

The CoinForth Documentation

Arduino Simple BLE Peripheral

Version 0.4

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Abstract

This started out as a Docbook example within Syntext Serna Free 4.3.0-20110207.0, which is the latest **FREE** version I found at <http://syntext-serna-free.software.informer.com/download/?ca336a2>. According to https://en.wikipedia.org/wiki/Syntext_Serna, the software was sold and is now the paid <http://www.corena.com/products/corena-studio/>. Another popular WYSIWYG XML Editor is <http://www.oxygenxml.com/>.

I've started adding my coinForth notes to the free version, with the eventual goal of becoming some useful documentation.

From a conversation with Peter Knaggs, I found http://download.cnet.com/XMLmind-XML-Editor/3000-7241_4-75962446.html, which got me [xxe-eval-5.7.0-setup.exe](#), but that's still the evaluation version. Peter mentions version 5.3, which I need to find. At <http://xmlmind-xml-editor.software.informer.com/3.8/> you end up getting the "Latest version 6.0.0", but scroll down on that page to find the following entry:

5.2.1 (32-bit) 22 Mar 2012 xxe-perso-5_2_1-setup.exe 46.7 MB Download

Peter did send me a link for his copy of version 5.3, but I'm not sure I can see a difference yet.

BLE-STACK

This software is usually available at <http://www.ti.com/tool/ble-stack>, but is being updated from time to time, so the version may change or disappear when it is being updated. Since the CC2540 is pretty old at this point. By default, it installs to this path, so all other files will be relative to this:

```
C:\Texas Instruments\BLE-CC254x-1.4.1.43908\
```

Later on, I moved it into my <https://github.com/DRuffer/coinForth> repository, but we'll discuss that later. For now, we don't need to be concerned, because we haven't changed anything yet.

The BLE Stack requires IAR's EW8051 v9.10.3 with a full license, but all I did was change the device from **CC2540F256** to **CC2540F128** and compiled the **CC2540EM** configuration for using the P0 serial port. I saved the [HostTestReleaseCC2540.hex](#) output file, which should work better than the [CC2540_SmartRF_HostTestRelease_All.hex](#) file TI included.

TI's SmartRF Flash Programmer Ver. 1.12.7 can program those files, but both files give the following error message:

```
CC2540 - ID1188: HEX file content at address 0x26CEE exceeds chip's 128 kB flash size
```

Even IAR, when debugging, gives the following warning:

```
Warning: Possible IDATA stack overflow detected.
To see the instruction that caused the possible overflow, choose Debug>Break and close this message box. To continue execution, just close
```

The Disassembly shows:

```
?BANKED_ENTER_XDATA:
001F20 65 0C      XRL  A,V4
>001F22 45 0D      ORL  A,V5
```

That is somewhere in TI's library (e.g. No source code).

I've also change the baud rate in [Projects\ble\common\npi\npi_np\npi.h](#) from 115,200 to 19,200 to fit with 328eForth v2.20's existing serial port driver.

```
#define NPI_UART_BR          HAL_UART_BR_19200
```

I have also found a "better" Project -> Options -> Linker -> Linker configuration file from:

[.\Projects\ble\common\cc2540\ti_51ew_cc2540b.xcl](#) to [.\Projects\ble\common\cc2540\ti_51ew_cc2540f128b.xcl](#)

However, now I get the following error when compiling:

```
Error[e16]: Segment BLENV_ADDRESS_SPACE (size: 0x1000 align: 0) is too long for segment definition. At least 0x1000 more bytes needed. The
where at the moment of placement the available memory ranges were "-none-"
Reserved ranges relevant to this placement:
CODE:3de6d-3fb30      BANKED_CODE
```

```

BIT:0-7          BREG
BIT:80-97        SFR_AN
BIT:a0-af        SFR_AN
BIT:b8-c7        SFR_AN
BIT:e8-ef        SFR_AN
BIT:f8-ff        SFR_AN
Error while running Linker

```

[\Projects\ble\SimpleBLEPeripheral\CC2540DB\SimpleBLEPeripheral.eww](#) compiles and

[\Projects\ble\SimpleBLEPeripheral\CC2540DB\CC2540F128DK-MINI Keyfob\Exe\SimpleBLEPeripheral.hex](#) can be flashed, so let's start there.

