@whatsit@count\@undefined

```

```

182 \countdef\@alloc@whatsit@count=261
183 \@alloc@whatsit@count=\z@
184 \fi
185 \def\newwhatsit#1{%
186 \@alloc@whatsit\@alloc@chardef
187 \@alloc@whatsit@count\m@ne\@alloc@top#1%
188 }

```

5.7 Lua bytecode registers

`\newluabytocode` These are only settable from Lua but for consistency are definable here.

```

189 \ifx\@alloc@bytecode@count\@undefined
190 \countdef\@alloc@bytecode@count=262
191 \@alloc@bytecode@count=\z@
192 \fi
193 \def\newluabytocode#1{%
194 \@alloc@luabytocode\@alloc@chardef
195 \@alloc@bytecode@count\m@ne\@alloc@top#1%
196 }

```

5.8 Lua chunk registers

`\newluachunkname` As for bytecode registers, but in addition we need to add a string to the `lua.name` table to use in stack tracing. We use the name of the command passed to the allocator, with no backslash.

```

197 \ifx\@alloc@luachunk@count\@undefined
198 \countdef\@alloc@luachunk@count=263
199 \@alloc@luachunk@count=\z@
200 \fi
201 \def\newluachunkname#1{%
202 \@alloc@luachunk\@alloc@chardef
203 \@alloc@luachunk@count\m@ne\@alloc@top#1%
204 {\escapechar\m@ne
205 \directlua{lua.name[\the\allocationnumber]="\string#1"}}%
206 }

```

5.9 Lua loader

Lua code loaded in the format often has to be loaded again at the beginning of every job, so we define a helper which allows us to avoid duplicated code:

```

207 \def\now@and@everyjob#1{%
208 \@everyjob\expandafter{\the\everyjob
209 #1%
210 }%
211 #1%
212 }

```

Load the Lua code at the start of every job. For the conversion of `TEX` into numbers at the Lua side we need some known registers: for convenience we use a set of systematic names, which means using a group around the Lua loader.

```

213 <2kernel>\now@and@everyjob{%
214 \begingroup

```

```

215 \attributedef\attributezero=0 %
216 \chardef \charzero =0 %

Note name change required on older luatex, for hash table access.

217 \countdef \CountZero =0 %
218 \dimendef \dimenzero =0 %
219 \mathchardef \mathcharzero =0 %
220 \muskipdef \muskipzero =0 %
221 \skipdef \skipzero =0 %
222 \toksdef \tokszero =0 %
223 \directlua{require("lualatex")}
224 \endgroup
225 <2kernel>}
226 <latexrelease> \EndIncludeInRelease

227 <latexrelease> \IncludeInRelease{0000/00/00}
228 <latexrelease> {\newluafunction}{LuaTeX}%
229 <latexrelease> \let\@alloc@attribute@count\@undefined
230 <latexrelease> \let\newattribute\@undefined
231 <latexrelease> \let\setattribute\@undefined
232 <latexrelease> \let\unsetattribute\@undefined
233 <latexrelease> \let\@alloc@ccodetable@count\@undefined
234 <latexrelease> \let\newcatcodetable\@undefined
235 <latexrelease> \let\catcodetable@initex\@undefined
236 <latexrelease> \let\catcodetable@string\@undefined
237 <latexrelease> \let\catcodetable@latex\@undefined
238 <latexrelease> \let\catcodetable@atletter\@undefined
239 <latexrelease> \let\@alloc@luafunction@count\@undefined
240 <latexrelease> \let\newluafunction\@undefined
241 <latexrelease> \let\@alloc@luafunction@count\@undefined
242 <latexrelease> \let\newwhatsit\@undefined
243 <latexrelease> \let\@alloc@whatsit@count\@undefined
244 <latexrelease> \let\newluabytecode\@undefined
245 <latexrelease> \let\@alloc@bytecode@count\@undefined
246 <latexrelease> \let\newluachunkname\@undefined
247 <latexrelease> \let\@alloc@luachunk@count\@undefined
248 <latexrelease> \directlua{luatexbase.uninstall()}
249 <latexrelease> \EndIncludeInRelease

```

In `\everyjob`, if `luaotfload` is available, load it and switch to TU.

