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Mastering Zephyr RTOS

DAY 1 : Welcome to Zephyr RTOS

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THE SPEAKER

Jacob Beningo

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jacobbeningo

Beningo Embedded Group – CEO / Founder

Focus: Software Architecture, Processes, and Dev Skills

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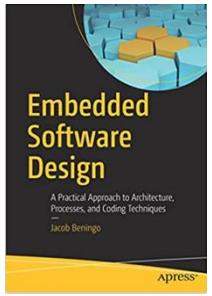

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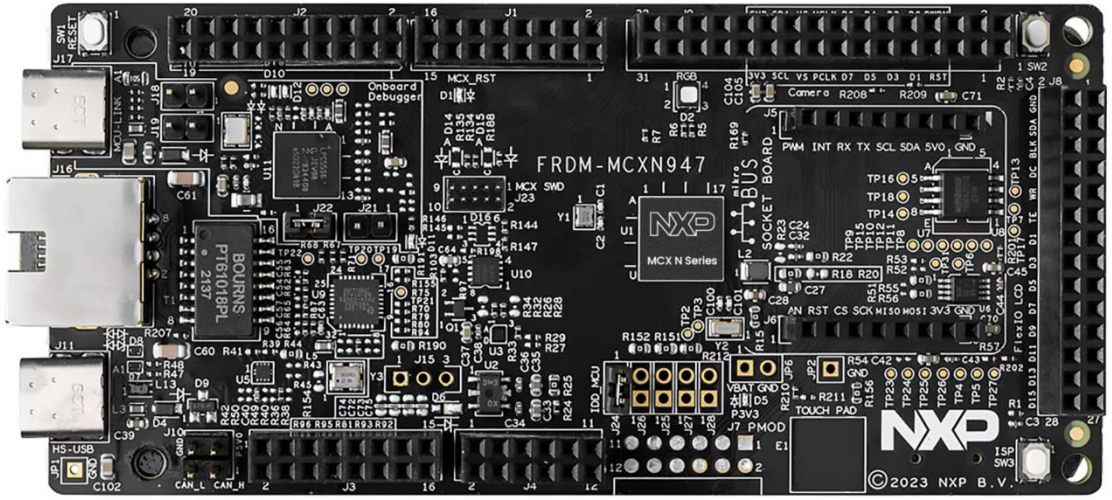
This week's topics:

- Welcome to Zephyr RTOS
- Build Systems, Kconfig, and Device Tree
- Threads, Scheduling, and RTOS Primitives
- Drivers, Peripherals, and Customization
- Debugging, Logging, and Best Practices