Bummer, I just crashed out of Serna Free, so I have to type in some stuff about what I'm doing, got lost. The additions are starting to jump around a bit, but it makes more sense to talk about this here, than in any other section.

I do not see any serial activity between the 2 CPUs yet, and I've seen in the TI CC254x Bluetooth Low Energy Software Developer's Guide (SWRU271G Version 1.4.1), Section 2.1 Configurations, Subsection 2. Network Processor: "To use the network processor, the Host Test Release project must be used."

It's time to start looking at the memory differences:

Table 1. Canned Binary Libraries

Project	Library	Size
Host Test Release	CC2540_BLE.lib	5,986,524
	CC254x_BLE_HCI_TL_Full.lib	1,961,35
Simple BLE Peripheral	CC2540_BLE_peri.lib	4,955,505
	CC254x_BLE_HCI_TL_None.lib	11,835

Straight out of the box, the Host Test Release does compile, but as we saw earlier, it's compiled for the CC2540F256 and this board has got a CC2540F128. Now, I will count down the memory overflow as I change the CPU and start taking away pieces:

Table 2. Memory Trimming

Element	Overage	Delta
CC2540F128	27,854	N/A
\$PROJ_DIR\$\\.\common\cc2540\ti_51ew_cc2540f128b.xcl	*4,096	23,758
-DHOST_CONFIG=PERIPHERAL_CFG	21,066	6,788
-DGATT_DB_OFF_CHIP	11,339	9,727
HAL_LCD=FALSE	*10,458	881
HAL_LED=FALSE	*9,497	961
CodeBankNrOfs 0x03	2,519	*6,978
INT_HEAP_LEN=1000	*513	2,006
INT_HEAP_LEN=588	9,489	

The asterisks in the previous table indicate some anomalies in how that number was calculated. There seems to be some sequence affected issues and the effects are not necessarily reproducible yet. I will have to see if I can do them again, at some point, but at the moment, I'm still a little over 9K beyond what will fit on the chip. I'm out of ideas and no where nearer to being done.

Arduino

The CC2540's serial port is connected to the ATA6614Q pins PD2 (RX) and PD3 (TX), which require a "soft" serial port, like what Arduino provides in their **SoftwareSerial**. <https://www.arduino.cc/en/Reference/SoftwareSerial> and <http://arduiniana.org/libraries/newsoftserial/>.

Switching back to the Arduino software requires burning their bootloader, and Atmel Studio. <http://ross-arduino.projects.blogspot.com/2014/04/setting-up-coin-ble-dev-kit.html> has: Tool: Select AVRISP mkII and Device: ATA6614Q for Atmel Studio setup, but can't get the mkII to show up there yet. My customer support ticket was at: <https://atmel.support.force.com/customers/500G000000ohYDZ>, but it's gone now. I can't remember what it was, but install issues are usually fixed with Atmel's help.

```

C:\Users\Dennis\Documents>atprogram -t avrispmk2 selftest
Firmware check OK
[ERROR] No self tests to perform for this tool. (TCF Error code: 1)

```

Under the Arduino source, burn the following bootloader:

[./hardware/arduino/avr/bootloaders/atmega/ATmegaBOOT_168_atmega328_pro_8MHz.hex](#)

Change the fuse: HIGH: 0XDA from 0XD9, which is used by eForth.

Inside Arduino 1.6.5, File -> Examples -> 01.Basics -> Blink, then Sketch -> Upload and the LED under the reset button starts blinking.

Yet Another Forth For Arduino

<https://github.com/sdwood68/YAFFA> Yet Another Forth For Arduino

Using Arduino's Serial Monitor @ 19200 baud, I get:

```

YAFFA - Yet Another Forth For Arduino, Version 0.6
Copyright (C) 2012 Stuart Wood
This program comes with ABSOLUTELY NO WARRANTY.
This is free software, and you are welcome to
redistribute it under certain conditions.