```

250 <latexrelease> \IncludeInRelease{2017/01/01}%
251 <latexrelease> {\fontencoding}{TU in everyjob}%
252 <latexrelease> \fontencoding{TU}\let\encodingdefault\f@encoding
253 <latexrelease> \ifx\directlua\@undefined\else
254 <2kernel> \everyjob\expandafter{%
255 <2kernel> \the\everyjob
256 <*2kernel, latexrelease>
257 \directlua{%
258 if xpcall(function ()%
259             require('luaotfload-main')%
260             end, texio.write_nl) then %
261 local _void = luaotfload.main ()%
262 else %
263 texio.write_nl('Error in luaotfload: reverting to OT1')%
264 tex.print('\string\def\string\encodingdefault{OT1}')%

```

```

265 end %
266 }%
267 \let\f@encoding\encodingdefault
268 \expandafter\let\csname ver@luaotfload.sty\endcsname\fmtversion
269 </2ekernel, latexrelease>
270 <latexrelease> \fi
271 <2ekernel> }
272 <latexrelease> \EndIncludeInRelease
273 <latexrelease> \IncludeInRelease{0000/00/00}%
274 <latexrelease> {\fontencoding}{TU in everyjob}%
275 <latexrelease> \fontencoding{OT1}\let\encodingdefault\f@encoding
276 <latexrelease> \EndIncludeInRelease
277 <2ekernel | latexrelease> \fi
278 </2ekernel | tex | latexrelease>

```

5.10 Lua module preliminaries

```
279 <*lua>
```

Some set up for the Lua module which is needed for all of the Lua functionality added here.

luatexbase Set up the table for the returned functions. This is used to expose all of the public functions.

```
280 luatexbase = luatexbase or { }
281 local luatexbase = luatexbase
```

Some Lua best practice: use local versions of functions where possible.

```

282 local string_gsub = string.gsub
283 local tex_count = tex.count
284 local tex_setattribute = tex.setattribute
285 local tex_setcount = tex.setcount
286 local texio_write_nl = texio.write_nl

287 local luatexbase_warning
288 local luatexbase_error

```

5.11 Lua module utilities

5.11.1 Module tracking

modules To allow tracking of module usage, a structure is provided to store information and to return it.

```
289 local modules = modules or { }
```

provides_module Local function to write to the log.

```

290 local function luatexbase_log(text)
291 texio_write_nl("log", text)
292 end

```

Modelled on `\ProvidesPackage`, we store much the same information but with a little more structure.

```

293 local function provides_module(info)
294 if not (info and info.name) then
295 luatexbase_error("Missing module name for provides_module")

```

```

296 end
297 local function spaced(text)
298   return text and (" " .. text) or ""
299 end
300 luatexbase_log(
301   "Lua module: " .. info.name
302   .. spaced(info.date)
303   .. spaced(info.version)
304   .. spaced(info.description)
305 )
306 modules[info.name] = info
307 end
308 luatexbase.provides_module = provides_module

```

5.11.2 Module messages

There are various warnings and errors that need to be given. For warnings we can get exactly the same formatting as from \TeX . For errors we have to make some changes. Here we give the text of the error in the \LaTeX format then force an error from Lua to halt the run. Splitting the message text is done using `\n` which takes the place of `\MessageBreak`.

First an auxiliary for the formatting: this measures up the message leader so we always get the correct indent.

