HSLU Lucerne University of Applied Sciences and Arts

MCU-Link Energy Aware Debugging

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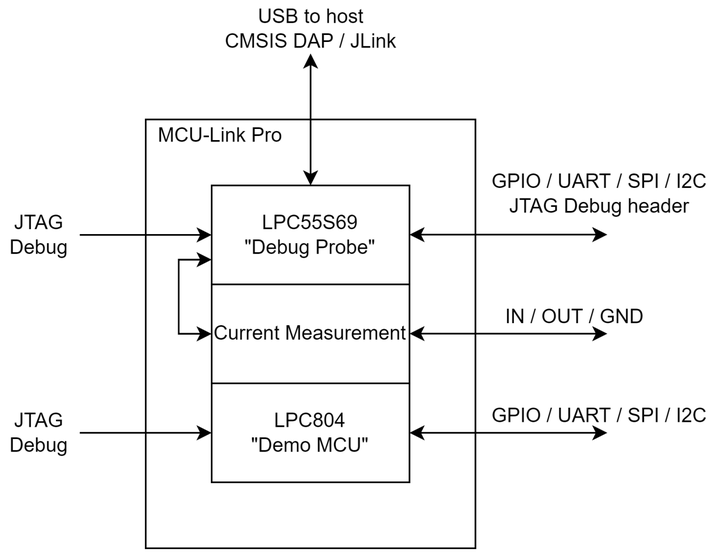
Engineering and Architecture
January 30, 2023

FH Zentralschweiz

MCU-Link Pro

- Debug probe with Current / Voltage measurement
- Based on LPC55S69
- Multiple firmwares available:
  - CMSIS-DAP (Linkserver)
  - J-Link (for NXP devices)
  - DAPLink (open source)



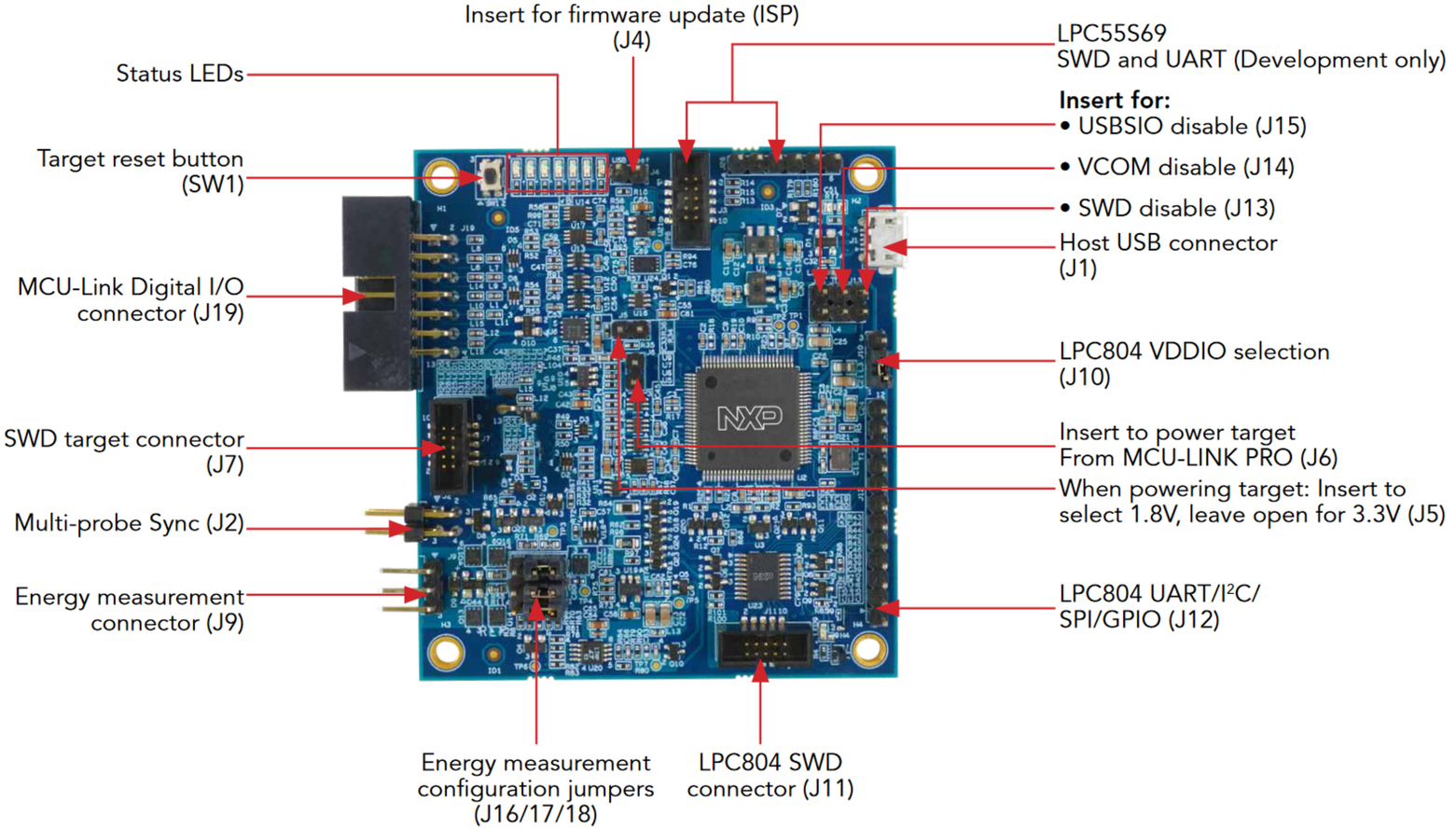
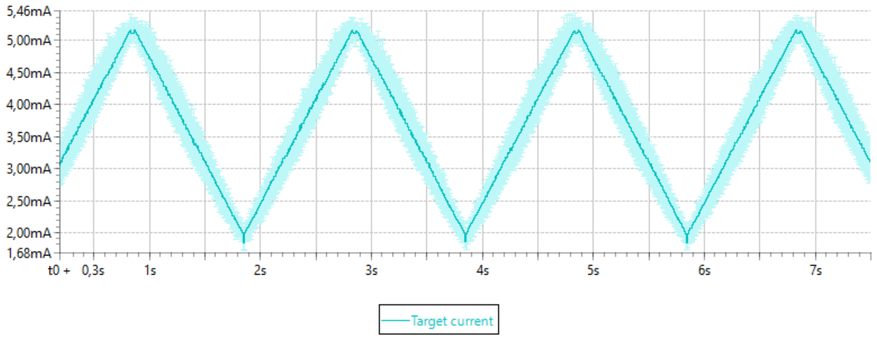


