Introducing CHESTER Platform for Industrial IoT Applications

Pavel Hübner <pavel.hubner@hardwario.com>

CEO & Co-Founder at HARDWARIO

How CHESTER started

- **A few years back:**

  One of our customers needs an NB-IoT thermometer in the forests to correlate the bark beetle occurrence…

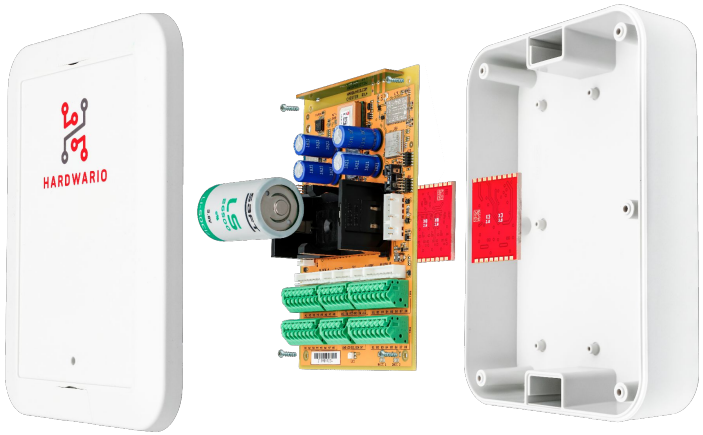
- **Where we are today:**

  An open and multi-purpose IoT hardware platform with businesses relying on it around the world…

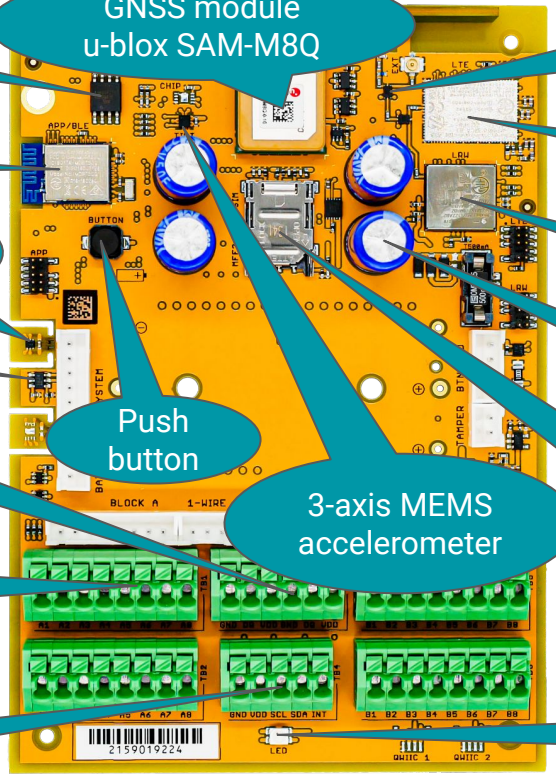
- **Target audience:**
  - **Connected hardware enthusiasts**
  - **Embedded software craftsmen**
  - **Anybody who likes to see things in action**

CHESTER introduction

- Configurable IoT hardware endpoint with open Zephyr-based SDK
- Open platform for HARDWARIO partners with possibility for full OEM customization
- Applications: Industrial IoT plus every thing that should be connected



Mainboard features



NOR flash memory 8 MB

GNSS module u-blox SAM-M8Q

Dynamic antenna system (cellular / LoRaWAN + internal / external)

Bluetooth module (nRF52840)

Cellular module (nRF9160)

Digital thermometer

1-Wire bus master

LoRaWAN module (Murata type ABZ)

1-Wire port

Push button

Supercapacitors

3-axis MEMS accelerometer

Terminal block mapped to extension module

Nano-SIM card holder (4FF)

I²C port

3-color LED (RGY)