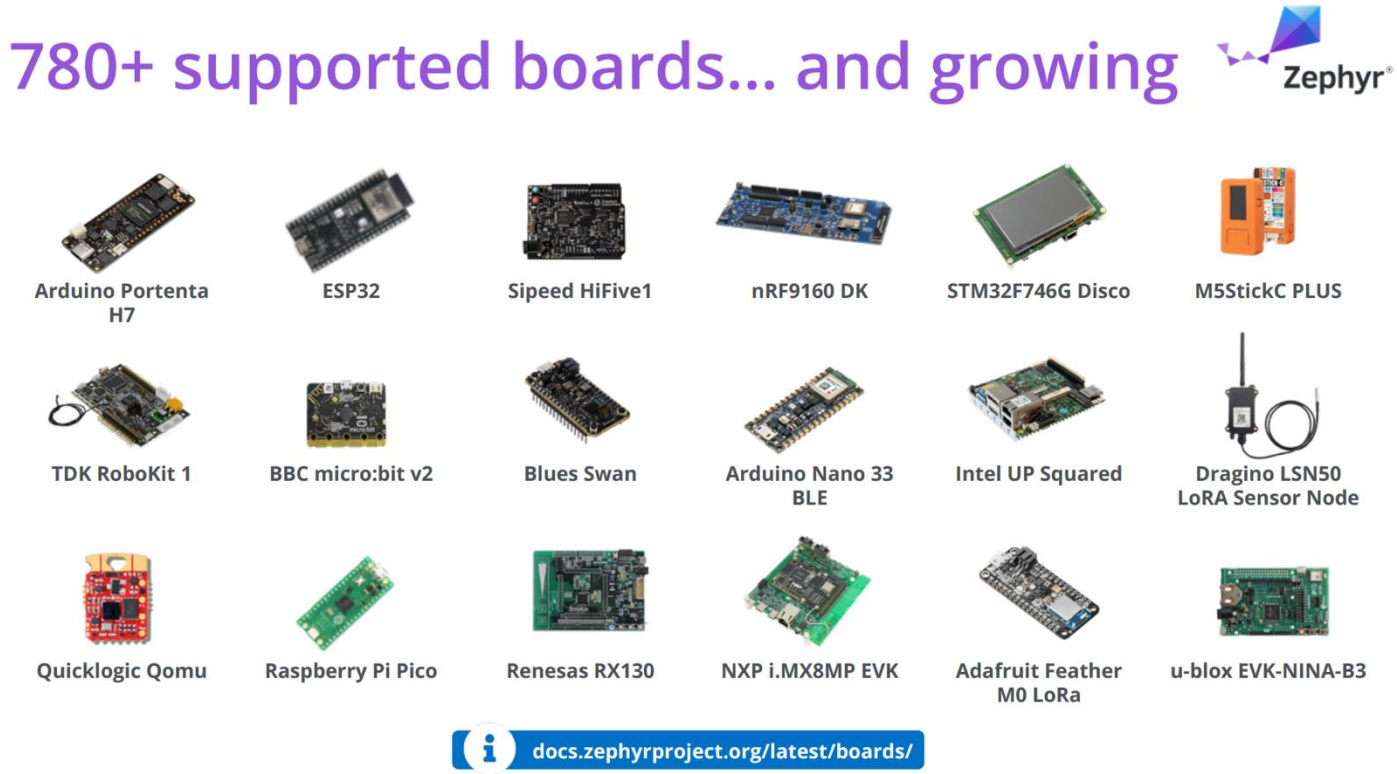
NXP FRDM-MCXN947

- MCX-N947 Dual Arm Cortex-M33 microcontroller running at 150 MHz
- 2MB dual-bank on chip Flash
- 512 KB RAM
- External Quad SPI flash over FlexSPI
- USB high-speed (Host/Device) with on-chip HS PHY. HS USB Type-C connectors
- 10x LP Flexcomms each supporting SPI, I2C, UART
- 2x FlexCAN with FD, 2x I3Cs, 2x SAI
- 1x Ethernet with QoS
- On-board MCU-Link debugger with CMSIS-DAP
- Arduino Header, FlexIO/LCD Header, SmartDMA/Camera Header, mikroBUS



Zephyr Board Support

https://docs.zephyrproject.org/latest/boards/index.html#



Zephyr RTOS

01

What is Zephyr?

An open-source RTOS (Apache 2.0)

- Linux Foundation supported
- Built with safety and security in mind
- Lightweight kernel with supporting services
  - Connectivity stacks like Wi-Fi, BLE, USB, MQTT, etc
- Developer Friendly
  - Logging, tracing, built-in-shell, Windows/Linux/macOS
- Ships with SBOMs (Software Bill of Materials)
- Supports more than 780 boards

- Additional Resources: Zephyr Project Overview Document

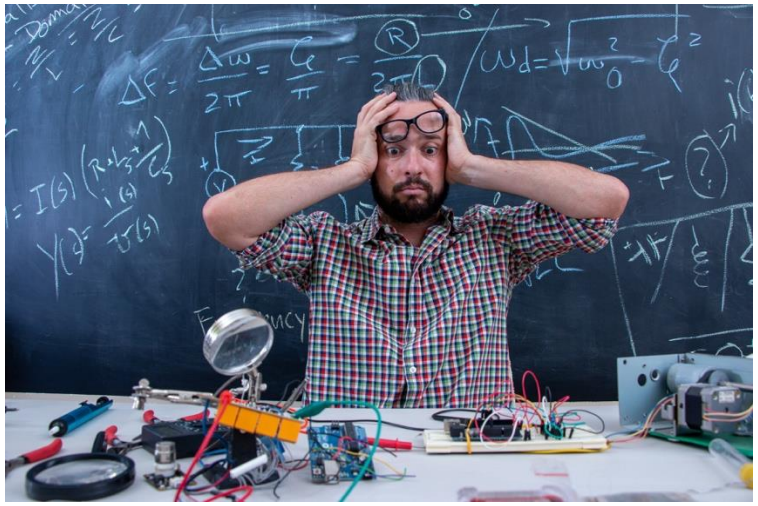
The Zephyr Community

- Hardware Engineers

Can get up and running quickly without being software experts.

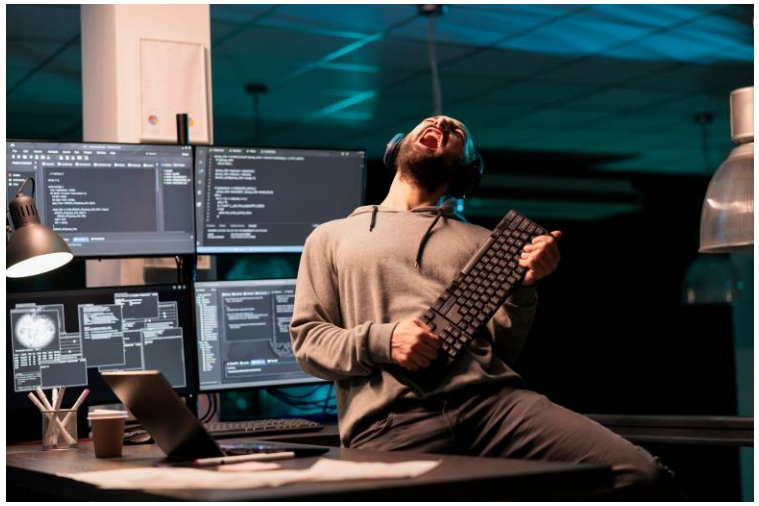
(Board Check-out)

