

¹The tagpdf package, v0.82¹

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⁵This package is not meant for normal document production. It is mainly a tool to *research* tagging.⁵

⁶You need a very current \LaTeX format. You need a very current L3 programming layer. You need the new \LaTeX PDF management bundle.⁶

⁷This package is incomplete, experimental and quite probably contains bugs. At some time it will disappear when the code has been integrated into the \LaTeX format.⁷

⁸This package can change in an incompatible way.⁸

⁹You need some knowledge about \TeX , PDF and perhaps even lua to use it.⁹

¹⁰Issues, comments, suggestions should be added as issues to the github tracker:¹⁰

¹¹<https://github.com/u-fischer/tagpdf>¹¹

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1. Preface to version 0.8 and newer

87 Starting with version 0.8 one major step towards integration of the code into the \LaTeX has been done: The code now relies on the new \LaTeX PDF management. This management, which is for a testphase provided as an external package, `pdfmanagement-testphase`, prepares the ground for better support for tagged PDF in \LaTeX . It is part of a larger project to automatically generate tagged PDF <https://www.latex-project.org/news/2020/11/30/tagged-pdf-FS-study/> 87

- ⁸⁸ While this is a major improvement—it will for example allow to use tagpdf with more engines as the new PDF management supports all major engines and allowed to add support for associated files—it also means that this version requires a special setup of the document and is incompatible with a number of packages, see the documentation of pdfmanagement-testphase for details. ⁸⁸
- ¹¹⁵ Another important step is the new hook management in \LaTeX : the newest development version has hooks for paragraphs which should at the end allow to tag many paragraphs automatically. The small red numbers around paragraphs in the documentation show them in action. The main problem here is not to tag a paragraph, but to avoid to tag too many: paragraphs pop up in many places. ¹¹⁵

2. Introduction

- ¹¹⁷ Since many year the creation of accessible PDF-files with \LaTeX which conform to the PDF/UA standard has been on the agenda of \TeX -meetings. Many people agree that this is important and Ross Moore has done quite some work on it. There is also a TUG-mailing list and a webpage [5] dedicated to this theme. ¹¹⁷
- ¹¹⁸ But in my opinion missing are means to *experiment* with tagging and accessibility. Means to try out, how difficult it is to tag some structures, means to try out, how much tagging is really needed (standards and validators don't need to be right ...), means to test what else is needed so that a PDF works e.g. with a screen reader. Without such experiments it is imho quite difficult to get a feeling about what has to be done, which kernel changes are needed, how packages should be adapted. ¹¹⁸
- ¹¹⁹ This package tries to close this gap by offering *core* commands to tag a PDF¹. ¹²⁰
- ¹²¹ My hope is that the knowledge gained by the use of this package will at the end allow to decide if and how code to do tagging should be part of the \LaTeX kernel. ¹²¹
- ¹²² The package does not patch commands from other packages. It is also not an aim of the package to develop such patches. While at the end changes to various commands in many classes and packages will be needed to get tagged PDF files – and the examples accompanying the package try (or will try) to show various strategies – these changes should in my opinion be done by the class, package and document writers themselves using a sensible API provided by the kernel and not by some external package that adds patches everywhere and would need constant maintenance – one only need to look at packages like tex4ht or bidi or hyperref to see how difficult and sometimes fragile this is. ¹²²
- ¹²³ So this package deliberately concentrates on the basics – and this already quite a lot, there are much more details involved as I expected when I started. ¹²³
- ¹²⁴ I'm sure that it has bugs. Bugs reports, suggestions and comments can be added to the issue tracker on github. <https://github.com/u-fischer/tagpdf>. ¹²⁴
- ¹²⁵ Please also check the github site for new examples and improvements. ¹²⁵

¹In case you don't know what this means: there will be some explanations later on.

2.1. Tagging and accessibility

¹²⁷ While the package is named `tagpdf` the goal is actually *accessible* PDF-files. Tagging is *one* requirement for accessibility but there are others. I will mention some later on in this documentation, and – if sensible – I will also try to add code, keys or tips for them. ¹²⁷

¹⁵⁴ So the name of the package is a bit wrong. As excuse I can only say that it is shorter and easier to pronounce. ¹⁵⁴

2.2. Engines and modes

¹⁵⁶ The package works currently with `pdflatex` and `lualatex`. First steps have been done to also enable support for `xelatex` and the `latex-dvips-route`; but this isn't yet much tested. ¹⁵⁶

¹⁵⁷ The package has two modes: the *generic mode* which should work in theory with every engine and the *lua mode* which works only with `lualatex`. ¹⁵⁷

¹⁵⁸ I implemented the generic mode first. Mostly because my tex skills are much better than my lua skills and I wanted to get the tex side right before starting to fight with attributes and node traversing. ¹⁵⁸

¹⁵⁹ While the generic mode is not bad and I spent quite some time to get it working I nevertheless think that the lua mode is the future and the only one that will be usable for larger documents. PDF is a page orientated format and so the ability of `luatex` to manipulate pages and nodes after the \TeX -processing is really useful here. Also with `luatex` characters are normally already given as unicode. ¹⁵⁹

2.3. References and target PDF version

¹⁶¹ My main reference for the first versions of this package was the free reference for PDF 1.7. [2] and so the package also targetted this version. ¹⁶¹

¹⁶² In 2018 PDF 2.0. has been released, and since 2020 all engines can set the version to 2.0. So the package will now target PDF 2.0. This doesn't mean that 2.0 will be required, but that the code and the options will be extended to support PDF 2.0. One example is the support for associated files, another the support for name spaces in version 0.82. ¹⁶²

¹⁶³ The packages doesn't try to suppress all 2.0 features if an older PDF version is produced. It normally doesn't harm if a PDF contains keys unknown in its version and it makes the code faster and easier to maintain if there aren't too many tests and code pathes; so for example associated files will always be added. But tests could be added in case this leads to incompatibilities. ¹⁶³

¹⁶⁴ It should be noted that some tools don't like PDF 2.0. PAC3 for example simply crashes, and `pdftk` will create a PDF 1.0 from it. This makes testing PDF 2.0 files a bit of a challenge. ¹⁶⁴

2.4. Validation

166 PDF's created with the commands of this package must be validated: 166

- 193 One must check that the PDF is *syntactically* correct. It is rather easy to create broken PDF: e.g. if a chunk is opened on one page but closed on the next page or if the document isn't compiled often enough. 193
- 194 One must check how good the requirements of the PDF/UA standard are followed *formally*. 194
- 195 One must check how good the accessibility is *practically*. 195

196 Syntax validation and formal standard validation can be done with preflight of the (non-free) adobe acrobat. It can also be done also with the free PDF Accessibility Checker (PAC 3) [7]. There is also the validator veraPDF [6]. A rather new tool is "Next Generation PDF" [3], a browser application which converts a tagged PDF to html, allows to inspect its structure and also to edit the structure. 196

197 Practical validation is naturally the more complicated part. It needs screen reader, users which actually knows how to handle them, can test documents and can report where a PDF has real accessibility problems. 197

198 Preflight woes 198

199 Sadly validators can not be always trusted. As an example for an reason that I don't understand the adobe preflight don't like the list structure L. It is also possible that validators contradict: that the one says everything is okay, while the other complains. 199

2.5. Examples wanted!

201 To make the package usable examples are needed: examples that demonstrate how various structures can be tagged and which patches are needed, examples for the test suite, examples that demonstrates problems. 201

202 Feedback, contributions and corrections are welcome! 202

204 All examples should use the `\tagpdfsetup` key `uncompress` described in the next section so that uncompressed PDF are created and the internal objects and structures can be inspected and – hopefully soon – be compared by the `l3build` checks. 204

2.6. Changes in 0.3

206 In this version I improved the handling of alternative and actual text. See section 5. This change meant that the package relied on the module `l3str-convert`. 206

207 I no longer try to (pdf-)escape the tag names: it is a bit unclear how to do it at best with `luatex`. This will perhaps later change again. 207

2.7. Changes in 0.5

²⁰⁹ I added code to handle attributes and attribute classes, see section 4.3.5 and corrected a small number of code errors. ²⁰⁹

²³⁶ I added code to add “real” space glyphs to the PDF, see section 7. ²³⁶

2.8. Changes in 0.6

²³⁸ **Breaking change!** The attributes used in luamode to mark the MC-chunks are no longer set globally. I thought that global attribute would make it easier to tag, but it only leads to problem when e.g. header and footer are inserted. So from this version on the attributes are set locally and the effect of a `\tagmcbegin` ends with the current group. This means that in some cases more `\tagmcbegin` are needed and this affected some of the examples, e.g. the patching commands for sections with KOMA. On the other side it means that quite often one can omit the `\tagmcend` command. ²³⁸

2.9. Changes in version 0.61

²⁴⁰ internal code adaption to expl3 changes. ²⁴⁰

²⁴¹ dropped the compresslevel key – probably not needed. ²⁴¹

2.10. Changes in version 0.8

²⁴³ As a first step to include the code proper in the \TeX kernel the module name has changed from `uftag` to `tag`. The commands starting with `\uftag` will stay valid for some time but then be deprecated. ²⁴³

²⁴⁴ **Breaking change!** The argument of `newattribute` option should no longer add the dictionary bracket `<< . . >>`, they are added by the code. ²⁴⁴

