

The `ltshipout` package*

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1 Introduction

The code provides an interface to the `\shipout` primitive of T_EX which is called when a finished pages is finally “shipped out” to the target output file, e.g., the `.dvi` or `.pdf` file. A good portion of the code is based on ideas by Heiko Oberdiek implemented in his packages `atbegshi` and `atenddvi` even though the interfaces are somewhat different.¹

1.1 Overloading the `\shipout` primitive

`\shipout`

With this implementation T_EX’s `shipout` primitive is no longer available for direct use. Instead `\shipout` is running some (complicated) code that picks up the box to be shipped out regardless of how that is done, i.e., as a constructed `\vbox` or `\hbox` or as a box register.

It then stores it in a named box register. This box can then be manipulated through a set of hooks after which it is shipped out for real.

Each `shipout` that actually happens (i.e., where the material is not discarded for one or the other reason) is recorded and the total number is available in a readonly variable and in a L^AT_EX counter.

`\RawShipout`

This command implements a simplified `shipout` that bypasses the foreground and background hooks, e.g., only `shipout/firstpage` and `shipout/lastpage` are executed and the total `shipout` counters are incremented.

The command doesn’t use `\ShipoutBox` but its own private box register so that it can be used inside of `shipout` hooks to do some additional `shipouts` while already in the output routine with the current page being stored in `\ShipoutBox`. It does have access to `\ShipoutBox` if it is used in `shipout/before` (or `shipout/after`) and can use its content.

It is safe to use it in `shipout/before` or `shipout/after` but not necessarily in the other `shipout/...` hooks as they are intended for special processing.

`\ShipoutBox` `\l_shipout_box`

This box register is called `\ShipoutBox` (alternatively available via the L₃ name `\l_shipout_box`).

This box is a “local” box and assignments to it should be done only locally. Global assignments (as done by some packages with older code where this is box is known as 255) may work but they are conceptually wrong and may result in errors under certain circumstances.

During the execution of `shipout/before` this box contains the accumulated material for the page, but not yet any material added by other `shipout` hooks. During execution of `shipout/after`, i.e., after the `shipout` has happened, the box also contains any background or foreground material.

Material from the hooks `shipout/firstpage` or `shipout/lastpage` is not included (but only used during the actual `shipout`) to facilitate reuse of the box data (e.g., `shipout/firstpage` material should never be added to a later page of the output).

¹Heiko’s interfaces are emulated by the kernel code, if a document requests his packages, so older documents will continue to work.

`\l_shipout_box_ht_dim`
`\l_shipout_box_dp_dim`
`\l_shipout_box_wd_dim`
`\l_shipout_box_ht_plus_dp_dim`

The shipout box dimensions are available in the L3 registers `\l_shipout_box_ht_dim`, etc. (there are no $\text{\LaTeX} 2_{\epsilon}$ names).² These variables can be used inside the hook code for `shipout/before`, `shipout/foreground` and `shipout/background` if needed.

1.2 Provided hooks

`shipout/before`
`shipout/after`
`shipout/foreground`
`shipout/background`
`shipout/firstpage`
`shipout/lastpage`

The code for `\shipout` offers a number of hooks into which packages (or the user) can add code to support different use cases. These are:

shipout/before This hook is executed after the finished page has been stored in `\ShipoutBox / \l_shipout_box`. It can be used to alter that box content or to discard it completely (see `\DiscardShipoutBox` below).

You can use `\RawShipout` inside this hook for special use cases. It can make use of `\ShipoutBox` (which doesn't yet include the background and foreground material).

Note: It is not possible (or say advisable) to try and use this hook to typeset material with the intention to return it to main vertical list, it will go wrong and give unexpected results in many cases—for starters it will appear after the current page not before or it will vanish or the vertical spacing will be wrong!

shipout/background This hook adds a picture environment into the background of the page with the (0,0) coordinate in the top-left corner using a `\unitlength` of `1pt`.

It should therefore only receive `\put` commands or other commands suitable in a `picture` environment and the vertical coordinate values would normally be negative.

Technically this is implemented by adding a zero-sized `\hbox` as the very first item into the `\ShipoutBox` containing that `picture` environment. Thus the rest of the box content will overprint what ever is typeset by that hook.

shipout/foreground This hook adds a picture environment into the foreground of the page with the (0,0) coordinate in the top-left corner using a `\unitlength` of `1pt`.

Technically this is implemented by adding a zero-sized `\hbox` as the very last item into the `\ShipoutBox` and raising it up so that it still has its (0,0) point in the top-left corner. But being placed after the main box content it will be typeset later and thus overprints it (i.e., is in the foreground).

shipout/firstpage The material from this hook is executed only once at the very beginning of the first output page that is shipped out (i.e., not discarded at the last minute). It should only contain `\special` or similar commands needed to direct post processors handling the `.dvi` or `.pdf` output.³

²Might need changing, but HO's version as strings is not really helpful I think).

³In $\text{\LaTeX} 2_{\epsilon}$ that was already existing, but implemented using a box register with the name `\@begindvibox`.

This hook is added to the very first page regardless of how it is shipped out (i.e., with `\shipout` or `\RawShipout`).

shipout/lastpage The corresponding hook to add `\specials` at the very end of the output file. It is only executed on the very last page of the output file — or rather on the page that \LaTeX believes is the last one. Again it is executed regardless of the shipout method.

It may not be possible for \LaTeX to correctly determine which page is the last one without several reruns. If this happens and the hook is non-empty then \LaTeX will add an extra page to place the material and also request a rerun to get the correct placement sorted out.

shipout/after This hook is executed after a shipout has happened. If the shipout box is discarded this hook is not looked at.

You can use `\RawShipout` inside this hook for special use cases and the main `\ShipoutBox` is still available at this point (but in contrast to `shipout/before` it now includes the background and foreground material).

Note: Just like `shipout/before` this hook is not meant to be used for adding adding typeset material back to the main vertical list—it might vanish or the vertical spacing will be wrong!

As mentioned above the hook `shipout/before` is executed first and can manipulate the prepared shipout box stored in `\ShipoutBox` or set things up for use in `\write` during the actual shipout. It is even run if there was a `\DiscardShipoutBox` request in the document.

The other hooks (except `shipout/after`) are added inside hboxes to the box being shipped out in the following order:

<code>shipout/firstpage</code>	only on the first page
<code>shipout/background</code>	
<code>\boxed content of \ShipoutBox</code>	
<code>shipout/foreground</code>	
<code>shipout/lastpage</code>	only on the last page

If any of the hooks has no code then that particular no box is added at that point.

Once the (page) box has been shipped out the `shipout/after` hook is called (while you are still inside the output routine). It is not called if the shipout box was discarded.

In a document that doesn't produce pages, e.g., only makes `\typeouts`, none of the hooks are ever executed (as there is no `\shipout`) not even the `shipout/lastpage` hook.

If `\RawShipout` is used instead of `\shipout` then only the hooks `shipout/firstpage` and `shipout/lastpage` are executed (on the first or last page), all others are bypassed.

1.3 Legacy \LaTeX commands

`\AtBeginDvi`
`\AtEndDvi`

`\AtBeginDvi` is the existing \LaTeX 2 ϵ interface to fill the `shipout/firstpage` hook. This is not really a good name as it is not just supporting `.dvi` but also `.pdf` output or `.xdv`.

`\AtEndDvi` is the counterpart that was not available in the kernel but only through the package `atenddvi`. It fills the `shipout/lastpage` hook.

As these two wrappers have been available for a long time we continue offering them. However, for new code we suggest using the high-level hook management commands directly instead of “randomly-named” wrappers. This will lead to code that is easier to understand and to maintain. For this reason we do not provide any other wrapper commands for the above hooks in the kernel.

1.4 Special commands for use inside the hooks

`\DiscardShipoutBox`
`\shipout_discard:`

```
\AddToHookNext {shipout/before} {...\DiscardShipoutBox...}
```

The `\DiscardShipoutBox` declaration (L3 name `\shipout_discard:`) requests that on the next shipout the page box is thrown away instead of being shipped to the `.dvi` or `.pdf` file.

Typical applications wouldn’t do this unconditionally, but have some processing logic that decides to use or not to use the page.

Note that if this declaration is used directly in the document it may depend on the placement to which page it applies, given that \LaTeX output routine is called in an asynchronous manner! Thus normally one would use this only as part of the `shipout/before` code.