- Firmware Engineers



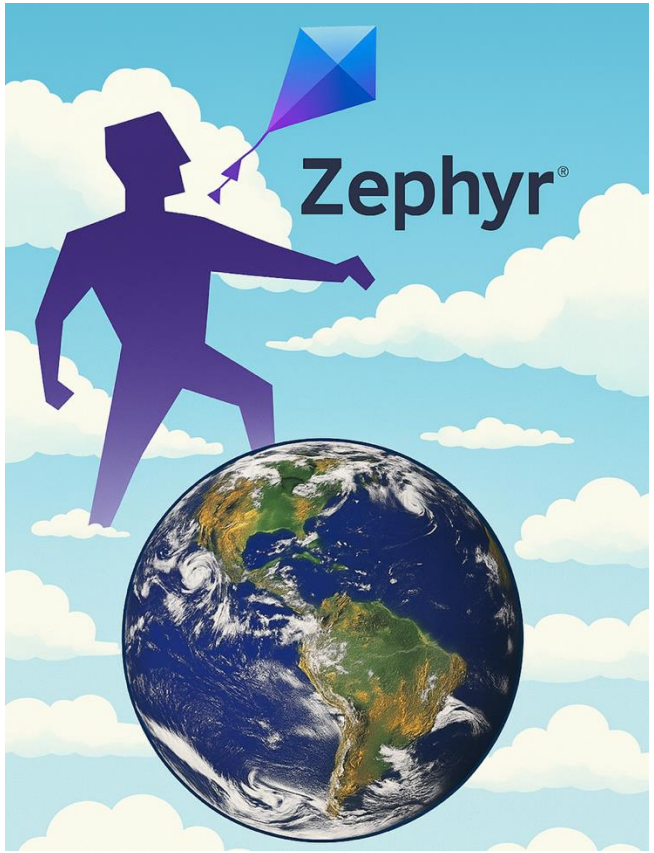
Work up and down the software stack including low-level including DTS, drivers, subsystems, etc.

