Úvod do ZephyrRTOS

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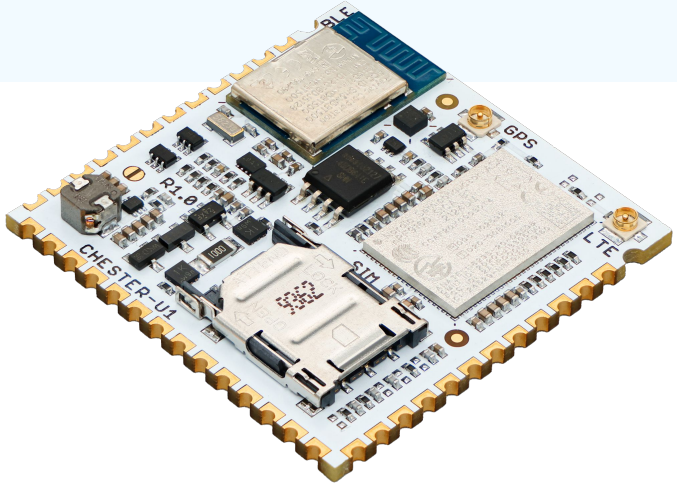
- Embedded vývoj, low-power, LTE-M, LoRaWAN,..
- HW / FW
- HARDWARIO
- @hubmartin
- hwdev.cz podcast

HARDWARIO CHESTER

- LPWAN IoT platforma + Cloud
- Modulární - shieldy, X moduly
- Low-Power
- Open FW
- docs.hardwario.com



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Byl by zájem na @OpenAlt o přednášku, jak v @hardwario_cz používáme @ZephyrIoT Embedded RTOS s NRF52 a jinými čipy?
Máme dost modulární platformu, že bych Zephyr/NCS představil, subsystémy, drivery, boards...
Možná i pár detailů z přechodu od EagleCAD na @kicad_pcb ? Lajky sem.

```c
#include <zephyr/kernel.h>
#include <zephyr/drivers/gpio.h>

/* The devicetree node identifier for the "led0" alias. */
#define LED0_NODE DT_ALIAS(led0)

static const struct gpio_dt_spec led = GPIO_DT_SPEC_GET(LED0_NODE, gpios);

int main(void)
{
   int ret;

   if (!gpio_is_ready_dt(&led)) {
       return 0;
   }

   ret = gpio_pin_configure_dt(&led, GPIO_OUTPUT_ACTIVE);
   if (ret < 0) {
       return 0;
   }

   while (1) {
       ret = gpio_pin_toggle_dt(&led);
       if (ret < 0) {
           return 0;
       }
       k_msleep(1000);
   }
   return 0;
}
```

Zephyr SDK

Windows, Linux, macOS

Podporované architektury:

- ARC (32-bit and 64-bit; ARCv1, ARCv2, ARCv3)
- ARM (32-bit and 64-bit; ARMv6, ARMv7, ARMv8; A/R/M Profiles)
- MIPS (32-bit and 64-bit)
- Nios II
- RISC-V (32-bit and 64-bit; RV32I, RV32E, RV64I)
- x86 (32-bit and 64-bit) - ideální pro testy
- Xtensa

Boards

Služby Zephyr kernelu

- Threads
- Scheduling
- CPU Idling
- Workqueue Threads
- Operation without Threads
- Interrupts
- Polling API
- Semaphores
- Mutexes
- Events
- Symmetric Multiprocessing
- ...

Build systém

- ❏ west
- ❏ CMake
- ❏ ninja
- ❏ Kconfig (prj.conf)
- ❏ Devicetree (*.dts, *.overlay)

Python příkaz west

- ❑ west init ~/zephyrproject
- ❑ cd ~/zephyrproject
- ❑ west update

- ❑ cd zephyr/samples/basic/blinky
- ❑ west build -b nrf52840dongle_nrf52840
- ❑ west flash (runners)

- ❑ rm -rf build/

Struktura Zephyr složek

- .west/config
- vendor (Váš projekt)
- chester (HARDWARIO CHESTER SDK)
- nrf (Nordic Connect SDK)
- nrfxlib (Nordic Connect SDK)
- zephyr (Zephyr)

Struktura vašeho projektu

- applications - Aplikace
- boards - Definice desky
- drivers - Ovladače
- dts - Devicetree a bindings
- lib - Samostatné knihovny
- samples - Ukázky (ideální pro vývoj)
- subsys - Subsystémy