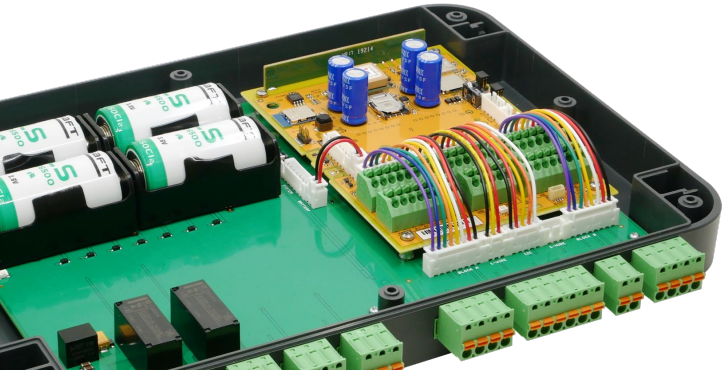
Rich connectivity

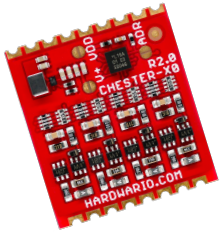
- Short range: Bluetooth Low Energy
- Cellular: NB-IoT (SIM card needed)
- Cellular: LTE-M (SIM card needed)
- ISM radio: LoRaWAN
- Satellite: Astrocast (top cover module with L-Band communication)
- Positioning: GNSS (GPS / Galileo / GLONASS / Beidou)

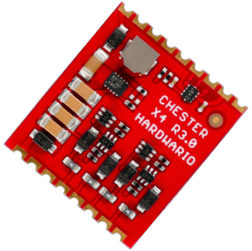
- All of these combined or targeted mainboard variants

Hardware extensibility

- Three types:
  - Backside modules
  - Top cover modules
  - Carrier boards







(Low-)Power flexibility

- Primary Lithium 3.6 V cells (LiSoCl2) - typically 7.700 mAh
- Integrated supercapacitors (energy bank for high current demand)
- Rechargeable Li-Ion battery (extension module CHESTER-Z)
- Solar photovoltaic panels (in connection with rechargeable cells)
- Idle current (incl. BLE) ~230 uA
- Battery lifespan incl. NB-IoT communication (in ECL 0) ~3 years
- Multiple power sources can be combined together

  (batteries have lower "hardware priority")