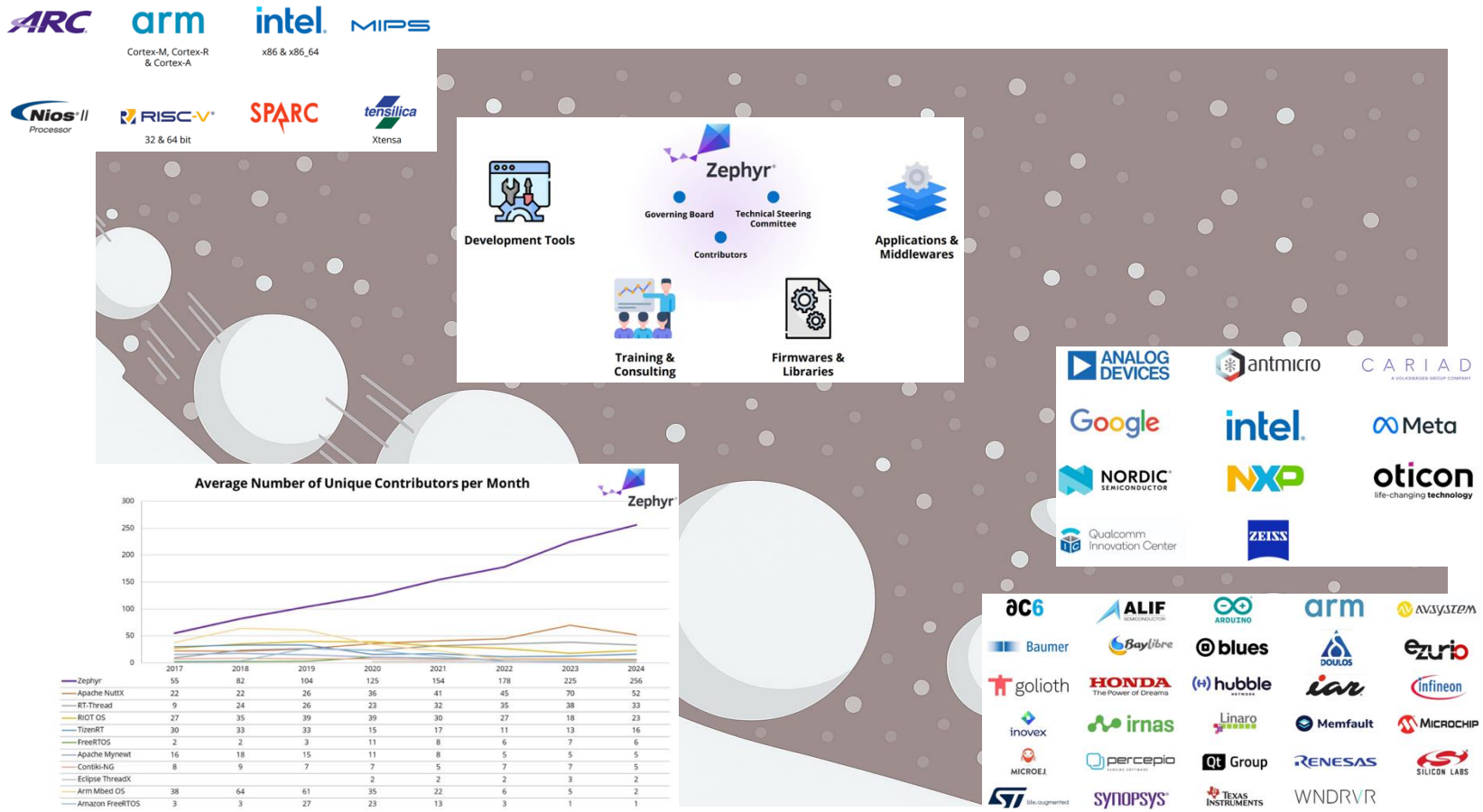
- Software Engineers



Treat Zephyr like a Linux system and can easily get up to speed developing real-time systems.

Zephyr Will Rule the World . . .





Audience POLL Question

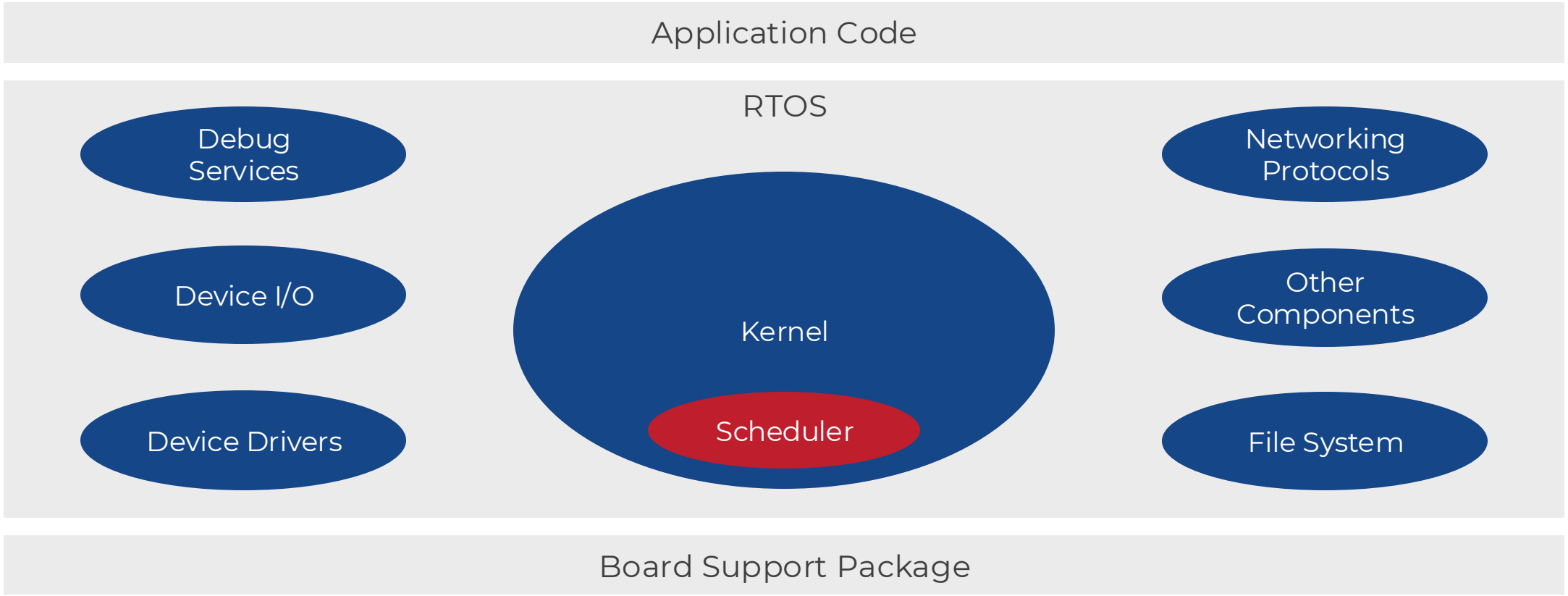
Which of the following best describes you?

a) Never used Zephyr before
b) Have installed and run “Hello World”
c) Played around a bit beyond the basics
d) Using Zephyr daily for work