```

309 local function msg_format(mod, msg_type, text)
310   local leader = ""
311   local cont
312   local first_head
313   if mod == "LaTeX" then
314     cont = string_gsub(leader, ".", " ")
315     first_head = leader .. "LaTeX: "
316   else
317     first_head = leader .. "Module " .. msg_type
318     cont = "(" .. mod .. ")"
319     .. string_gsub(first_head, ".", " ")
320     first_head = leader .. "Module " .. mod .. " " .. msg_type .. ":"
321   end
322   if msg_type == "Error" then
323     first_head = "\n" .. first_head
324   end
325   if string.sub(text,-1) ~= "\n" then
326     text = text .. " "
327   end
328   return first_head .. " "
329   .. string_gsub(
330     text
331     .. "on input line "
332     .. tex.inputlineno, "\n", "\n" .. cont .. " "
333   )
334   .. "\n"
335 end

```

```

module_info Write messages.
module_warning 336 local function module_info(mod, text)
module_error

```

```

337 texio_write_nl("log", msg_format(mod, "Info", text))
338 end
339 luatexbase.module_info = module_info
340 local function module_warning(mod, text)
341   texio_write_nl("term and log",msg_format(mod, "Warning", text))
342 end
343 luatexbase.module_warning = module_warning
344 local function module_error(mod, text)
345   error(msg_format(mod, "Error", text))
346 end
347 luatexbase.module_error = module_error

```

Dedicated versions for the rest of the code here.

```

348 function luatexbase_warning(text)
349   module_warning("luatexbase", text)
350 end
351 function luatexbase_error(text)
352   module_error("luatexbase", text)
353 end

```

5.12 Accessing register numbers from Lua

Collect up the data from the \TeX level into a Lua table: from version 0.80, Lua \TeX makes that easy.

```

354 local luaregisterbasetable = { }
355 local registermap = {
356   attributezero = "assign_attr"   ,
357   charzero      = "char_given"    ,
358   CountZero     = "assign_int"    ,
359   dimenzero     = "assign_dimen"  ,
360   mathcharzero  = "math_given"    ,
361   muskipzero    = "assign_mu_skip",
362   skipzero      = "assign_skip"   ,
363   tokszero     = "assign_toks"    ,
364 }
365 local createtoken
366 if tex.luatexversion > 81 then
367   createtoken = token.create
368 elseif tex.luatexversion > 79 then
369   createtoken = newtoken.create
370 end
371 local hashtokens = tex.hashtokens()
372 local luatexversion = tex.luatexversion
373 for i,j in pairs (registermap) do
374   if luatexversion < 80 then
375     luaregisterbasetable[hashtokens[i][1]] =
376       hashtokens[i][2]
377   else
378     luaregisterbasetable[j] = createtoken(i).mode
379   end
380 end

```

registernumber Working out the correct return value can be done in two ways. For older Lua \TeX releases it has to be extracted from the `hashtokens`. On the other hand, newer

LuaTeX's have `newtoken`, and whilst `.mode` isn't currently documented, Hans Hagen pointed to this approach so we should be OK.

```

381 local registernumber
382 if luatexversion < 80 then
383   function registernumber(name)
384     local nt = hashtokens[name]
385     if(nt and luaregisterbasetable[nt[1]]) then
386       return nt[2] - luaregisterbasetable[nt[1]]
387     else
388       return false
389     end
390   end
391 else
392   function registernumber(name)
393     local nt = createtoken(name)
394     if(luaregisterbasetable[nt.cmdname]) then
395       return nt.mode - luaregisterbasetable[nt.cmdname]
396     else
397       return false
398     end
399   end
400 end
401 luatexbase.registernumber = registernumber

```

5.13 Attribute allocation

`new_attribute` As attributes are used for Lua manipulations its useful to be able to assign from this end.

```

402 local attributes=setmetatable(
403 {}),
404 {
405   __index = function(t,key)
406     return registernumber(key) or nil
407   end}
408 )
409 luatexbase.attributes = attributes
410 local attribute_count_name =
411   attribute_count_name or "e@alloc@attribute@count"
412 local function new_attribute(name)
413   tex_setcount("global", attribute_count_name,
414     tex_count[attribute_count_name] + 1)
415   if tex_count[attribute_count_name] > 65534 then
416     luatexbase_error("No room for a new \\attribute")
417   end
418   attributes[name]= tex_count[attribute_count_name]
419   luatexbase_log("Lua-only attribute " .. name .. " = " ..
420     tex_count[attribute_count_name])
421   return tex_count[attribute_count_name]
422 end
423 luatexbase.new_attribute = new_attribute

```


5.14 Custom whatsit allocation

`new_whatsit` Much the same as for attribute allocation in Lua.

