ACME performance and precision with multiple Powercapes

using HWMON/Sigrok

Measurement principle

- Measure the time from update to update for the first probe @0x40 and verify there is always enough time to read out all registers until next sample time is due

- Write trace “a” when entering *update_device*
- Write trace “b” after completion of i2c operations

- Measure time $b_k - a_k$ ***cost of i2c transfer***
- Measure time $b_k - b_{k-1}$ ***achievable sampling period***

- Do this for both versions of the hwmon driver

Test commands

- **Data acquisition**

trace-cmd start -p nop
sigrok-cli -d baylibre-acme --samples 200 --config samplerate=${freq}
trace-cmd stop
trace-cmd extract

- **Possible frequency values with sigrok-cli**

Libsigrok/src/hardware/baylibre-acme will set the update interval through sysfs, possible values are discrete however, resulting of the possible averaging parameter time the constant Integration Time setting of 2.2ms

Averaging values	1	4	16	64	128	512	1024
Periods (s)	0.0022	0.0088	0.0352	0.1408	0.2816	1.1264	2.2528
Freq (Hz)	454	113.63	28.41	7.1	3.55	0.887	0.443
Tested (Hz)	**454**	**113**	**28**	**7**			

- **Visualization**

Done with kernelshark

Preliminary discussion

- **Expected achievable sample rates**

With the 4.3 hwmon driver, upon accessing sysfs with the show function, all 8 registers are read once per programmed update interval. The 4.4 driver will read only the required value register.

Reading all registers take at best 500us * 8 = 4ms per probe, but this can be much longer if the threaded IQR completion is delayed (i2c-omap).

The table bellow provides the **best sampling frequency (Hz)** based on the number of connected probes, and the driver version, where no old value is repeat.

#probes #channels	1 Probe	2 Probes	3 Probes	4 Probes	5 Probes	6 Probes	7 Probes	8 Probes
Driver 4.3 Any ch #	113	113	28	28	28	28	28	28
Driver 4.4 1 channel	454	454	454	454	113	113	28	28
Driver 4.4 2 channels	454	454	454	113	113	113	28	28
Driver 4.4 3 channels	454	454	113	113	113	28	28	28
Driver 4.4 4 channels	454	454	113	113	28	28	28	28

4.3 Driver, 8 probes, 7 Hz

- **Command and driver setup trace verification**

sigrok-cli -d baylibre-acme --samples 200 --config samplerate=7

[4232.068759] Setup averaging = 64 64*2.2ms = 141ms ~ 7.1 Hz **OK**
[4232.072163] Actual interval = 140800 us

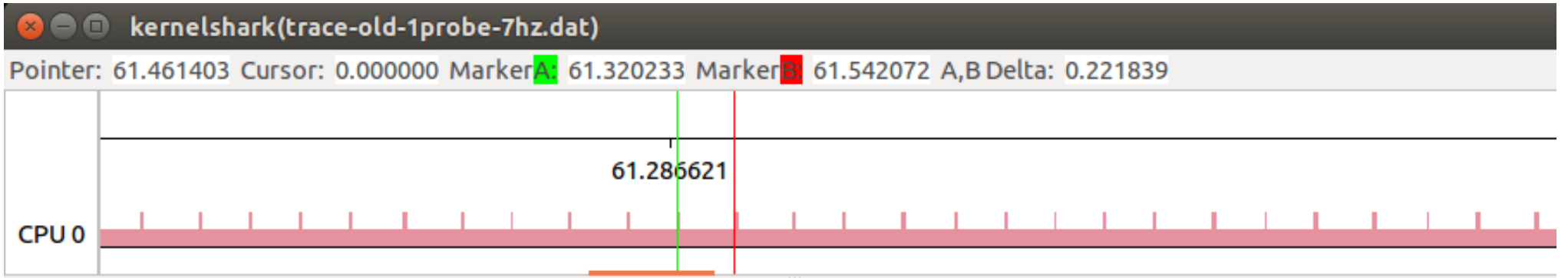
- **Results**

Elapsed time between sigrok-cli readout: ~200 ms **KO, see [1]**
Elapsed time between fresh values: ~200 ms **KO, see [2]**

- **Comment**

[1] with driver 4.3 bl_acme_receive_data requires a small patch to prevent introducing an additional delay.

[2] driver 4.3 will prevent the read out every second time, this might be related to how timer events for sleeping are managed.