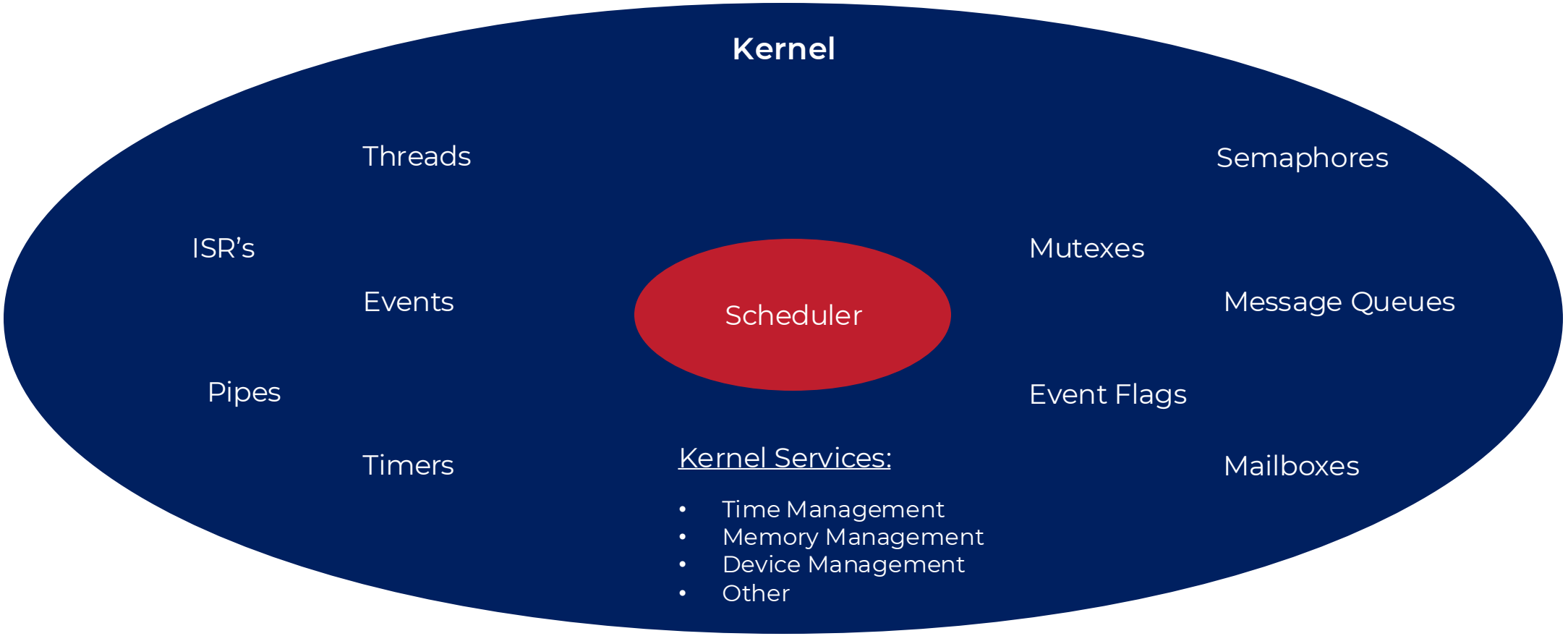
The Zephyr Kernel

01

Real-time Operating Systems

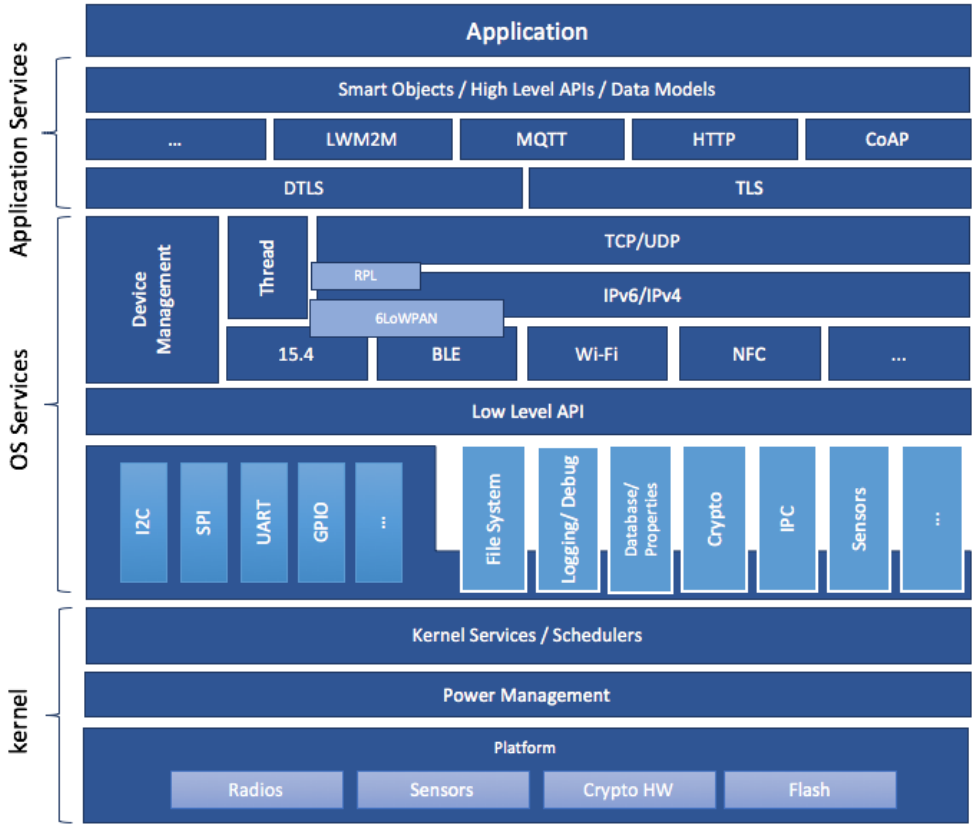


What is a Kernel

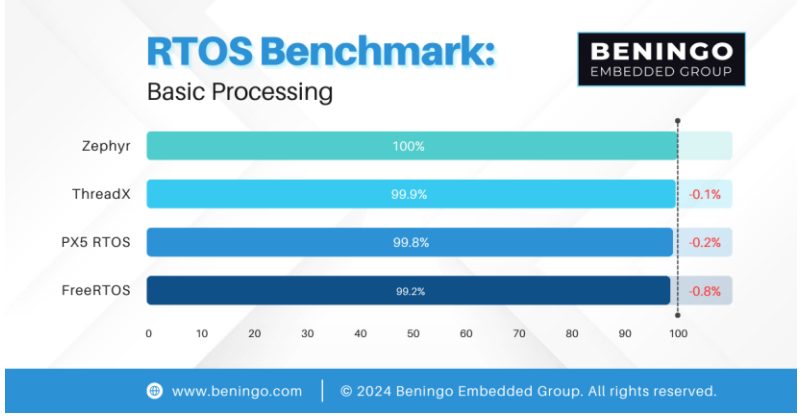


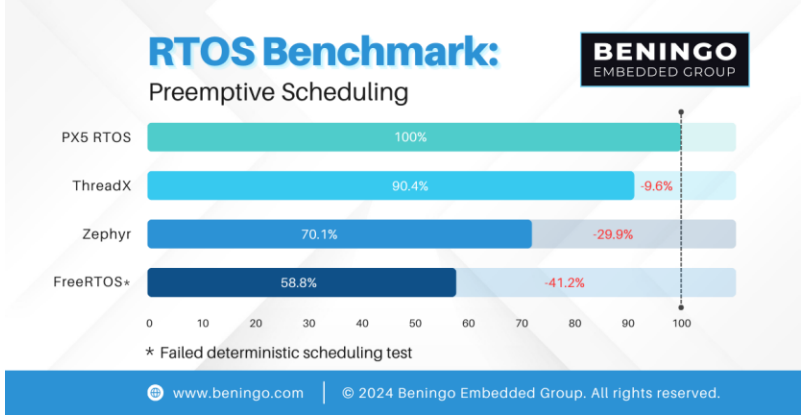
Zephyr Architecture