Todo: Once we have a new mark mechanism available we can improve on that and make sure that the declaration applies to the page that contains it.

In the `atbegshi` package there are a number of additional commands for use inside the `shipout/before` hook. They should normally not be needed any more as one can instead simply add code to the hooks `shipout/before`, `shipout/background` or `shipout/foreground`.⁴ If `atbegshi` gets loaded then those commands become available as public functions with their original names as given below.

1.5 Provided \LaTeX callbacks

`pre_shipout_filter`

Under \LaTeX the `pre_shipout_filter` Lua callback is provided which gets called immediately before the shipout primitive gets invoked. The signature is

```
function(<node> head)
  return true
end
```

The `head` is the list node corresponding to the box to be shipped out. The return value should always be `true`.

⁴If that assumption turns out to be wrong it would be trivial to change them to public functions (right now they are private).

1.6 Information counters

<code>\ReadonlyShipoutCounter</code>	<code>\ifnum\ReadonlyShipoutCounter=...</code>
<code>\g_shipout_readonly_int</code>	<code>\int_use:N \g_shipout_readonly_int % expl3 usage</code>

This integer holds the number of pages shipped out up to now (including the one to be shipped out when inside the output routine). More precisely, it is incremented only after it is clear that a page will be shipped out, i.e., after the `shipout/before` hook (because that might discard the page)! In contrast `shipout/after` sees the incremented value.

Just like with the `page` counter its value is only accurate within the output routine. In the body of the document it may be off by one as the output routine is called asynchronously!

Also important: it *must not* be set, only read. There are no provisions to prevent that restriction, but if you manipulate it, chaos will be the result. To emphasize this fact it is not provided as a \LaTeX counter but as a \TeX counter (i.e., a command), so `\Alph{\ReadonlyShipoutCounter}` etc, would not work.

<code>totalpages</code>	<code>\arabic{totalpages}</code>
<code>\g_shipout_totalpages_int</code>	<code>\int_use:N \g_shipout_totalpage_int % expl3 usage</code>

In contrast to `\ReadonlyShipoutCounter`, the `totalpages` counter is a \LaTeX counter and incremented for each shipout attempt including those pages that are discarded for one or the other reason. Again `shipout/before` sees the counter before it is incremented. In contrast `shipout/after` sees the incremented value.

Furthermore, while it is incremented for each page, its value is never used by \LaTeX . It can therefore be freely reset or changed by user code, for example, to additionally count a number of pages that are not build by \LaTeX but are added in a later part of the process, e.g., cover pages or picture pages made externally.

Important: as this is a page-related counter its value is only reliable inside the output routine!

<code>\PreviousTotalPages</code>	<code>\thetotalpages/\PreviousTotalPages</code>
----------------------------------	---

Command that expands to the number of total pages from the previous run. If there was no previous run or if used in the preamble it expands to 0. Note that this is a command and not a counter, so in order to display the number in, say, Roman numerals you have to assign its value to a counter and then use `\Roman` on that counter.

1.7 Debugging shipout code

<code>\DebugShipoutsOn</code>	<code>\DebugShipoutsOn</code>
<code>\DebugShipoutsOff</code>	Turn the debugging of shipout code on or off. This displays changes made to the shipout data structures.
<code>\shipout_debug_on:</code>	
<code>\shipout_debug_off:</code>	

Todo: This needs some rationalizing and may not stay this way.

2 Emulating commands from other packages

The packages in this section are no longer necessary, but as they are used by other packages, they are emulated when they are explicitly loaded with `\usepackage` or `\RequirePackage`.

Please note that the emulation only happens if the package is explicitly requested, i.e., the commands documented below are not automatically available in the L^AT_EX kernel! If you write a new package we suggest to use the appropriate kernel hooks directly instead of loading the emulation.

2.1 Emulating `atbegshi`

<code>\AtBeginShipoutUpperLeft</code>	<code>\AddToHook {shipout/before}</code>
<code>\AtBeginShipoutUpperLeftForeground</code>	<code>{... \AtBeginShipoutUpperLeft{<code>}...}</code>

This adds a `picture` environment into the background of the shipout box expecting `<code>` to contain `picture` commands. The same effect can be obtained by simply using kernel features as follows:

```
\AddToHook{shipout/background}{<code>}
```

There is one technical difference: if `\AtBeginShipoutUpperLeft` is used several times each invocation is put into its own box inside the shipout box whereas all `<code>` going into `shipout/background` ends up all in the same box in the order it is added or sorted based on the rules for the hook chunks.

`\AtBeginShipoutUpperLeftForeground` is similar with the difference that the `picture` environment is placed in the foreground. To model it with the kernel functions use the hook `shipout/foreground` instead.

<code>\AtBeginShipoutAddToBox</code>	<code>\AddToHook {shipout/before} {... \AtBeginShipoutAddToBox{<code>}...}</code>
<code>\AtBeginShipoutAddToBoxForeground</code>	

These work like `\AtBeginShipoutUpperLeft` and `\AtBeginShipoutUpperLeftForeground` with the difference that `<code>` is directly placed into an `\hbox` inside the shipout box and not surrounded by a `picture` environment.

To emulate them using `shipout/background` or `shipout/foreground` you may have to wrap `<code>` into a `\put` statement but if the code is not doing any typesetting just adding it to the hook should be sufficient.

<code>\AtBeginShipoutBox</code>	This is the name of the shipout box as <code>atbegshi</code> knows it.
---------------------------------	--

<code>\AtBeginShipoutOriginalShipout</code>	
---	--

This is the name of the `\shipout` primitive as `atbegshi` knows it. This bypasses all the mechanisms set up by the L^AT_EX kernel and there are various scenarios in which it can therefore fail. It should only be used to run existing legacy `atbegshi` code but not in newly developed applications.

The kernel alternative is `\RawShipout` which is integrated with the L^AT_EX mechanisms and updates, for example, the `\ReadOnlyShipoutCounter` counter. Please use `\RawShipout` for new code if you want to bypass the before, foreground and background hooks.

`\AtBeginShipoutInit` By default `atbegshi` delayed its action until `\begin{document}`. This command was forcing it in an earlier place. With the new concept it does nothing.

`\AtBeginShipout` `\AtBeginShipout{<code>} ≡ \AddToHook{shipout/before}{<code>}`
`\AtBeginShipoutNext` `\AtBeginShipoutNext{<code>} ≡ \AddToHookNext{shipout/before}{<code>}`

This is equivalent to filling the `shipout/before` hook by either using `\AddToHook` or `\AddToHookNext`, respectively.

`\AtBeginShipoutFirst` The `atbegshi` names for `\AtBeginDvi` and `\DiscardShipoutBox`.
`\AtBeginShipoutDiscard`

2.2 Emulating `everyshi`

The `everyshi` package is providing commands to run arbitrary code just before the shipout starts. One point of difference: in the new shipout hooks the page is available as `\ShipoutBox` for inspection of change, one should not manipulate box 255 directly inside `shipout/before`, so old code doing this would change to use `\ShipoutBox` instead of 255 or `\@cclv`.

`\EveryShipout` `\EveryShipout{<code>} ≡ \AddToHook{shipout/before}{<code>}`

`\AtNextShipout` `\AtNextShipout{<code>} ≡ \AddToHookNext{shipout/before}{<code>}`

However, most use cases for `everyshi` are attempts to put some picture or text into the background or foreground of the page and that can be done today simply by using the `shipout/background` and `shipout/foreground` hooks without any need to coding.

2.3 Emulating `atenddvi`

The `atenddvi` package implemented only a single command: `\AtEndDvi` and that is now available out of the box so the emulation makes the package a no-op.

2.4 Emulating `everypage`

This package patched the original `\@begindvi` hook and replaced it with its own version. Its functionality is now covered by the hooks offered by the kernel so that there is no need for such patching any longer.

`\AddEverypageHook` `\AddEverypageHook{<code>} ≡`
`\AddToHook{shipout/background}{\put(1in,-1in){<code>}}`

`\AddEverypageHook` is adding something into the background of every page at a position of 1in to the right and 1in down from the top left corner of the page. By using the kernel hook directly you can put your material directly to the right place, i.e., use other coordinates in the `\put` statement above.

`\AddThispageHook` `\AddThispageHook{<code>} ≡`
`\AddToHookNext{shipout/background}{\put(1in,-1in){<code>}}`

The `\AddThispageHook` wrapper is similar but uses `\AddToHookNext`.