²⁴⁵ **Breaking change!** The package now requires the new PDF management as provided for now by the package `pdfmanagement-testphase` ²⁴⁵

²⁴⁶ Support to add associated files to structures has been added with new keys `AF`, `AFinline` and `AFinline-o`. ²⁴⁶

²⁴⁷ **Breaking change!** The support for other 8-bit input encodings has been removed. `utf8` is now the required encoding. ²⁴⁷

²⁴⁸ The keys `lang`, `ref` and `E` have been added for structures. ²⁴⁸













2.11. Changes in version 0.81

- ²⁵⁰ Hook code to tag links (URI and GoTo type) have been added. So normally they should simply work if tagging is activated. ²⁵⁰
- ²⁵¹ Commands and keys to allow automatic paragraph tagging have been added. See section **??**. As can be seen in this documentation the code works quite good already, but one should be aware that “paragraphs” can appear in many places and sometimes there are even more paragraph begin than ends. ²⁵¹
- ²⁷⁸ A key to test if local or global setting of the mc-attributes in luamode is more sensible, see [4.2.3](#) for more details. ²⁷⁸
- ²⁷⁹ New commands to store and reset mc-tags. ²⁷⁹
- ²⁸⁰ PDF 2.0 namespace are now supported. ²⁸⁰

2.12. Proof of concept: the tagging of the documentation itself

- ²⁸² Starting with version 0.6 the documentation itself has been tagged. The tagging wasn’t (and isn’t) in no way perfect. The validator from Adobe didn’t complain, but PAX3 wanted alternative text for all links (no idea why) and so I put everywhere simple text like “link” and “ref”. The links to footnotes gave warnings, so I disabled them. I used types from the PDF version 1.7, mostly as I have no idea what should be used for code in 2.0. Margin notes were simply wrong ... ²⁸²
- ²⁸³ The tagging has been improved and automated over time in sync with improvements and new features in the LaTeX kernel and the pdfmanagement code. ²⁸³
- ²⁸⁴ But even if the documentation passed the tests of the validators: as mentioned above passing a formal test doesn’t mean that the content is really good and usable. I have a lot doubts that the code parts are really readable. The bibliography and the references must be improved. The user commands used for the tagging and also some of the patches used are still rather crude. So there is lot space for improvement. ²⁸⁴

²⁸⁵ Be aware that to create the tagged version a current lualatex-dev and a current version of the pdfmanagment-testphase package is needed. ²⁸⁵

Dateiname tagpdf.pdf			
Sprache en-UK		Tags 814	Seiten 29
PDF/JA			
 Die von PAC geprüften PDF/UA-Anforderungen sind erfüllt			
Prüfpunkt	Bestan...	Warnung	D
 PDF Syntax	65	0	
 Schriften	18	0	
 Inhalt	72892	0	
 Eingebettete Dateien	0	0	
 Natürliche Sprache	35008	0	
 Strukturelemente	296	0	
 Strukturbaum	16	0	
 Rollenzuordnungen	22	0	
 Alternative Beschreibungen	32	0	
 Metadaten	0	0	
 Dokumenteinstellungen	34	0	

3. Setup

315 **Activation needed!** 315

316 When the package is loaded it will – apart from loading more packages and defining a lot of things – not do much. You will have to activate it with `\tagpdfsetup`, see below. (At least that's the theory, I'm not quite sure, if really the tests are done always as planned....) 316

317 Most commands do nothing if tagging is not activated, but in case a test is needed a command (with the usual p,T,F variants) is provided: 317

319 `\tag_if_active:TF` 319

3.1. Modes and package options

322 The package has two different modes: The **generic mode** works (in theory, currently only tested with pdfTeX and LuaTeX) probably with all engines, the **lua mode** only with LuaTeX. The differences between both modes will be described later. The mode can be set with package options: 322

323 `luamode` 323

³²⁴ This is the default mode. It will use the generic mode if the document is processed with pdf_latex and the lua mode with lua_latex. ³²⁴

³⁵¹ genericmode ³⁵¹

³⁵² This will force the generic mode for all engines. ³⁵²

3.2. Setup and activation

³⁵⁵ `\tagpdfsetup{⟨key-val-list⟩}` ³⁵⁵

³⁵⁷ This command setups the general behaviour of the package. The command should be normally used only in the preamble (for a few keys it could also make sense to change them in the document). ³⁵⁷

³⁵⁸ The key-val list understands the following keys: ³⁵⁸

activate-all Boolean, initially false. Activates everything, that's normally the sensible thing to do. ³⁵⁹

activate-mc Boolean, initially false. Activates the code related to marked content. ³⁶⁰

activate-struct Boolean, initially false. Activates the code related to structures. Should be used only if activate-mc has been used too. ³⁶¹

activate-tree Boolean, initially false. Activates the code related to trees. Should be used only if the two other keys has been used too. ³⁶²

add-new-tag Allows to define new tag names, see section 6 for a description. ³⁶³

check-tags Boolean, initially true. Activates some safety checks (but doesn't do very much currently. It will perhaps be merged with the log-level key). ³⁶⁴

interwordspace Choice key, possible values are true/"on and false/off. The key activates/deactivates the insertion of space glyphs, see section 7. In the luamode it only works if at least activate-mc has been used. ³⁶⁵

log ³⁶⁶ Choice key, possible values none, v, vv, vvv, all. Setups the log level. Changing the value affects currently mostly the luamode: "higher" values gives more messages in the log. The current levels and messages have been setup in a quite ad-hoc manner and will need improvement. ³⁶⁶

newattribute This key takes two arguments and declares an attribute. See 4.3.5. ³⁶⁷

luamode **show-spaces** Boolean. That's a debug option, it helps in lua mode to see where space glyph will be inserted if interwordspace is activated. ³⁷⁰

paratagging Boolean. This activate/deactivates the automatic tagging of paragraphs. It uses the para/begin and para/end hooks of the newest L^AT_EX version (2021-05-01). This is a first try to use this hooks, and the code is bound to change. Paragraphs can appear in many unexpected places and the code can easily break, so there is also an option to see where such paragraphs are: ³⁷¹

paratagging-show Boolean. This activate/deactivates small red numbers in the places where the paratagging hook code is used.³⁷²

tabsorder Choice key, possible values are row, column, structure, none. This decides if a /Tabs value is written to the dictionary of the page objects. Not really needed for tagging itself, but one of the things you probably need for accessibility checks. So I added it. Currently the tabsorder is the same for all pages. Perhaps this should be changed³⁹⁹

luamode **tagunmarked** Boolean, initially true. When this boolean is true, the lua code will try to mark everything that has not been marked yet as an artifact. The benefit is that one doesn't have to mark up every deco rule oneself. The danger is that it perhaps marks things that shouldn't be marked – it hasn't been tested yet with complicated documents containing annotations etc. See also section 4.6 for a discussion about automatic tagging.⁴⁰²

uncompress Sets both the PDF compresslevel and the PDF objcompresslevel to 0 and so allows to inspect the PDF.⁴⁰³

global-mc Only relevant for luatex and luamode and can only be used in the preamble. If used the attributes used for the mc-tags are set globally. This key is temporary! It is there to allow to test if global or local setting is more sensible. See section 4.2.3 for more info.⁴⁰⁴

4. Tagging

⁴⁰⁶pdf is a page orientated graphic format. It simply puts ink and glyphs at various coordinates on a page. A simple stream of a page can look like this²:⁴⁰⁷

```
stream
  BT
    /F27 14.3462 Tf                %select font
    89.291 746.742 Td              %move point
    [(1)-574(Intro)-32(duction)]TJ %print text
    /F24 10.9091 Tf                %select font
    0 -24.35 Td                    %move point
    [(Let's)-331(start)]TJ         %print text
    205.635 -605.688 Td            %move point
    [(1)]TJ                        %print text
  ET
endstream
```

⁴²⁰From this stream one can extract the characters and their placement on the page but not their semantic meaning (the first line is actually a section heading, the last the page number). And while in the example the order is correct there is actually no guaranty that the stream contains the text in the order it should be read.⁴²⁰

⁴²¹Tagging means to enrich the PDF with information about the *semantic* meaning and the *reading order*. (Tagging can do more, one can also store all sorts of layout information like

²The appendix contains some remarks about the syntax of a PDF file

font properties and indentation with tags. But as I already wrote this package concentrates on the part of tagging that is needed to improve accessibility.)⁴²¹