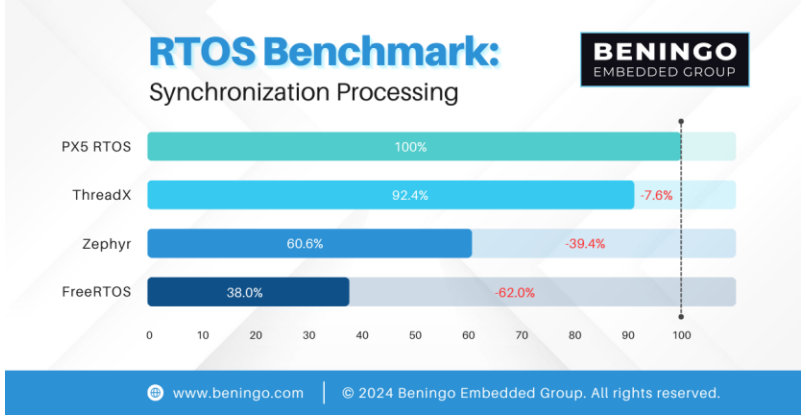
- Kernel
  - Light-weight, real-time kernel
  - Thread Management
  - Power Management
- OS-Services
  - Memory Management
  - Connectivity Stacks
  - Device Drivers
- Application Services
  - Logging and Tracing
  - Internet Protocols