```

```

Terminal Echo is On
Pre-Defined Words : 157
Input Buffer: Starts at $6AB, Ends at $70A
Token Buffer: Starts at $68B, Ends at $6AA
Forth Space: Starts at $140, Ends at $63F
315 ($13B) bytes free
>>
>>
>> words5 .

```

Looks like there is some work to do. Later, Stuart Wood (<https://github.com/sdwood68>) got back to me and told me that "The Arduino Serial Monitor needs to be set up to send Carriage Returns per line. Line Feeds are stripped out." So that method works too.

Then again, using my 328eForth setup in HyperAccess (or whatever your favorite terminal emulator is, setup for 19200 @ 8-None-1), it's working fine!

```

>> 5 .
5 OK
>> : junk 5 0 do [char] * emit loop ;
OK
>> junk
***** OK

```

UART Pins

Now, to line up the UART pins with each other, I reference [C:\Texas Instruments\BLE-CC254x-1.4.0\Documents\swru191f.pdf](http://www.ti.com/lit/ug/swru191f/swru191f.pdf) which is available here <http://www.ti.com/lit/ug/swru191f/swru191f.pdf>. Table 7-1. Peripheral I/O Pin Mapping tells me that what is called AR_TX on the schematic is connected to P0_5 (pin 14), is USART 1 RX Alt. 1 configuration. The same is true for AR_RX on P0_4 (pin 15), which is TX for that same configuration. However, this means that, in [C:\Texas Instruments\BLE-CC254x-1.4.1.43908\Components\hal\target\CC2540EB\hal_uart_isr.c](https://github.com/sdwood68), this is wrong:

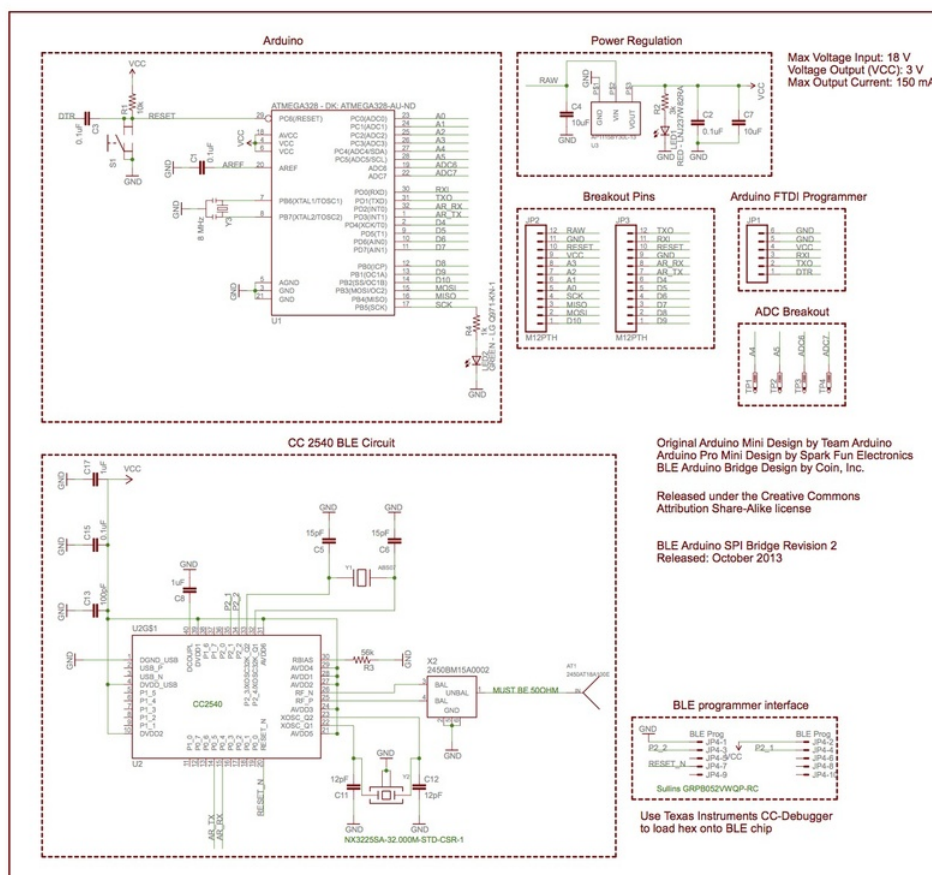
```
#define HAL_UART_PERCFG_BIT    0x02    // USART1 on P1, Alt-2; so set this bit.
```

It needs to be:

```
#define HAL_UART_PERCFG_BIT    0x02    // USART1 on P0, Alt-1; so clear this bit.
```

So, I added a BLE_ARDUINO configuration option to switch and keep track of these changes to TI's code.