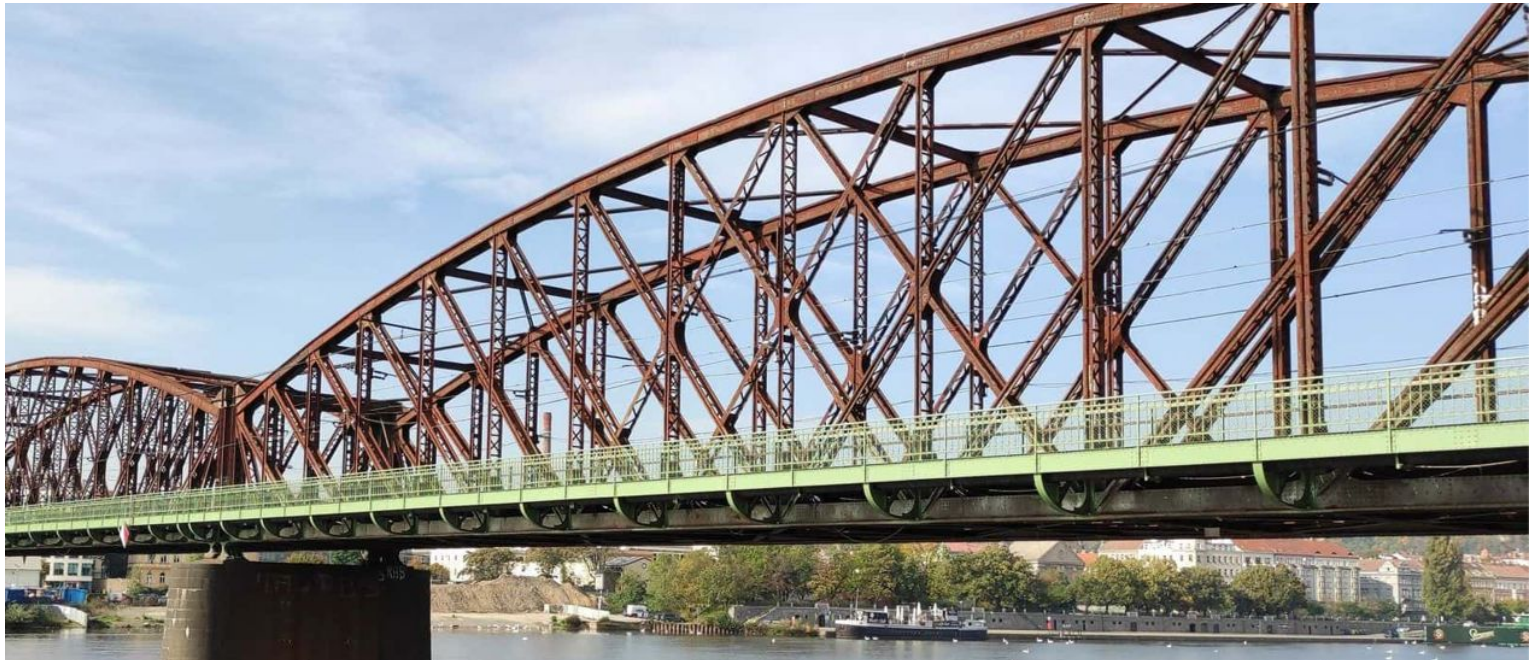
If just one is not enough…

Real applications

Environmental monitoring in the UK forests

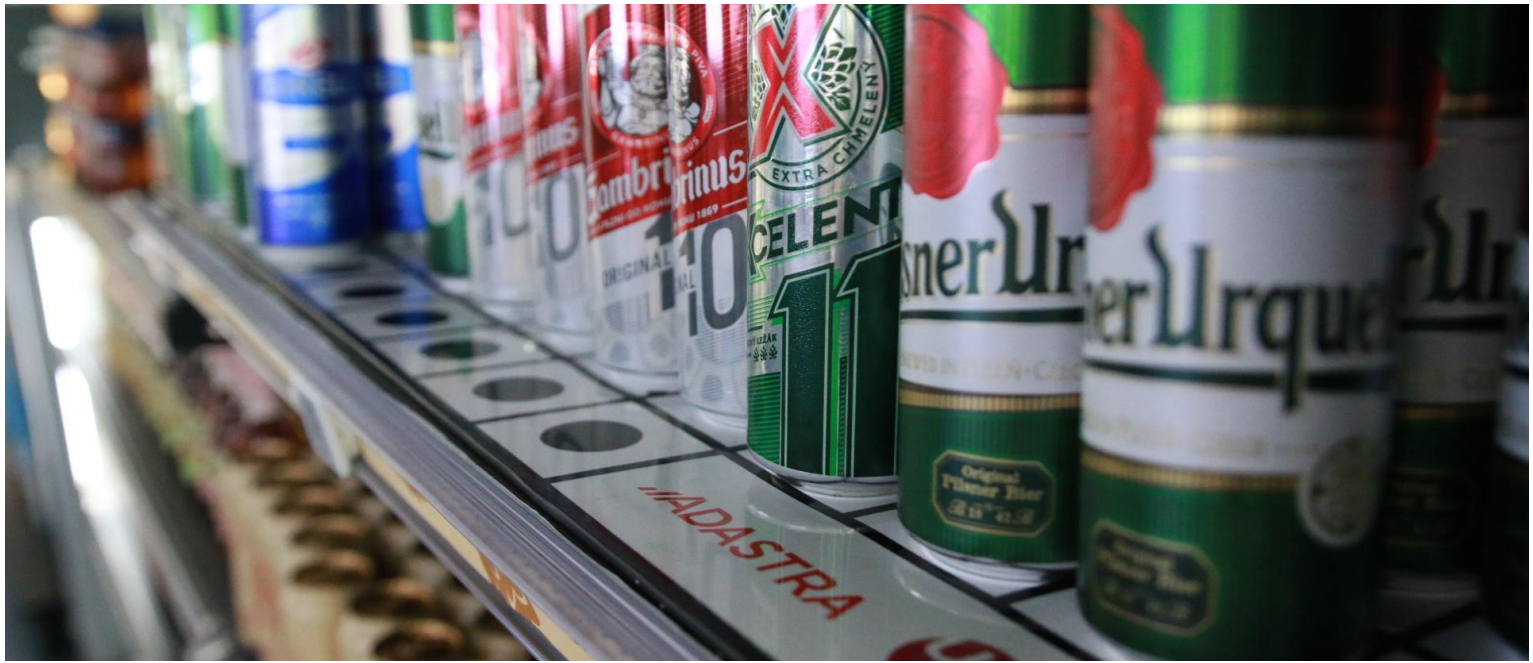
Real applications

Bridge inclination monitoring



Real applications

Retail digitization



Real applications

Utility - cathodic protection monitoring + rack cabinets

Catalog applications

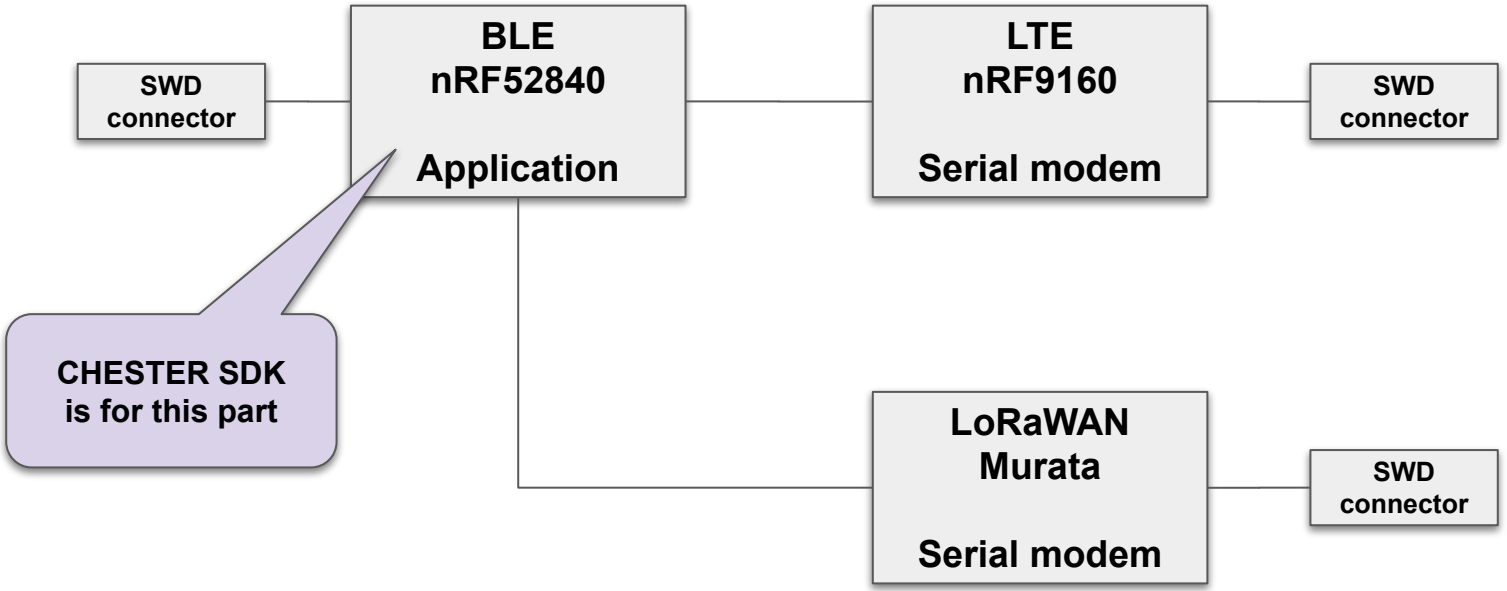
- Ready-to-go products:
  - CHESTER Push - Rugged button notification system
  - CHESTER Clime - Environmental monitoring
  - CHESTER Current - Current measurement for OEE / predictive maintenance
  - CHESTER Input - Configurable analog/digital generic sensor telemetry unit
  - CHESTER Meteo - Outdoor weather and soil moisture monitoring
  - CHESTER Modbus - Rugged button notification system
  - CHESTER Scale - Precise weight scale measurement
  - CHESTER Range - Distance measurement using ultrasonic ranger
  - CHESTER Control (COMING SOON) - Remote appliance control and input scanning
- …they are all open-source