3 The Implementation

```
1 <@@=shipout>
```

At the moment the whole module rolls back in one go, but if we make any modifications in later releases this will then need splitting.

```
2 <*2ekernel | latexrelease>
3 <latexrelease> \IncludeInRelease{2020/10/01}%
4 <latexrelease>           {\shipout}{Hook management (shipout)}%
5 \ExplSyntaxOn
```

3.1 Debugging

`\g__shipout_debug_bool` Holds the current debugging state.

```
6 \bool_new:N \g__shipout_debug_bool
```

(End definition for \g__shipout_debug_bool.)

`\shipout_debug_on:` Turns debugging on and off by redefining `__shipout_debug:n`.

```
\shipout_debug_off:
  \__shipout_debug:n
\__shipout_debug_gset:
7 \cs_new_eq:NN \__shipout_debug:n \use_none:n
8 \cs_new_protected:Npn \shipout_debug_on:
9   {
10    \bool_gset_true:N \g__shipout_debug_bool
11    \__shipout_debug_gset:
12   }
13 \cs_new_protected:Npn \shipout_debug_off:
14   {
15    \bool_gset_false:N \g__shipout_debug_bool
16    \__shipout_debug_gset:
17   }
18 \cs_new_protected:Npn \__shipout_debug_gset:
19   {
20    \cs_gset_protected:Npx \__shipout_debug:n ##1
21    { \bool_if:NT \g__shipout_debug_bool {##1} }
22   }
```

(End definition for \shipout_debug_on: and others. These functions are documented on page 6.)

`\ShipoutBox` The box filled with the page to be shipped out (both L³ and L^AT_EX 2_ε name).

```
\l_shipout_box
23 \box_new:N \l_shipout_box
24 \cs_set_eq:NN \ShipoutBox \l_shipout_box
```

(End definition for \ShipoutBox and \l_shipout_box. These functions are documented on page 2.)

`\l__shipout_raw_box` The `\RawShipout` gets its own box but it is internal as there is no hook manipulation for it.

```
25 \box_new:N \l__shipout_raw_box
```

(End definition for \l__shipout_raw_box.)

`__shipout_finalize_box:` For LuaTeX invoke the `pre_shipout_filter` callback.

```
26 \sys_if_engine luatex:TF
27 {
28   \newluafunction \__shipout_finalize_box:
29   \exp_args:Nx \everyjob {
30     \exp_not:V \everyjob
31     \exp_not:N \lua_now:n {
32       luatexbase.create_callback('pre_shipout_filter', 'list')
33       local~call, getbox, setbox = luatexbase.call_callback, tex.getbox, tex.setbox~
34       lua.get_functions_table()[\the \__shipout_finalize_box:] = function()
35         local~result = call('pre_shipout_filter', getbox(\the \l_shipout_box))
36         if~not (result == true) then~
37           setbox(\the \l_shipout_box, result~or~nil)
38         end~
39       end
40     }
41   }
42   \protected \luadef \__shipout_finalize_box: \the \__shipout_finalize_box:
43 } {
44   \cs_set_eq:NN \__shipout_finalize_box: \scan_stop:
45 }
```

(End definition for __shipout_finalize_box:.)

`__shipout_execute:` This is going to be the code run by `\shipout`. The code follows closely the ideas from atbegshi, so not documenting that here for now.

```
46 \cs_set_protected:Npn \__shipout_execute: {
47   \tl_set:Nx \l__shipout_group_level_tl
48   { \int_value:w \tex_currentgrouplevel:D }
49   \tex_afterassignment:D \__shipout_execute_test_level:
50   \tex_setbox:D \l_shipout_box
51 }
```

(End definition for __shipout_execute:.)

\shipout Overloading the `\shipout` primitive:

```
52 \cs_gset_eq:NN \shipout \__shipout_execute:
```

(End definition for \shipout. This function is documented on page 2.)

`\l__shipout_group_level_tl` Helper token list to record the group level at which `__shipout_execute:` is encountered.

```
53 \tl_new:N \l__shipout_group_level_tl
```

(End definition for \l__shipout_group_level_tl.)

`__shipout_execute_test_level:` If the group level has changed then we are still constructing `\l_shipout_box` and to continue we need to wait until the current group has finished, hence the `\tex_aftergroup:D`.

```
54 \cs_new:Npn \__shipout_execute_test_level: {
55   \int_compare:nNnT
56     \l__shipout_group_level_tl < \tex_currentgrouplevel:D
57     \tex_aftergroup:D \__shipout_execute_cont:
58 }
```

(End definition for __shipout_execute_test_level:.)

`_shipout_execute_cont:` This does the actual shipout running several hooks as part of it. The code for them is passed as argument #2 to #4 to `_shipout_execute_main_cont:Nnnn`; the first argument is the box to be shipped out.

```

59 \cs_new:Npn \_shipout_execute_cont: {
60   \_shipout_execute_main_cont:Nnnn
61     \l_shipout_box
62     { \hook_use:n {shipout/before} }
63     { \hook_if_empty:nF {shipout/foreground}
64       { \_shipout_add_foreground_picture:n
65         { \hook_use:n {shipout/foreground} } } }

```

If the user hook for the background (`shipout/background`) has no code, there might still code in the kernel hook so we need to test for this too. We only test for the `\@kernel@before@shipout@background`. If the `\@kernel@after@shipout@background` needs executing even if the user hook is empty then we can add another test (or the kernel could put something into the before hook).

```

66     \bool_lazy_and:nnF
67       { \hook_if_empty_p:n {shipout/background} }
68       { \tl_if_empty_p:N \@kernel@before@shipout@background }
69     { \_shipout_add_background_picture:n
70       { \@kernel@before@shipout@background
71         \hook_use:n {shipout/background}
72         \@kernel@after@shipout@background }
73     }
74   }
75   { \hook_use:n {shipout/after} }
76 }

```

(End definition for `_shipout_execute_cont:.`)

`_shipout_execute_main_cont:Nnnn`

When we have reached this point the shipout box has been processed and is available in `\l_shipout_box` and ready for real ship out (unless it gets discarded during the process).

The three arguments hold hook code that is executed just before the actual shipout (#1), within the shipout adding background and foreground material (#2) and after the shipout has happened (#3). These are passed as arguments because the same code without those hooks is also used when doing a “raw” shipout implemented by `\RawShipout`. The only hook that is always executed is that for the very last page, i.e., `shipout/lastpage`.

First we quickly check if it is void (can’t happen in the standard L^AT_EX output routine but `\shipout` might be called from a package that has some special processing logic). If it is void we aren’t shipping anything out and processing ends.⁵

```

77 \cs_new:Npn \_shipout_execute_main_cont:Nnnn #1#2#3#4 {
78   \box_if_empty:NTF #1
79     { \@latex@warning{Ignoring~ void~ shipout~ box} }
80     {

```

Otherwise we assume that we will ship something and prepare for final adjustments (in particular setting the state of `\protect` while we are running the hook code). We also save the current `\protect` state to restore it later.

```

81 %       \bool_gset_false:N \g__shipout_discard_bool % setting this would disable
82                                     % \DiscardShipoutBox on doc-level

```

⁵In that case we don’t reset the deadcycles, that would be up to the OR processing logic to do.

```

83     \cs_set_eq:NN \__shipout_saved_protect: \protect
84     \set@typeset@protect

```

We also store the current shipout box dimension in registers, so that they can be used in the hook code.⁶

```

85     \__shipout_get_box_size:N #1

```

Then we execute the `shipout/before` hook (or nothing in case of `\RawShipout`).

```

86     #2

```

In `\g_shipout_totalpages_int` we count all shipout attempts so we increment that counter already here (the other one is incremented later when we know for sure that we do a `\shipout`).