```
424 local whatsit_count_name = whatsit_count_name or "e@alloc@whatsit@count"
425 local function new_whatsit(name)
426   tex_setcount("global", whatsit_count_name,
427               tex_count[whatsit_count_name] + 1)
428   if tex_count[whatsit_count_name] > 65534 then
429     luatexbase_error("No room for a new custom whatsit")
430   end
431   luatexbase_log("Custom whatsit " .. (name or "") .. " = " ..
432                 tex_count[whatsit_count_name])
433   return tex_count[whatsit_count_name]
434 end
435 luatexbase.new_whatsit = new_whatsit
```

5.15 Bytecode register allocation

`new_bytecode` Much the same as for attribute allocation in Lua. The optional $\langle name \rangle$ argument is used in the log if given.

```
436 local bytecode_count_name =
437   bytecode_count_name or "e@alloc@bytecode@count"
438 local function new_bytecode(name)
439   tex_setcount("global", bytecode_count_name,
440               tex_count[bytecode_count_name] + 1)
441   if tex_count[bytecode_count_name] > 65534 then
442     luatexbase_error("No room for a new bytecode register")
443   end
444   luatexbase_log("Lua bytecode " .. (name or "") .. " = " ..
445                 tex_count[bytecode_count_name])
446   return tex_count[bytecode_count_name]
447 end
448 luatexbase.new_bytecode = new_bytecode
```

5.16 Lua chunk name allocation

`new_chunkname` As for bytecode registers but also store the name in the `lua.name` table.

```
449 local chunkname_count_name =
450   chunkname_count_name or "e@alloc@luachunk@count"
451 local function new_chunkname(name)
452   tex_setcount("global", chunkname_count_name,
453               tex_count[chunkname_count_name] + 1)
454   local chunkname_count = tex_count[chunkname_count_name]
455   chunkname_count = chunkname_count + 1
456   if chunkname_count > 65534 then
457     luatexbase_error("No room for a new chunkname")
458   end
459   lua.name[chunkname_count]=name
460   luatexbase_log("Lua chunkname " .. (name or "") .. " = " ..
461                 chunkname_count .. "\n")
462   return chunkname_count
463 end
464 luatexbase.new_chunkname = new_chunkname
```

5.17 Lua function allocation

`new_luafunction` Much the same as for attribute allocation in Lua. The optional $\langle name \rangle$ argument is used in the log if given.

```
465 local luafunction_count_name =
466         luafunction_count_name or "e@alloc@luafunction@count"
467 local function new_luafunction(name)
468     tex_setcount("global", luafunction_count_name,
469         tex_count[luafunction_count_name] + 1)
470     if tex_count[luafunction_count_name] > 65534 then
471         luatexbase_error("No room for a new luafunction register")
472     end
473     luatexbase_log("Lua function " .. (name or "") .. " = " ..
474         tex_count[luafunction_count_name])
475     return tex_count[luafunction_count_name]
476 end
477 luatexbase.new_luafunction = new_luafunction
```

5.18 Lua callback management

The native mechanism for callbacks in LuaTeX allows only one per function. That is extremely restrictive and so a mechanism is needed to add and remove callbacks from the appropriate hooks.

5.18.1 Housekeeping

The main table: keys are callback names, and values are the associated lists of functions. More precisely, the entries in the list are tables holding the actual function as `func` and the identifying description as `description`. Only callbacks with a non-empty list of functions have an entry in this list.

```
478 local callbacklist = callbacklist or { }
```

Numerical codes for callback types, and name-to-value association (the table keys are strings, the values are numbers).