4.1. Three tasks

⁴⁴⁹ To tag a PDF three tasks must be carried out:⁴⁴⁹

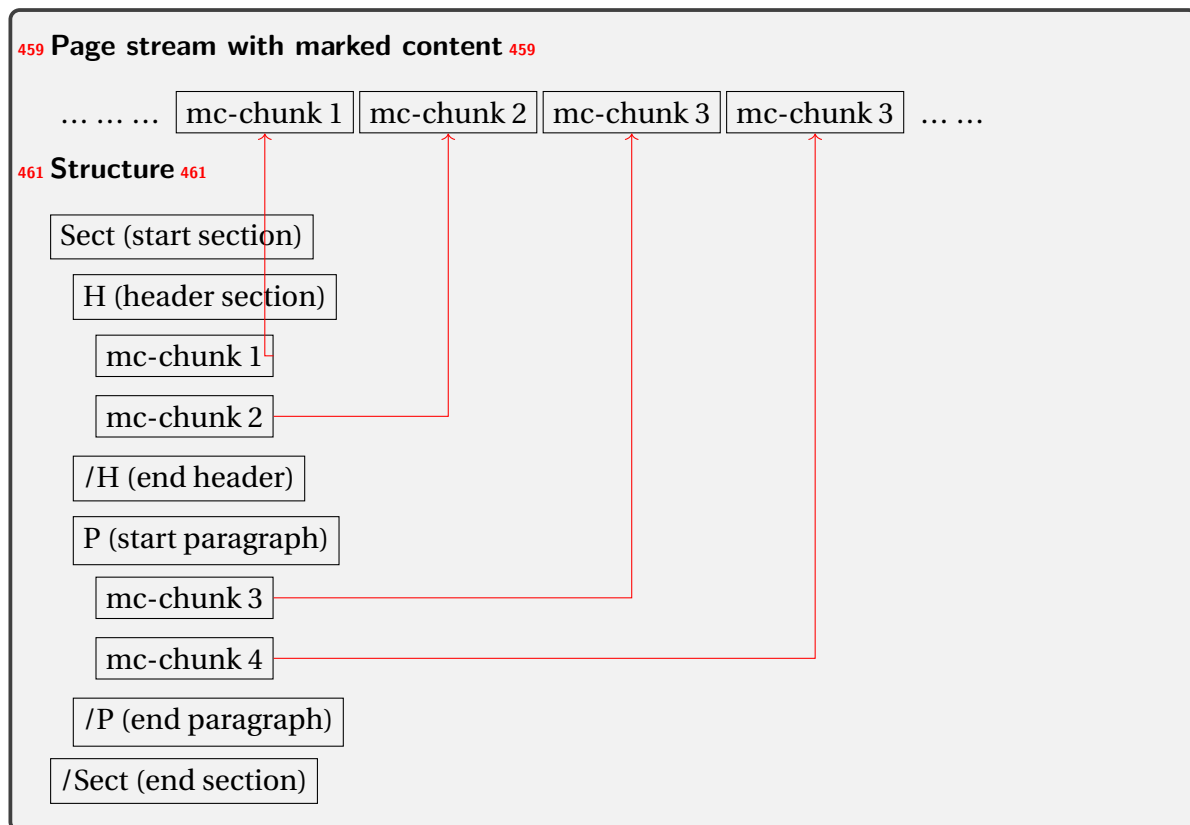
- | | |
|-------------|---|
| mc-task | ^{1.50} The mark-content-task: The document must add “labels” to the page stream which allows to identify and reference the various chunks of text and other content. This is the most difficult part of tagging – both for the document writer but also for the package code. At first there can be quite many chunks as every one is a leaf node of the structure and so often a rather small unit. At second the chunks must be defined page-wise – and this is not easy when you don’t know where the page breaks are. Also in a standard document a lot text is created automatically, e.g. the toc, references, citations, list numbers etc and it is not always easy to mark them correctly. ⁴⁵² |
| struct-task | ^{2.53} The structure-task: The document must declare the structure. This means marking the start and end of semantically connected portions of the document (correctly nested as a tree). This too means some work for the document writer, but less than for the mc-task: at first quite often the mc-task and the structure-task can be combined, e.g. when you mark up a list number or a tabular cell or a section header; at second one doesn’t have to worry about page breaks so quite often one can patch standard environments to declare the structure. On the other side a number of structures end in \LaTeX only implicitly – e.g. an item ends at the next item, so getting the PDF structure right still means that additional mark up must be added. ⁴⁵⁵ |
| tree-task | ^{3.56} The tree management: At last the structure must be written into the PDF. For every structure an object of type <code>StructElem</code> must be created and flushed with keys for the parents and the kids. A parenttree must be created to get a reference from the mc-chunks to the parent structure. A rolemap must be written. And a number of dictionary entries. All this is hopefully done automatically and correctly by the package ⁴⁵⁸ |

4.2. Task 1: Marking the chunks: the mark-content-step

⁴⁶⁷ To be able to refer to parts of the text in the structure, the text in the page stream must get “labels”. In the PDF reference they are called “marked content”. The three main variants needed here are:⁴⁶⁷

Artifacts They are marked with of a pair of keywords, BMC and EMC which surrounds the text. BMC has a single prefix argument, the fix tag name `/Artifact`. Artifacts should be used for irrelevant text and page content that should be ignored in the structure. Sadly it is often not possible to leave such text simply unmarked – the accessibility tests in Acrobat and other validators complain.⁴⁶⁸

```
/Artifact BMC
text to be marked
/EMC
```



465 Figure 1: Schematical description of the relation between marked content in the page stream and the structure 465

Artifacts with a type They are marked with of a pair of keywords, BDC and EMC which surrounds the text. BDC has two arguments: again the tag name /Artifact and a following dictionary which allows to specify the suppressed info. Text in header and footer can e.g. be declared as pagination like this: 472

```
/Artifact <</Type /Pagination>> BDC
text to be marked
/EMC
```

Content Content is marked also with of a pair of keywords, BDC and EMC. The first argument of BDC is a tag name which describes the structural type of the text³Examples are /P (paragraph), /H2 (header), /TD (table cell). The reference mentions a number of standard types but it is possible to add more or to use different names. 503

504 In the second argument of BDC – in the property dictionary – more data can be stored. *Required* is an /MCID-key which takes an integer as a value: 504

```
/H1 <</MCID 3>> BDC
```

³There is quite some redundancy in the specification here. The structural type is also set in the structure tree. One wonders if it isn't enough to use always /SPAN here.

```
text to be marked
/EMC
```

⁵³⁴ This integer is used to identify the chunk when building the structure tree. The chunks are numbered by page starting with 0. As the numbers are also used as an index in an array they shouldn't be "holes" in the numbering system (It is perhaps possible to handle a numbering scheme not starting by 0 and having holes, but it will enlarge the PDF as one would need dummy objects.). ⁵³⁴

⁵³⁵ It is possible to add more entries to the property dictionary, e.g. a title, alternative text or a local language setting. ⁵³⁵

⁵³⁶ The needed markers can be added with low level code e.g. like this (in pdfTeX syntax): ⁵³⁶

```
\pdfliteral page {/H1 <</MCID 3>> BDC}%
text to be marked
\pdfliteral page {EMC}%
```

⁵⁴⁰ This sounds easy. But there are quite a number of traps, mostly with pdfLaTeX: ⁵⁴⁰

⁵⁴¹ PDF is a page oriented format. And this means that the start BDC/BMC and the corresponding end EMC must be on the same page. So marking e.g. a section title like in the following example won't always work as the literal before the section could end on the previous page: ⁵⁴¹

```
\pdfliteral page {/H1 <</MCID 3>> BDC} %problem: possible pagebreak here
\section{mysection}
\pdfliteral page {EMC}%
```

⁵⁴⁵ Using the literals *inside* the section argument is better, but then one has to take care that they don't wander into the header and the toc. ⁵⁴⁵

⁵⁴⁶ Literals are "whatsits" nodes and can change spacing, page and line breaking. The literal *behind* the section in the previous example could e.g. lead to a lonely section title at the end of the page. ⁵⁴⁶

⁵⁴⁷ The /MCID numbers must be unique on a page. So you can't use the literal in a saved box that you reuse in various places. This is e. g. a problem with `longtable` as it saves the table header and footer in a box. ⁵⁴⁷

⁵⁴⁸ The /MCID-chunks are leaf nodes in the structure tree, so they shouldn't be nested. ⁵⁴⁸

⁵⁴⁹ Often text in a document is created automatically or moved around: entries in the table of contents, index, bibliography and more. To mark these text chunks correctly one has to analyze the code creating such content to find suitable places to inject the literals. ⁵⁴⁹

⁵⁵⁰ The literals are inserted directly and not at shipout. This means that due to the asynchronous page breaking of \TeX the MCID-number can be wrong even if the counter is reset at every page (this package uses in generic mode a label-ref-system to get around this problem. This sadly means that three compilations are needed until everything has settled down). ⁵⁵⁰

7⁵⁵¹ There exist environments which process their content more than once – examples are `align` and `tabularx`. So one has to check for doublettes and holes in the counting system.⁵⁵¹

8⁷⁸ PDF is a page oriented format. And this means that the start and the end marker must be on the same page ... *so what to do with normal paragraphs that split over pages??*. This question will be discussed in subsection 4.2.7.⁵⁷⁸

4.2.1. Generic mode versus lua mode in the mc-task

580 While in generic mode the commands insert the literals directly and so have all the problems described above the lua mode works quite differently: The tagging commands don't insert literals but set some *attributes* which are attached to all the following nodes. When the page is shipped out some lua code is called which wanders through the shipout box and injects the literals at the places where the attributes changes.⁵⁸⁰

581 This means that quite a number of problems mentioned above are not relevant for the lua mode:⁵⁸¹

1⁵⁸² Pagebreaks between start and end of the marker are *not* a problem. So you can mark a complete paragraph. If a pagebreak occur directly after an start marker or before an end marker this can lead to empty chunks in the PDF and so bloat up PDF a bit, but this is imho not really a problem (compared to the size increase by the rest of the tagging).⁵⁸²

2⁵⁸³ The commands don't insert literals directly and so affect line and page breaking much less.⁵⁸³