We increment it after running the above hook so that the values for `\g_shipout_totalpages_int` and `\g_shipout_readonly_int` are in sync while the hook is executed (in the case that `totalpages` isn't manually altered or through discarding pages that is).

```

87     \int_gincr:N \g_shipout_totalpages_int

```

The above hook might contain code that requests the page to be discarded so we now test for it.

```

88     \bool_if:NTF \g__shipout_discard_bool
89     { \@latex@info@no@line{Completed~ page~ discarded}
90     \bool_gset_false:N \g__shipout_discard_bool

```

As we are discarding the page box and not shipping anything out, we need to do some house cleaning and reset T_EX's deadcycles so that it doesn't complain about too many calls to the OR without any shipout.

```

91     \tex_deadcycles:D \c_zero_int

```

Todo: In `atbegshi` the box was dropped but is that actually needed? Or the resetting of `\protect` to its kernel value?

```

92 %     \group_begin:
93 %     \box_set_eq_drop:NN #1 #1
94 %     \group_end:
95 %     \cs_set_eq:NN \protect \exp_not:N
96     }

```

Even if there was no explicit request to discard the box it is possible that the code for the hook `shipout/before` has voided the box (by mistake or deliberately). We therefore test once more but this time make it a warning, because the best practice way is to use the request mechanism.

```

97     { \box_if_empty:NTF #1
98     { \@latex@warning{
99     Shipout~ box~ was~ voided~ by~ hook,\MessageBreak
100     ignoring~ shipout~ box }
101     }

```

Finally, if the box is still non-empty we are nearly ready to ship it out. First we increment the total page counter so that we can later test if we have reached the final page according to our available information.⁷

⁶This is not really necessary as the code could access them via `\box_ht:N`, etc., but it is perhaps convenient.

⁷Doing that earlier would be wrong because we might end up with the last page counted but discard and then we have no place to add the final objects into the output file.

```

102     {
103       \int_gincr:N \g_shipout_readonly_int
104       \__shipout_debug:n {
105         \typeout{Absolute~ page~ =~ \int_use:N \g_shipout_readonly_int
106           \space (target:~ \@abspage@last)}
107     }

```

Then we store the box sizes again (as they may have changed) and then look at the hooks `shipout/foreground` and `shipout/background`. If either or both are non-empty we add a `picture` environment to the box (in the foreground and/or in the background) and execute the hook code inside that environment.

```

108     \__shipout_get_box_size:N #1

```

The first hook we run is the `shipout/firstpage` hook. This is only done once, then the `__shipout_run_firstpage_hook:` command redefines itself to do nothing. If the hook contains `\specials` for integration at the top of the page they will be temporarily stored in a safe place and added later with `__shipout_add_firstpage_specials:`.

```

109     \__shipout_run_firstpage_hook:

```

Run the hooks for background and foreground or, if this is called by `\RawShipout`, copy the box `\l__shipout_raw_box` to `\l_shipout_box` so that firstpage and lastpage material gets added if necessary (that is always done to `\l_shipout_box`).

```

110     #3

```

We then run `__shipout_add_firstpage_specials:` that adds the content of the hook `shipout/firstpage` to the start of the first page (if non-empty). It is then redefined to do nothing on later pages.

```

111     \__shipout_add_firstpage_specials:

```

Then we check if we have to add the `shipout/lastpage` hook or the corresponding kernel hook because we have reached the last page. This test will be false for all but one (and hopefully the correct) page.

```

112     \int_compare:nNnT \@abspage@last = \g_shipout_readonly_int
113     { \bool_lazy_and:nnF
114       { \hook_if_empty_p:n {shipout/lastpage} }
115       { \tl_if_empty_p:N \@kernel@after@shipout@lastpage }
116       { \__shipout_debug:n { \typeout{Executing~ lastpage~ hook~
117         on~ page~ \int_use:N \g_shipout_readonly_int } }
118         \__shipout_add_foreground_box:n
119         { \UseHook{shipout/lastpage}
120           \@kernel@after@shipout@lastpage }
121       }
122     } \bool_gset_true:N \g__shipout_lastpage_handled_bool
123   }
124   \__shipout_finalize_box:

```

Finally we run the actual \TeX primitive for `shipout`. As that will expand delayed `\write` statements inside the page in which protected commands should not expand we first change `\protect` to the appropriate definition for that case.

```

125     \cs_set_eq:NN \protect \exp_not:N
126     \tex_shipout:D \box_use:N \l_shipout_box

```

The `\l_shipout_box` may contain the firstpage material if this was the very first `shipout`. That makes it unsuitable for reuse in another `shipout`, so as a safety measure the next

command resets `\l_shipout_box` to its earlier state if that is necessary. On later pages this is then a no-op.

```
127         \__shipout_drop_firstpage_specials:
```

The `shipout/after` hook (if in #4) needs to run with `\protected` commands again being executed, because that hook will “typeset” material added at the top of the next page.

```
128         \set@typeset@protect
129         #4
130     }
131 }
```

Restore the value of `\protect` in case `\shipout` is called outside of the output routine (where it is automatically restored because of the implicit group).

```
132     \cs_set_eq:NN \protect \__shipout_saved_protect:
133 }
134 }
```

(End definition for `__shipout_execute_main_cont:Nnnn`.)

`__shipout_execute_raw:` This implements the “raw” shipout which bypasses the before, foreground, background and after hooks. It follows the same pattern than `__shipout_execute_raw:` except that it finally calls `__shipout_execute_main_cont:Nnnn` with three empty arguments. instead of the hook code.

```
135 \cs_set_protected:Npn \__shipout_execute_raw: {
136     \tl_set:Nx \l__shipout_group_level_tl
137     { \int_value:w \tex_currentgrouplevel:D }
138     \tex_afterassignment:D \__shipout_execute_test_level_raw:
139     \tex_setbox:D \l__shipout_raw_box
140 }

141 \cs_new:Npn \__shipout_execute_test_level_raw: {
142     \int_compare:nNnT
143     \l__shipout_group_level_tl < \tex_currentgrouplevel:D
144     \tex_aftergroup:D \__shipout_execute_nohooks_cont:
145 }
```

Well, not totally empty arguments, we add some debugging if we are actually doing a shipout.

```
146 \cs_new:Npn \__shipout_execute_nohooks_cont: {
147     \__shipout_execute_main_cont:Nnnn \l__shipout_raw_box
148     {} { \__shipout_debug:n{ \typeout{Doing~ raw~ shipout~ ...} }
149     \box_set_eq:NN \l_shipout_box \l__shipout_raw_box } {}
150 }
```

(End definition for `__shipout_execute_raw:` and `__shipout_execute_test_level_raw:`.)

`\RawShipout` The interface name for raw shipout.

```
151 \cs_gset_eq:NN \RawShipout \__shipout_execute_raw:
```

(End definition for `\RawShipout`. This function is documented on page 2.)

`__shipout_saved_protect:` Remember the current `\protect` state.

```
152 \cs_new_eq:NN \__shipout_saved_protect: \protect
```

(End definition for `__shipout_saved_protect:.`)

```

shipout/before Declaring all hooks for the shipout code.
shipout/after 153 \hook_new:n{shipout/before}
shipout/foreground 154 \hook_new:n{shipout/after}
shipout/background 155 \hook_new:n{shipout/foreground}
shipout/firstpage 156 \hook_new:n{shipout/background}
shipout/lastpage 157 \hook_new:n{shipout/firstpage}
158 \hook_new:n{shipout/lastpage}

```

(End definition for `shipout/before` and others. These functions are documented on page 3.)

```

\@kernel@after@shipout@lastpage And here are the internal kernel hooks going before or after the public ones where needed.
\@kernel@before@shipout@background
\@kernel@after@shipout@background
159 \let\@kernel@after@shipout@lastpage\@empty
160 \let\@kernel@before@shipout@background\@empty
161 \let\@kernel@after@shipout@background\@empty

```

(End definition for `\@kernel@after@shipout@lastpage`, `\@kernel@before@shipout@background`, and `\@kernel@after@shipout@background`. These functions are documented on page ??.)

```

\_shipout_run_firstpage_hook: There are three commands to handle the shipout/firstpage hook: \__shipout_run_
firstpage_hook:, \__shipout_add_firstpage_specials: and \__shipout_drop_
firstpage_specials:.

```

That hook is supposed to contain `\specials` and similar material to be placed at the very beginning of the output page and so it needs careful placing to avoid that anything else gets in front of it. And this means we have to wait with this until other hooks such as `shipout/background` have added their bits. It is also important that such `\specials` show up only on the very first page, so if this page gets saved before `\shipout` for later reuse, we have to make sure that they aren't in the saved version.

In addition the hook may also contain code to be executed “first”, e.g., visible from code in `shipout/background` and this conflicts with adding the `\specials` late.