```
479 local list, data, exclusive, simple, reverselist = 1, 2, 3, 4, 5
480 local types = {
481     list      = list,
482     data      = data,
483     exclusive = exclusive,
484     simple    = simple,
485     reverselist = reverselist,
486 }
```

Now, list all predefined callbacks with their current type, based on the LuaTeX manual version 1.01. A full list of the currently-available callbacks can be obtained using

```
\directlua{
  for i,_ in pairs(callback.list()) do
    texio.write_nl("- " .. i)
  end
}
```

```
\bye
```

in plain LuaTeX. (Some undocumented callbacks are omitted as they are to be removed.)

```
487 local callbacktypes = callbacktypes or {
```

Section 8.2: file discovery callbacks.

```
488 find_read_file      = exclusive,
489 find_write_file     = exclusive,
490 find_font_file      = data,
491 find_output_file    = data,
492 find_format_file    = data,
493 find_vf_file        = data,
494 find_map_file       = data,
495 find_enc_file       = data,
496 find_pk_file        = data,
497 find_data_file      = data,
498 find_opentype_file  = data,
499 find_truetype_file  = data,
500 find_type1_file     = data,
501 find_image_file     = data,

502 open_read_file      = exclusive,
503 read_font_file      = exclusive,
504 read_vf_file        = exclusive,
505 read_map_file       = exclusive,
506 read_enc_file       = exclusive,
507 read_pk_file        = exclusive,
508 read_data_file      = exclusive,
509 read_truetype_file  = exclusive,
510 read_type1_file     = exclusive,
511 read_opentype_file  = exclusive,
```

Not currently used by luatex but included for completeness. may be used by a font handler.

```
512 find_cidmap_file   = data,
513 read_cidmap_file    = exclusive,
```

Section 8.3: data processing callbacks.

```
514 process_input_buffer = data,
515 process_output_buffer = data,
516 process_jobname      = data,
```

Section 8.4: node list processing callbacks.

```
517 contribute_filter   = simple,
518 buildpage_filter    = simple,
519 build_page_insert   = exclusive,
520 pre_linebreak_filter = list,
521 linebreak_filter    = exclusive,
522 append_to_vlist_filter = exclusive,
523 post_linebreak_filter = reverselist,
524 hpack_filter        = list,
525 vpack_filter        = list,
526 hpack_quality       = list,
527 vpack_quality       = list,
528 pre_output_filter   = list,
529 process_rule        = exclusive,
530 hyphenate           = simple,
```

```

531 ligaturing          = simple,
532 kerning            = simple,
533 insert_local_par   = simple,
534 pre_mlist_to_hlist_filter = list,
535 mlist_to_hlist     = exclusive,
536 post_mlist_to_hlist_filter = reverselist,
537 new_graf           = exclusive,

```

Section 8.5: information reporting callbacks.

```

538 pre_dump           = simple,
539 start_run          = simple,
540 stop_run           = simple,
541 start_page_number  = simple,
542 stop_page_number   = simple,
543 show_error_hook    = simple,
544 show_warning_message = simple,
545 show_error_message = simple,
546 show_lua_error_hook = simple,
547 start_file         = simple,
548 stop_file          = simple,
549 call_edit          = simple,
550 finish_synctex     = simple,
551 wrapup_run         = simple,

```

Section 8.6: PDF-related callbacks.

```

552 finish_pdf_file    = data,
553 finish_pdf_page    = data,
554 page_objnum_provider = data,
555 page_order_index   = data,
556 process_pdf_image_content = data,

```

Section 8.7: font-related callbacks.

```

557 define_font        = exclusive,
558 glyph_info         = exclusive,
559 glyph_not_found    = exclusive,
560 glyph_stream_provider = exclusive,
561 make_extensible    = exclusive,
562 font_descriptor_objnum_provider = exclusive,

```

```
563 }
```

```
564 luatexbase.callbacktypes=callbacktypes
```

`callback.register` Save the original function for registering callbacks and prevent the original being used. The original is saved in a place that remains available so other more sophisticated code can override the approach taken by the kernel if desired.

