Overview of LoRa & LoRaWAN support in Zephyr

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Agenda

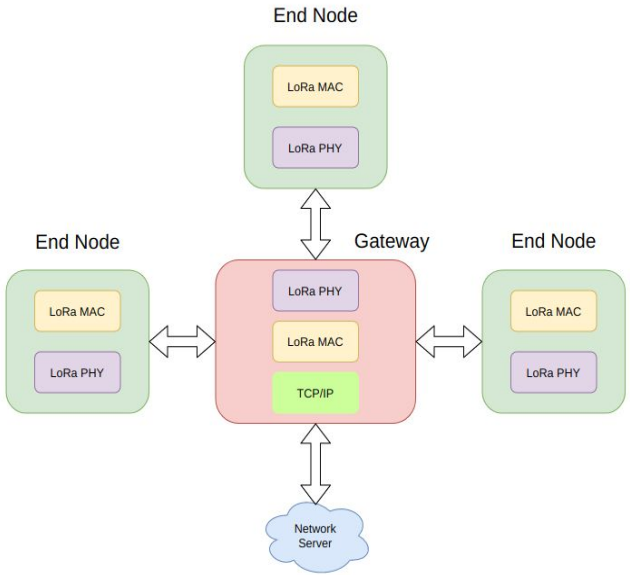
- What is LoRa and LoRaWAN?
- Why Zephyr?
- Current status of LoRa and LoRaWAN support in Zephyr
- Planned improvements in Zephyr
- Proposal for LoRa and LoRaWAN in Linux kernel

What is LoRa?

- Long Range (LoRa)
- A LPWAN wireless technology based on Chirp spread spectrum (CSS) modulation technique
- Originally developed by Cycleo but later acquired by Semetch
- Operates in a license free Sub Gigahertz frequency (865 MHz-India, 868 MHz-Europe etc...)
- Perfect for low data rate and long range applications

What is LoRaWAN?

- Long Range Wide Area Network (LoRaWAN)
- LoRaWAN is the MAC soft layer
- Uses LoRa as the PHY layer
- LoRa protocol is closed while LoRaWAN spec is open
  - Stack for End Node
  - Stack for Gateway
  - Stack for Network server
- Works in a star topology
- Governed by LoRa Alliance



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Why Zephyr?

- Small footprint Real Time Operating System (RTOS)
  - Highly configurable
- Supports multiple architectures
  - x86, ARM, RISC-V, Xtensa
- Offers rich functionality
  - BLE, WiFi, OpenThread, USB, Display, Modem etc...
- Truly open source
  - Uses Apache 2.0 license

Current status of LoRa support in Zephyr

- APIs supported - *include/drivers/lora.h*
  - lora_config()
  - lora_send()
  - lora_recv()
  - lora_test_cw()
- Point to Point (P2P) over LoRa radio
- Sample applications
  - *samples/drivers/lora/send/*
  - *samples/drivers/lora/receive/*

Current status of LoRaWAN support in Zephyr

- APIs supported - *include/lorawan/lorawan.h*
  - lorawan_set_battery_level_callback()
  - lorawan_register_dr_changed_callback()
  - lorawan_register_downlink_callback()
  - lorawan_join()
  - lorawan_start()
  - lorawan_send()
  - lorawan_set_class()
  - lorawan_set_conf_msg_tries()
  - lorawan_enable_adr()
  - lorawan_set_datarate()
  - lorawan_get_min_datarate()
  - lorawan_get_payload_sizes()

Current status of LoRaWAN support in Zephyr

- Sample application
  - samples/subsys/lorawan/class_a/
- Only Class-A is tested
  - Other classes should also work
- Both uplink and downlinks are supported
- Both OTAA and ABP joins are supported
  - Only OTAA join is added in the sample application
- Adaptive Data Rate (ADR) is supported
- Battery level reporting is supported
  - Application should implement the relevant callback
- Currently based on "LoRaWAN specification 1.0.4" and "LoRaWAN Regional Parameters 2-1.0.1"

Planned improvements in Zephyr

- Improvements planned in Zephyr for LoRa/LoRaWAN
  - Persistent storage
  - Key management

Persistent storage

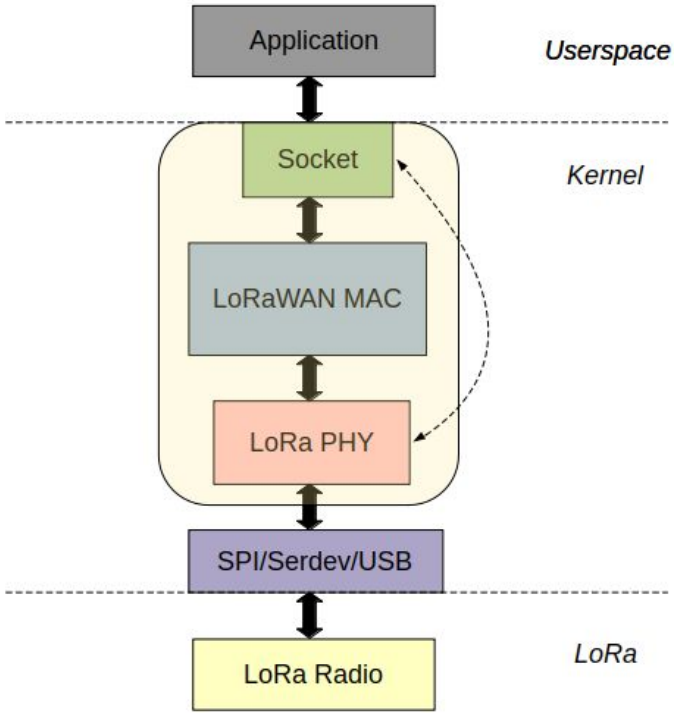
- Need to store non-sensitive volatile context to Non-volatile memory
  - EEPROM
- Parameters that need to be stored - DevNonce, Frame counter etc...
- *loramac-node* repo has a structure that packs all these parameters
  - **LoRaMacNvmData_t** fetched using **MIB_NVM_CTXS** request
- Context to be stored during *MacProcessNotify()* callback and PM suspend
- Context to be restored during power-up and PM resume
- Zephyr's **Settings API** could be leveraged
  - *include/settings/settings.h*
- WIP code by Andreas Sandberg