Image source: https://www.nxp.com/design/microcontrollers-developer-resources/mcu-link-pro-debug-probe:MCU-LINK-PRO

Task

- Energy Aware Debugging -> “Link energy measurement to debug information”
- Energy measurement



- Debug information

242	0.109 001 226	SysTick	ISR Exit	Returns to Scheduler
243	0.109 005 244	Scheduler	Task Ready	HPTask, runs after 3.631 us
244	0.109 008 875	HPTask	Task Run	Runs for 6.482 us
245	0.109 012 571	HPTask	OS_TASK_Delay	50 ticks
246	0.109 015 357	HPTask	Task Block	Delayed
247	0.109 019 994	Idle	System Idle	Idle for 49.981 ms
248	0.109 997 821	SysTick	ISR Enter	Runs for 3.458 us

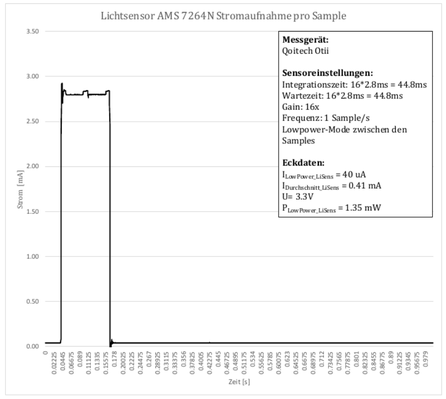
Why?