```

565 local callback_register = callback_register or callback.register
566 function callback.register()
567   luatexbase_error("Attempt to use callback.register() directly\n")
568 end

```

5.18.2 Handlers

The handler function is registered into the callback when the first function is added to this callback's list. Then, when the callback is called, the handler takes care of running all functions in the list. When the last function is removed from the callback's list, the handler is unregistered.

More precisely, the functions below are used to generate a specialized function (closure) for a given callback, which is the actual handler.

The way the functions are combined together depends on the type of the callback. There are currently 4 types of callback, depending on the calling convention of the functions the callback can hold:

simple is for functions that don't return anything: they are called in order, all with the same argument;

data is for functions receiving a piece of data of any type except node list head (and possibly other arguments) and returning it (possibly modified): the functions are called in order, and each is passed the return value of the previous (and the other arguments untouched, if any). The return value is that of the last function;

list is a specialized variant of *data* for functions filtering node lists. Such functions may return either the head of a modified node list, or the boolean values **true** or **false**. The functions are chained the same way as for *data* except that for the following. If one function returns **false**, then **false** is immediately returned and the following functions are *not* called. If one function returns **true**, then the same head is passed to the next function. If all functions return **true**, then **true** is returned, otherwise the return value of the last function not returning **true** is used.

reverselist is a specialized variant of *list* which executes functions in inverse order.

exclusive is for functions with more complex signatures; functions in this type of callback are *not* combined: An error is raised if a second callback is registered..

Handler for **data** callbacks.

```
569 local function data_handler(name)
570   return function(data, ...)
571     for _,i in ipairs(callbacklist[name]) do
572       data = i.func(data,...)
573     end
574     return data
575   end
576 end
```

Default for user-defined **data** callbacks without explicit default.

```
577 local function data_handler_default(value)
578   return value
579 end
```

Handler for **exclusive** callbacks. We can assume `callbacklist[name]` is not empty: otherwise, the function wouldn't be registered in the callback any more.

```
580 local function exclusive_handler(name)
581   return function(...)
582     return callbacklist[name][1].func(...)
583   end
584 end
```

Handler for list callbacks.

```
585 local function list_handler(name)
586   return function(head, ...)
587     local ret
588     local alltrue = true
589     for _,i in ipairs(callbacklist[name]) do
590       ret = i.func(head, ...)
591       if ret == false then
592         luatexbase_warning(
593           "Function '" .. i.description .. "' returned false\n"
594           .. "in callback '" .. name .. "'")
595       )
596       return false
597     end
598     if ret ~= true then
599       alltrue = false
600       head = ret
601     end
602   end
603   return alltrue and true or head
604 end
605 end
```

Default for user-defined list and reverselist callbacks without explicit default.

```
606 local function list_handler_default()
607   return true
608 end
```

Handler for reverselist callbacks.

```
609 local function reverselist_handler(name)
610   return function(head, ...)
611     local ret
612     local alltrue = true
613     local callbacks = callbacklist[name]
614     for i = #callbacks, 1, -1 do
615       local cb = callbacks[i]
616       ret = cb.func(head, ...)
617       if ret == false then
618         luatexbase_warning(
619           "Function '" .. cb.description .. "' returned false\n"
620           .. "in callback '" .. name .. "'")
621       )
622       return false
623     end
624     if ret ~= true then
625       alltrue = false
626       head = ret
627     end
628   end
629   return alltrue and true or head
630 end
631 end
```

Handler for simple callbacks.

```
632 local function simple_handler(name)
```

```

633 return function(...)
634   for _,i in ipairs(callbacklist[name]) do
635     i.func(...)
636   end
637 end
638 end

```

Default for user-defined `simple` callbacks without explicit default.

```

639 local function simple_handler_default()
640 end

```

Keep a handlers table for indexed access and a table with the corresponding default functions.