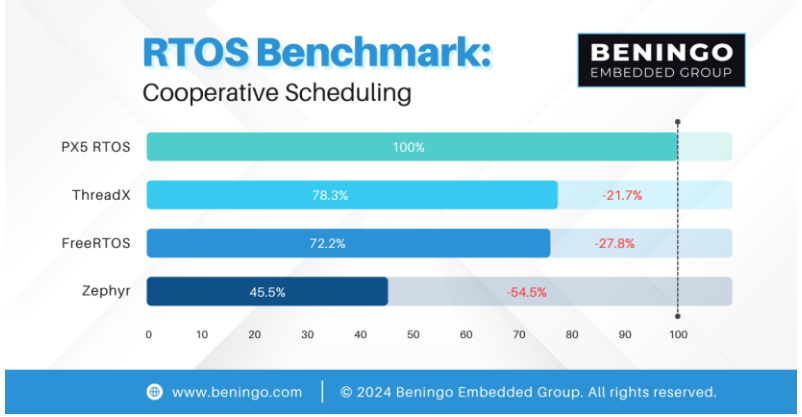


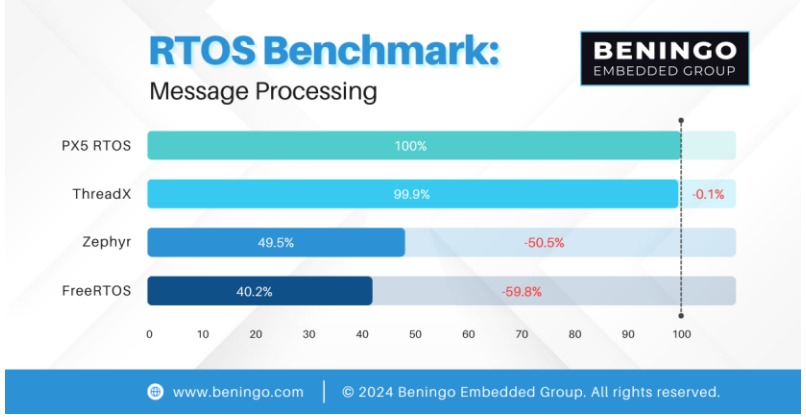
Kernel Performance – 2024 Zephyr 3.7

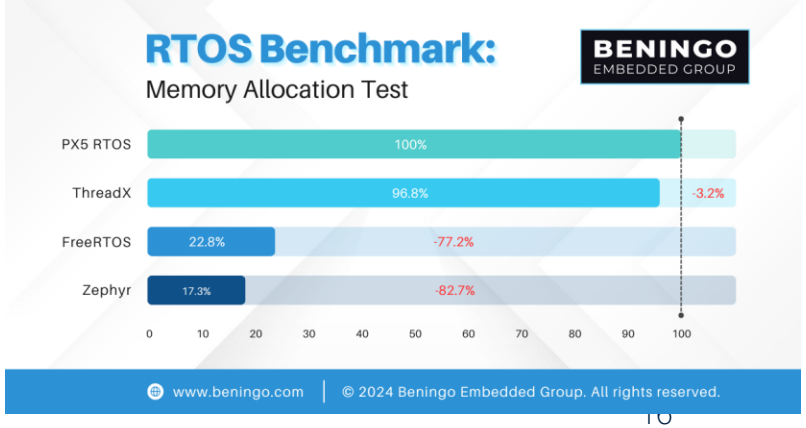










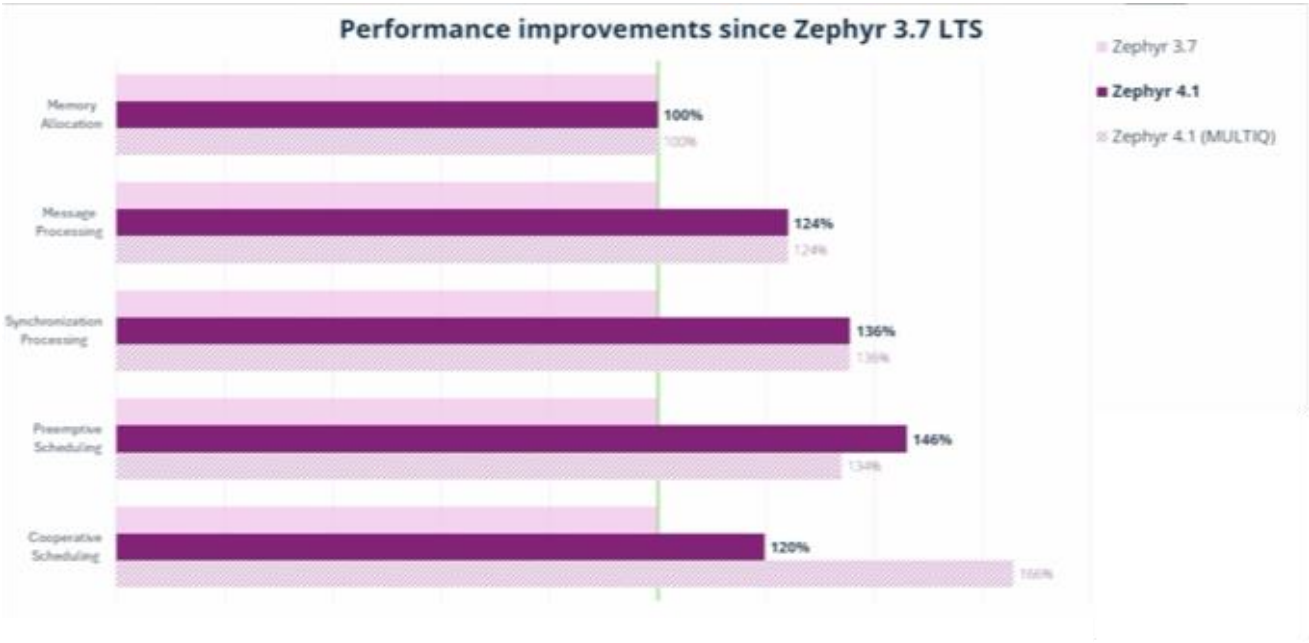


Kernel Performance – Zephyr 4.1

Major Performance Increases

- 46% Faster Preemptive Scheduling
- 36% Faster Synchronization
- 24% Faster Message Processing