Therefore the processing is split into different parts: `__shipout_run_firstpage_hook:` is done early and checks if there is any material in the hook.

```

162 \cs_new:Npn \__shipout_run_firstpage_hook: {
163   \hook_if_empty:nTF {shipout/firstpage}

```

If not then we define the other two commands to do nothing.

```

164   {
165     \cs_gset_eq:NN \__shipout_add_firstpage_specials: \prg_do_nothing:
166     \cs_gset_eq:NN \__shipout_drop_firstpage_specials: \prg_do_nothing:
167   }

```

If there is material we execute inside a box, which means any `\special` will end up in that box and any other code is executed and can have side effects (as long as they are global).

```

168   {
169     \hbox_set:Nn \l__shipout_firstpage_box { \UseHook{shipout/firstpage} }
170   }

```

Once we are here we change the definition to do nothing next time and we also change the command used to implement `\AtBeginDvi` to become a warning and not add further material to a hook that is never used again.

```

171 \cs_gset_eq:NN \__shipout_run_firstpage_hook: \prg_do_nothing:
172 \cs_gset:Npn \__shipout_add_firstpage_material:Nn ##1 ##2 {
173   \@latex@warning{

```

```

174         First~ page~ is~ already~ shipped~ out,~ ignoring\MessageBreak
175         \string##1 }
176     }
177 }

```

(End definition for _shipout_run_firstpage_hook:.)

`_shipout_add_firstpage_specials:` The `_shipout_add_firstpage_specials:` then adds the `\specials` stored in `\l__shipout_firstpage_box` to the page to be shipped out when the time is ready. Note that if there was no material in the `shipout/firstpage` hook then this command gets redefined to do nothing. But for most documents there is something, e.g., some PostScript header, or some meta data declaration, etc. so by default we assume there is something to do.

```

178 \cs_new:Npn \_shipout_add_firstpage_specials: {

```

First we make a copy of the `\l_shipout_box` that we can restore it later on.

```

179   \box_set_eq:NN \l__shipout_raw_box \l_shipout_box

```

Adding something to the beginning means adding it to the background as that layer is done first in the output.

```

180   \__shipout_add_background_box:n { \hbox_unpack_drop:N \l__shipout_firstpage_box }

```

After the actual shipout `_shipout_drop_firstpage_specials:` is run to restore the earlier content of `\l_shipout_box` and then redefines itself again to do nothing.

As a final act we change the definition to do nothing next time.

```

181   \cs_gset_eq:NN \_shipout_add_firstpage_specials: \prg_do_nothing:
182 }

```

The `_shipout_drop_firstpage_specials:` is run after the shipout has occurred but before the `shipout/afterpage` hook is executed. That is the point where we have to restore the `\ShipoutBox` to its state without the `shipout/firstpage` material.

```

183 \cs_new:Npn \_shipout_drop_firstpage_specials: {
184   \box_set_eq:NN \l_shipout_box \l__shipout_raw_box

```

If there was no such material then `_shipout_run_firstpage_hook:` will have changed the definition to a no-op already. Otherwise this is what we do here.

```

185   \cs_gset_eq:NN \_shipout_drop_firstpage_specials: \prg_do_nothing:
186 }

```

(End definition for _shipout_add_firstpage_specials: and _shipout_drop_firstpage_specials:.)

`\l__shipout_firstpage_box` The box to hold any firstpage `\specials`.

```

187 \box_new:N \l__shipout_firstpage_box

```

(End definition for \l__shipout_firstpage_box.)

`\g__shipout_lastpage_handled_bool` A boolean to signal if we have already handled the `shipout/lastpage` hook.

```

188 \bool_new:N \g__shipout_lastpage_handled_bool

```

(End definition for \g__shipout_lastpage_handled_bool.)

`_shipout_add_firstpage_material:Nn` This command adds material to the `shipout/firstpage` hook. It is used in `\AtBeginDvi`, etc. The first argument is the command through which it is called. Initially this is ignored but once we are passed the first page it can be used to generate a warning message mentioning the right user command.

```
189 \cs_new:Npn \_shipout_add_firstpage_material:Nn #1#2 {
190   \AddToHook{shipout/firstpage}{#2}
191 }
```

(End definition for `_shipout_add_firstpage_material:Nn`.)

`_shipout_get_box_size:N` Store the box dimensions in dimen registers.

Todo: This could/should perhaps be generalized to set height depth and width given an arbitrary box.

```
192 \cs_new:Npn \_shipout_get_box_size:N #1 {
193   \dim_set:Nn \l_shipout_box_ht_dim { \box_ht:N #1 }
194   \dim_set:Nn \l_shipout_box_dp_dim { \box_dp:N #1 }
195   \dim_set:Nn \l_shipout_box_wd_dim { \box_wd:N #1 }
196   \dim_set:Nn \l_shipout_box_ht_plus_dp_dim
197     { \l_shipout_box_ht_dim + \l_shipout_box_dp_dim }
198 }
```

(End definition for `_shipout_get_box_size:N`.)

`\l_shipout_box_ht_dim` And here are the variables set by `_shipout_get_box_size:N`.

```
\l_shipout_box_dp_dim 199 \dim_new:N \l_shipout_box_ht_dim
\l_shipout_box_wd_dim 200 \dim_new:N \l_shipout_box_dp_dim
\l_shipout_box_ht_plus_dp_dim 201 \dim_new:N \l_shipout_box_wd_dim
202 \dim_new:N \l_shipout_box_ht_plus_dp_dim
```

(End definition for `\l_shipout_box_ht_dim` and others. These functions are documented on page 3.)

`\g__shipout_discard_bool` Indicate whether or not the current page box should be discarded

```
203 \bool_new:N \g__shipout_discard_bool
```

(End definition for `\g__shipout_discard_bool`.)

`\l__shipout_tmp_box` We need a box for the background and foreground material and a token register to
`\l__shipout_saved_badness_tl` remember badness settings as we disable them during the buildup below.

```
204 \box_new:N \l__shipout_tmp_box
205 \tl_new:N \l__shipout_saved_badness_tl
```

(End definition for `\l__shipout_tmp_box` and `\l__shipout_saved_badness_tl`.)

`_shipout_add_background_box:n` In standard L^AT_EX the shipout box is always a `\vbox` but here we allow for other usage as well, in case some package has its own output routine.

```
206 \cs_new:Npn \_shipout_add_background_box:n #1
207 { \_shipout_get_box_size:N \l_shipout_box
```

But we start testing for a vertical box as that should be the normal case.

```
208   \box_if_vertical:NTF \l_shipout_box
209     {
```

Save current values of `\vfuzz` and `\vbadness` then change them to allow box manipulations without warnings.

```

210     \tl_set:Nx \l__shipout_saved_badness_tl
211         { \vfuzz=\the\vfuzz\relax
212           \vbadness=\the\vbadness\relax }
213     \vfuzz=\c_max_dim
214     \vbadness=\c_max_int

```

Then we reconstruct `\l_shipout_box` ...

```

215     \vbox_set_to_ht:Nnn \l_shipout_box \l_shipout_box_ht_plus_dp_dim
216     {

```

... the material in #1 is placed into a horizontal box with zero dimensions.

```

217         \hbox_set:Nn \l__shipout_tmp_box
218         { \l__shipout_saved_badness_tl #1 }
219     \box_set_wd:Nn \l__shipout_tmp_box \c_zero_dim
220     \box_set_ht:Nn \l__shipout_tmp_box \c_zero_dim
221     \box_set_dp:Nn \l__shipout_tmp_box \c_zero_dim

```

The we typeset that box followed by whatever was in `\l_shipout_box` before (unpacked).

```

222     \skip_zero:N \baselineskip
223     \skip_zero:N \lineskip
224     \skip_zero:N \lineskiplimit
225     \box_use:N \l__shipout_tmp_box
226     \vbox_unpack:N \l_shipout_box

```

The `\kern` ensures that the box has no depth which is afterwards explicitly corrected.

```

227     \kern \c_zero_dim
228     }
229     \box_set_ht:Nn \l_shipout_box \l_shipout_box_ht_dim
230     \box_set_dp:Nn \l_shipout_box \l_shipout_box_dp_dim

```

Todo: The whole boxing maneuver looks a bit like overkill to me, but for the moment I leave.

```

231     \l__shipout_saved_badness_tl
232     }
233     {

```

A horizontal box is handled in a similar way. The last case would be a void box in which case we do nothing hence the missing F branch.

```

234     \box_if_horizontal:NT \l_shipout_box
235     {
236         \tl_set:Nx \l__shipout_saved_badness_tl
237         { \hfuzz=\the\hfuzz\relax
238           \hbadness=\the\hbadness\relax }
239     \hfuzz=\c_max_dim
240     \hbadness=\c_max_int
241     \hbox_set_to_wd:Nnn \l_shipout_box \l_shipout_box_wd_dim
242     {
243         \hbox_set:Nn \l__shipout_tmp_box
244         { \l__shipout_saved_badness_tl #1 }
245     \box_set_wd:Nn \l__shipout_tmp_box \c_zero_dim
246     \box_set_ht:Nn \l__shipout_tmp_box \c_zero_dim
247     \box_set_dp:Nn \l__shipout_tmp_box \c_zero_dim

```

```

248         \box_move_up:nn
249         \l_shipout_box_ht_dim
250         { \box_use:N \l__shipout_tmp_box }
251         \hbox_unpack:N \l_shipout_box
252     }
253     \l__shipout_saved_badness_tl
254 }
255 }
256 }

```

(End definition for __shipout_add_background_box:n.)