```

641 local handlers = {
642   [data]      = data_handler,
643   [exclusive] = exclusive_handler,
644   [list]      = list_handler,
645   [reverselist] = reverselist_handler,
646   [simple]     = simple_handler,
647 }
648 local defaults = {
649   [data]      = data_handler_default,
650   [exclusive] = nil,
651   [list]      = list_handler_default,
652   [reverselist] = list_handler_default,
653   [simple]     = simple_handler_default,
654 }

```

5.18.3 Public functions for callback management

Defining user callbacks perhaps should be in package code, but impacts on `add_to_callback`. If a default function is not required, it may be declared as `false`. First we need a list of user callbacks.

```

655 local user_callbacks_defaults = {
656   pre_mlist_to_hlist_filter = list_handler_default,
657   mlist_to_hlist           = node.mlist_to_hlist,
658   post_mlist_to_hlist_filter = list_handler_default,
659 }

```

`create_callback` The allocator itself.

```

660 local function create_callback(name, ctype, default)
661   local ctype_id = types[ctype]
662   if not name or name == ""
663   or not ctype_id
664   then
665     luatexbase_error("Unable to create callback:\n" ..
666                       "valid callback name and type required")
667   end
668   if callbacktypes[name] then
669     luatexbase_error("Unable to create callback '" .. name ..
670                       "':\ncallback is already defined")
671   end
672   default = default or defaults[ctype_id]
673   if not default then

```

```

674     luatexbase_error("Unable to create callback '" .. name ..
675                       "':\ndefault is required for '" .. ctype ..
676                       "' callbacks")
677 elseif type (default) ~= "function" then
678     luatexbase_error("Unable to create callback '" .. name ..
679                       "':\ndefault is not a function")
680 end
681 user_callbacks_defaults[name] = default
682 callbacktypes[name] = ctype_id
683 end
684 luatexbase.create_callback = create_callback

```

`call_callback` Call a user defined callback. First check arguments.

```

685 local function call_callback(name,...)
686   if not name or name == "" then
687     luatexbase_error("Unable to create callback:\n" ..
688                       "valid callback name required")
689   end
690   if user_callbacks_defaults[name] == nil then
691     luatexbase_error("Unable to call callback '" .. name
692                       .. "':\nunknown or empty")
693   end
694   local l = callbacklist[name]
695   local f
696   if not l then
697     f = user_callbacks_defaults[name]
698   else
699     f = handlers[callbacktypes[name]](name)
700   end
701   return f(...)
702 end
703 luatexbase.call_callback=call_callback

```

`add_to_callback` Add a function to a callback. First check arguments.

```

704 local function add_to_callback(name, func, description)
705   if not name or name == "" then
706     luatexbase_error("Unable to register callback:\n" ..
707                       "valid callback name required")
708   end
709   if not callbacktypes[name] or
710     type(func) ~= "function" or
711     not description or
712     description == "" then
713     luatexbase_error(
714       "Unable to register callback.\n\n"
715       .. "Correct usage:\n"
716       .. "add_to_callback(<callback>, <function>, <description>)"
717     )
718   end

```

Then test if this callback is already in use. If not, initialise its list and register the proper handler.

```

719   local l = callbacklist[name]
720   if l == nil then

```



```

721     l = { }
722     callbacklist[name] = l

```

If it is not a user defined callback use the primitive callback register.

```

723     if user_callbacks_defaults[name] == nil then
724         callback_register(name, handlers[callbacktypes[name]](name))
725     end
726 end

```

Actually register the function and give an error if more than one exclusive one is registered.

```

727 local f = {
728     func          = func,
729     description   = description,
730 }
731 local priority = #l + 1
732 if callbacktypes[name] == exclusive then
733     if #l == 1 then
734         luatexbase_error(
735             "Cannot add second callback to exclusive function\n" ..
736             name .. "'")
737     end
738 end
739 table.insert(l, priority, f)

```

Keep user informed.

```

740 luatexbase_log(
741     "Inserting '" .. description .. "' at position "
742     .. priority .. " in '" .. name .. "'")
743 )
744 end
745 luatexbase.add_to_callback = add_to_callback

```

`remove_from_callback` Remove a function from a callback. First check arguments.