Energy debugging,

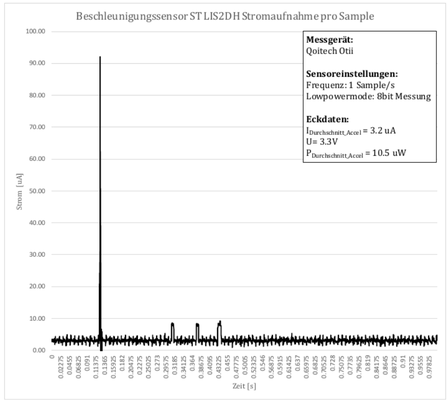
From ‘printf-like’

to rich information in context

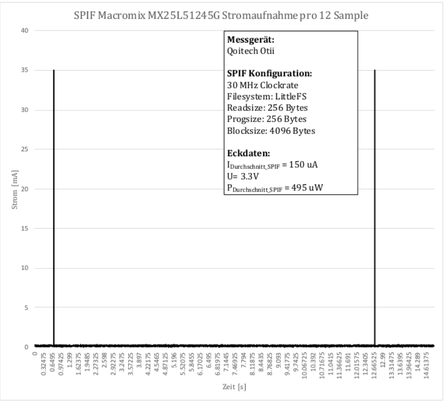
Light Sensor



Accelerometer



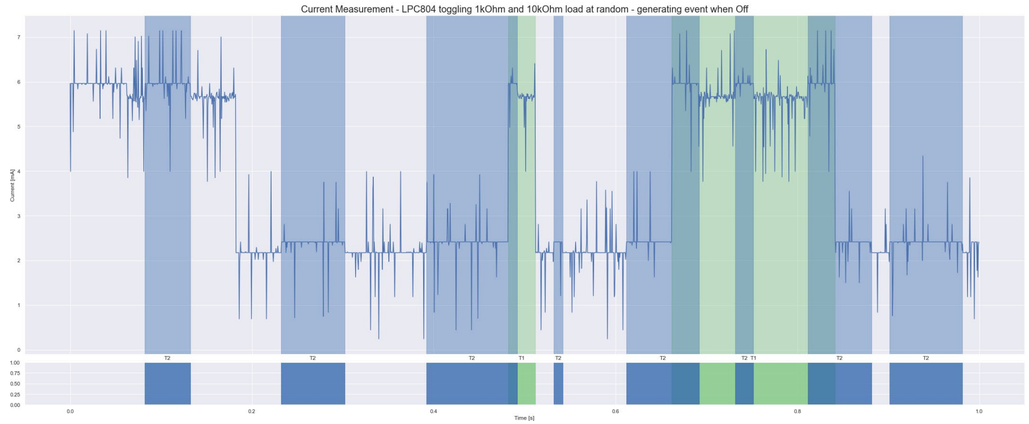
SPI-Flash



Examples:

Unexpected behaviour (wake up from sleep)

Constrained maximum energy consumption (e.g. bus power)