_shipout_add_foreground_box:n Foreground boxes are done in the same way, only the order and placement of boxes has to be done differently.

```

257 \cs_new:Npn \__shipout_add_foreground_box:n #1
258 {
259   \box_if_vertical:NTF \l_shipout_box
260   {
261     \tl_set:Nx \l__shipout_saved_badness_tl
262     { \vfuzz=\the\vfuzz\relax
263       \vbadness=\the\vbadness\relax }
264     \vfuzz=\c_max_dim
265     \vbadness=\c_max_int
266     \vbox_set_to_ht:Nnn \l_shipout_box \l_shipout_box_ht_plus_dp_dim
267     {
268       \hbox_set:Nn \l__shipout_tmp_box
269       { \l__shipout_saved_badness_tl #1 }
270       \box_set_wd:Nn \l__shipout_tmp_box \c_zero_dim
271       \box_set_ht:Nn \l__shipout_tmp_box \c_zero_dim
272       \box_set_dp:Nn \l__shipout_tmp_box \c_zero_dim
273       \skip_zero:N \baselineskip
274       \skip_zero:N \lineskip
275       \skip_zero:N \lineskiplimit
276       \vbox_unpack:N \l_shipout_box
277       \kern -\l_shipout_box_ht_plus_dp_dim
278       \box_use:N \l__shipout_tmp_box
279       \kern \l_shipout_box_ht_plus_dp_dim
280     }
281     \l__shipout_saved_badness_tl
282     \box_set_ht:Nn \l_shipout_box \l_shipout_box_ht_dim
283     \box_set_dp:Nn \l_shipout_box \l_shipout_box_dp_dim
284   }
285   {
286     \box_if_horizontal:NT \l_shipout_box
287     {
288       \tl_set:Nx \l__shipout_saved_badness_tl
289       { \hfuzz=\the\hfuzz\relax
290         \hbadness=\the\hbadness\relax }
291       \hfuzz=\c_max_dim
292       \hbadness=\c_max_int
293       \hbox_set_to_wd:Nnn \l_shipout_box \l_shipout_box_wd_dim
294       {
295         \hbox_unpack:N \l_shipout_box
296         \kern -\box_wd:N \l_shipout_box

```

```

297         \hbox_set:Nn \l__shipout_tmp_box
298         { \l__shipout_saved_badness_tl #1 }
299         \box_set_wd:Nn \l__shipout_tmp_box \c_zero_dim
300         \box_set_ht:Nn \l__shipout_tmp_box \c_zero_dim
301         \box_set_dp:Nn \l__shipout_tmp_box \c_zero_dim
302         \box_move_up:nn { \box_ht:N \l__shipout_box }
303         { \box_use:N \l__shipout_tmp_box }
304         \kern \box_wd:N \l__shipout_box
305     }%
306     \l__shipout_saved_badness_tl
307 }
308 }
309 }

```

(End definition for `__shipout_add_foreground_box:n`.)

`__shipout_init_page_origins:` Two constants holding the offset of the top-left with respect to the media box.
`\c__shipout_horigin_tl` Setting the constants this way is courtesy of Bruno.
`\c__shipout_vorigin_tl` We delay setting the constants to the last possible place as there might be updates

in the preamble or even in the `begindocument` hook that affects their setup.

```

310 \cs_new:Npn \__shipout_init_page_origins: {
311   \tl_const:Nx \c__shipout_horigin_tl
312   {
313     \cs_if_exist_use:NTF \pdfvariable { horigin }
314     { \cs_if_exist_use:NF \pdfhorigin { 1in } }
315   }
316   \tl_const:Nx \c__shipout_vorigin_tl
317   {
318     \cs_if_exist_use:NTF \pdfvariable { vorigin }
319     { \cs_if_exist_use:NF \pdfvorigin { 1in } }
320   }

```

After the constants have been set there is no need to execute this command again, in fact it would raise an error, so we redefine it to do nothing.

```

321   \cs_gset_eq:NN \__shipout_init_page_origins: \prg_do_nothing:
322 }

```

(End definition for `__shipout_init_page_origins:`, `\c__shipout_horigin_tl`, and `\c__shipout_vorigin_tl`.)

`__shipout_picture_overlay:n` Put the argument into a `picture` environment that doesn't take up any size and uses `1pt` for `\unitlength`.

Todo: Could perhaps be generalized as it might be useful elsewhere. For now it is not.

```

323 \cs_new:Npn \__shipout_picture_overlay:n #1 {

```

The very first time this is executed we have to initialize (and freeze) the origins.

```

324   \__shipout_init_page_origins:
325   \kern -\c__shipout_horigin_tl \scan_stop:
326   \vbox_to_zero:n {
327     \kern -\c__shipout_vorigin_tl \scan_stop:
328     \unitlength 1pt \scan_stop:

```

This mimics a simple zero-sized picture environment. The `\hss` is need in case there is horizontal material (without using `\put` with a positive width).

```

329     \hbox_set_to_wd:Nnn \l__shipout_tmp_box \c_zero_dim
330         { \ignorespaces #1 \hss }
331     \box_set_ht:Nn \l__shipout_tmp_box \c_zero_dim
332     \box_set_dp:Nn \l__shipout_tmp_box \c_zero_dim
333     \box_use:N \l__shipout_tmp_box
334     \tex_vss:D
335 }
336 }

```

(End definition for `__shipout_picture_overlay:n`.)

`__shipout_add_background_picture:n` Put a `picture` env in the background of the shipout box with its reference point in the top-left corner.

```

337 \cs_new:Npn \__shipout_add_background_picture:n #1 {
338     \__shipout_add_background_box:n { \__shipout_picture_overlay:n {#1} }
339 }

```

(End definition for `__shipout_add_background_picture:n`.)

`__shipout_add_foreground_picture:n` Put a `picture` env in the foreground of the shipout box with its reference point in the top-left corner.

```

340 \cs_new:Npn \__shipout_add_foreground_picture:n #1 {
341     \__shipout_add_foreground_box:n { \__shipout_picture_overlay:n {#1} }
342 }

```

(End definition for `__shipout_add_foreground_picture:n`.)

`\shipout_discard:` Request that the next shipout box should be discarded. At the moment this is just setting a boolean, but we may want to augment this behavior that the position of the call is taken into account (in case \LaTeX looks ahead and is not using the position for on the next page).

```

343 \cs_new_protected:Npn \shipout_discard: {
344     \bool_gset_true:N \g__shipout_discard_bool
345 }

```

(End definition for `\shipout_discard:`. This function is documented on page 5.)

3.2 Handling the end of job hook

At the moment this is partly solved by using the existing hooks. But rather than putting the code into these hooks it should be moved to the right place directly as we shouldn't prefill hooks with material unless it needs to interact with other code.

`\g_shipout_readonly_int` We count every shipout activity that makes a page (but not those that are discarded) in order to know how many pages got produced.

`\ReadonlyShipoutCounter`

```

346 \int_new:N \g_shipout_readonly_int

```

For $\LaTeX 2_\epsilon$ it is available as a command (i.e., a \TeX counter only).

```

347 \cs_new_eq:NN \ReadonlyShipoutCounter \g_shipout_readonly_int

```

(End definition for `\g_shipout_readonly_int` and `\ReadonlyShipoutCounter`. These functions are documented on page 6.)