Living ecosystem

CHESTER + Zephyr

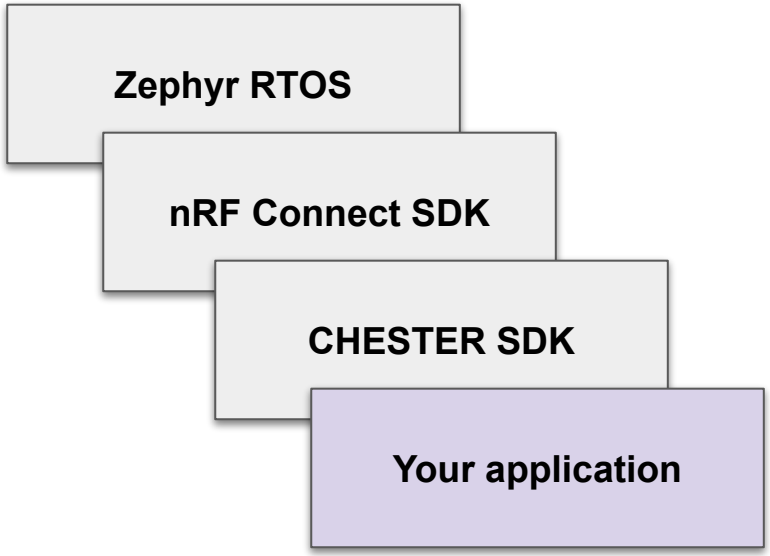
- Scalable, secure & safe
- Friendly for low-power applications
- Designed with IoT projects in mind
  - Vast range of connectivity options
  - Integrates with MCUboot bootloader
- Encourages portability & code re-usability
- Protects investments to your code by imposing low-maintenance requirements
- But there is a learning curve…