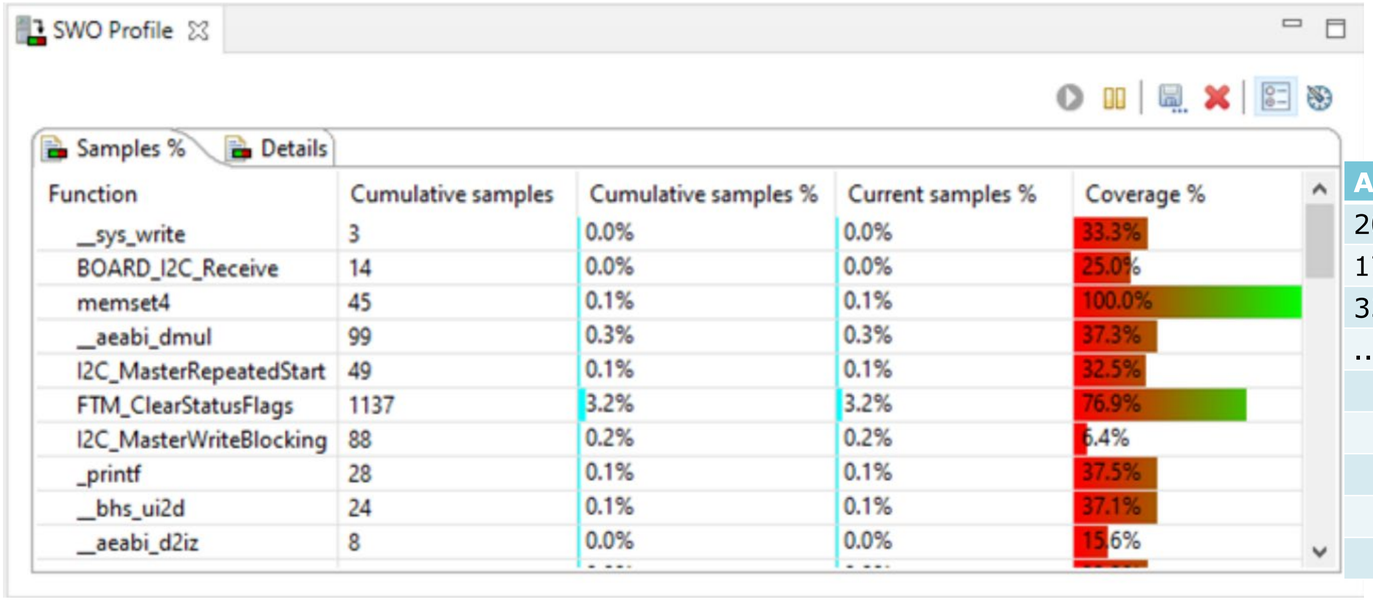


Source images top: VA2 Low Power Licht Dosimeter, David Huwyler

Synchronized Logic Analyzer

Source: https://circuitdigest.com/review/nordics-power-profiler-kit-2-a-must-have-tool-for-embedded-engineers

SWO PC Sampling (in MCUXpresso)



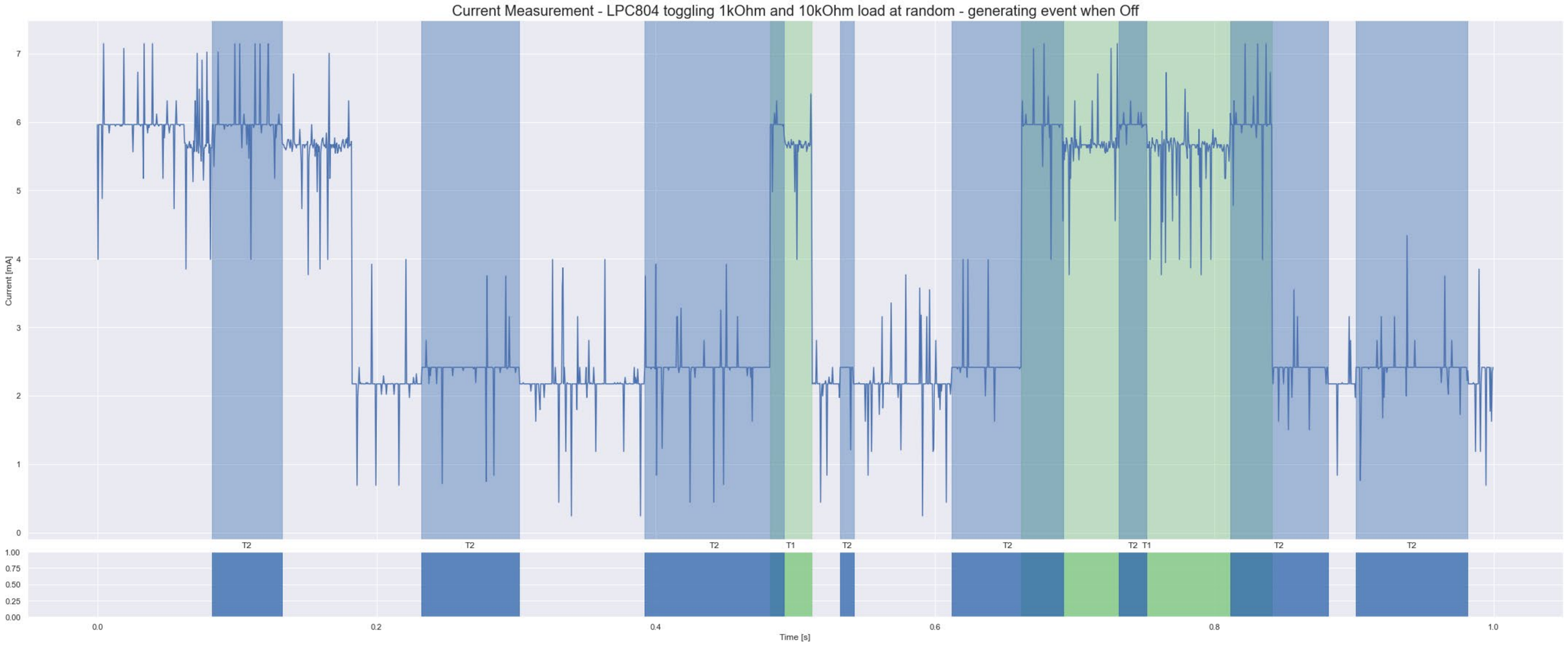
Average Power
20.3mW
17.7mW
33.6mW
...