`\g_shipout_totalpages_int` We count every shipout attempt (even those that are discarded) in this counter. It is not used in the code but may get used in user code.

```
348 \int_new:N \g_shipout_totalpages_int
```

For L^AT_εX this is offered as a L^AT_εX counter so can be easily typeset inside the output routine to display things like “\thepage/\thetotalpages”, etc.

```
349 \cs_new_eq:NN \c@totalpages \g_shipout_totalpages_int
350 \cs_new:Npn \thetotalpages { \arabic{totalpages} }
```

(End definition for \g_shipout_totalpages_int and \c@totalpages. These functions are documented on page 6.)

`\@abspage@last` In `\@abspage@last` record the number of pages from the last run. This is written to the .aux and this way made available to the next run. In case there is no .aux file or the statement is missing from it we initialize it with the largest possible number in T_EX. We use this as the default because then we are inserting the `shipout/lastpage` on the last page (or after the last page) but not on page 1 for a multipage document.

```
351 \xdef\@abspage@last{\number\maxdimen}
```

(End definition for \@abspage@last. This function is documented on page ??.)

`\enddocument` Instead of using the hooks `enddocument` and `enddocument/afterlastpage` we add this code to private kernel hooks to be 100% sure when it is executed and to avoid cluttering the hooks with data that is always there.

Inside `\enddocument` there is a `\clearpage`. Just before that we execute this code here. There is a good chance that we are on the last page. Therefore, if we don't know the value from the last run, we assume that the current page is the right one. So we set `\@abspage@last` and as a result the next shipout will run the `shipout/lastpage` code. Of course, if there are floats that still need a placement this guess will be wrong but then rerunning the document will give us the correct value next time around.

```
\@kernel@after@enddocument 352 \g@addto@macro \@kernel@after@enddocument {
353   \int_compare:nNnT \@abspage@last = \maxdimen
354   {
```

We use L^AT_εX coding as `\@abspage@last` is not an L₃ name.

```
355     \xdef\@abspage@last{ \int_eval:n {\g_shipout_readonly_int + 1} }
356   }
357 }
```

`\@kernel@after@enddocument@afterlastpage` Once the `\clearpage` has done its work inside `\enddocument` we know for sure how many pages this document has, so we record that in the .aux file for the next run.

```
358 \g@addto@macro \@kernel@after@enddocument@afterlastpage {
```

There is one special case: If no output is produced then there is no point in a) recording the number as 0 will never match the page number of a real page and b) adding an extra page to run the `shipout/lastpage` is pointless as well (as it would remain forever). So we test for this and run the code only if there have been pages.

```
359   \int_compare:nNnF \g_shipout_readonly_int = 0
360   {
```

This ends up in the .aux so we use L^AT_εX names here.

Todo: This needs an interface for \nofiles in expl3, doesn't at the moment!

```

361     \if@filesw
362         \iow_now:Nx \@auxout {
363             \gdef\string\@abspage@last {\int_use:N \g_shipout_readonly_int}}
364     \fi

```

But we may have guessed wrongly earlier and we still have to run the `shipout/lastpage` even though there is no page to place it into. If that is the case we make a trivial extra page and put it there. This temporary page will then vanish again on the next run but helps to keep pdf viewers happy.

```

365     \bool_if:NF \g__shipout_lastpage_handled_bool
366     {

```

However, making this extra page in case the hook is actually empty would be forcing a rerun without any reason, so we check that condition and also check if `\@kernel@after@shipout@lastpage` contains any code. If both are empty we omit the page generation.

```

367         \bool_lazy_and:nnF
368         { \hook_if_empty_p:n {shipout/lastpage} }
369         { \tl_if_empty_p:N \@kernel@after@shipout@lastpage }
370         {
371             \tex_shipout:D\vbox to\textheight
372             {
373                 \hbox:n { \UseHook{shipout/lastpage}
374                     \@kernel@after@shipout@lastpage }

```

This extra page could be totally empty except for the hook content, but to help the user understanding why it is there we put some text into it.

```

375             \__shipout_excuse_extra_page:
376             \null
377         }

```

At this point we also signal to L^AT_EX's endgame that a rerun is necessary so that an appropriate message can be shown on the terminal. We do this by simply defining a command used as a flag and tested in `\enddocument`.

```

378             \cs_gset_eq:NN \@extra@page@added \relax
379         }
380     }
381 }
382 }

```

(End definition for \enddocument, \@kernel@after@enddocument, and \@kernel@after@enddocument@afterlastpage. These functions are documented on page ??.)

`__shipout_excuse_extra_page:` Say mea culpa ...

```

383 \cs_new:Npn \__shipout_excuse_extra_page: {
384     \vfil
385     \begin{center}
386         \bfseries Temporary~ page!
387     \end{center}
388     \LaTeX{}~ was~ unable~ to~ guess~ the~ total~ number~ of~ pages~
389     correctly.~ ~ As~ there~ was~ some~ unprocessed~ data~ that~
390     should~ have~ been~ added~ to~ the~ final~ page~ this~ extra~
391     page~ has~ been~ added~ to~ receive~ it.

```

```

392   \par
393   If you rerun the document (without altering it) this
394   surplus page will go away, because LaTeX{} now knows
395   how many pages to expect for this document.
396   \vfil
397 }

```

(End definition for `_shipout_excuse_extra_page:.`)

`\PreviousTotalPages` In the preamble before the aux file was read `\PreviousTotalPages` is always zero.

```

\kernel@before@begindocument 398 \def\PreviousTotalPages{0}

```

In the aux file there should be an update for `\@abspage@last` recording the number of pages from the previous run. If not that macro holds the value of `\maxdimen`. So we test for it and update `\PreviousTotalPages` if there was a real value. This should happen just before the `begindocument` hook is executed so that the value can be used inside that hook.

```

399 \g@addto@macro\kernel@before@begindocument
400   {\ifnum\@abspage@last<\maxdimen
401     \xdef\PreviousTotalPages{\@abspage@last}\fi}

```

(End definition for `\PreviousTotalPages` and `\kernel@before@begindocument`. These functions are documented on page 6.)

4 Legacy L^AT_EX 2_ε interfaces

`\DiscardShipoutBox` Request that the next shipout box is to be discarded.

```

402 \cs_new_eq:NN \DiscardShipoutBox \shipout_discard:

```

(End definition for `\DiscardShipoutBox`. This function is documented on page 5.)

`\AtBeginDvi` If we roll forward from an earlier kernel `\AtBeginDvi` is defined so we better not use `\cs_new_protected:Npn` here.

```

403 \cs_set_protected:Npn \AtBeginDvi
404   {\_shipout_add_firstpage_material:Nn \AtBeginDvi}

```

(End definition for `\AtBeginDvi`. This function is documented on page 4.)

`\DebugShipoutsOn`

`\DebugShipoutsOff`

```

405 \cs_new_eq:NN \DebugShipoutsOn \shipout_debug_on:
406 \cs_new_eq:NN \DebugShipoutsOff \shipout_debug_off:

```

(End definition for `\DebugShipoutsOn` and `\DebugShipoutsOff`. These functions are documented on page 6.)

5 Internal commands needed elsewhere

These internal commands use double and triple @ signs so we need to stop getting them translated to the module name.

407 <@=@>

Some internals needed elsewhere.

```

\@expl@@@shipout@add@firstpage@material@@Nn
  \expl@@@shipout@add@background@box@@n
  \expl@@@shipout@add@foreground@box@@n
\@expl@@@shipout@add@background@picture@@n
\@expl@@@shipout@add@foreground@picture@@n
408 \cs_set_eq:NN \@expl@@@shipout@add@firstpage@material@@Nn
409     \__shipout_add_firstpage_material:Nn
410 \cs_set_eq:NN \@expl@@@shipout@add@background@box@@n
411     \__shipout_add_background_box:n
412 \cs_set_eq:NN \@expl@@@shipout@add@foreground@box@@n
413     \__shipout_add_foreground_box:n
414 \cs_set_eq:NN \@expl@@@shipout@add@background@picture@@n
415     \__shipout_add_background_picture:n
416 \cs_set_eq:NN \@expl@@@shipout@add@foreground@picture@@n
417     \__shipout_add_foreground_picture:n

```

(End definition for \@expl@@@shipout@add@firstpage@material@@Nn and others. These functions are documented on page ??.)

```

418 \ExplSyntaxOff
419 </2kernel | latexrelease>
420 <latexrelease>\EndIncludeInRelease