Section 7.6.5 USART 1 of the User's Guide says that "the SFR register bit PERCFG.U1CFG (0xF1 Peripheral Control bit 1 set to 0) selects whether to use alternative 1 or alternative 2 locations" and that "P2DIR.PRIP0 (0xFF Port 0 Peripheral Priority Control bits 7:6 set to 0x01) selects the order of precedence when assigning several peripherals to Port 0. When set to 01, USART 1 has precedence."



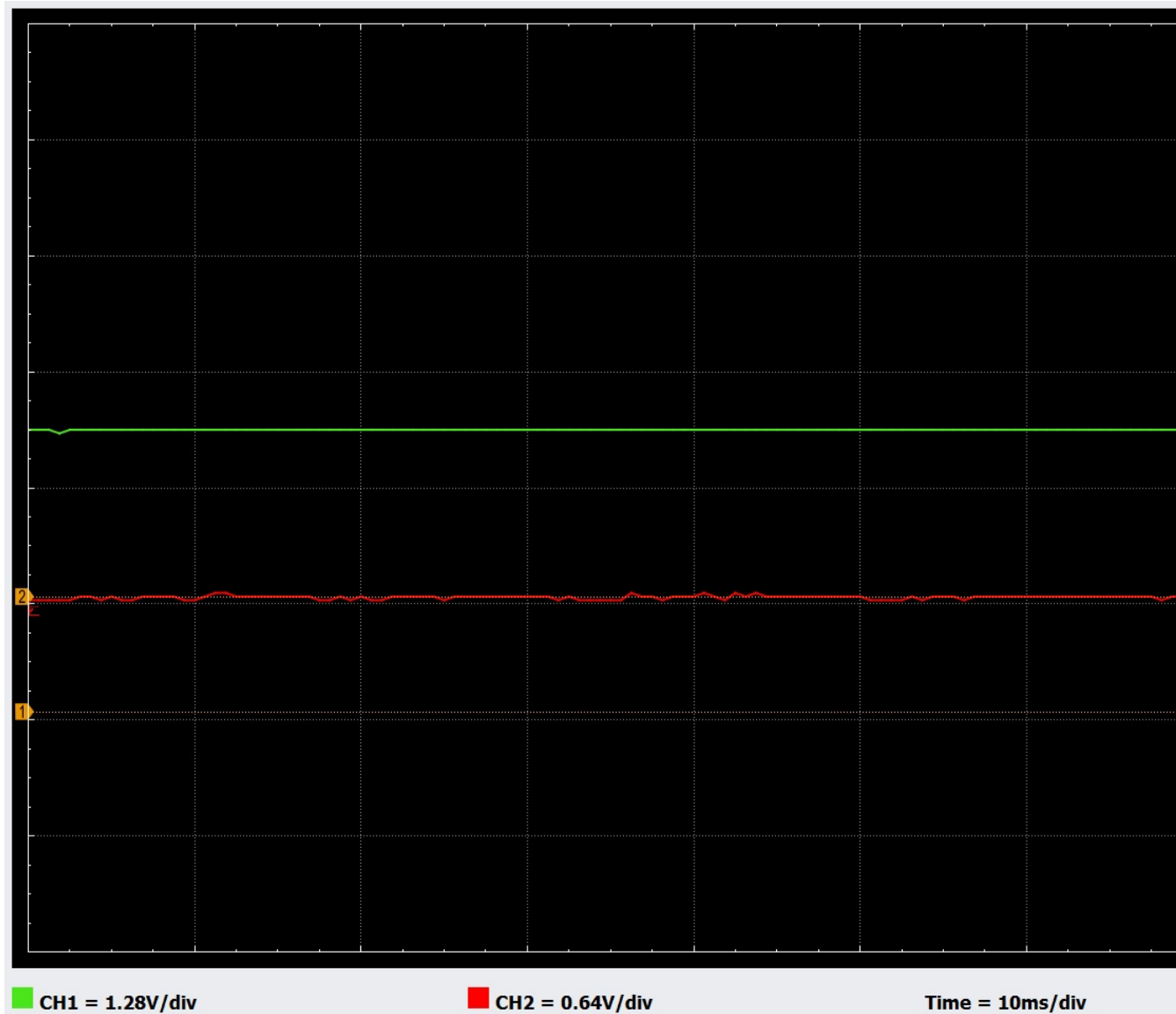
10/2/2013 6:37:40 PM f=0.75 C:\Users\coin\Dropbox\Paybot\BLE to Arduino\I2R.sch (Sheet: 1/1)