Firmware landscape



Software stack

Zephyr's West tool makes structuring Git repositories convenient…



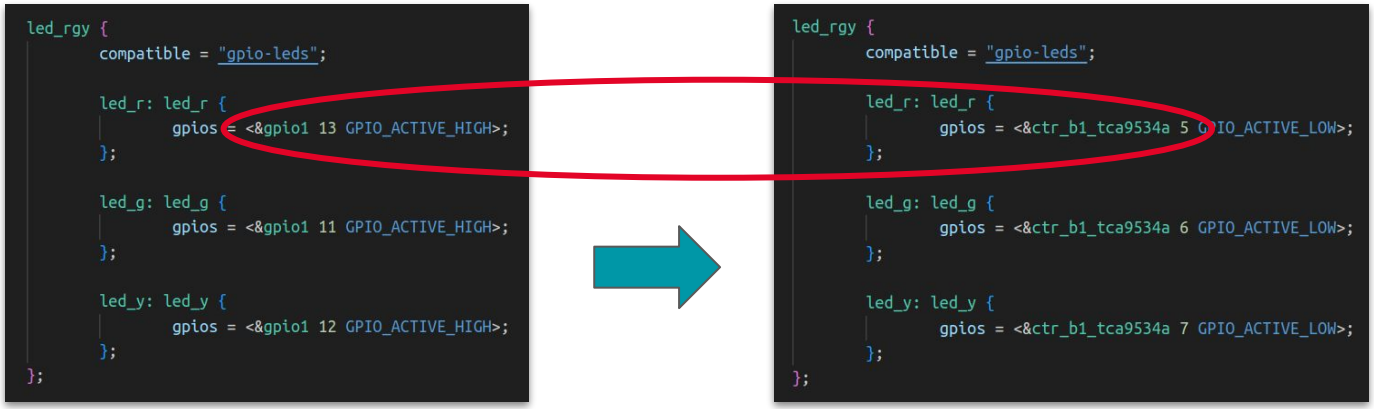
File: **west.yml**

```yaml
manifest:
  version: "0.12"
  remotes:
    - name: hardwario
      url-base: https://github.com/hardwario
  projects:
    - name: nrf
      remote: hardwario
      repo-path: ncs.git
      revision: v2.2-chester-branch
      import: true
  self:
    path: chester
    west-commands: scripts/west-commands.yml
```

Hardware abstraction

Exercise:

Let's move an LED indication from CHESTER mainboard to a carrier board where LED is driven by an I^{2}C expander.



Modularity

- Goal: Keep independents block truly independent (avoid cross-dependency whenever possible)
- Symbol definition via Kconfig (enable/disable modules being built)

```
add_subdirectory_ifdef(CONFIG_SERIAL serial)
```

- Zephyr modules (add sources w/o altering CMake)

File: Kconfig

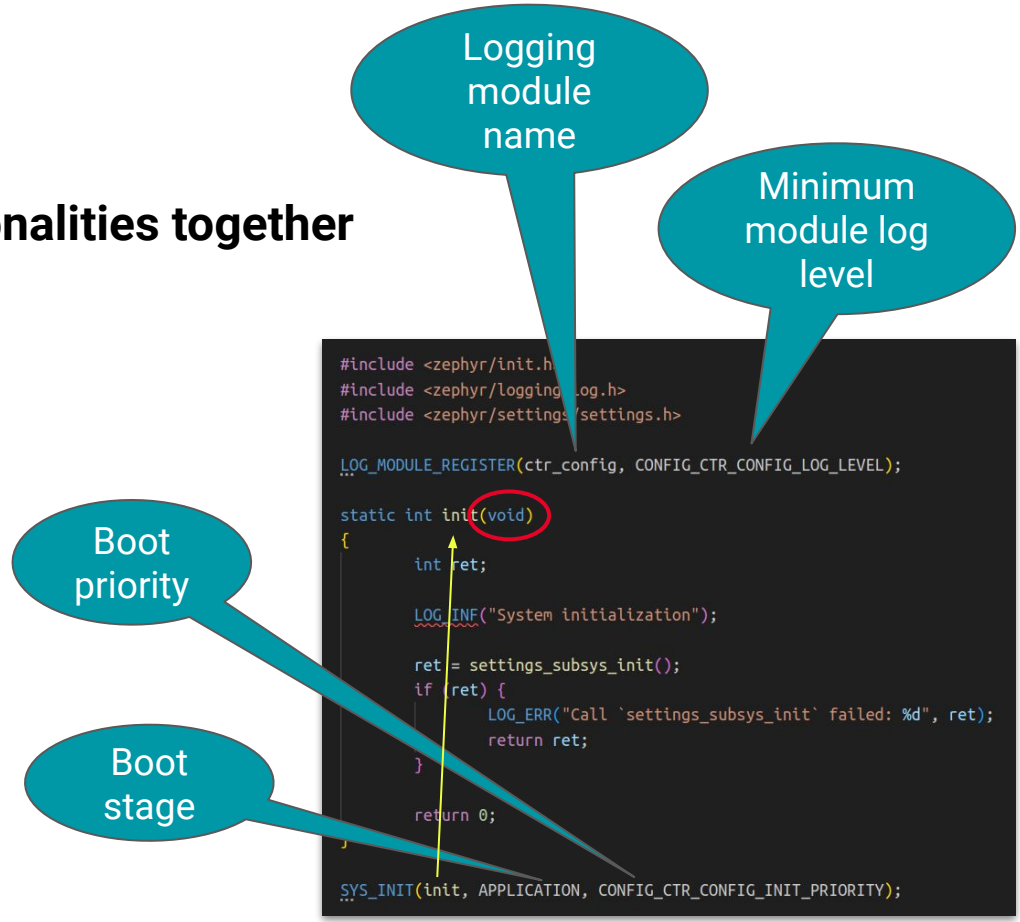
```
menu "Application"

config APP_REPORT_JITTER
        bool "Add random time jitter to report transfers"
        default y
        select ENTROPY_GENERATOR

endmenu

menu "Zephyr Kernel"
source "Kconfig.zephyr"
endmenu
```