3⁵⁸⁴ The numbering of the MCID are done at shipout, so no label/ref system is needed.⁵⁸⁴

4⁵⁸⁵ The code can do some marking automatically. Currently everything that has not been marked up by the document is marked as artifact.⁵⁸⁵

4.2.2. Commands to mark content and chunks

Generic 587 In generic mode is vital that the end command is executed on the same page as the begin mode command. So think carefully how to place them. For strategies how to handle paragraphs only that split over pages see subsection 4.2.7.⁵⁸⁹

591 `\tagmcbegin{<key-val-list>}`⁵⁹¹

594 `\tag_mc_begin:n{<key-val-list>}`⁵⁹⁴

596 These commands insert the begin of the marked content code in the PDF. They don't start a paragraph. *They don't start a group*. The user command additionally issues an `\ignorespaces` to suppress spaces after itself. Such markers should not be nested. The command will warn you if this happens.⁵⁹⁶

597 The key-val list understands the following keys:⁵⁹⁷

tag⁵⁹⁸ This is required, unless you use the artifact key. The value of the key is normally one of the standard type listed in section 6 (without a slash at the begin, this is added by the code). It is possible to setup new tags, see the same section. The value of the key is expanded, so it can be a command. The expansion is passed unchanged to the PDF, so it should with a starting slash give a valid PDF name (some ascii with numbers like H4 is fine).⁵⁹⁸

artifact This will setup the marked content as an artifact. The key should be used for content that should be ignored. The key can take one of the values pagination, layout, page, background and notype (this is the default). Text in the header and footer should be marked with artifact=pagination.⁶²⁵

⁶²⁶ It is not quite clear if rules and other decorative graphical objects needs to be marked up as artifacts. Acrobat seems not to mind if not, but PAC 3 complained.⁶²⁶

⁶²⁷ The validators complain if some text is not marked up, but it is not quite clear if this is a serious problem.⁶²⁷

lua mode
only

⁶²⁸ The lua mode will mark up everything unmarked as artifact=notype. You can suppress this behaviour by setting the tagpdfsetup key tagunmarked to false. See section 3.2.⁶³⁰

stash Normally marked content will be stored in the “current” structure. This may not be what you want. As an example you may perhaps want to put a marginnote behind or before the paragraph it is in the tex-code. With this boolean key the content is marked but not stored in the kid-key of the current structure.⁶³¹

label⁶³² This key sets a label by which you can call the marked content later in another structure (if it has been stashed with the previous key). Internally the label name will start with tagpdf-.⁶³²

alttext This key inserts an /Alt value in the property dictionary of the BDC operator. See section 5. The value is handled as verbatim string, commands are not expanded.⁶³³

alttext-o This key inserts an /Alt value in the property dictionary of the BDC operator. See section 5. The value is handled as verbatim string like the key alttext but expanded once (the o refers to the o type in expl3). That means that you can do something like in the following listing and it will insert $\frac{a}{b}$ (hex encoded) in the PDF.⁶³⁴

```
\newcommand\myalttext{\frac{a}{b}}
\tagmcbegin{tag=P,alttext-o=\myalttext}
```

actualtext This key inserts an /ActualText value in the property dictionary of the BDC operator. See section 5. The value is handled as verbatim string, commands are not expanded.⁶³⁷

actualtext-o This key inserts an /ActualText value in the property dictionary of the BDC operator. See section 5. The value is handled as verbatim string like the key actualtext but expanded once (the o refers to the o type in expl3). That means that you can do something like in the following listing and and it will insert X (hex encoded) in the PDF.⁶³⁸

```
\newcommand\myactualtext{X}
\tagmcbegin{tag=P,alttext-o=\myactualtext}
```

raw⁶⁴¹ This key allows you to add more entries to the properties dictionary. The value must be correct, low-level PDF. E.g. `raw=/Alt (Hello)` will insert an alternative Text.⁶⁴¹

⁶⁶⁹ `\tagmcend`⁶⁶⁹

⁶⁷² `\tag_mc:end`⁶⁷²

⁶⁷⁴ These commands insert the end code of the marked content. They don't end a group and in generic mode it doesn't matter if they are in another group as the starting commands. The user command also issues in hmode at first an `\unskip`. In generic mode both commands check if there has been a begin marker and issue a warning if not. In luamode it is often possible to omit the command, as the effect of the begin command ends with the current group or with a new `\tagmcbegin` anyway.⁶⁷⁴

luamode

⁶⁷⁵ **About nesting mc-commands**⁶⁷⁵

⁶⁷⁶ **Attention!** As mentioned above in luamode it is often possible to omit the `\tagmcend` command. This basically means that mc-chunks can be nested. But be aware that this can have surprising side effects on the order in the structure.⁶⁷⁸

⁶⁷⁹ Consider a code like this:⁶⁷⁹

```
\tagmcbegin{tag=P} Block 1 {\tagmcbegin{tag=P} Block 2} Block 3 \tagmcend
```

⁶⁸¹ Block 3 will here get the same id number as Block 1 and be stored in the structure *before* Block 2. The PDF will record the chunks in the order Block 1 -- Block 3 -- Block 2. See also section 4.2.3.⁶⁸¹

⁶⁸⁴ `\tagmcuse`⁶⁸⁴

⁶⁸⁷ `\tag_mc_use:n`⁶⁸⁷

⁶⁸⁹ These commands allow you to record a marked content that you stashed away into the current structure. Be aware that a marked content can be used only once – the command will warn you if you try to use it a second time.⁶⁸⁹

⁶⁹¹ `\tag_mc_end_push:`⁶⁹¹

⁶⁹⁴ `\tag_mc_begin_pop:n{⟨key-val-list⟩}`⁶⁹⁴

⁶⁹⁶ If there is an open mc chunk, the first command ends it and pushes its tag on a stack. If there is no open chunk, it puts `-1` on the stack (for debugging). The second command removes a value from the stack. If it is different from `-1` it opens a tag with it. The command is mainly meant to be used inside hooks and command definitions so there is only an `expl3` version. Perhaps other content of the mc-dictionary (for example the Lang) needs to be saved on the stacked too.⁶⁹⁶

⁶⁹⁸ `\tagmcifinTF{⟨true code⟩}{⟨false code⟩}`⁶⁹⁸

⁷⁰¹ `\tag_mc_if_in:TF{⟨true code⟩}{⟨false code⟩}`⁷⁰¹

703 These commands check if a marked content is currently open and allows you to e.g. add the end marker if yes. 703

730 In *generic mode*, where marked content command shouldn't be nested, it works with a global boolean. 730

731 In *lua mode* it tests if the mc-attribute is currently unset. You can't test the nesting level with it! 731

733 `\tagpdfget{<key word>}` 733

736 `\tag_get:n{<key word>}` 736

738 These commands give back some variables. Currently the only working key words are `mc_tag` and `struct_tag`. 738

4.2.3. Luamode: global or not global – that is the question

Luamode 740 In luamode the mc-commands set and unset an attribute to mark the nodes. One can view mode such an attribute like a font change or a color: they affect all following chars and glue node only until stopped. 742

743 Currently the attributes are set locally. This has the advantage that the attributes don't spill over in area where they are not wanted like the header and footer or the background pictures. But it has the disadvantage that is difficult for an inner structure to correctly interrupt the outer mc-chunk if it can't control the group level. For example this would work fine: 743

```
\tagstructbegin{tag=P}
\tagmcbegin{tag=P}
  Start paragraph
  \tag_mc_end_push:
  \tagstructbegin{tag=Em}
  \tagmcbegin{tag=Em}
  \emph{Emphasized test}
  \tagmcend
  \tagstructend
  \tag_mc_begin_pop:n{}
  Continuation of paragraph
\tagmcend
\tagstructend
```

757 But if the user adds a group like in the following listing, then the reading order will be wrong and the *emphasized text* will move in the structure at the end as described in the box about nesting mc-chunks on page 16. 757

```
\tagstructbegin{tag=P}
\tagmcbegin{tag=P}
  Start paragraph
  { %group
```

```

\tag_mc_end_push:
\tagstructbegin{tag=Em}
\tagmcbegin{tag=Em}
\emph{with emphasized text}
\tagmcend
\tagstructend
\tag_mc_begin_pop:n{ }
} %group
Continuation of paragraph
\tagmcend
\tagstructend

```

⁷⁹⁹ If the attribute is set globally this wouldn't be a problem. Currently the question is undecided. To allow to test with both versions it is possible to switch for a document with `global-mc` to global attributes. ⁷⁹⁹

4.2.4. Tips

- ⁸⁰¹ Mark commands inside floats should work fine (but need perhaps some compilation rounds in generic mode). ⁸⁰¹
- ⁸⁰² In case you want to use it inside a `\savebox` (or some command that saves the text internally in a box): If the box is used directly, there is probably no problem. If the use is later, stash the marked content and add the needed `\tagmcuse` directly before oder after the box when you use it. ⁸⁰²
- ⁸⁰³ Don't use a saved box with markers twice. ⁸⁰³
- ⁸⁰⁴ If boxes are unboxed you will have to analyze the PDF to check if everything is ok. ⁸⁰⁴
- ⁸⁰⁵ If you use complicated structures and commands (breakable boxes like the one from `tcolorbox`, `multicol`, many footnotes) you will have to check the PDF. ⁸⁰⁵