Page 1 Search: Column: # contains graph follows

#	CPU	Time Stamp	Task	PID	Latency	Event	Info
16	0	37.484030	sigrok-cli	162	....	bprint	ina2xx_update_device: #3: elapsed = 232589 us
17	0	37.491360	sigrok-cli	162	....	bprint	ina2xx_update_device: sfer 7327 ns
18	0	37.492536	sigrok-cli	162	....	bprint	ina2xx_show_value: probe 0x40: ina2xx_show_value #10
19	0	37.493553	sigrok-cli	162	....	bprint	ina2xx_show_value: probe 0x40: ina2xx_show_value #11
20	0	37.708806	sigrok-cli	162	....	bprint	ina2xx_show_value: probe 0x40: ina2xx_show_value #12
21	0	37.708836	sigrok-cli	162	....	bprint	ina2xx_update_device: #4: elapsed = 224809 us
22	0	37.713273	sigrok-cli	162	....	bprint	ina2xx_update_device: sfer 4434 ns
23	0	37.713961	sigrok-cli	162	....	bprint	ina2xx_show_value: probe 0x40: ina2xx_show_value #13
24	0	37.714532	sigrok-cli	162	....	bprint	ina2xx_show_value: probe 0x40: ina2xx_show_value #14
25	0	37.901740	sigrok-cli	162	....	bprint	ina2xx_show_value: probe 0x40: ina2xx_show_value #15
26	0	37.901770	sigrok-cli	162	....	bprint	ina2xx_update_device: #5: elapsed = 192934 us
27	0	37.907960	sigrok-cli	162	....	bprint	ina2xx_update_device: sfer 6179 ns
28	0	37.909230	sigrok-cli	162	....	bprint	ina2xx_show_value: probe 0x40: ina2xx_show_value #16
29	0	37.910254	sigrok-cli	162	....	bprint	ina2xx_show_value: probe 0x40: ina2xx_show_value #17
30	0	38.128849	sigrok-cli	162	....	bprint	ina2xx_show_value: probe 0x40: ina2xx_show_value #18
31	0	38.128898	sigrok-cli	162	....	bprint	ina2xx_update_device: #6: elapsed = 227124 us
32	0	38.136212	sigrok-cli	162	....	bprint	ina2xx_update_device: sfer 7311 ns

The remaining tests and measurements are done with hwmon driver v4.4 (the one using regmap) because v4.3 is even worse, and linux-next will provide v4.4 anyhow.

4.4 Driver, 8 probes, 28 Hz

- **Command and driver setup trace verification**

sigrok-cli -d baylibre-acme --samples 200 --config samplerate=28

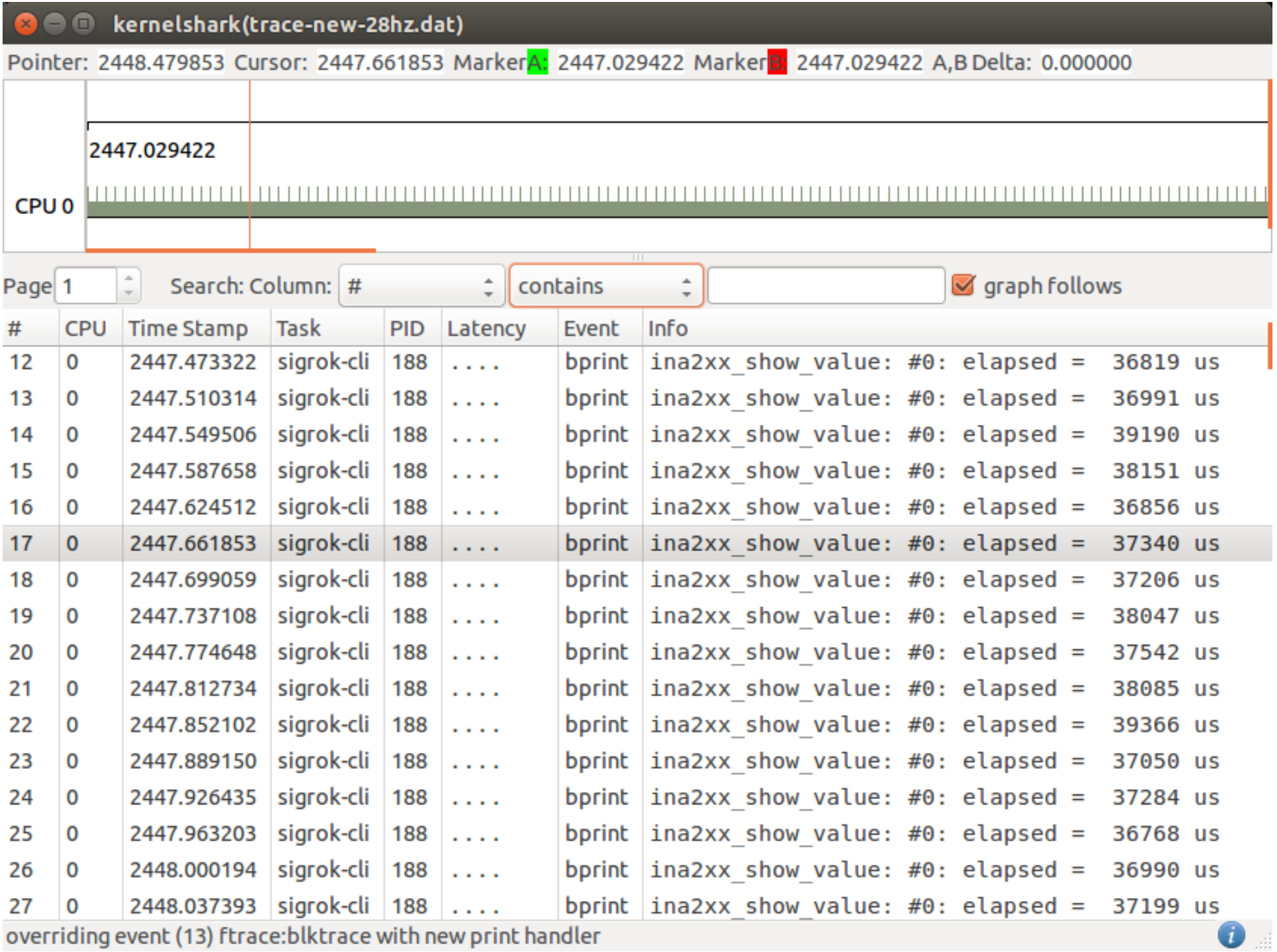
[39.494589] Setup interval = 35 us
[39.498304] Setup averaging = 16
[39.501685] Actual interval = 35200 us OK