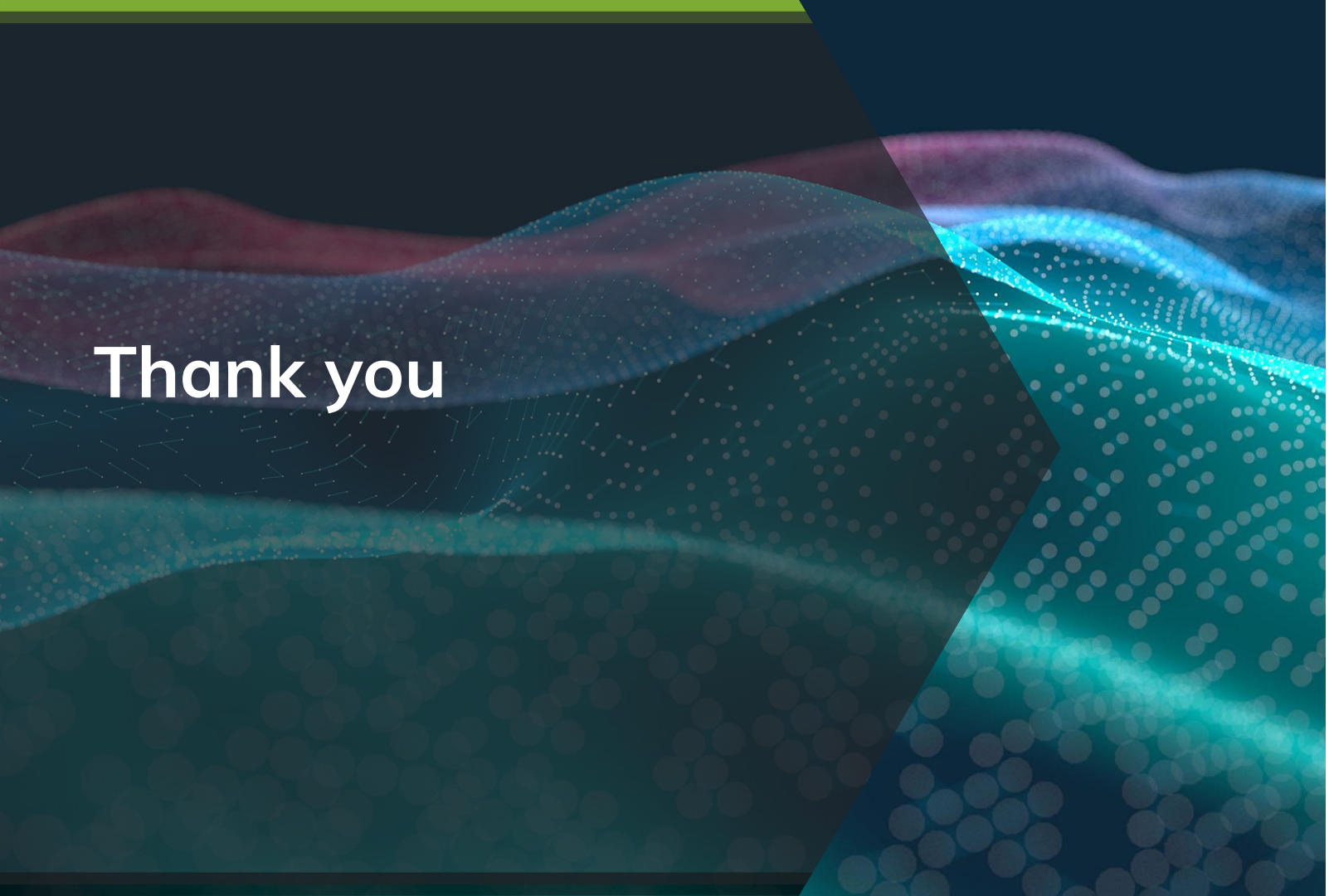
Key management

- Need to encrypt/decrypt, and store the sensitive information to a Cryptographic module
  - Secure Element (SE)
- Parameters that need to be encrypted and stored
  - DevAddr, Session keys etc...
- *loramac-node* repo provides Secure Element API
  - *src/mac/secure-element.h*
- Zephyr's **Crypto API** could be leveraged
  - *include/crypto/cipher.h*
- WIP code by Andreas Sandberg

Proposal for LoRa and LoRaWAN in Linux kernel

- A socket for LoRa and LoRaWAN
  - **PF_LORA, PF_LORAWAN**
- LoRa as PHY
  - Device drivers for LoRa modules
- LoRaWAN as Soft MAC
  - Stack written from scratch!
- Primary developers
  - Andreas Färber, Jian-Hong Pan
- Effort appears to have stalled!
  - No update in the repo for the past 3 years





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