4.2.5. Links and other annotations

- ⁸³⁷ Annotations (like links or form field annotations) are objects associated with a geometric region of the page rather than with a particular object in its content stream. Any connection between a link or a form field and the text is based solely on visual appearance (the link text is in the same region, or there is empty space for the form field annotation) rather than on an explicitly specified association. ⁸³⁷
- ⁸³⁸ To connect such a annotation with the structure and so with surrounding or underlying text a specific structure has to be added, see 2: The annotation is added to a structure element as an object reference. It is not referenced directly but through an intermediate object of type OBJR. To the dictionary of the annotation a `/StructParent` entry must be added, the value is a number which is then used in the `ParentTree` to define a relationship between the annotation and the parent structure element. ⁸³⁸

```

18 0 obj    %Link Object
<< /Type /Annot /Subtype/Link
  /Rect [ 196.109 494.573 399.167 506.831 ]
  /StructParent 16
  /A<</Type/Action /S/URI /URI(https://github.com/u-fischer/tagpdf)>>
>>
endobj

19 0 obj    %Object reference (OBJR)
<</Type /OBJR /Obj 18 0 R>>
endobj

17 0 obj    %Structure Element
<< /Type /StructElem /S /Link /P 11 0 R
  /K [<</Type /MCR /Pg 8 0 R /MCID 6>> 19 0 R ]>>
endobj};

5 0 obj    %Parenttree
<< /Nums
  [... 16 17 0 R ...] >>
endobj

```

Figure 2: Structure needed for a link annotation

839 To support this, tagpdf offers currently two commands 839

893 `\tag_struct_parent_int:` 893

895 This insert the current value of a global counter used to track such object. It can be used to add the /StructParent value to the annotation dictionary. 895

897 `\tag_struct_insert_annot:nn`{*<object reference>*}{*<struct parent number>*} 897

899 This will insert the annotation described by the object reference into the current structure by creating the OBJR object. It will also add the necessary entry to the parent tree and increase the global counter referred to by `\tag_struct_parent_int:`. It does nothing if (structure) tagging is not activated. 899

900 Attention! As the second command increases the global counter at the end it changes the value given back by the first. That means that if nesting is involved care must be taken that the correct numbers is used. This should be easy to fulfil for most annotations, as there are boxes. There the second command should at best be used directly behind the annotation and it can make use of `\tag_struct_parent_int:`. For links nesting is theoretically possible, and it could be that future versions need more sophisticated handling here. 900

901 In environments which process their content twice like tabularx or align it would be the best to exclude the second command from the trial step, but this will need better support from these environments. 901

902 Typically using this commands is not often needed: Since version 0.81 tagpdf already handles (unnested) links, and form fields created with the `l3pdfxfield-testphase` package will be handle by this package. 902

903 The following listing shows low-level to create link where the two commands are used: 903

```
\pdfextension startlink
  attr
  {
    /StructParent \tag_struct_parent_int: %<----
  }
  user {
    /Subtype/Link
    /A
    <<
      /Type/Action
      /S/URI
      /URI(http://www.dante.de)
    >>
  }
```

This is a link.

```
\pdfextension endlink
\tag_struct_insert_annot:xx {\pdfannot_link_ref_last:}{\tag_struct_parent_int:}
```

⁹²¹ With luatex and local attributes (see section 4.2.3) commands like `\url` should not be grouped to allow them to reset the mc-attributes, or if groups are involved the mc-chunks should be closed and reopened manually to get the right reading order. ⁹²¹

4.2.6. Math

⁹⁴⁹ Math is a problem. I have seen an example where *every single symbol* has been marked up with tags from MathML along with an `/ActualText` entry and an entry with alternate text which describes how to read the symbol. The PDF then looked like this ⁹⁴⁹

```
/mn <</MCID 6 /ActualText<FEFF0034>/Alt( : open bracket: four )>>BDC
...
/mn <</MCID 7 /ActualText<FEFF0033>/Alt( third s )>>BDC
...
/mo <</MCID 8 /ActualText<FEFF2062>/Alt( times )>>BDC
```

⁹⁵⁵ If this is really the way to go one would need some script to add the mark-up as doing it manually is too much work and would make the source unreadable – at least with pdf_latex and the generic mode. In lua mode is it possible to hook into the `mlist_to_hlist` callback and add marker automatically. Some first implementation is done by Marcel Krüger in the `luamml` project. ⁹⁵⁵

⁹⁵⁶ But I'm not sure that this is the best way to do math. It looks rather odd that a document should have to tell a screen reader in such detail how to read an equation. It would be much more efficient, sensible and flexible if a complete representation of the equation in mathML could be stored in the PDF and the task how to read this aloud delegated to the screen reader. As PDF 2.0 introduced associated files it is probable that this will be the way to go but more investigations are needed here. ⁹⁵⁶

⁹⁵⁷ See also section 5 for some more remarks and tests. ⁹⁵⁷

4.2.7. Split paragraphs

Generic mode only ⁹⁵⁹ A problem in generic mode are paragraphs with page breaks. As already mentioned the end marker EMC must be added on the same page as the begin marker. But it is in pdf_latex *very* difficult to inject something at the page break automatically. One can manipulate the shipout box to some extent in the output routine, but this is not easy and it gets even more difficult if inserts like footnotes and floats are involved: the end of the paragraph is then somewhere in the middle of the box. ⁹⁶¹

⁹⁶² So with pdf_latex in generic mode one currently has to do the splitting manually. ⁹⁶²

⁹⁶³ The example `mc-manual-para-split` demonstrates how this can be done. The general idea is to use `\vadjust` in the right place: ⁹⁶³

```

\tagmcbegin{tag=P}
...
fringilla, ligula wisi commodo felis, ut adipiscing felis dui in
enim. Suspendisse malesuada ultrices ante.% page break
\vadjust{\tagmcend\pagebreak\tagmcbegin{tag=P}}
Pellentesque scelerisque
...
sit amet, lacus.\tagmcend

```

4.2.8. Automatic tagging of paragraphs

1000 `\tagpdfparaOn` 1000

1003 `\tagpdfparaOff` 1003

1005 Another feature that emerged from the L^AT_EX tagged PDF project are hooks at the begin and end of paragraphs. `tagpdf` makes use of these hooks to tag paragraphs. This can be activated/deactivated (also locally) with options of `\tagpdfsetup` or with the two commands above. *This is very experimental and it requires a new latex-dev!* 1005

4.3. Task 2: Marking the structure

1007 The structure is represented in the PDF with a number of objects of type `StructElem` which build a tree: each of this objects points back to its parent and normally has a number of kid elements, which are either again structure elements or – as leafs of the tree – the marked contents chunks marked up with the `tagmc`-commands. The root of the tree is the `StructTreeRoot`. 1007

4.3.1. Structure types

1009 The tree should reflect the *semantic* meaning of the text. That means that the text should be marked as section, list, table head, table cell and so on. A number of standard structure types is predefined, see section 6 but it is allowed to create more. If you want to use types of your own you must declare them. E.g. this declares two new types `TAB` and `FIG` and bases them on `P`: 1009

```

\tagpdfsetup{
  add-new-tag = TAB/P,
  add-new-tag = FIG/P,
}

```

4.3.2. Sectioning

1015 The sectioning units can be structured in two ways: a flat, html-like and a more (in pdf/UA2 basically deprecated) xml-like version. The flat version creates a structure like this: 1015

```
<H1>section header</H1>
<P> text</P>
<H2>subsection header</H2>
...
```

1046 So here the headers are marked according their level with H1, H2, etc. 1046

1047 In the xml-like tree the complete text of a sectioning unit is surrounded with the Sect tag, and all headers with the tag H. Here the nesting defines the level of a sectioning header. 1047

```
<Sect>
  <H>section header</H>
  <P> text</p>
  <Sect>
    <H>subsection header</H>
    ...
  </Sect>
</Sect>
```

1056 The flat version is more \LaTeX -like and it is rather straightforward to patch `\chapter`, `\section` and so on to insert the appropriate H... start and end markers. The xml-like tree is more difficult to automate. If such a tree is wanted I would recommend to use – like the context format – explicit commands to start and end a sectioning unit. 1056

4.3.3. Commands to define the structure

1058 The following commands can be used to define the tree structure: 1058

1060 `\tagstructbegin{<key-val-list>}` 1060

1063 `\tag_struct_begin:n{<key-val-list>}` 1063

1065 These commands start a new structure. They don't start a group. They set all their values globally. 1065

1066 The key-val list understands the following keys: 1066

tag 061 This is required. The value of the key is normally one of the standard types listed in section 6. It is possible to setup new tags/types, see the same section. The value can also be of the form `type/NS`, where NS is the shorthand of a declared name space. Currently the names spaces `pdf`, `pdf2`, `mathml` and `user` are defined. This allows to use a different name space than the one connected by default to the tag. But normally this should not be needed. 1067

stash Normally a new structure inserts itself as a kid into the currently active structure. This key prohibits this. The structure is nevertheless from now on “the current active structure” and parent for following marked content and structures. ¹⁰⁶⁸

label This key sets a label by which you can use the structure later in another structure. Internally the label name will start with tagpdfstruct-. ¹⁰⁹⁵

alttext This key inserts an /Alt value in the dictionary of structure object, see section 5. The value is handled as verbatim string and hex encoded. ¹⁰⁹⁶

alttext-o This key inserts an /Alt value in the dictionary of a structure object, see section 5. The value is handled as verbatim string like the key alttext but expanded once (the o refers to the o type in expl3). That means that you can do something like this: ¹⁰⁹⁷

```
\newcommand\myalttext{\frac{a}{b}}
\tagstructbegin{tag=P,alttext-o=\myalttext}
```