- **Results**

Elapsed time between fresh values: ~37 ms (sigrok timer) OK

- **Comment**

Kernelshark shows very regular readout times for probe0/vshunt, meaning that this configuration can be sustained in terms of performances.


kernelshark(trace-new-28hz.dat)
Pointer: 2448.479853 Cursor: 2447.661853 MarkerA: 2447.029422 MarkerB: 2447.029422 A,B Delta: 0.000000
2447.029422
CPU 0
Page 1 Search: Column: # contains graph follows
CPU Time Stamp Task PID Latency Event Info
12 0 2447.473322 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 36819 us
13 0 2447.510314 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 36991 us
14 0 2447.549506 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 39190 us
15 0 2447.587658 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 38151 us
16 0 2447.624512 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 36856 us
17 0 2447.661853 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 37340 us
18 0 2447.699059 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 37206 us
19 0 2447.737108 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 38047 us
20 0 2447.774648 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 37542 us
21 0 2447.812734 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 38085 us
22 0 2447.852102 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 39366 us
23 0 2447.889150 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 37050 us
24 0 2447.926435 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 37284 us
25 0 2447.963203 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 36768 us
26 0 2448.000194 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 36990 us
27 0 2448.037393 sigrok-cli 188 .... bprint ina2xx_show_value: #0: elapsed = 37199 us
overriding event (13) ftrace:blktrace with new print handler

4.4 Driver, 8 probes, 113 Hz

- **Command and driver setup trace verification**

sigrok-cli -d baylibre-acme --samples 200 --config samplerate=113

[4418.708234] Setup interval = 8 us
[4418.711755] Setup averaging = 4
[4418.715047] Actual interval = 8800 us OK

- **Results**

Elapsed time between fresh values: 32 ms (sigrok timer) KO

- **Comment**

As expected, setting a readout period under the required time spent in i2c-omap will result in an erratic sample rate (bottleneck effect).

Sample rate above 28 Hz result in time stretching (repeated samples).

Conclusions

Using 8 probes is functional, but with sample freq restrictions (28 Hz max) for accurate signal properties.

Recommended changes in Current End-user package

It is important to provide user with:

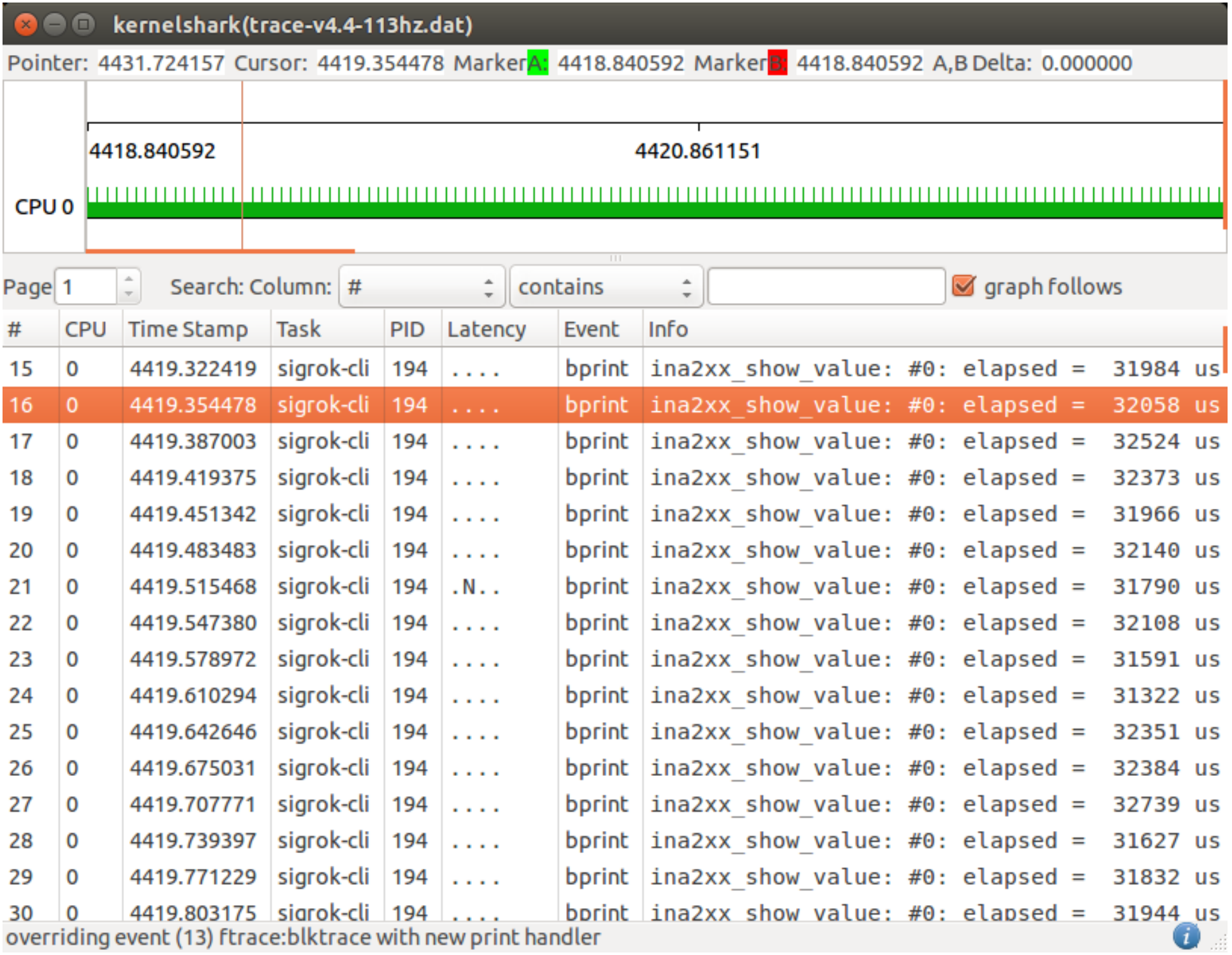
- the version of sigrok that uses the timer device.
- the hwmon driver 4.4, as it will allow for better sampling frequencies for simple use-cases (see table in slide 4)

Changes in Documentation

I recommend providing table 4 (remove the driver-4.3 line) to the user, with explanation
Using higher sampling rates is always possible to avoid a slow GUI refresh rate, but any sampling freq above the compatible one will result in time stretching (repeated samples). Signal process software can probably do a better job with proper interpolation algos.

Corrective action and evolutions

- **Support smaller integration times with hwmon than the fixed 2.2ms to increase sample freq, and switch to IIO driver when sigrok pluging is available (no sysfs)**
- Investigate using a bitclock higher than 400kHz, might not be possible with the current gpio routers ? Might be difficult to upstream
- Investigate using a non-threaded irq instead of a threaded_irq + completion routine for i2c-omap. Might be difficult to upstream.


kernelshark(trace-v4.4-113hz.dat)
Pointer: 4431.724157 Cursor: 4419.354478 MarkerA: 4418.840592 MarkerB: 4418.840592 A,B Delta: 0.000000
4418.840592
4420.861151
CPU 0
Page 1
Search: Column: #
contains
graph follows
CPU Time Stamp Task PID Latency Event Info
15 0 4419.322419 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 31984 us
16 0 4419.354478 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 32058 us
17 0 4419.387003 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 32524 us
18 0 4419.419375 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 32373 us
19 0 4419.451342 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 31966 us
20 0 4419.483483 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 32140 us
21 0 4419.515468 sigrok-cli 194 .N.. bprint ina2xx_show_value: #0: elapsed = 31790 us
22 0 4419.547380 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 32108 us
23 0 4419.578972 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 31591 us
24 0 4419.610294 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 31322 us
25 0 4419.642646 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 32351 us
26 0 4419.675031 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 32384 us
27 0 4419.707771 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 32739 us
28 0 4419.739397 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 31627 us
29 0 4419.771229 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 31832 us
30 0 4419.803175 sigrok-cli 194 .... bprint ina2xx_show_value: #0: elapsed = 31944 us
overriding event (13) ftrace:blktrace with new print handler