File: prj.conf

```
CONFIG_APP_REPORT_JITTER=n
CONFIG_ADC_NRFX_SAADC=n
CONFIG_ADC_SHELL=n
CONFIG_CTR_ACCEL=y
CONFIG_CTR_BATT=y
CONFIG_CTR_BLE=y
CONFIG_CTR_BUF=y
CONFIG_CTR_DEFAULTS=y
CONFIG_CTR_INFO=y
CONFIG_CTR_LED=y
CONFIG_CTR_LOG=y
CONFIG_CTR_LTE_CLKSYNC=y
CONFIG_CTR_RTC=y
```

Coherence

- **Goal:** Keep the related functionalities together
- Zephyr facilitates this:
  - Initialization
  - Logging
  - Shell
  - Settings
- Avoid cross-dependencies:
  - `init1(); init2();` …



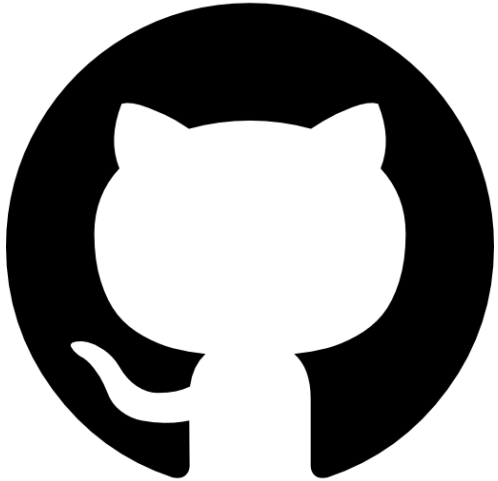
TIME TO DEMO


Windows
An error has occurred. To continue:
Press Enter to return to Windows, or
Press CTRL+ALT+DEL to restart your computer. If you do this,
you will lose any unsaved information in all open applications.
Error: 0E : 016F : BFF9B3D4
Press any key to continue _

Past & Future

- Contributions:
  - Testing and improvements to 1-Wire subsystem:
    - Thomas Stranger (1-Wire subsystem)
    - Caspar Friedrich (Drivers for 1-Wire bus masters)
  - Several minor enhancements (also to nRF Connect SDK)
- Next development:
  - Consider replacing Zephyr shields with Zephyr snippets
  - Adopt Zephyr zbus pub/sub messaging