Since I'm starting to make some significant changes to the BLE-CC254x stack, I've added it to my coinForth repository <https://github.com/DRuffer/coinForth>. This also allowed me to update to BLE-CC254x-1.4.1.43908b which is the latest release from TI. Opening this in IAR's EW8051 v 9.10.3 reminded me that you have to select the CC2540F128DK-MINI Keyfob workspace.

Gabtronics XMEGA Xprotolab

I've gotten a few of these little devices, and blown up, at least, one of them, but they do prove to be useful when you are trying to see if something in the "real" world is doing something useful. You can find them yourself at: <http://www.gabtronics.com/development-boards/xmega-xprotolab.htm>.

I hooked the the scope channels up to the AR_RX and AR_TX pins on the Arduino. At this point, I see that the RX pin goes high (3.2v) when the CC2540 is in reset, which is what I'd expect, but otherwise, no activity.



Testing

Trying IForth (<https://github.com/jdfreder/iforth>), even with "conda create -n snakes python=3.4" from <http://conda.pydata.org/docs/downloads/conda-cheatsheet.pdf>, I got:

```
Notebook Validation failed: u'name' is a required property:
{}
```

So, now I'm trying forth-notebooks (<https://github.com/ozayn/forth-notebooks>), with help from <http://ipython.readthedocs.org/en/stable/config/intro.html>. In **source setup.sh** I see that it's trying to use mkfifo, so I updated my Ubuntu 64-bit system to VMware Workstation 12 Pro, but then I also found that it's in cygwin 64-bit.

```
Dennis@DaRPC /cygdrive/c/Users/Dennis/Documents/Atmel Studio/7.0/coinForth/doc
$ ipython profile create
[ProfileCreate] Generating default config file: u'C:\\cygwin64\\home\\Dennis\\.ipython\\profile_default\\ipython_config.py'
[ProfileCreate] Generating default config file: u'C:\\cygwin64\\home\\Dennis\\.ipython\\profile_default\\ipython_kernel_config.py'
```

Added forth-notebook's cell magic, with the following modification:

```
c.ScriptMagics.script_paths = {
    'gforth' : 'python /usr/src/forth-notebooks_ozayn/forth-client.py'
}
```

When I run `hello-forth.ipynb` I get:

```
python: can't open file '/usr/src/forth-notebooks_ozayn/forth-client.py': [Errno 2] No such file or directory
```

On every code cell.

Added `"C:/cygwin64"` to the cell magic path, and now I get:

```
Traceback (most recent call last):
  File "C:/cygwin64/usr/src/forth-notebooks_ozayn/forth-client.py", line 26, in <module>
    forth_out=open("forth-out", "rb")
IOError: [Errno 2] No such file or directory: 'forth-out'
```

Back over in VMware® Workstation 12.1 Pro w/ Ubuntu 15.10, that much works fine:

```
0 Hello, IPython notebook world with Forth.
1 Hello, IPython notebook world with Forth.
2 Hello, IPython notebook world with Forth.
3 Hello, IPython notebook world with Forth. ok
```

I could only do the "[source setup.sh](#)" on the Linux file system, so it's going to be cumbersome to share. However, it's possible and I've got a working example. Now, I have to see what I will do with it, if anything. My prior notebook experience has been with using python's serial interface to talk to the target. I will have to figure out if my gforth serial code still works and then design an umbilical-like extension to <https://github.com/gerryjackson/forth2012-test-suite/tree/master>.

