
Linux Doc-guide Documentation

Release 6.8.0

The kernel development community

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USING SPHINX FOR KERNEL DOCUMENTATION

The Linux kernel uses [Sphinx](#) to generate pretty documentation from [reStructuredText](#) files under Documentation. To build the documentation in HTML or PDF formats, use `make htmldocs` or `make pdfdocs`. The generated documentation is placed in Documentation/output.

The reStructuredText files may contain directives to include structured documentation comments, or kernel-doc comments, from source files. Usually these are used to describe the functions and types and design of the code. The kernel-doc comments have some special structure and formatting, but beyond that they are also treated as reStructuredText.

Finally, there are thousands of plain text documentation files scattered around Documentation. Some of these will likely be converted to reStructuredText over time, but the bulk of them will remain in plain text.

1.1 Sphinx Install

The ReST markups currently used by the Documentation/ files are meant to be built with Sphinx version 2.4.4 or higher.

There's a script that checks for the Sphinx requirements. Please see [*Checking for Sphinx dependencies*](#) for further details.

Most distributions are shipped with Sphinx, but its toolchain is fragile, and it is not uncommon that upgrading it or some other Python packages on your machine would cause the documentation build to break.

A way to avoid that is to use a different version than the one shipped with your distributions. In order to do so, it is recommended to install Sphinx inside a virtual environment, using `virtualenv-3` or `virtualenv`, depending on how your distribution packaged Python 3.

Note:

- 1) It is recommended to use the RTD theme for html output. Depending on the Sphinx version, it should be installed separately, with `pip install sphinx_rtd_theme`.

In summary, if you want to install Sphinx version 2.4.4, you should do:

```
$ virtualenv sphinx_2.4.4
$ . sphinx_2.4.4/bin/activate
(sphinx_2.4.4) $ pip install -r Documentation/sphinx/requirements.txt
```

After running `. sphinx_2.4.4/bin/activate`, the prompt will change, in order to indicate that you're using the new environment. If you open a new shell, you need to rerun this command to enter again at the virtual environment before building the documentation.

1.1.1 Image output

The kernel documentation build system contains an extension that handles images on both GraphViz and SVG formats (see [Figures & Images](#)).

For it to work, you need to install both GraphViz and ImageMagick packages. If those packages are not installed, the build system will still build the documentation, but won't include any images at the output.

1.1.2 PDF and LaTeX builds

Such builds are currently supported only with Sphinx versions 2.4 and higher.

For PDF and LaTeX output, you'll also need XeLaTeX version 3.14159265.

Depending on the distribution, you may also need to install a series of `texlive` packages that provide the minimal set of functionalities required for XeLaTeX to work.

1.1.3 Math Expressions in HTML

Some ReST pages contain math expressions. Due to the way Sphinx works, those expressions are written using LaTeX notation. There are two options for Sphinx to render math expressions in html output. One is an extension called `imgmath` which converts math expressions into images and embeds them in html pages. The other is an extension called `mathjax` which delegates math rendering to JavaScript capable web browsers. The former was the only option for pre-6.1 kernel documentation and it requires quite a few `texlive` packages including `amsfonts` and `amsmath` among others.

Since kernel release 6.1, html pages with math expressions can be built without installing any `texlive` packages. See [Choice of Math Renderer](#) for further info.

1.1.4 Checking for Sphinx dependencies

There's a script that automatically check for Sphinx dependencies. If it can recognize your distribution, it will also give a hint about the install command line options for your distro:

```
$ ./scripts/sphinx-pre-install
Checking if the needed tools for Fedora release 26 (Twenty Six) are available
Warning: better to also install "texlive-luatex85".
You should run:

    sudo dnf install -y texlive-luatex85
    /usr/bin/virtualenv sphinx_2.4.4
    . sphinx_2.4.4/bin/activate
    pip install -r Documentation/sphinx/requirements.txt
```

Can't build as 1 mandatory dependency is missing at ./scripts/sphinx-pre-install line 468.

By default, it checks all the requirements for both html and PDF, including the requirements for images, math expressions and LaTeX build, and assumes that a virtual Python environment will be used. The ones needed for html builds are assumed to be mandatory; the others to be optional.

It supports two optional parameters:

--no-pdf

Disable checks for PDF;

--no-virtualenv

Use OS packaging for Sphinx instead of Python virtual environment.

1.2 Sphinx Build

The usual way to generate the documentation is to run `make htmldocs` or `make pdfdocs`. There are also other formats available: see the documentation section of `make help`. The generated documentation is placed in format-specific subdirectories under `Documentation/output`.

To generate documentation, Sphinx (`sphinx-build`) must obviously be installed. For PDF output you'll also need XeLaTeX and `convert(1)` from ImageMagick (<https://wwwimagemagick.org>).¹ All of these are widely available and packaged in distributions.

To pass extra options to Sphinx, you can use the `SPHINXOPTS` make variable. For example, use `make SPHINXOPTS=-v htmldocs` to get more verbose output.

It is also possible to pass an extra `DOCS_CSS` overlay file, in order to customize the html layout, by using the `DOCS_CSS` make variable.

By default, the "Alabaster" theme is used to build the HTML documentation; this theme is bundled with Sphinx and need not be installed separately. The Sphinx theme can be overridden by using the `DOCS_THEME` make variable.

There is another make variable `SPHINXDIRS`, which is useful when test building a subset of documentation. For example, you can build documents under `Documentation/doc-guide` by running `make SPHINXDIRS=doc-guide htmldocs`. The documentation section of `make help` will show you the list of subdirectories you can specify.

To remove the generated documentation, run `make cleandocs`.