Drivers

- Periferie MCU (GPIO, I2C, SPI, UART, PWM...)
- Externí čipy (senzory, expandéry, převodníky)
- Ethernet, CAN, displeje (zephyr/drivers/sensor/tmp112/tmp112.c)

a01nyub, adt7310, adt7420, adxl345, adxl362, adxl372, ak8975, akm09918c, amg88xx, ams_as5600, ams_iAQcore, apds9960, bh1750, bma280, bmc150_magn, bme280, bme680, bmg160, bmi08x, bmi160, bmi270, bmi323, bmm150, bmp388, bq274xx, ccs811, CMakeLists.txt, default_rtio_se, dht, dps310, ds18b20, ens210, esp32_temp, fdc2×1x, fxas21002, fxos8700, grove, grow_r502a, hmc5883l, hp206c, hts221, i3g4250d, icm42605, icm42670, icm42688, icp10125, iis2dh, iis2dlpc, iis2iclx, iis2mdc, iis3dhhc, ina219, ina23x, ina3221, isl29035, ism330dhcx, ist8310, ite_tach_it8xxx, ite_vcmp_it8xxx, Kconfig, lis2dh, lis2ds12, lis2dw12, lis2mdl, lis3mdl, lm75, lm77, lps22hb, lps22hh, lps25hb, lsm303dlhc_magn, lsm6ds0, lsm6dsl, lsm6dso, lsm6dso16is, lsm6dsv16x, lsm9ds0_gyro, lsm9ds0_mfd, max17055, max17262, max30101, max31855, max31865, max31875, max44009, max6675, mchp_tach_xec, mcp9600, mcp970x, mcp9808, mcux_acmp, mhz19b, mpr, mpu6050, mpu9250, ms5607, ms5837, npm1300_charger, nrf5, ntc_thermistor, nuvoton_adc_cmp, nuvoton_tach_np, nxp_kinetis_tem, nxp_tempmon, opt3001, pcnt_esp32, pms7003, qdec_mcux, qdec_nrfx, qdec_sam, qdec_stm32, rpi_pico_temp, s11059, sbs_gauge, sensor_decoders, sensor_handlers, sensor_shell.c, sensor.txt, sgp40, shell_battery.c, sht3xd, sht4x, shtcx, si7006, si7055, si7060, si7210, sm351lt, stm32_temp, stm32_vbat, stm32_vref, stmemsc, stts751, sx9500, tcn75a, tcs3400, th02, ti_hdc, ti_hdc20xx, tmd2620, tmp007, tmp108, tmp112, tmp116, vcnl4040, veml7700, vl53l0x, vl53l1x, wsen_hids, wsen_itds, wsen_pads, wsen_pdus, wsen_tids, xmc4xxx_temp (link)

Subsystems

- Shell
- Funguje přes uart, BLE NUS, J-Link RTT (accel read)
- zephyr/drivers/dac/dac_shell.c
- Modbus
- EXT2, Flash circular buffer (FCB), Non-volatile storage (NVS), FAT, LittleFS, shell (fs příkaz)
- IP, HTTP, MQTT, SNTP, WS, DNS ,CoAP, ..
- .....

Devicetree (DTS) - staticky kompilované

```
&i2c0 {
    compatible = "nordic,nrf-twim";
    status = "okay";
    clock-frequency = <I2C_BITRATE_STANDARD>;

    sht30: sht30@44 {
        compatible = "sensirion,sht3xd";
        status = "disabled";
        reg = <0x44>;
    };

    tmp112: tmp112@48 {
        compatible = "ti,tmp112";
        reg = <0x48>;
    };

};
```

Troubleshooting

LOG_INF, WRN, DBG, HEXDUMP (/zephyr/samples/subsys/logging/logger native_posix)

nRF Connect for VS Code (debugger)

I2C scan (i2c scan i2c@40003000), flash, fs ls/cat

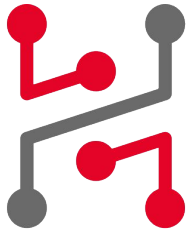
Runtime výpis Flash partition

Hlídání buffer overflow, MPU

SYS_INIT (ctr_therm.c)

Zephyr ChatGPT

- **build/zephyr/zephyr.dts** — **Kompletní devicetree**
- **build/zephyr/include/generated/autoconf.h** — **KConfig položky**
- **build/zephyr/zephyr.bin (elf|hex|map) / merged**



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