Now open-source



- Published on June 26, 2023
- 5-clause open-source license

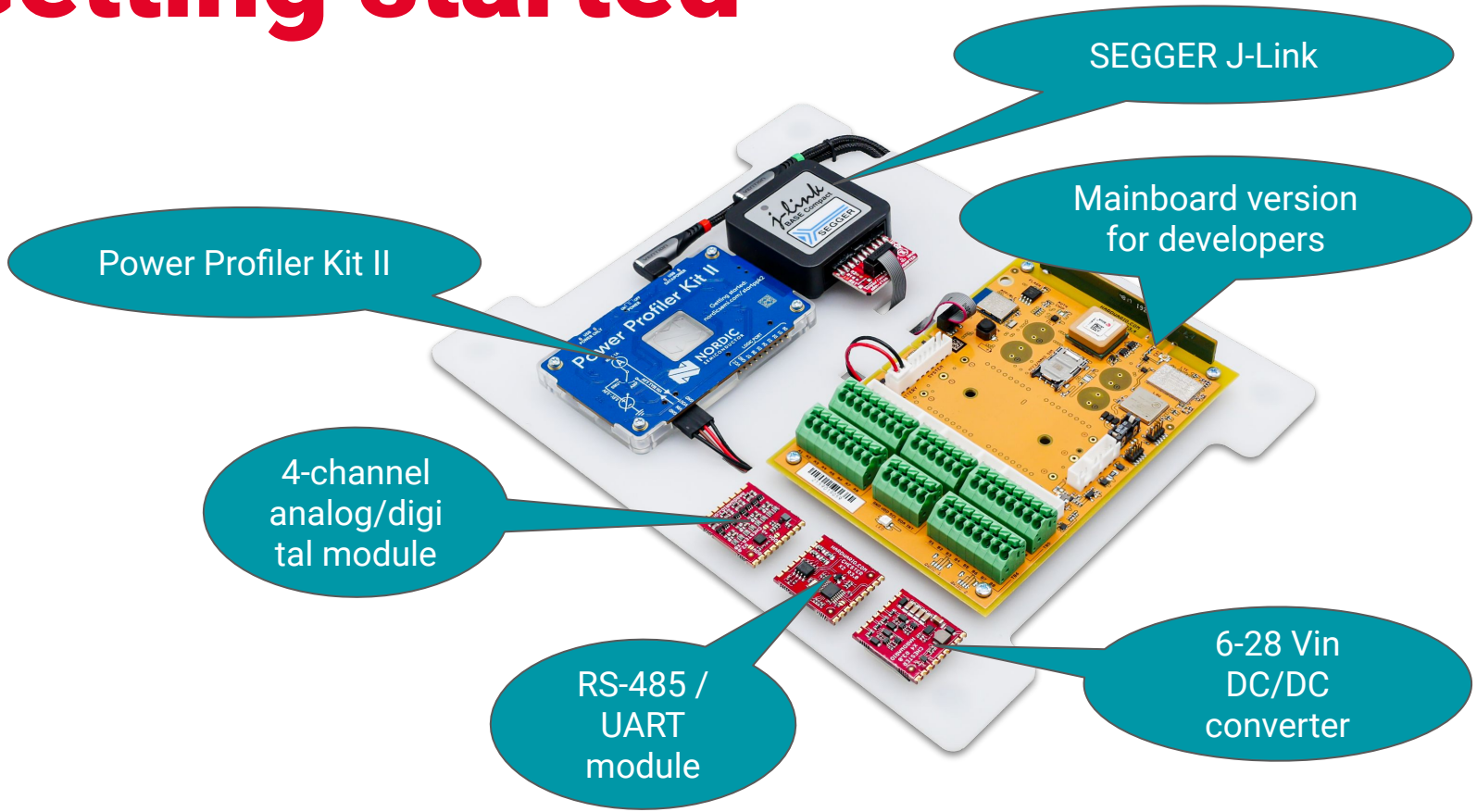
  (inheritance from Nordic Semiconductor)
- CHESTER SDK:

  https://github.com/hardwario/chester-sdk
- CHESTER Skeleton application:

  https://github.com/hardwario/chester-skeleton
- CHESTER documentation:

  https://docs.hardwario.com/chester/

Getting started



GRACIAS

www.hardwario.com

Twitter: @pavelhubner

Welcome to our booth number 33