```

746 local function remove_from_callback(name, description)
747     if not name or name == "" then
748         luatexbase_error("Unable to remove function from callback:\n" ..
749             "valid callback name required")
750     end
751     if not callbacktypes[name] or
752         not description or
753         description == "" then
754         luatexbase_error(
755             "Unable to remove function from callback.\n\n"
756             .. "Correct usage:\n"
757             .. "remove_from_callback(<callback>, <description>)"
758         )
759     end
760     local l = callbacklist[name]
761     if not l then
762         luatexbase_error(
763             "No callback list for '" .. name .. "'\n")
764     end

```

Loop over the callback's function list until we find a matching entry. Remove it and check if the list is empty: if so, unregister the callback handler.

```

765 local index = false
766 for i,j in ipairs(l) do
767   if j.description == description then
768     index = i
769     break
770   end
771 end
772 if not index then
773   luatexbase_error(
774     "No callback '" .. description .. "' registered for '" ..
775     name .. "'\n")
776 end
777 local cb = l[index]
778 table.remove(l, index)
779 luatexbase_log(
780   "Removing '" .. description .. "' from '" .. name .. "'."
781 )
782 if #l == 0 then
783   callbacklist[name] = nil
784   if user_callbacks_defaults[name] == nil then
785     callback_register(name, nil)
786   end
787 end
788 return cb.func,cb.description
789 end
790 luatexbase.remove_from_callback = remove_from_callback

```

`in_callback` Look for a function description in a callback.

```

791 local function in_callback(name, description)
792   if not name
793     or name == ""
794     or not callbacklist[name]
795     or not callbacktypes[name]
796     or not description then
797     return false
798   end
799   for _, i in pairs(callbacklist[name]) do
800     if i.description == description then
801       return true
802     end
803   end
804   return false
805 end
806 luatexbase.in_callback = in_callback

```

`disable_callback` As we subvert the engine interface we need to provide a way to access this functionality.

```

807 local function disable_callback(name)
808   if(callbacklist[name] == nil) then
809     callback_register(name, false)
810   else
811     luatexbase_error("Callback list for '" .. name .. "' not empty")
812   end
813 end

```

```
814 luatexbase.disable_callback = disable_callback
```

`callback_descriptions` List the descriptions of functions registered for the given callback.

```
815 local function callback_descriptions (name)
816   local d = {}
817   if not name
818     or name == ""
819     or not callbacklist[name]
820     or not callbacktypes[name]
821   then
822     return d
823   else
824     for k, i in pairs(callbacklist[name]) do
825       d[k] = i.description
826     end
827   end
828   return d
829 end
830 luatexbase.callback_descriptions = callback_descriptions
```

`uninstall` Unlike at the \TeX level, we have to provide a back-out mechanism here at the same time as the rest of the code. This is not meant for use by anything other than `latexrelease`: as such this is *deliberately* not documented for users!

```
831 local function uninstall()
832   module_info(
833     "luatexbase",
834     "Uninstalling kernel luatexbase code"
835   )
836   callback.register = callback_register
837   luatexbase = nil
838 end
839 luatexbase.uninstall = uninstall
```

`mlist_to_hlist` To emulate these callbacks, the “real” `mlist_to_hlist` is replaced by a wrapper calling the wrappers before and after.

```
840 callback_register("mlist_to_hlist", function(head, display_type, need_penalties)
841   local current = call_callback("pre_mlist_to_hlist_filter", head, display_type, need_penalties)
842   if current == false then
843     flush_list(head)
844     return nil
845   elseif current == true then
846     current = head
847   end
848   current = call_callback("mlist_to_hlist", current, display_type, need_penalties)
849   local post = call_callback("post_mlist_to_hlist_filter", current, display_type, need_penalties)
850   if post == true then
851     return current
852   elseif post == false then
853     flush_list(current)
854     return nil
855   end
856   return post
857 end)
```

858 `</lua>`

Reset the catcode of @.

859 `<tex>\catcode'\@=\etacatcode\relax`