Zephyr OS:
Industrial IoT support

Andrei Laperie, Intel
Zephyr Project

- **Open source** real time operating system
- **Vibrant Community** participation
- Built with **safety and security** in mind
- **Cross-architecture** with broad SoC and development board support.
- **Vendor Neutral** governance
- **Permissively** licensed - Apache 2.0
- **Complete**, fully integrated, highly configurable, **modular** for **flexibility**
- **Product** development ready using LTS includes security updates
- **Certification** ready with Auditable

Open Source, RTOS, Connected, Embedded
Fits where Linux is too big

Zephyr OS

- 3rd Party Libraries
- Application Services
- OS Services
- Kernel
- HAL
Zephyr Supported Hardware Architectures

- ARC Synopsys
- ARM Cortex-M & Cortex-R
- Intel X86 & x86_64
- Nios II Processor
- RISC-V 32 & 64 bit
- Tensilica Xtensa

Coming soon:
- SPARC
- OpenPOWER™
Board Support – 200+ and growing

<table>
<thead>
<tr>
<th>Board Support</th>
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<tbody>
<tr>
<td>Arduino Due</td>
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<tr>
<td>Nucleo 103RB</td>
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<tr>
<td>SiFive HiFive1</td>
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<td>NXP i.MX RT1050</td>
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Zephyr Project Members

- Intel
- Oticon
- Nordic Semiconductor
- NXP
- Adafruit
- Antmicro
- Bose
- Foundries.io
- Linaro
- SiFive
- Synopsys
- Texas Instruments

and more...
Zephyr in RTOS Landscape 2019/12/26

### Total GitHub Contributors

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<tr>
<td>3</td>
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• Highly Configurable, Highly Modular
• Cooperative and Preemptive Threading
• Memory and Resources are typically statically allocated
• Integrated device driver interface
• Memory Protection: Stack overflow protection, Kernel object and device driver permission tracking, Thread isolation
• Bluetooth® Low Energy (BLE 5.1) with both controller and host, BLE Mesh
• 802.15.4 OpenThread
• Native, fully featured and optimized networking stack

Fully featured OS allows developers to focus on the application
Aspects Of Industrial Use

Functional aspects (“What”)
- Industrial networking
- Real-time scheduling

Non-functional aspects (“How”)
- Safety
- Security
Ongoing activity to make Zephyr certifiable for Functional Safety using IEC 61508

This requires tailored development process and special artefacts. These will be deployed to special branch ‘auditable’

- Auditable branch based on Zephyr Long-Term Support release (2 year cadence)
- Supports V-model requirement by FuSa standards
Zephyr Networking Features

High-Level Protocols
- CoAP v1
- MQTT Client v3.1.1
- HTTP
  - As of Zephyr 2.0 server is implemented using CivetWEB library
  - Native HTTP client
  - Websocket client
- SOCKS5
- LWM2M
- Thread
  - Supported by OpenThread project

Supported technologies
- Ethernet
- Ethernet over USB
- WiFi with IP offload
- IEEE 802.15.4 with 6Lo
- Bluetooth LE with 6Lo
- CANbus with 6Lo
- PPP
Introducing Time Sensitive Networking

TSN is a set of IEEE 802.1 standards for the time-sensitive transmission of data over deterministic Ethernet networks.

They define:
- Time synchronization
- Scheduling and traffic shaping
- Selection of communication paths and fault-tolerance

Sample uses:
- Synchronizing time between different parts of assembly robot
- Transfer multimedia content inside car multimedia system
IEEE 802.1AS-2011 defines the Generic Precision Time Protocol (gPTP). It uses gPTP messages to establish a hierarchy of clocks and synchronize time between them.
TSN: Traffic Scheduling and Shaping

- **Traffic scheduling for TSN** - defined by a group of standards extending IEEE 802.1Q to guarantee end-to-end latencies for the various traffic classes

- TSN scheduling standards include 802.1Qav, Qbu, Qbv

- **Traffic shaping** is a method of distributing traffic in time to allow consistent bandwidth usage
Zephyr TSN Support: Supported Features

Zephyr supports 802.1AS-2011 gPTP protocol

- It can act as a grand master or a slave

Supported hardware needs to have Ethernet packet timestamping implemented:

- Atmel SAM-E70 Xplained (gPTP and Qav supported)
- NXP FRDM-K64F (only gPTP supported)

See samples/net/gptp application for details

https://docs.zephyrproject.org/latest/reference/networking/tsn.html
Introducing CAN Bus

Controller Area Network bus is a serial bus developed by Bosch in 1983. Family of ISO standards 11898, since 1993

Commonly used to interconnect Electronic Control Units in car:
- Engine,
- Power steering
- ABS
- Wipers
- etc

Used for OBD II in your car

Thanks to the low cost of equipment, used as a common fieldbus in automation solutions
Zephyr CAN bus support

Hardware support:
- NXP TWR-KE18F
- STM32-based chips: F0, F7, ...

Protocols:
- direct/raw CAN access
- SocketCAN (using Socket API to access CAN)
- CANOpen (protocol over CAN)

6LoCAN
- IPv6 over CAN bus, IETF draft (Oct 2019)

https://docs.zephyrproject.org/latest/reference/networking/can.html
Closing Thoughts

Open Source operating systems can be a good fit for industrial IOT, if
• They have right technologies enabled
• They have right license
• They enable safety/security certification

Zephyr Project has a unique combination of advantages that can make it a viable alternative to closed source platforms in IIOT

You are welcome to try it at www.zephyrproject.org!