```

Rolling back here doesn't undefine the interface commands as they may be used in packages without rollback functionality. So we just make them do nothing which may or may not work depending on the code usage.

```

421 <latexrelease>\IncludeInRelease{0000/00/00}%
422 <latexrelease>           {\shipout}{Hook management (shipout)}%
423 <latexrelease>

```

If we roll forward then \tex_shipout:D may not be defined in which case \shipout does have it original definition and so we must not \let it to something else which is \relax!

```

424 <latexrelease>\ifcsname tex_shipout:D\endcsname
425 <latexrelease>\expandafter\let\expandafter\shipout
426 <latexrelease>           \csname tex_shipout:D\endcsname
427 <latexrelease>\fi
428 <latexrelease>
429 <latexrelease>\let \RawShipout\@undefined
430 <latexrelease>\let \ShipoutBox\@undefined
431 <latexrelease>\let \ReadOnlyShipoutCounter \@undefined
432 <latexrelease>\let \c@totalpages \@undefined
433 <latexrelease>\let \thetotalpages \@undefined
434 <latexrelease>
435 <latexrelease>\let \DiscardShipoutBox \@undefined
436 <latexrelease>\let \DebugShipoutsOn \@undefined
437 <latexrelease>\let \DebugShipoutsOff \@undefined
438 <latexrelease>
439 <latexrelease>\DeclareRobustCommand \AtBeginDvi [1]{%
440 <latexrelease>  \global \setbox \@begindvibox
441 <latexrelease>  \vbox{\unvbox \@begindvibox #1}%

```

```

442 <latexrelease>}
443 <latexrelease>
444 <latexrelease>\let \AtBeginShipout \@undefined
445 <latexrelease>\let \AtBeginShipoutNext \@undefined
446 <latexrelease>
447 <latexrelease>\let \AtBeginShipoutFirst \@undefined
448 <latexrelease>
449 <latexrelease>\let \ShipoutBoxHeight \@undefined
450 <latexrelease>\let \ShipoutBoxDepth \@undefined
451 <latexrelease>\let \ShipoutBoxWidth \@undefined
452 <latexrelease>

```

We do not undo a substitution when rolling back. As the file support gets undone the underlying data is no longer used (and sufficiently obscure that it should not interfere with existing commands) and properly removing it would mean we need to make the `\undeclare@...` and its support macros available in all earlier kernel releases which is pointless (and actually worse).

```

453 <latexrelease>
454 <latexrelease>\let \AtEndDvi \@undefined

```

We do not reenale a disabled package load when rolling back. As the file support gets undone the underlying data is no longer checked (and sufficiently obscure that it should not interfere with existing commands) and properly removing it would mean we need to make the `\reenable@package@load` command available in all earlier kernel releases which is pointless (and actually worse).

```

455 %\reenable@package@load{atenddvi}
456 <latexrelease>
457 <latexrelease>\EndIncludeInRelease
458 <*2kernel>

```

6 Package emulation for compatibility

6.1 Package `atenddvi` emulation

`\AtEndDvi` This package has only one public command to simulating it is easy and actually sensible to provide as part of the kernel.

```

459 </2kernel>
460 <*2kernel | latexrelease>
461 <latexrelease>\IncludeInRelease{2020/10/01}%
462 <latexrelease>                {\AtEndDvi}{atenddvi emulation}%
463 \ExplSyntaxOn
464 \cs_new_protected:Npn \AtEndDvi {\AddToHook{shipout/lastpage}}
465 \ExplSyntaxOff

```

As the package is integrate we prevent loading (no need to roll that back):

```

466 \disable@package@load{atenddvi}
467   {\PackageWarning{atenddvi}
468     {Functionality of this package is already\MessageBreak
469     provided by LaTeX.\MessageBreak\MessageBreak
470     It is there no longer necessary to load it\MessageBreak
471     and you can safely remove it.\MessageBreak
472     Found on}}

```

```

473 </2ekernel | latexrelease>
474 <latexrelease>\EndIncludeInRelease
475 <latexrelease>\IncludeInRelease{0000/00/00}%
476 <latexrelease>          {\AtEndDvi}{atendddvi emulation}%
477 <latexrelease>\let \AtEndDvi \@undefined
478 <latexrelease>\EndIncludeInRelease
479 <*2ekernel>

```

(End definition for \AtEndDvi. This function is documented on page 4.)

```
480 </2ekernel>
```

6.2 Package atbegshi emulation

```

481 <*atbegshi-ltx>
482 \ProvidesPackage{atbegshi-ltx}
483 [2021/01/10 v1.0c
484   Emulation of the original atbegshi^^Jpackage with kernel methods]

```

\AtBeginShipoutBox

```
485 \let \AtBeginShipoutBox \ShipoutBox
```

(End definition for \AtBeginShipoutBox. This function is documented on page 7.)

\AtBeginShipoutInit

Compatibility only, we aren't delaying ...

```
486 \let \AtBeginShipoutInit \@empty
```

(End definition for \AtBeginShipoutInit. This function is documented on page 8.)

\AtBeginShipout
\AtBeginShipoutNext

Filling hooks

```

487 \protected \def \AtBeginShipout      {\AddToHook{shipout/before}}
488 \protected \def \AtBeginShipoutNext  {\AddToHookNext{shipout/before}}

```

(End definition for \AtBeginShipout and \AtBeginShipoutNext. These functions are documented on page 8.)

\AtBeginShipoutFirst

Slightly more complex as we need to know the name of the command under which the shipout/firstpage hook is filled.

```

489 \protected \def \AtBeginShipoutFirst
490   {\@expl@@@shipout@add@firstpage@material@@Nn \AtBeginShipoutFirst}

```

(End definition for \AtBeginShipoutFirst. This function is documented on page 8.)

\AtBeginShipoutDiscard

Just a different name.

```
491 \let \AtBeginShipoutDiscard \DiscardShipoutBox
```

(End definition for \AtBeginShipoutDiscard. This function is documented on page 8.)

\AtBeginShipoutAddToBox

We don't expose them.

\AtBeginShipoutAddToBoxForeground
\AtBeginShipoutUpperLeft
\AtBeginShipoutUpperLeftForeground

```

492 \let \AtBeginShipoutAddToBox
493     \@expl@@@shipout@add@background@box@@n
494 \let \AtBeginShipoutAddToBoxForeground
495     \@expl@@@shipout@add@foreground@box@@n

```

```

496 \let \AtBeginShipoutUpperLeft
497       \expl@@@shipout@add@background@picture@@n
498 \let \AtBeginShipoutUpperLeftForeground
499       \expl@@@shipout@add@foreground@picture@@n

```

(End definition for `\AtBeginShipoutAddToBox` and others. These functions are documented on page 7.)

`\AtBeginShipoutOriginalShipout`

This offers the raw `\shipout` primitive of the engine. A page shipped out with this is not counted by `\ReadonlyShipoutCounter` counter and thus the mechanism to place `\specials` at the very end of the output might fail, etc. It should therefore not be used in new applications but is only provided to allow running legacy code. For new code use the commands provided by the kernel instead.

```

500 \ExplSyntaxOn
501 \cs_new_eq:NN \AtBeginShipoutOriginalShipout \tex_shipout:D

```

(End definition for `\AtBeginShipoutOriginalShipout`. This function is documented on page 7.)

`\ShipoutBoxHeight`
`\ShipoutBoxWidth`
`\ShipoutBoxDepth`

This is somewhat different from the original in `atbegshi` where `\ShipoutBoxHeight` etc. only holds the `\the\ht<box>` value. This may has some implications in some use cases and if that is a problem then it might need changing.

```

502 \cs_new:Npn \ShipoutBoxHeight { \dim_use:N \l_shipout_box_ht_dim }
503 \cs_new:Npn \ShipoutBoxDepth { \dim_use:N \l_shipout_box_dp_dim }
504 \cs_new:Npn \ShipoutBoxWidth { \dim_use:N \l_shipout_box_wd_dim }
505 \ExplSyntaxOff

```

(End definition for `\ShipoutBoxHeight`, `\ShipoutBoxWidth`, and `\ShipoutBoxDepth`. These functions are documented on page ??.)

```

506 </atbegshi-ltx>

```

If the package is requested we substitute the one above:

```

507 <*2kernel>
508 \declare@file@substitution{atbegshi.sty}{atbegshi-ltx.sty}
509 </2kernel>

```

6.3 Package `everyshi` emulation

This is now directly handled in that package so emulation is not necessary any more.

Rather important :-)

```

510 <@@=>

```

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