¹¹⁰⁰ and it will insert \frac{a}{b} (hex encoded) in the PDF. ¹¹⁰⁰

actualtext This key inserts an /ActualText value in the dictionary of structure object, see section 5. The value is handled as verbatim string, commands are not expanded. ¹¹⁰¹

actualtext-o This key inserts an /ActualText value in the dictionary of structure object, see section 5. The value is handled as verbatim string like the key actualtext but expanded once (the o refers to the o type in expl3). That means that you can do something like this: ¹¹⁰²

```
\newcommand\myactualtext{X}
\tagstructbegin{tag=P,alttext-o=\myactualtext}
```

¹¹⁰⁵ and it will insert X (hex encoded) in the PDF. ¹¹⁰⁵

attribute This key takes as argument a comma list of attribute names (use braces to protect the commas from the external key-val parser) and allows to add one or more attribute dictionary entries in the structure object. As an example ¹¹⁰⁶

```
\tagstructbegin{tag=TH,attribute= TH-row}
```

¹¹⁰⁸ See also section 4.3.5. ¹¹⁰⁸

attribute-class This key takes as argument a comma list of attribute names (use braces to protect the commas from the external key-val parser) and allows to add one or more attribute classes to the structure object. As an example ¹¹⁰⁹

```
\tagstructbegin{tag=TH,attribute-class= TH-row}
```

¹¹¹¹ See also section 4.3.5. ¹¹¹¹

title This key allows to set the dictionary entry /Title in the structure object. The value is handled as verbatim string and hex encoded. Commands are not expanded. ¹¹¹²

title-o This key allows to set the dictionary entry /Title in the structure object. The value is expanded once and then handled as verbatim string like the title key. ¹¹¹³

AF¹¹¹¹ This key allows to reference an associated file in the structure element. The value should be the name of an object pointing to the /Filespec dictionary as expected by \pdf_object_ref:n from a current l3kernel. For example: ¹¹¹⁴

```
\pdfdict_put:nnn {l_pdffile/Filespec} {AFRelationship}{/Supplement}
\pdffile_embed_file:nnn{example-input-file.tex}{}{tag/AFtest}
\tagstructbegin{tag=P,AF=tag/AFtest}
```

¹¹⁴⁴ As shown, the wanted AFRelationship can be set by filling the dictionary with the value. The mime type is here detected automatically, but for unknown types it can be set too. See the l3pdf file documentation for details. Associated files are a concept new in PDF 2.0, but the code currently doesn't check the pdf version, it is your responsibility to set it (this can be done with the pdfversion key in \DeclareDocumentMetadata). ¹¹⁴⁴

AFinline This key allows to embed an associated file with inline content. The value is some text, which is embedded in the PDF as a text file with mime type text/plain. ¹¹⁴⁵

```
\tagstructbegin{tag=P,AFinline=Some extra text}
```

AFinline-o This is like verb+AFinline+, but it expands the value once. ¹¹⁴⁷

lang¹¹⁴⁸ This key allows to set the language for a structure element. The value should be a bcp-identifier, e.g. de-De. ¹¹⁴⁸

ref¹¹⁴⁹ This key allows to add references to other structure elements, it adds the /Ref array to the structure. The value should be a comma separated list of structure labels set with the label key. e.g. ref={label1,label2}. ¹¹⁴⁹

E¹¹⁵⁰ This key sets the /E key, the expanded form of an abbreviation or an acronym (I couldn't think of a better name, so I stuck to E). ¹¹⁵⁰

¹¹⁵² \tagstructend ¹¹⁵²

¹¹⁵⁵ \tag_struct_end: ¹¹⁵⁵

¹¹⁵⁷ These commands end a structure. They don't end a group and it doesn't matter if they are in another group as the starting commands. ¹¹⁵⁷

¹¹⁵⁹ \tagstructuse{<label>} ¹¹⁵⁹

¹¹⁶² \tag_struct_use:n{<label>} ¹¹⁶²

¹¹⁶⁴ These commands insert a structure previously stashed away as kid into the currently active structure. A structure should be used only once, if the structure already has a parent you will get a warning. ¹¹⁶⁴

4.3.4. Root structure

¹¹⁶⁶ A document should have at least one structure which contains the whole document. A suitable tag is Document or Article. I'm considering to automatically inserting it. ¹¹⁶⁶

4.3.5. Attributes and attribute classes

1168 Structure Element can have so-called attributes. A single attribute is a dictionary (or a stream but this is currently not supported by the package as I don't know an use-case) with at least the required key /O (for "Owner" which describes the scope the attribute applies too. As an example here an attribute that can be attached to tabular header (type TH) and adds the info that the header is a column header: **1168**

```
<</O /Table /Scope /Column>>
```

1196 One or more such attributes can be attached to a structure element. It is also possible to store such an attribute under a symbolic name in a so-called "ClassedMap" and then to attach references to such classes to a structure. **1196**

1197 To use such attributes you must at first declare it in \tagpdfsetup with the key newattribute. This key takes two argument, a name and the content of the attribute. The name should be a sensible key name, the content a dictionary. **1197**

```
\tagpdfsetup
{
  newattribute =
    {TH-col}{/O /Table /Scope /Column},
  newattribute =
    {TH-row}{/O /Table /Scope /Row},
}
```

1205 Attributes are only written to the PDF when used, so it is not a problem to predeclare a number of standard attributes. **1205**

1206 It is your responsibility that the content of the dictionary is valid PDF and that the values are sensible! **1206**

1207 Attributes can then be used with the key attribute or attribute-class which both take a comma list of attribute names as argument: **1207**

```
\tagstructbegin{tag=TH,
  attribute-class= {TH-row,TH-col},
  attribute = {TH-row,TH-col},
}
```

4.4. Task 3: tree Management

1213 When all the document content has been correctly marked and the data for the trees has been collected they must be flushed to the PDF. This is done automatically (if the package has been activated) with the following command in \AfterEndDocument: **1213**

1215 \tag_finish_structure: **1215**

¹²¹⁷ This will hopefully write all the needed objects and values to the PDF. (Beside the already mentioned StructTreeRoot and StructElem objects, additionally a so-called ParentTree is needed which records the parents of all the marked contents bits, a Rolemap, perhaps a ClassMap and object for the attributes, and a few more values and dictionaries). ¹²¹⁷

¹²⁴⁴ I'm not quite sure if this shouldn't be a really internal command. ¹²⁴⁴

4.5. A fully marked up document body

¹²⁴⁶ The following shows the marking needed for a section, a sentence and a list with two items. It is obvious that one wouldn't like to have to do this for real documents. If tagging should be usable, the commands must be hidden as much as possible inside suitable \TeX commands and environments. ¹²⁴⁶

```
\begin{document}

\tagstructbegin{tag=Document}

\tagstructbegin{tag=Sect}
\tagstructbegin{tag=H}
\tagmcbegin{tag=H} %avoid page break!
\section{Section}
\tagmcend
\tagstructend
\tagstructbegin{tag=P}
\tagmcbegin{tag=P,raw=/Alt (x)}
a paragraph\par x
\tagmcend
\tagstructend

\tagstructbegin{tag=L} %List
\tagstructbegin{tag=LI}
\tagstructbegin{tag=Lbl}
\tagmcbegin{tag=Lbl}
1.
\tagmcend
\tagstructend
\tagstructbegin{tag=LBody}
\tagmcbegin{tag=P}
List item body
\tagmcend
\tagstructend %lbody
\tagstructend %Li

\tagstructbegin{tag=LI}
\tagstructbegin{tag=Lbl}
\tagmcbegin{tag=Lbl}
```

```

2.
\tagmccend
\tagstructend
\tagstructbegin{tag=LBody}
\tagmcbegin{tag=P}
another List item body
\tagmccend
\tagstructend %lbody
\tagstructend %Li
\tagstructend %L

\tagstructend %Sect
\tagstructend %Document
\end{document}

```

4.6. Lazy and automatic tagging

¹³²¹ A number of features of PDF readers need a fully tagged PDF. As an example screen readers tend to ignore alternative text (see section 5) if the PDF is not fully tagged. Also reflowing a PDF only works for me (even if real space chars are in the PDF) if the PDF is fully tagged. ¹³²¹

¹³²² This means that even if you don't care about a proper structure you should try to add at least some minimal tagging. With pdf_latex this is not easy due to the page break problem. But with lua_latex you can use an Document structure and inside it rather large mc-chunks. This minimizes the needed work. ¹³²²

¹³²³ One could ask if in lua mode the code couldn't try to mark up unmarked parts e.g. as P-type chunks, like it marks them up as artifacts currently. Sadly this is not so easy, as it is quite difficult to reliably identify the structure and the place in the kids array where such chunks belongs too. I also don't think that it is really needed. It is not so difficult to define user macros which e.g. opens a structure and start an mc-chunk or which close an open mc-chunk before issuing the next \tagmcbegin. ¹³²³