1.2.1 Choice of Math Renderer

Since kernel release 6.1, `mathjax` works as a fallback math renderer for html output.²

Math renderer is chosen depending on available commands as shown below:

¹ Having `inkscape(1)` from Inkscape (<https://inkscape.org>) as well would improve the quality of images embedded in PDF documents, especially for kernel releases 5.18 and later.

² Fallback of math renderer requires Sphinx >=1.8.

Table 1: Math Renderer Choices for HTML

Math renderer	Required commands	Image format
imgmath	latex, dvipng	PNG (raster)
mathjax		

The choice can be overridden by setting an environment variable `SPHINX_IMGMATH` as shown below:

Table 2: Effect of Setting `SPHINX_IMGMATH`

Setting	Renderer
<code>SPHINX_IMGMATH=yes</code>	imgmath
<code>SPHINX_IMGMATH=no</code>	mathjax

1.3 Writing Documentation

Adding new documentation can be as simple as:

1. Add a new `.rst` file somewhere under Documentation.
2. Refer to it from the Sphinx main [TOC tree](#) in `Documentation/index.rst`.

This is usually good enough for simple documentation (like the one you're reading right now), but for larger documents it may be advisable to create a subdirectory (or use an existing one). For example, the graphics subsystem documentation is under `Documentation/gpu`, split to several `.rst` files, and has a separate `index.rst` (with a `toctree` of its own) referenced from the main index.

See the documentation for [Sphinx](#) and [reStructuredText](#) on what you can do with them. In particular, the Sphinx [reStructuredText Primer](#) is a good place to get started with reStructuredText. There are also some [Sphinx specific markup constructs](#).

1.3.1 Specific guidelines for the kernel documentation

Here are some specific guidelines for the kernel documentation:

- Please don't go overboard with reStructuredText markup. Keep it simple. For the most part the documentation should be plain text with just enough consistency in formatting that it can be converted to other formats.
- Please keep the formatting changes minimal when converting existing documentation to reStructuredText.
- Also update the content, not just the formatting, when converting documentation.
- Please stick to this order of heading adornments:
 1. = with overline for document title:

```
=====
Document title
=====
```

2. = for chapters:

```
Chapters
=====
```

3. - for sections:

```
Section
-----
```

4. ~ for subsections:

```
Subsection
~~~~~
```

Although RST doesn't mandate a specific order ("Rather than imposing a fixed number and order of section title adornment styles, the order enforced will be the order as encountered."), having the higher levels the same overall makes it easier to follow the documents.

- For inserting fixed width text blocks (for code examples, use case examples, etc.), use :: for anything that doesn't really benefit from syntax highlighting, especially short snippets. Use ... code-block:: <language> for longer code blocks that benefit from highlighting. For a short snippet of code embedded in the text, use ``.

1.3.2 the C domain

The **Sphinx C Domain** (name c) is suited for documentation of C API. E.g. a function prototype:

```
.. c:function:: int ioctl( int fd, int request )
```

The C domain of the kernel-doc has some additional features. E.g. you can *rename* the reference name of a function with a common name like open or ioctl:

```
.. c:function:: int ioctl( int fd, int request )
  :name: VIDIOC_LOG_STATUS
```

The func-name (e.g. ioctl) remains in the output but the ref-name changed from ioctl to VIDIOC_LOG_STATUS. The index entry for this function is also changed to VIDIOC_LOG_STATUS.

Please note that there is no need to use c:func: to generate cross references to function documentation. Due to some Sphinx extension magic, the documentation build system will automatically turn a reference to function() into a cross reference if an index entry for the given function name exists. If you see c:func: use in a kernel document, please feel free to remove it.

1.3.3 Tables

ReStructuredText provides several options for table syntax. Kernel style for tables is to prefer *simple table* syntax or *grid table* syntax. See the [reStructuredText user reference for table syntax](#) for more details.

list tables

The list-table formats can be useful for tables that are not easily laid out in the usual Sphinx ASCII-art formats. These formats are nearly impossible for readers of the plain-text documents to understand, though, and should be avoided in the absence of a strong justification for their use.

The `flat-table` is a double-stage list similar to the `list-table` with some additional features:

- column-span: with the role `cspan` a cell can be extended through additional columns
- row-span: with the role `rspan` a cell can be extended through additional rows
- auto span rightmost cell of a table row over the missing cells on the right side of that table-row. With Option `:fill-cells:` this behavior can changed from *auto span* to *auto fill*, which automatically inserts (empty) cells instead of spanning the last cell.

options:

- `:header-rows:` [int] count of header rows
- `:stub-columns:` [int] count of stub columns
- `:widths:` [[int] [int] ...] widths of columns
- `:fill-cells:` instead of auto-spanning missing cells, insert missing cells

roles:

- `:cspan:` [int] additional columns (*morecols*)
- `:rspan:` [int] additional rows (*morerows*)

The example below shows how to use this markup. The first level of the staged list is the *table-row*. In the *table-row* there is only one markup allowed, the list of the cells in this *table-row*. Exceptions are *comments* (. . .) and *targets* (e.g. a ref to `:ref:`last row <last row>` / last row`).