Source image: https://www.nxp.com/docs/en/quick-reference-guide/MCUXpresso_IDE_SWO_Trace.pdf

Work done in VM2

- Reimplementation of current measurement on MCU-Link
- Transmitting current measurement data to host over RTT through external debug probe
- Receiving rudimentary ‘debug pointers’ / trigger signals with values from 0-255 from DUT over UART while measuring
  - Manually added in test device firmware
- Static visualization of this data

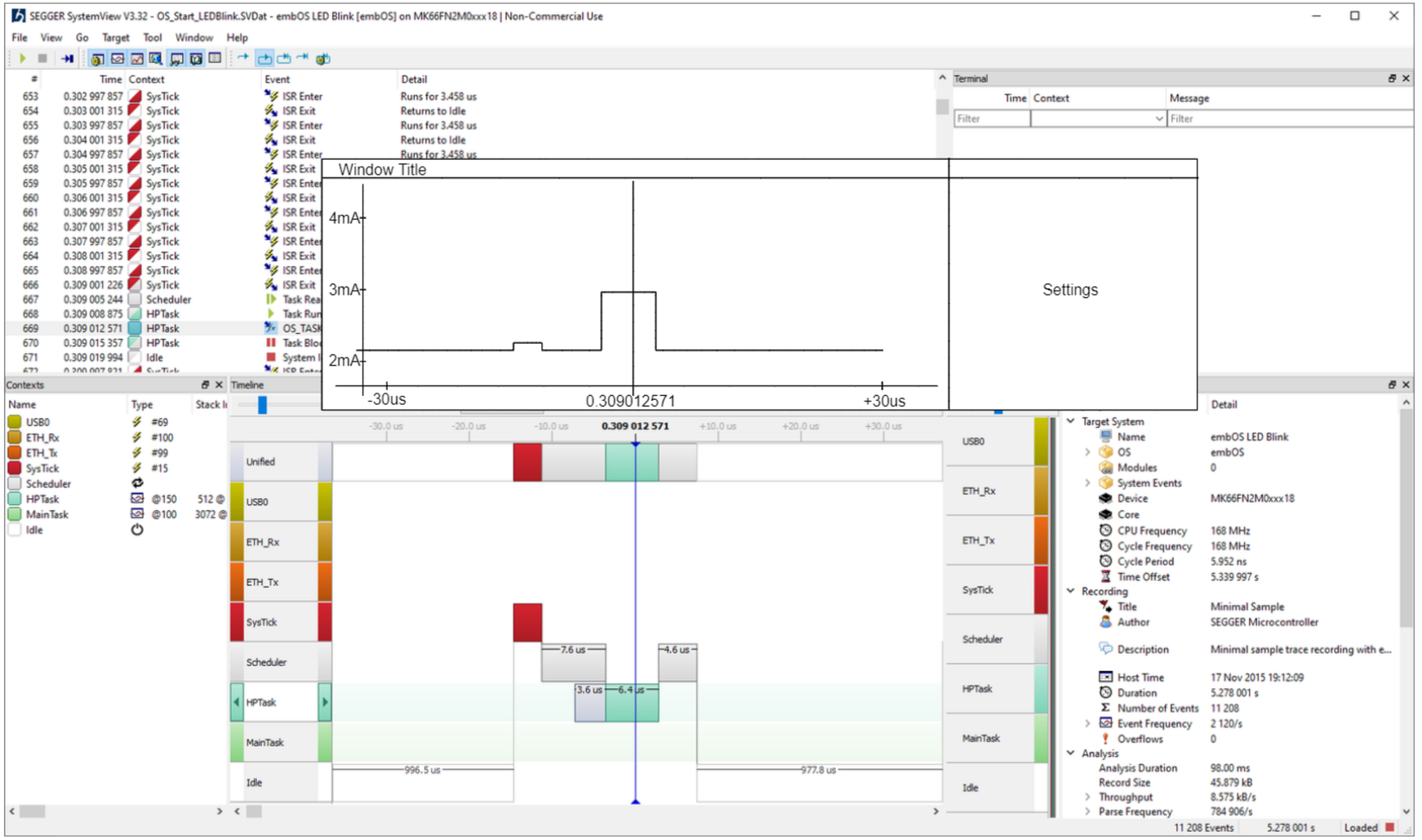
Manual triggers



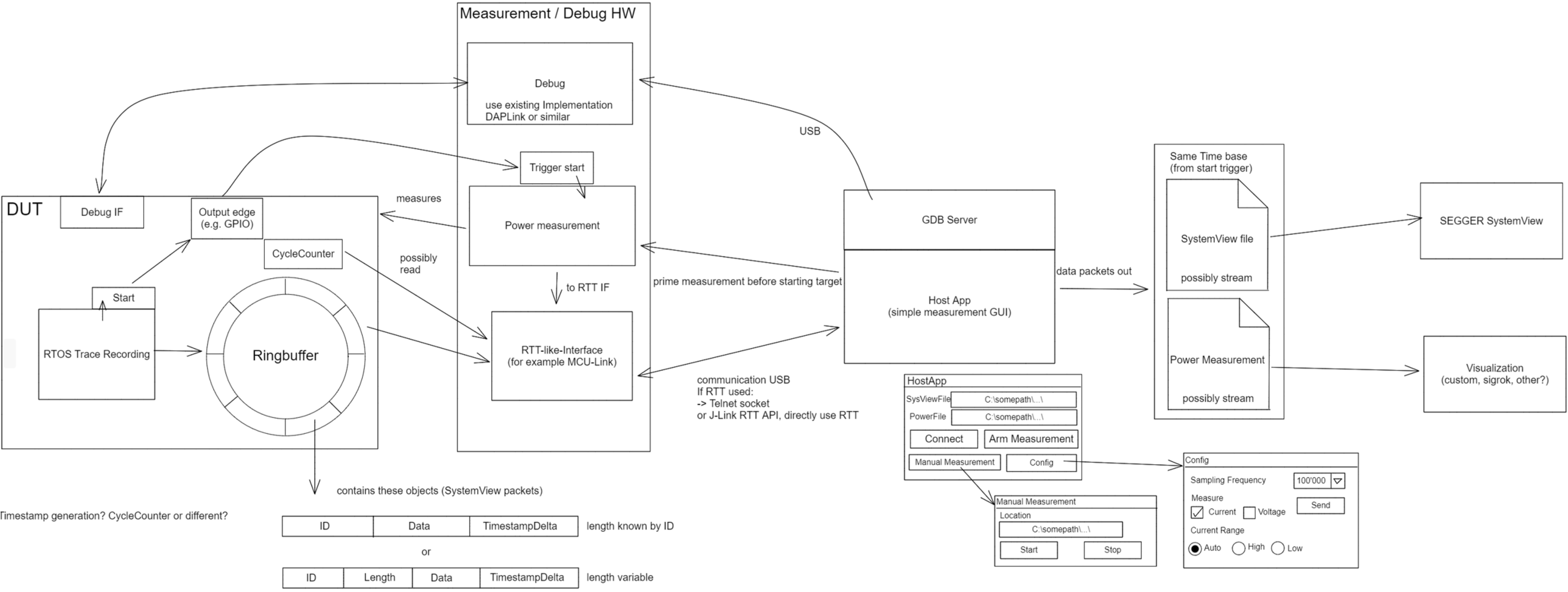
Energy Aware Debugging

- Program instrumentation options for execution data
  - finstrument-functions flag (gcc, clang)
  - RTOS event hooks
  - Manual flags (VM2)
- Communication channel instrumentation -> measurement hardware
  - SWO -> only Cortex M 3,4,7,33
  - Serial (I3C/I2S etc.)
  - RTT(-like) - save in memory, access memory through debug hardware + gdb -> only Cortex M
- Synchronization power measurement & instrumentation
- For proof of concept
  - Segger SystemView
  - RTOS event hooks -> SystemView Library
  - Get data from memory
  - Display data over top of SystemView (or within SystemView)

Visualization Concept



Concept overview



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Questions

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