4.7. Adding tagging to commands

¹³²⁵ As mentioned above the mc-markers should not be nested. Basically you write: ¹³²⁵

```

\tagmcbegin{..}some text ... \tagmccend
<optional structure commands>
\tagmcbegin{..}some other text \tagmccend

```

¹³²⁹ This is quite workable as long as you mark everything manually. But how to write commands, e.g for a tabular or a graphic, that do tagging automatically without breaking the flow and the structure? ¹³²⁹

5. Alternative text, ActualText and text-to-speech software

- ¹³³¹ The PDF format allows to add alternative text through the `/Alt` and the `/ActualText` key. Both can be added either to the marked content in the page stream or to the object describing the structure. ¹³³¹
- ¹³⁵⁸ The value of `/ActualText` (inserted by `tagpdf` with `actualtext`) is meant to replace single characters or rather small pieces of text. It can be used also without any tagging (e.g. with the package `accsupp`). If the PDF reader support this (adobe reader does, sumatra not) one can change with it how a piece of text is copied and pasted e.g. to split up a ligature. ¹³⁵⁸
- ¹³⁵⁹ `/Alt` (inserted by `tagpdf` with `alttext`) is a key to improve accessibility: with it one can add to a picture or something else an alternative text. ¹³⁵⁹
- ¹³⁶⁰ The file `ex-alt-actualtext.tex` shows some experiments I made with with both keys and text-to-speech software (the in-built of adobe and nvda). To sum them up: ¹³⁶⁰
- ¹³⁶¹ The keys have an impact on text-to-speech software only if the document is fully tagged. ¹³⁶¹
 - ¹³⁶² `/ActualText` should be at best used around short pieces of marked content. ¹³⁶²
 - ¹³⁶³ `/Alt` is used at best with a structure – this avoids problems with `luatex` where marked contents blocks can be split over pages. ¹³⁶³
 - ¹³⁶⁴ To some extend one can get a not so bad reading of math with the alternative text. ¹³⁶⁴

6. Standard types and new tags

- ¹³⁶⁶ The tags used to describe the type of a structure element can be rather freely chosen. PDF 1.7 and earlier only requires that in a tagged PDF all types should be either from a known set of standard types or are “role mapped” to such a standard type. Such a role mapping is a simple key-value in the `RoleMap` dictionary. ¹³⁶⁶
- ¹³⁶⁷ So instead of `H1` the type `section` could be used. The role mapping can then be declared with the `add-new-tag` key: ¹³⁶⁷
- ```
\tagpdfsetup{add-new-tag = section/H1}
```
- <sup>1369</sup> In PDF 2.0 the situation is a bit more complicated. At first PDF 2.0 introduced *name spaces*. That means that a type can have more than one “meaning” depending on the name space it belongs to. `section` (name space A) and `section` (name space B) are two different types. <sup>1369</sup>
- <sup>1370</sup> At second PDF 2.0 still requires that a tagged PDF maps all types to a standard type, but now there are three sets of standard types (The meanings of the PDF types can be looked up in the PDF-references [1, 4]): <sup>1370</sup>

**1371** The *standard structure namespace for PDF 1.7*, also called the *default standard structure namespace*. The public name of the namespace is `tag/NS/pdf`. This can be used to reference the namespace e.g. in attributes. These are the structure names from PDF 1.7: Document, Part, Sect, Div, Caption, Index, NonStruct, H, H1, H2, H3, H4, H5, H6, P, L, Ll, Lbl, LBody, Table, TR, TH, TD, THead, TBody, TFoot, Span, Link, Annot, Figure, Formula, Form, Ruby, RB, RT, Warichu, WT, WP, Artifact, Art, BlockQuote, TOC, TOCI, Index, Private, Quote, Note, Reference, BibEntry, Code **1371**

**2398** The *standard structure namespace for PDF 2.0*. The public name of the namespace is `tag/NS/pdf2`. This can be used to reference the namespace e.g. in attributes. These are more or less same types as in PDF. The following types have been removed from this set: Art, BlockQuote, TOC, TOCI, Index, Private, Quote, Note, Reference, BibEntry, Code and the following are new: DocumentFragment, Aside, H7, H8, H9, H10, Title, FENote, Sub, Em, Strong, Artifact **1398**

**3399** MathML 3.0 as an *other namespaces*. The public name of the namespace is `tag/NS/mathml`. This can be used to reference the namespace e.g. in attributes. There are nearly 200 types in this name space, so I refrain from listing them here. **1399**

**1400** To allow to this more complicated setup the syntax of the `add-new-tag` key has been extended. It now takes as argument a key-value list with the following keys. A normal document shouldn't need the extended syntax, the simple syntax `section/H1` should in most cases do the right thing. **1400**

**tag** **1401** This is the name of the new type as it should then be used in `\tagstructbegin`. **1401**

**namespace** This is the namespace of the new type. The value should be a shorthand of a namespace. The allowed values are currently `pdf`, `pdf2`, `mathml` and `user`. The default value (and recommended value for a new tag) is `user`. The public name of the user namespace is `tag/NS/user`. This can be used to reference the namespace e.g. in attributes. **1402**

**role** **1403** This is type the tag should be mapped too. In a PDF 1.7 or earlier this is normally a type from the `pdf` set, in PDF 2.0 from the `pdf`, `pdf2` and `mathml` set. It can also be a user type, or a still unknown type. The PDF format allows mapping to be done transitively. But you should be aware that `tagpdf` can't (or more precisely won't) check such unusual role mapping. It lies in the responsibility of the author to ensure here that every type is correctly role mapped. **1403**

**role** **1404** **namespace** If the role is a known type the default value is the default namespace: `pdf2` for all types in this set, `pdf` for the type which exist only in PDF 1.7, `mathml` for the MathML types, and for previously defined user types whatever namespace has been set there. If the role is unknown, `user` is used and the code hopes that the type will be defined later. **1404**

**unknown key** An unknown key is interpreted as a `tag/role`, this preserves the old syntax. So this two calls are equivalent:

```
\tagpdfsetup{add-new-tag = section/H1}
\tagpdfsetup{add-new-tag = {tag=section,role=H1}}
```

<sup>1408</sup> The exact effects of the key depends on the PDF version. With PDF 1.7 or older the namespace keys are ignored, with PDF 2.0 the namespace keys are used to setup the correct rolemaps. The namespace key is also used to define the default namespace if the type is used as a role or as tag in a structure. <sup>1408</sup>

## 7. “Real” space glyphs

<sup>1436</sup> TeX uses only spaces (horizontal movements) to separate words. That means that a PDF reader has to use some heuristic when copying text or reflowing the text to decide if a space is meant as a word boundary or e.g. as a kerning. Accessible document should use real space glyphs (U+0032) from a font in such places. <sup>1436</sup>

<sup>1437</sup> With the key `interwordspace` you can activate such space glyphs. <sup>1437</sup>

<sup>1438</sup> With `pdftex` this will simply call the primitive `\pdfinterwordspaceon`. `pdftex` will then insert at various places a char from a font called dummy-space. Attention! This means that at every space there are additional font switches in the PDF: from the current font to the dummy-space font and back again. This will make the PDF larger. As `\pdfinterwordspaceon` is a primitive function it can't be fine tuned or adapted. You can only turn it on and off and insert manually such a space glyph with `\pdffakepace`. <sup>1438</sup>

<sup>1439</sup> With `luatex` (in `luamode`) `interwordspace` is implemented with a lua-function which is inserted in two callbacks and marks up the places where it seems sensible to insert a space glyph. Later in the process (when also the mc-markers are inserted) the space glyphs are injected – the code will take the glyph from the current font if this has a space glyph or switch to the default latin modern font. The current code works reasonable well in normal text. <sup>1439</sup>

<sup>1440</sup> The key `show-spaces` will show lines at the places where in lua mode spaces are inserted and so can help you to find problematic places. For listings – which have a quite specific handling of spaces – you can find a suggestion in the example `ex-space-glyph-listings`. <sup>1440</sup>

<sup>1441</sup> *Attention:* Even with real spaces copy& pasting of code doesn't need to give the correct results: you get spaces but not necessarily the right number of spaces. The PDF viewers I tried all copied four real space glyphs as one space. I only got the four spaces with the export to text or xml in the AdobePro. <sup>1441</sup>

<sup>1443</sup> `\pdffakepace` <sup>1443</sup>

<sup>1445</sup> This is in `pdftex` a primitive. It inserts the dummy space glyph. `tagpdf` defines this command also for `luatex` – attention if it can perhaps insert break points. <sup>1445</sup>

## 8. Accessibility is not only tagging

<sup>1447</sup> A tagged PDF is needed for accessibility but this is not enough. As already mentioned there are more requirements: <sup>1447</sup>

1448 The language must be declared by adding a `/Lang xx-XX` to the PDF catalog or – if the language changes for a part of the text to the structure or the marked content. Setting the document language can be rather easily done with existing packages. With the new PDF resource management it should be done with `\pdfmanagement_add:nnn{Catalog}{Lang}{(en-US)}`. For settings in marked content and structure I will have to add keys. 1448

1475 All characters must have an unicode representation or a suitable alternative text. With lualatex and open type (unicode) fonts this is normally not a problem. With pdflatex it could need 1475

```
\input{glyphtounicode}
\pdfgentounicode=1
```