```
.. flat-table:: table title
  :widths: 2 1 1 3

  * - head col 1
    - head col 2
    - head col 3
    - head col 4

  * - row 1
    - field 1.1
    - field 1.2 with autospan

  * - row 2
```

```

- field 2.1
- :rspan:`1` :cspan:`1` field 2.2 - 3.3

* .. _`last row`:

- row 3

```

Rendered as:

Table 3: table title

head col 1	head col 2	head col 3	head col 4
row 1	field 1.1	field 1.2 with rowspan	
row 2	field 2.1	field 2.2 - 3.3	
row 3			

1.3.4 Cross-referencing

Cross-referencing from one documentation page to another can be done simply by writing the path to the document file, no special syntax required. The path can be either absolute or relative. For absolute paths, start it with "Documentation/". For example, to cross-reference to this page, all the following are valid options, depending on the current document's directory (note that the .rst extension is required):

See Documentation/doc-guide/sphinx.rst. This always works.
 Take a look at sphinx.rst, which is at this same directory.
 Read ../sphinx.rst, which is one directory above.

If you want the link to have a different rendered text other than the document's title, you need to use Sphinx's doc role. For example:

See :doc:`my custom link text for document sphinx <sphinx>`.

For most use cases, the former is preferred, as it is cleaner and more suited for people reading the source files. If you come across a :doc: usage that isn't adding any value, please feel free to convert it to just the document path.

For information on cross-referencing to kernel-doc functions or types, see [Writing kernel-doc comments](#).

Referencing commits

References to git commits are automatically hyperlinked given that they are written in one of these formats:

```

commit 72bf4f1767f0
commit 72bf4f1767f0 ("net: do not leave an empty skb in write queue")

```

1.4 Figures & Images

If you want to add an image, you should use the `kernel-figure` and `kernel-image` directives. E.g. to insert a figure with a scalable image format, use SVG (*SVG image example*):

```
.. kernel-figure:: svg_image.svg
:alt: simple SVG image

SVG image example
```

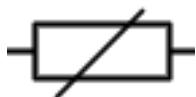


Fig. 1: SVG image example

The kernel figure (and image) directive supports **DOT** formatted files, see

- DOT: <http://graphviz.org/pdf/dotguide.pdf>
- Graphviz: <http://www.graphviz.org/content/dot-language>

A simple example (*DOT's hello world example*):

```
.. kernel-figure:: hello.dot
:alt: hello world

DOT's hello world example
```

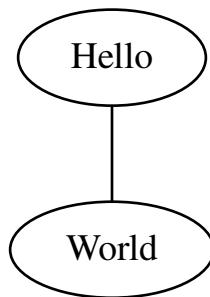


Fig. 2: DOT's hello world example

Embedded *render* markups (or languages) like Graphviz's **DOT** are provided by the `kernel-render` directives.:

```
.. kernel-render:: DOT
:alt: foobar digraph
:caption: Embedded **DOT** (Graphviz) code

digraph foo {
  "bar" -> "baz";
}
```

How this will be rendered depends on the installed tools. If Graphviz is installed, you will see

a vector image. If not, the raw markup is inserted as *literal-block* ([Embedded DOT \(Graphviz\) code](#)).

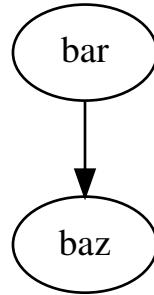


Fig. 3: Embedded **DOT** (Graphviz) code

The *render* directive has all the options known from the *figure* directive, plus option *caption*. If *caption* has a value, a *figure* node is inserted. If not, an *image* node is inserted. A *caption* is also needed, if you want to refer to it ([Embedded SVG markup](#)).

Embedded **SVG**:

```

.. kernel-render::: SVG
  :caption: Embedded **SVG** markup
  :alt: so-nw-arrow

  <?xml version="1.0" encoding="UTF-8"?>
  <svg xmlns="http://www.w3.org/2000/svg" version="1.1" ...>
    ...
  </svg>
  
```



Fig. 4: Embedded **SVG** markup

WRITING KERNEL-DOC COMMENTS

The Linux kernel source files may contain structured documentation comments in the kernel-doc format to describe the functions, types and design of the code. It is easier to keep documentation up-to-date when it is embedded in source files.

Note: The kernel-doc format is deceptively similar to javadoc, gtk-doc or Doxygen, yet distinctively different, for historical reasons. The kernel source contains tens of thousands of kernel-doc comments. Please stick to the style described here.

Note: kernel-doc does not cover Rust code: please see Documentation/rust/general-information.rst instead.

The kernel-doc structure is extracted from the comments, and proper [Sphinx C Domain](#) function and type descriptions with anchors are generated from them. The descriptions are filtered for special kernel-doc highlights and cross-references. See below for details.

Every function that is exported to loadable modules using EXPORT_SYMBOL or EXPORT_SYMBOL_GPL should have a kernel-doc comment. Functions and data structures in header files which are intended to be used by modules should also have kernel-doc comments.

It is good practice to also provide kernel-doc formatted documentation for functions externally visible to other kernel files (not marked static). We also recommend providing kernel-doc formatted documentation for private (file static) routines, for consistency of kernel source code layout. This is lower priority and at the discretion of the maintainer of that kernel source file.

2.1 How to format kernel-doc comments

The opening comment mark `/**` is used for kernel-doc comments. The kernel-doc tool will extract comments marked this way. The rest of the comment is formatted like a normal multi-line comment with a column of asterisks on the left side, closing with `*/` on a line by itself.

The function and type kernel-doc comments should be placed just before the function or type being described in order to maximise the chance that somebody changing the code will also change the documentation. The overview kernel-doc comments may be placed anywhere at the top indentation level.

Running the `kernel-doc` tool with increased verbosity and without actual output generation may be used to verify proper formatting of the documentation comments. For example:

```
scripts/kernel-doc -v -none drivers/foo/bar.c
```

The documentation format is verified by the kernel build when it is requested to perform extra gcc checks:

```
make W=n
```

2.2 Function documentation

The general format of a function and function-like macro kernel-doc comment is:

```
/**  
 * function_name() - Brief description of function.  
 * @arg1: Describe the first argument.  
 * @arg2: Describe the second argument.  
 *         One can provide multiple line descriptions  
 *         for arguments.  
 *  
 * A longer description, with more discussion of the function function_name()  
 * that might be useful to those using or modifying it. Begins with an  
 * empty comment line, and may include additional embedded empty  
 * comment lines.  
 *  
 * The longer description may have multiple paragraphs.  
 *  
 * Context: Describes whether the function can sleep, what locks it takes,  
 *          releases, or expects to be held. It can extend over multiple  
 *          lines.  
 * Return: Describe the return value of function_name.  
 *  
 * The return value description can also have multiple paragraphs, and should  
 * be placed at the end of the comment block.  
 */
```

The brief description following the function name may span multiple lines, and ends with an argument description, a blank comment line, or the end of the comment block.

2.2.1 Function parameters

Each function argument should be described in order, immediately following the short function description. Do not leave a blank line between the function description and the arguments, nor between the arguments.

Each `@argument`: description may span multiple lines.

Note: If the `@argument` description has multiple lines, the continuation of the description should start at the same column as the previous line:

```
* @argument: some long description
*           that continues on next lines
```

or:

```
* @argument:
*       some long description
*       that continues on next lines
```

If a function has a variable number of arguments, its description should be written in kernel-doc notation as:

```
* @...: description
```

2.2.2 Function context

The context in which a function can be called should be described in a section named `Context`. This should include whether the function sleeps or can be called from interrupt context, as well as what locks it takes, releases and expects to be held by its caller.

Examples:

```
* Context: Any context.
* Context: Any context. Takes and releases the RCU lock.
* Context: Any context. Expects <lock> to be held by caller.
* Context: Process context. May sleep if @gfp flags permit.
* Context: Process context. Takes and releases <mutex>.
* Context: Softirq or process context. Takes and releases <lock>, BH-safe.
* Context: Interrupt context.
```

2.2.3 Return values

The return value, if any, should be described in a dedicated section named `Return`.

Note:

- 1) The multi-line descriptive text you provide does *not* recognize line breaks, so if you try to format some text nicely, as in:

```
* Return:
* %0 - OK
* %-EINVAL - invalid argument
* %-ENOMEM - out of memory
```

this will all run together and produce:

```
Return: 0 - OK -EINVAL - invalid argument -ENOMEM - out of memory
```

So, in order to produce the desired line breaks, you need to use a ReST list, e. g.:

```
* Return:
* * %0           - OK to runtime suspend the device
* * %-EBUSY      - Device should not be runtime suspended
```

- 2) If the descriptive text you provide has lines that begin with some phrase followed by a colon, each of those phrases will be taken as a new section heading, which probably won't produce the desired effect.

2.3 Structure, union, and enumeration documentation

The general format of a struct, union, and enum kernel-doc comment is:

```
/** 
 * struct struct_name - Brief description.
 * @member1: Description of member1.
 * @member2: Description of member2.
 *           One can provide multiple line descriptions
 *           for members.
 *
 * Description of the structure.
 */
```

You can replace the `struct` in the above example with `union` or `enum` to describe unions or enums. `member` is used to mean `struct` and `union` member names as well as enumerations in an `enum`.

The brief description following the structure name may span multiple lines, and ends with a member description, a blank comment line, or the end of the comment block.

2.3.1 Members

Members of structs, unions and enums should be documented the same way as function parameters; they immediately succeed the short description and may be multi-line.

Inside a struct or union description, you can use the `private:` and `public:` comment tags. Structure fields that are inside a `private:` area are not listed in the generated output documentation.

The `private:` and `public:` tags must begin immediately following a `/*` comment marker. They may optionally include comments between the `:` and the ending `*/` marker.

Example:

```
/** 
 * struct my_struct - short description
 * @a: first member
 * @b: second member
 * @d: fourth member
 *
 * Longer description
```

```
/*
struct my_struct {
    int a;
    int b;
/* private: internal use only */
    int c;
/* public: the next one is public */
    int d;
};
```

2.3.2 Nested structs/unions

It is possible to document nested structs and unions, like:

```
/** 
 * struct nested_foobar - a struct with nested unions and structs
 * @memb1: first member of anonymous union/anonymous struct
 * @memb2: second member of anonymous union/anonymous struct
 * @memb3: third member of anonymous union/anonymous struct
 * @memb4: fourth member of anonymous union/anonymous struct
 * @bar: non-anonymous union
 * @bar.st1: struct st1 inside @bar
 * @bar.st2: struct st2 inside @bar
 * @bar.st1.memb1: first member of struct st1 on union bar
 * @bar.st1.memb2: second member of struct st1 on union bar
 * @bar.st2.memb1: first member of struct st2 on union bar
 * @bar.st2.memb2: second member of struct st2 on union bar
 */
struct nested_foobar {
    /* Anonymous union/struct*/
    union {
        struct {
            int memb1;
            int memb2;
        };
        struct {
            void *memb3;
            int memb4;
        };
    };
    union {
        struct {
            int memb1;
            int memb2;
        } st1;
        struct {
            void *memb1;
            int memb2;
        } st2;
    } bar;
```

```
};
```

Note:

- 1) When documenting nested structs or unions, if the struct/union `foo` is named, the member `bar` inside it should be documented as `@foo.bar`:
 - 2) When the nested struct/union is anonymous, the member `bar` in it should be documented as `@bar`:
-

2.3.3 In-line member documentation comments

The structure members may also be documented in-line within the definition. There are two styles, single-line comments where both the opening `/**` and closing `*/` are on the same line, and multi-line comments where they are each on a line of their own, like all other kernel-doc comments:

```
/**  
 * struct foo - Brief description.  
 * @foo: The Foo member.  
 */  
struct foo {  
    int foo;  
    /**  
     * @bar: The Bar member.  
     */  
    int bar;  
    /**  
     * @baz: The Baz member.  
     *  
     * Here, the member description may contain several paragraphs.  
     */  
    int baz;  
    union {  
        /** @foobar: Single line description. */  
        int foobar;  
    };  
    /** @bar2: Description for struct @bar2 inside @foo */  
    struct {  
        /**  
         * @bar2.barbar: Description for @barbar inside @foo.bar2  
         */  
        int barbar;  
    } bar2;  
};
```

2.4 Typedef documentation

The general format of a typedef kernel-doc comment is:

```
/**  
 * typedef type_name - Brief description.  
 *  
 * Description of the type.  
 */
```

Typedefs with function prototypes can also be documented:

```
/**  
 * typedef type_name - Brief description.  
 * @arg1: description of arg1  
 * @arg2: description of arg2  
 *  
 * Description of the type.  
 *  
 * Context: Locking context.  
 * Return: Meaning of the return value.  
 */  
typedef void (*type_name)(struct v4l2_ctrl *arg1, void *arg2);
```

2.5 Highlights and cross-references

The following special patterns are recognized in the kernel-doc comment descriptive text and converted to proper reStructuredText markup and [Sphinx C Domain](#) references.

Attention: The below are **only** recognized within kernel-doc comments, **not** within normal reStructuredText documents.

funcname()

Function reference.

@parameter

Name of a function parameter. (No cross-referencing, just formatting.)

%CONST

Name of a constant. (No cross-referencing, just formatting.)

``literal``

A literal block that should be handled as-is. The output will use a monospaced font.

Useful if you need to use special characters that would otherwise have some meaning either by kernel-doc script or by reStructuredText.

This is particularly useful if you need to use things like %ph inside a function description.

\$ENVVAR

Name of an environment variable. (No cross-referencing, just formatting.)

&struct name

Structure reference.

&enum name

Enum reference.

&typedef name

Typedef reference.

&struct_name->member or &struct_name.member

Structure or union member reference. The cross-reference will be to the struct or union definition, not the member directly.

&name

A generic type reference. Prefer using the full reference described above instead. This is mostly for legacy comments.

2.5.1 Cross-referencing from reStructuredText

No additional syntax is needed to cross-reference the functions and types defined in the kernel-doc comments from reStructuredText documents. Just end function names with () and write struct, union, enum or typedef before types. For example:

```
See foo().  
See struct foo.  
See union bar.  
See enum baz.  
See typedef meh.
```

However, if you want custom text in the cross-reference link, that can be done through the following syntax:

```
See :c:func:`my custom link text for function foo <foo>`.  
See :c:type:`my custom link text for struct bar <bar>`.
```

For further details, please refer to the [Sphinx C Domain](#) documentation.

2.6 Overview documentation comments

To facilitate having source code and comments close together, you can include kernel-doc documentation blocks that are free-form comments instead of being kernel-doc for functions, structures, unions, enums, or typedefs. This could be used for something like a theory of operation for a driver or library code, for example.

This is done by using a DOC: section keyword with a section title.

The general format of an overview or high-level documentation comment is:

```
/**  
 * DOC: Theory of Operation  
 *  
 * The whizbang foobar is a dilly of a gizmo. It can do whatever you  
 * want it to do, at any time. It reads your mind. Here's how it works.
```

```
*  
* foo bar splat  
*  
* The only drawback to this gizmo is that it can sometimes damage  
* hardware, software, or its subject(s).  
*/
```

The title following `DOC:` acts as a heading within the source file, but also as an identifier for extracting the documentation comment. Thus, the title must be unique within the file.

INCLUDING KERNEL-DOC COMMENTS

The documentation comments may be included in any of the reStructuredText documents using a dedicated kernel-doc Sphinx directive extension.

The kernel-doc directive is of the format:

```
.. kernel-doc:: source
:option:
```

The *source* is the path to a source file, relative to the kernel source tree. The following directive options are supported:

export: [*source-pattern* ...]

Include documentation for all functions in *source* that have been exported using EXPORT_SYMBOL or EXPORT_SYMBOL_GPL either in *source* or in any of the files specified by *source-pattern*.

The *source-pattern* is useful when the kernel-doc comments have been placed in header files, while EXPORT_SYMBOL and EXPORT_SYMBOL_GPL are next to the function definitions.

Examples:

```
.. kernel-doc:: lib/bitmap.c
:export:

.. kernel-doc:: include/net/mac80211.h
:export: net/mac80211/*.c
```

internal: [*source-pattern* ...]

Include documentation for all functions and types in *source* that have **not** been exported using EXPORT_SYMBOL or EXPORT_SYMBOL_GPL either in *source* or in any of the files specified by *source-pattern*.

Example:

```
.. kernel-doc:: drivers/gpu/drm/i915/intel_audio.c
:internal:
```

identifiers: [*function/type* ...]

Include documentation for each *function* and *type* in *source*. If no *function* is specified, the documentation for all functions and types in the *source* will be included.

Examples:

```
.. kernel-doc:: lib/bitmap.c
   :identifiers: bitmap_parselist bitmap_parselist_user

.. kernel-doc:: lib/idr.c
   :identifiers:
```

no-identifiers: [*function/type* ...]

Exclude documentation for each *function* and *type* in *source*.

Example:

```
.. kernel-doc:: lib/bitmap.c
   :no-identifiers: bitmap_parselist
```

functions: [*function/type* ...]

This is an alias of the 'identifiers' directive and deprecated.

doc: *title*

Include documentation for the DOC: paragraph identified by *title* in *source*. Spaces are allowed in *title*; do not quote the *title*. The *title* is only used as an identifier for the paragraph, and is not included in the output. Please make sure to have an appropriate heading in the enclosing reStructuredText document.

Example:

```
.. kernel-doc:: drivers/gpu/drm/i915/intel_audio.c
   :doc: High Definition Audio over HDMI and Display Port
```

Without options, the kernel-doc directive includes all documentation comments from the source file.

The kernel-doc extension is included in the kernel source tree, at Documentation/sphinx/kerneldoc.py. Internally, it uses the scripts/kernel-doc script to extract the documentation comments from the source.

3.1 How to use kernel-doc to generate man pages

If you just want to use kernel-doc to generate man pages you can do this from the kernel git tree:

```
$ scripts/kernel-doc -man \
$(git grep -l '/\*\*' -- :^Documentation :^tools) \
| scripts/split-man.pl /tmp/man
```

Some older versions of git do not support some of the variants of syntax for path exclusion. One of the following commands may work for those versions:

```
$ scripts/kernel-doc -man \
$(git grep -l '/\*\*' -- . ':!Documentation' ':!tools') \
| scripts/split-man.pl /tmp/man

$ scripts/kernel-doc -man \
```

```
$(git grep -l '/\*\*' -- . ":(exclude)Documentation" ":(exclude)tools") \  
| scripts/split-man.pl /tmp/man
```


INCLUDING UAPI HEADER FILES

Sometimes, it is useful to include header files and C example codes in order to describe the userspace API and to generate cross-references between the code and the documentation. Adding cross-references for userspace API files has an additional vantage: Sphinx will generate warnings if a symbol is not found at the documentation. That helps to keep the uAPI documentation in sync with the Kernel changes. The *parse_headers.pl* provide a way to generate such cross-references. It has to be called via Makefile, while building the documentation. Please see Documentation/userspace-api/media/Makefile for an example about how to use it inside the Kernel tree.

4.1 parse_headers.pl

4.1.1 NAME

`parse_headers.pl` - parse a C file, in order to identify functions, structs, enums and defines and create cross-references to a Sphinx book.

4.1.2 SYNOPSIS

parse_headers.pl [<options>] <C_FILE> <OUT_FILE> [<EXCEPTIONS_FILE>]

Where <options> can be: --debug, --help or --usage.

4.1.3 OPTIONS

--debug

Put the script in verbose mode, useful for debugging.

--usage

Prints a brief help message and exits.

--help

Prints a more detailed help message and exits.

4.1.4 DESCRIPTION

Convert a C header or source file (C_FILE), into a ReStructured Text included via ..parsed-literal block with cross-references for the documentation files that describe the API. It accepts an optional EXCEPTIONS_FILE with describes what elements will be either ignored or be pointed to a non-default reference.

The output is written at the (OUT_FILE).

It is capable of identifying defines, functions, structs, typedefs, enums and enum symbols and create cross-references for all of them. It is also capable of distinguish #define used for specifying a Linux ioctl.

The EXCEPTIONS_FILE contain two types of statements: **ignore** or **replace**.

The syntax for the ignore tag is:

ignore type name

The **ignore** means that it won't generate cross references for a **name** symbol of type **type**.

The syntax for the replace tag is:

replace type name new_value

The **replace** means that it will generate cross references for a **name** symbol of type **type**, but, instead of using the default replacement rule, it will use **new_value**.

For both statements, **type** can be either one of the following:

ioctl

The ignore or replace statement will apply to ioctl definitions like:

```
#define VIDIOC_DBG_S_REGISTER _IOW('V', 79, struct v4l2_dbg_register)
```

define

The ignore or replace statement will apply to any other #define found at C_FILE.

typedef

The ignore or replace statement will apply to typedef statements at C_FILE.

struct

The ignore or replace statement will apply to the name of struct statements at C_FILE.

enum

The ignore or replace statement will apply to the name of enum statements at C_FILE.

symbol

The ignore or replace statement will apply to the name of enum value at C_FILE.

For replace statements, **new_value** will automatically use :c:type: references for **typedef**, **enum** and **struct** types. It will use :ref: for **ioctl**, **define** and **symbol** types. The type of reference can also be explicitly defined at the replace statement.

4.1.5 EXAMPLES

```
ignore define _VIDEODEV2_H
```

Ignore a #define _VIDEODEV2_H at the C_FILE.

```
ignore symbol PRIVATE
```

On a struct like:

```
enum foo { BAR1, BAR2, PRIVATE };
```

It won't generate cross-references for **PRIVATE**.

```
replace symbol BAR1 :c:type:`foo` replace symbol BAR2 :c:type:`foo`
```

On a struct like:

```
enum foo { BAR1, BAR2, PRIVATE };
```

It will make the BAR1 and BAR2 enum symbols to cross reference the foo symbol at the C domain.

4.1.6 BUGS

Report bugs to Mauro Carvalho Chehab <mchehab@kernel.org>

4.1.7 COPYRIGHT

Copyright (c) 2016 by Mauro Carvalho Chehab <mchehab+samsung@kernel.org>.

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HOW TO HELP IMPROVE KERNEL DOCUMENTATION

Documentation is an important part of any software-development project. Good documentation helps to bring new developers in and helps established developers work more effectively. Without top-quality documentation, a lot of time is wasted in reverse-engineering the code and making avoidable mistakes.

Unfortunately, the kernel's documentation currently falls far short of what it needs to be to support a project of this size and importance.

This guide is for contributors who would like to improve that situation. Kernel documentation improvements can be made by developers at a variety of skill levels; they are a relatively easy way to learn the kernel process in general and find a place in the community. The bulk of what follows is the documentation maintainer's list of tasks that most urgently need to be done.

5.1 The documentation TODO list

There is an endless list of tasks that need to be carried out to get our documentation to where it should be. This list contains a number of important items, but is far from exhaustive; if you see a different way to improve the documentation, please do not hold back!

5.1.1 Addressing warnings

The documentation build currently spews out an unbelievable number of warnings. When you have that many, you might as well have none at all; people ignore them, and they will never notice when their work adds new ones. For this reason, eliminating warnings is one of the highest-priority tasks on the documentation TODO list. The task itself is reasonably straightforward, but it must be approached in the right way to be successful.

Warnings issued by a compiler for C code can often be dismissed as false positives, leading to patches aimed at simply shutting the compiler up. Warnings from the documentation build almost always point at a real problem; making those warnings go away requires understanding the problem and fixing it at its source. For this reason, patches fixing documentation warnings should probably not say "fix a warning" in the changelog title; they should indicate the real problem that has been fixed.

Another important point is that documentation warnings are often created by problems in kerneldoc comments in C code. While the documentation maintainer appreciates being copied on fixes for these warnings, the documentation tree is often not the right one to actually carry those fixes; they should go to the maintainer of the subsystem in question.

For example, in a documentation build I grabbed a pair of warnings nearly at random:

```
./drivers/devfreq/devfreq.c:1818: warning: bad line:
    - Resource-managed devfreq_register_notifier()
./drivers/devfreq/devfreq.c:1854: warning: bad line:
    - Resource-managed devfreq_unregister_notifier()
```

(The lines were split for readability).

A quick look at the source file named above turned up a couple of kerneldoc comments that look like this:

```
/***
 * devm_devfreq_register_notifier()
 *     - Resource-managed devfreq_register_notifier()
 * @dev:      The devfreq user device. (parent of devfreq)
 * @devfreq:   The devfreq object.
 * @nb:        The notifier block to be unregistered.
 * @list:     DEVFREQ_TRANSITION_NOTIFIER.
 */
```

The problem is the missing “**”, which confuses the build system's simplistic idea of what C comment blocks look like. This problem had been present since that comment was added in 2016 — a full four years. Fixing it was a matter of adding the missing asterisks. A quick look at the history for that file showed what the normal format for subject lines is, and `scripts/get_maintainer.pl` told me who should receive it (pass paths to your patches as arguments to `scripts/get_maintainer.pl`). The resulting patch looked like this:

[PATCH] PM / devfreq: Fix two malformed kerneldoc comments

Two kerneldoc comments in `devfreq.c` fail to adhere to the required format, resulting in these doc-build warnings:

```
./drivers/devfreq/devfreq.c:1818: warning: bad line:
    - Resource-managed devfreq_register_notifier()
./drivers/devfreq/devfreq.c:1854: warning: bad line:
    - Resource-managed devfreq_unregister_notifier()
```

Add a couple of missing asterisks and make kerneldoc a little happier.

Signed-off-by: Jonathan Corbet <corbet@lwn.net>

```
---
drivers/devfreq/devfreq.c | 4 +--
1 file changed, 2 insertions(+), 2 deletions(-)

diff --git a/drivers/devfreq/devfreq.c b/drivers/devfreq/devfreq.c
index 57f6944d65a6..00c9b80b3d33 100644
--- a/drivers/devfreq/devfreq.c
+++ b/drivers/devfreq/devfreq.c
@@ -1814,7 +1814,7 @@ static void devm_devfreq_notifier_release(struct device_
    *dev, void *res)

/***
```

```

 * devm_devfreq_register_notifier()
-     - Resource-managed devfreq_register_notifier()
+ *     - Resource-managed devfreq_register_notifier()
 * @dev:      The devfreq user device. (parent of devfreq)
 * @devfreq:   The devfreq object.
 * @nb:        The notifier block to be unregistered.
@@ -1850,7 +1850,7 @@ EXPORT_SYMBOL(devm_devfreq_register_notifier);

 /**
 * devm_devfreq_unregister_notifier()
-     - Resource-managed devfreq_unregister_notifier()
+ *     - Resource-managed devfreq_unregister_notifier()
 * @dev:      The devfreq user device. (parent of devfreq)
 * @devfreq:   The devfreq object.
 * @nb:        The notifier block to be unregistered.
--
```

2.24.1

The entire process only took a few minutes. Of course, I then found that somebody else had fixed it in a separate tree, highlighting another lesson: always check linux-next to see if a problem has been fixed before you dig into it.

Other fixes will take longer, especially those relating to structure members or function parameters that lack documentation. In such cases, it is necessary to work out what the role of those members or parameters is and describe them correctly. Overall, this task gets a little tedious at times, but it's highly important. If we can actually eliminate warnings from the documentation build, then we can start expecting developers to avoid adding new ones.

In addition to warnings from the regular documentation build, you can also run `make refcheckdocs` to find references to nonexistent documentation files.

5.1.2 Languishing kerneldoc comments

Developers are encouraged to write kerneldoc comments for their code, but many of those comments are never pulled into the docs build. That makes this information harder to find and, for example, makes Sphinx unable to generate links to that documentation. Adding `kernel-doc` directives to the documentation to bring those comments in can help the community derive the full value of the work that has gone into creating them.

The `scripts/find-unused-docs.sh` tool can be used to find these overlooked comments.

Note that the most value comes from pulling in the documentation for exported functions and data structures. Many subsystems also have kerneldoc comments for internal use; those should not be pulled into the documentation build unless they are placed in a document that is specifically aimed at developers working within the relevant subsystem.

5.1.3 Typo fixes

Fixing typographical or formatting errors in the documentation is a quick way to figure out how to create and send patches, and it is a useful service. I am always willing to accept such patches. That said, once you have fixed a few, please consider moving on to more advanced tasks, leaving some typos for the next beginner to address.

Please note that some things are *not* typos and should not be "fixed":

- Both American and British English spellings are allowed within the kernel documentation. There is no need to fix one by replacing it with the other.
- The question of whether a period should be followed by one or two spaces is not to be debated in the context of kernel documentation. Other areas of rational disagreement, such as the "Oxford comma", are also off-topic here.

As with any patch to any project, please consider whether your change is really making things better.

5.1.4 Ancient documentation

Some kernel documentation is current, maintained, and useful. Some documentation is ... not. Dusty, old, and inaccurate documentation can mislead readers and casts doubt on our documentation as a whole. Anything that can be done to address such problems is more than welcome.

Whenever you are working with a document, please consider whether it is current, whether it needs updating, or whether it should perhaps be removed altogether. There are a number of warning signs that you can pay attention to here:

- References to 2.x kernels
- Pointers to SourceForge repositories
- Nothing but typo fixes in the history for several years
- Discussion of pre-Git workflows

The best thing to do, of course, would be to bring the documentation current, adding whatever information is needed. Such work often requires the cooperation of developers familiar with the subsystem in question, of course. Developers are often more than willing to cooperate with people working to improve the documentation when asked nicely, and when their answers are listened to and acted upon.

Some documentation is beyond hope; we occasionally find documents that refer to code that was removed from the kernel long ago, for example. There is surprising resistance to removing obsolete documentation, but we should do that anyway. Extra cruft in our documentation helps nobody.

In cases where there is perhaps some useful information in a badly outdated document, and you are unable to update it, the best thing to do may be to add a warning at the beginning. The following text is recommended:

```
.. warning ::  
    This document is outdated and in need of attention. Please use  
    this information with caution, and please consider sending patches  
    to update it.
```

That way, at least our long-suffering readers have been warned that the document may lead them astray.

5.1.5 Documentation coherency

The old-timers around here will remember the Linux books that showed up on the shelves in the 1990s. They were simply collections of documentation files scrounged from various locations on the net. The books have (mostly) improved since then, but the kernel's documentation is still mostly built on that model. It is thousands of files, almost each of which was written in isolation from all of the others. We don't have a coherent body of kernel documentation; we have thousands of individual documents.

We have been trying to improve the situation through the creation of a set of "books" that group documentation for specific readers. These include:

- Documentation/admin-guide/index.rst
- Documentation/core-api/index.rst
- Documentation/driver-api/index.rst
- Documentation/userspace-api/index.rst

As well as this book on documentation itself.

Moving documents into the appropriate books is an important task and needs to continue. There are a couple of challenges associated with this work, though. Moving documentation files creates short-term pain for the people who work with those files; they are understandably unenthusiastic about such changes. Usually the case can be made to move a document once; we really don't want to keep shifting them around, though.

Even when all documents are in the right place, though, we have only managed to turn a big pile into a group of smaller piles. The work of trying to knit all of those documents together into a single whole has not yet begun. If you have bright ideas on how we could proceed on that front, we would be more than happy to hear them.

5.1.6 Stylesheet improvements

With the adoption of Sphinx we have much nicer-looking HTML output than we once did. But it could still use a lot of improvement; Donald Knuth and Edward Tufte would be unimpressed. That requires tweaking our stylesheets to create more typographically sound, accessible, and readable output.

Be warned: if you take on this task you are heading into classic bikeshed territory. Expect a lot of opinions and discussion for even relatively obvious changes. That is, alas, the nature of the world we live in.

5.1.7 Non-LaTeX PDF build

This is a decidedly nontrivial task for somebody with a lot of time and Python skills. The Sphinx toolchain is relatively small and well contained; it is easy to add to a development system. But building PDF or EPUB output requires installing LaTeX, which is anything but small or well contained. That would be a nice thing to eliminate.

The original hope had been to use the `rst2pdf` tool (<https://rst2pdf.org/>) for PDF generation, but it turned out to not be up to the task. Development work on `rst2pdf` seems to have picked up again in recent times, though, which is a hopeful sign. If a suitably motivated developer were to work with that project to make `rst2pdf` work with the kernel documentation build, the world would be eternally grateful.

5.1.8 Write more documentation

Naturally, there are massive parts of the kernel that are severely underdocumented. If you have the knowledge to document a specific kernel subsystem and the desire to do so, please do not hesitate to do some writing and contribute the result to the kernel. Untold numbers of kernel developers and users will thank you.

DOCUMENTATION SUBSYSTEM MAINTAINER ENTRY PROFILE

The documentation “subsystem” is the central coordinating point for the kernel’s documentation and associated infrastructure. It covers the hierarchy under Documentation/ (with the exception of Documentation/devicetree), various utilities under scripts/ and, at least some of the time, LICENSES/.

It’s worth noting, though, that the boundaries of this subsystem are rather fuzzier than normal. Many other subsystem maintainers like to keep control of portions of Documentation/, and many more freely apply changes there when it is convenient. Beyond that, much of the kernel’s documentation is found in the source as kerneldoc comments; those are usually (but not always) maintained by the relevant subsystem maintainer.

The mailing list for documentation is linux-doc@vger.kernel.org. Patches should be made against the docs-next tree whenever possible.

6.1 Submit checklist addendum

When making documentation changes, you should actually build the documentation and ensure that no new errors or warnings have been introduced. Generating HTML documents and looking at the result will help to avoid unsightly misunderstandings about how things will be rendered.

6.2 Key cycle dates

Patches can be sent anytime, but response will be slower than usual during the merge window. The docs tree tends to close late before the merge window opens, since the risk of regressions from documentation patches is low.

6.3 Review cadence

I am the sole maintainer for the documentation subsystem, and I am doing the work on my own time, so the response to patches will occasionally be slow. I try to always send out a notification when a patch is merged (or when I decide that one cannot be). Do not hesitate to send a ping if you have not heard back within a week of sending a patch.