Conclusion

The December 2015 SVFIG Meeting on Saturday, December 19, 2015 is driving me to whip this document into shape, which, of course, takes away from what's supposed to be the fun part. The layout of the UART Pins is a major setback, since the BLE-STACK doesn't account for it. The The forth-notebooks is also the latest shinny object to distract me, but that was more for the SVFIG meeting than any real need yet.

For the moment, this is enough

Warning:

The rest of this doc are the original contents, which I'll delete from the final doc, but for now, provide easy reference for things I want to do in my content.

Draft Areas

Note the presence of gray "Draft Areas" in the document. They are necessary because Docbook stylesheet rules are often intricate. For instance, `title` in `section` can be specified within `section` itself and within `sectioninfo`. If you specify both, one of them becomes hidden. To avoid this, all such meta-information is shown also in Draft Areas. They can be turned off by changing value of `show-preamble-editing` parameter to 0 in `parameters.xml` file in Docbook stylesheet.

Serna Docbook stylesheet also takes special care of empty content. For example, when you make new article, it provides you with "Title: " inscription where you can enter article title.

Basic editing

Editing of Docbook documents in Serna is quite straightforward, much like in a traditional word-processor. One difference is that you must use "InsertElement" command (**Ctrl-Enter**) to insert new elements. Serna will suggest you a list of elements which you can insert at any given location. Other element operations are listed in "Element" menu.

By default **ENTER** splits the current element. For example, if you are within a `para`, it will be split in two. If you are at the end of paragraph, new paragraph will be added.

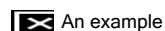
You can see current editing context in the bottom status bar. Navigation commands from "Go" menu should be use for easier navigation in "tagless" mode. Also, pay attention to the two modes of selection: *balanced* and *unbalanced* (they can be toggled from Edit menu or with **Ctrl-B**). In unbalanced mode, selection is more distinct, but it sometimes can be difficult to correctly place ends of selection. In balanced mode selection is automatically adjusted, so it is easier to select list items, etc.

To edit element attributes, press **Ctrl-Enter**.

Images

Inserting images is easy: just insert `figure` or `graphic` elements, invoke *Element Attributes Dialog* for corresponding element, and choose an image file by pressing Browse button for the `fileref` attribute in Element Attributes Dialog.

Figure 1. An example figure



Program listings

Serna supports whitespace stripping policies, as defined by the stylesheet. Editing behavior within whitespace-preserved ares like Docbook `programlisting` is different. Within those elements **ENTER** means newline, and you can mix white-spaces and newlines freely.

```
SubscriberPtr(SubscriberPtrWatcher* watcher, T* ptr)
    : SubscriberPtrBase(watcher, ptr), P(ptr) {}
SubscriberPtr<T>& operator=(T* ptr)
{
    remove();
```

```
P::operator=(ptr);
if (!P::isNull())
    P::pointer()->registerSubscriber(this);
return *this;
}
SubscriberPtr(const SubscriberPtr<T>& other)
    : SubscriberPtrBase(other.watcher(), other.pointer()),
      P(other.pointer()) {}
```

Lists and tables

There are two types of lists in Docbook:

Ordered list. A list may have optional title.

- 1. First item.
- 2. Second item.
- 3. Third item.

Itemized list. Optional title is also available.

- First item.
- Second item.
- Third item.

In Serna, CALS tables are supported by Docbook stylesheet.

Table 3. An example of complex table

Title 1		Title 2	Title 3		Title 4		Title 5	
Sub1	Sub2		Sub3	Sub4	Sub5	Sub6	Sub7	Sub8
A B C D E F G		1. This is item1		Content		Cells with vertical span.		
		2. This is item2						
		Contents....		This is another horizontal span.				

Localization

It is possible to localize your docbook documents or their parts by simply changing *lang* parameter of the compound element. For example, this section's attribute *lang* is set to *de*, that is why you see German inscriptions for this section.