1479 and perhaps some `\pdfglyphtounicode` commands. 1479

1480 Hard and soft hyphen must be distinct. 1480

1481 Spaces between words should be space glyphs and not only a horizontal movement. See section 7. 1481

1482 Various small infos must be present in the catalog dictionary, info dictionary and the page dictionaries, e.g. metadata like title. 1482

1483 If suitable I will add code for this tasks to this packages. But some of them can also be done already with existing packages like hyperref, hyperxmp, pdfx. 1483

## 9. Debugging

1485 While developing commands and tagging a document, it can be useful to get some info about the current structure. For this a number of commands are provided 1485

1487 `\showtagstack` 1487

1489 This shows the tag names of the currently open structures. Typically it will contain at least root and Document. 1489

1491 `\showtagpdfmcdatal[<mc number>]` 1491

luaonly 1493 This can only be used with lualatex and shows some info about the current mc-chunk. The optional argument allows to select a number. 1495

1497 `\showtagpdfattributes` 1497

luaonly 1499 This can only be used with lualatex and shows some info about the current attributes. 1501



## 10. To-do

- 1503 Add commands and keys to enable/disable the checks. 1503
- 1530 Check/extend the code for language tags. 1530
- 1531 Think about math. 1531
- 1532 Think about Links/Annotations 1532
- 1533 Keys for alternative and actualtext. How to define the input encoding? Like in Accsupp? 1533
- 1534 Check twocolumn documents 1534
- 1535 Examples 1535
- 1536 Write more Tests 1536
- 1537 Write more Tests 1537
- 1538 Unicode 1538
- 1539 Hyphenation char 1539
- 1540 Think about included (tagged) PDF. Can one handle them? 1540
- 1541 Improve the documentation 1541
- 1542 Tag as proof of concept the documentation (nearly done) 1542
- 1543 Document the code better 1543
- 1544 Create dtx 1544
- 1545 Find someone to check and improve the lua code 1545
- 1546 Move more things to lua in the luamode 1546
- 1547 Find someone to check and improve the rest of the code 1547
- 1548 Check differences between PDF versions 1.7 and 2.0. 1548
- 1549 bidi? 1549

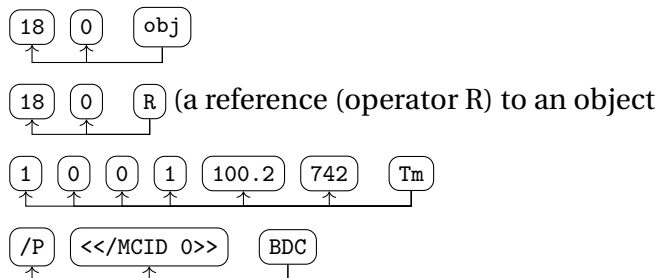
## References

- [1]<sup>1551</sup> Adobe Systems Incorporated. *Document management – Portable document format – Part 1: PDF 1.7*. 1st ed. July 1, 2008. URL: [https://www.adobe.com/content/dam/acom/en/devnet/pdf/pdfs/PDF32000\\_2008.pdf](https://www.adobe.com/content/dam/acom/en/devnet/pdf/pdfs/PDF32000_2008.pdf) (visited on 04/18/2021). <sup>1551</sup>
- [2]<sup>1552</sup> Adobe Systems Incorporated. *PDF Reference, sixth edition*. 2006. URL: [https://www.adobe.com/content/dam/acom/en/devnet/pdf/pdfs/PDF32000\\_2008.pdf](https://www.adobe.com/content/dam/acom/en/devnet/pdf/pdfs/PDF32000_2008.pdf). <sup>1552</sup>
- [3]<sup>1553</sup> Dual Lab. *Next-Generation PDF*. URL: <http://ngpdf.com/>. <sup>1553</sup>
- [4]<sup>1554</sup> International Standard. *ISO 32000-2:2020(en). Document management — Portable document format — Part 2: PDF 2.0*. 2nd ed. Dec. 2020. URL: <https://www.iso.org/obp/ui/#iso:std:iso:32000:-2:ed-2:v1:en> (visited on 04/18/2021). <sup>1554</sup>
- [5]<sup>1581</sup> TeX User Group. *PDF accessibility and PDF standards*. URL: <https://tug.org/twg/accessibility/>. <sup>1581</sup>
- [6]<sup>1582</sup> veraPDF consortium. *veraPDF*. URL: <http://verapdf.org/>. <sup>1582</sup>
- [7]<sup>1583</sup> Zugang für alle – Schweizerische Stiftung zur behindertengerechten Technologienutzung. *PDF Accessibility Checker (PAC 3)*. URL: <http://www.access-for-all.ch/ch/pdf-werkstatt/pdf-accessibility-checker-pac.html> (visited on 07/05/2018). <sup>1583</sup>

## A. Some remarks about the PDF syntax

<sup>1585</sup> This is not meant as a full reference only as a background to make the examples and remarks easier to understand. <sup>1585</sup>

**postfix notation** PDF uses in various places postfix notation. This means that the operator is behind its arguments: <sup>1586</sup>



**Names** PDF knows a sort of variable called a “name”. Names start with a slash and may include any regular characters, but not delimiter or white-space characters. Uppercase and lowercase letters are considered distinct: /A and /a are different names. /.notdef and /Adobe#20Green are valid names. <sup>1591</sup>

<sup>1592</sup> Quite a number of the options of tagpdf actually define such a name which is later added to the PDF. I recommend *strongly* not to use spaces and exotic chars in such names. While it is possible to escape such names it is rather a pain when moving them through the various lists and commands and quite probably I forgot some place where it is needed. <sup>1592</sup>

**Strings** There are two types of strings: *Literal strings* are enclosed in round parentheses. They normally contain a mix of ascii chars and octal numbers: <sup>1593</sup>

<sup>1620</sup> (gr\374\377ehello []\050\051). <sup>1620</sup>

<sup>1621</sup> *Hexadezimal strings* are enclosed in angle brackets. They allow for a representation of all characters the whole unicode ranges. This is the default output of luatex. <sup>1621</sup>

<sup>1622</sup> <003B00600243013D0032>. <sup>1622</sup>

**Arrays** Arrays are enclosed by square brackets. They can contain all sort of objects including more arrays. As an example here an array which contains five objects: a number, an object reference, a string, a dictionary and another array. Be aware that despite the spaces 15 0 R is *one* element of the array. <sup>1623</sup>

<sup>1624</sup> [0 15 0 R (hello) <</Type /X>> [1 2 3]] <sup>1624</sup>

(0) (15 0 R) ((hello)) (<</Type /X>>) ([1 2 3])

**Dictionaries** Dictionaries are enclosed by double angle brackets. They contain key-value pairs. The key is always a name. The value can be all sort of objects including more dictionaries. It doesn't matter in which order the keys are given. <sup>1626</sup>

<sup>1627</sup> Dictionaries can be written all in one line:

<</Type/Page/Contents 3 0 R/Resources 1 0 R/Parent 5 0 R>>

but at least for examples a layout with line breaks and indentation is more readable: <sup>1627</sup>

```
<<
 /Type /Page
 /Contents 3 0 R
 /Resources 1 0 R
 /MediaBox [0 0 595.276 841.89]
 /Parent 5 0 R
>>
```

**(indirect) objects** These are enclosed by the keywords obj (which has two numbers as prefix arguments) and endobj. The first argument is the object number, the second a generation number – if a PDF is edited objects with a larger generation number can be added. As with pdfflatex/luatex the PDF is always new we can safely assume that the number is always 0. Objects can be referenced in other places with the R operator. The content of an object can be all sort of things. <sup>1635</sup>

**streams** A stream is a sequence of bytes. It can be long and is used for the real content of PDF: text, fonts, content of graphics. A stream starts with a dictionary which at least sets the /Length name to the length of the stream followed by the stream content enclosed by the keywords stream and endstream. <sup>1636</sup>

<sup>1637</sup> Here an example of a stream, an object definition and reference. In the object 2 (a page object) the /Contents key references the object 3 and this then contains the text of the page in a stream. Tf, Tm and TJ are (postfix) operators, the first chooses the font with the name /F15 at the size 10.9, the second displaces the reference point on the page and the third inserts the text. <sup>1637</sup>

```

% a page object (shortened)
2 0 obj
<<
 /Type/Page
 /Contents 3 0 R
 /Resources 1 0 R
 ...
>>
endobj

%the /Contents object (/Length value is wrong)
3 0 obj
<</Length 153 >>
stream
BT
 /F15 10.9 Tf 1 0 0 1 100.2 746.742 Tm [(hello)]TJ
ET
endstream
endobj

```

<sup>1683</sup> In such a stream the BT–ET pair encloses texts while drawing and graphics are outside of such pairs. <sup>1683</sup>

**Number tree** This is a more complex data structure that is meant to index objects by numbers. In the core is an array with number-value pairs. A simple version of number tree which has the keys 0 and 3 is <sup>1684</sup>

```

6 0 obj
<<
 /Nums [
 0 [20 0 R 22 0 R]
 3 21 0 R
]
>>
endobj

```

<sup>1693</sup> This maps 0 to an array and 2 to the object reference 21 0 R. Number trees can be split over various nodes – root, intermediate and leaf nodes. We will need such a tree for the *parent tree*. <sup>1693</sup>