Experimental MUTLIQ scheduling



source: https://www.youtube.com/watch?v=TOIwI9XrHZM

Audience POLL Question

How important is kernel performance to your application?

a) Critical – We have hard real-time constraints, and even microseconds matter.
b) Important – Latency and responsiveness affect our user experience or power efficiency.
c) Somewhat important – We care, but the kernel isn't usually our bottleneck.
d) Not important – Our app is simple, and kernel overhead isn’t a concern.

Installing Zephyr

03

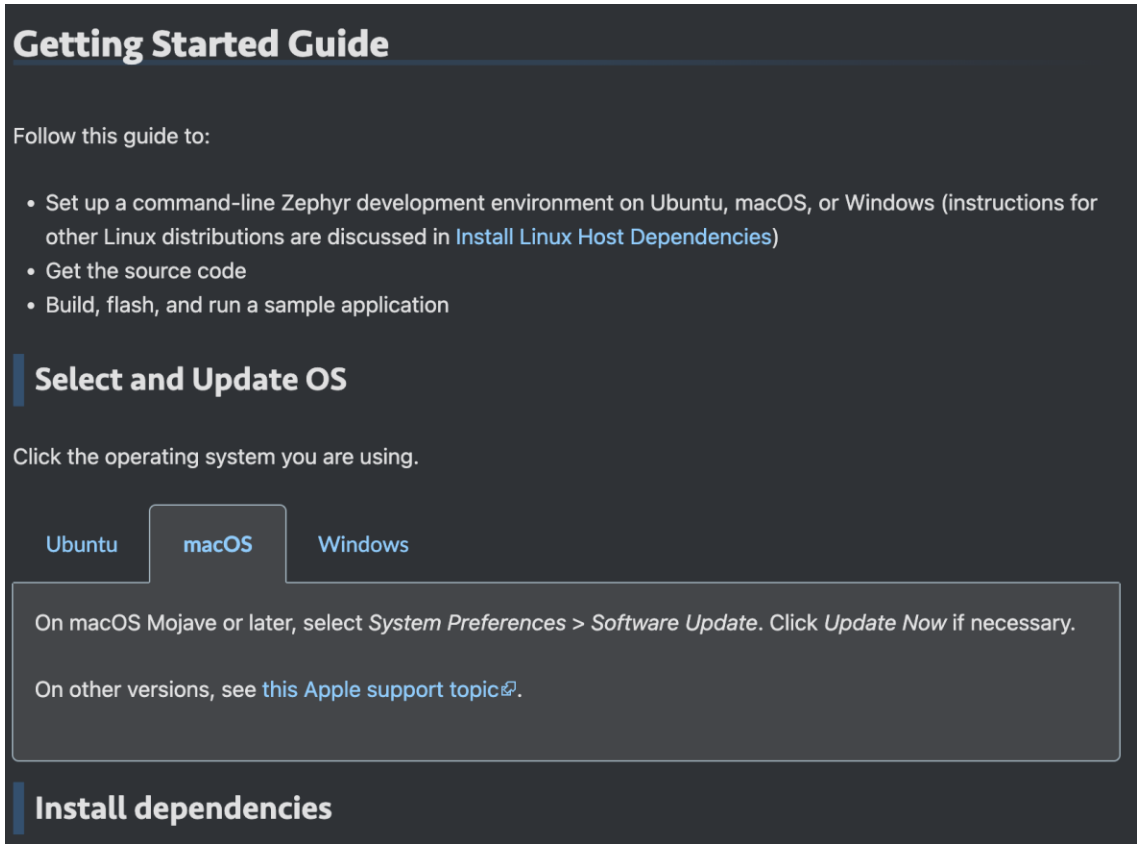
Zephyr is Self-Contained

- Use “West” to download everything
- Support for:
  - CPUs
  - Boards
  - Bootloader
  - Subsystems
  - Peripherals
- Drivers are vetted
  - Thriving open-source community with maintainers
  - Zephyr Discord Channel

Installing Zephyr with West

https://docs.zephyrproject.org/latest/develop/getting_started/index.html

- Select OS
- Install Dependencies
  - Cmake
  - Python
  - Devicetree Compiler
- Get Zephyr and install Python Dependencies
- Install the Zephyr SDK
- Build the Blinky Sample



Installing Zephyr with West - Windows

Tool	Min. Version
CMake	3.20.5
Python	3.10
Devicetree compiler	1.4.6

cd $Env:HOMEPATH python -m venv

zephyrproject\.venv

zephyrproject\.venv\Scripts\Activate.ps1

Install and Configure West

pip install west

west init zephyrproject

cd zephyrproject

west update

west zephyr-export

west packages pip --install

Install Zephyr SDK

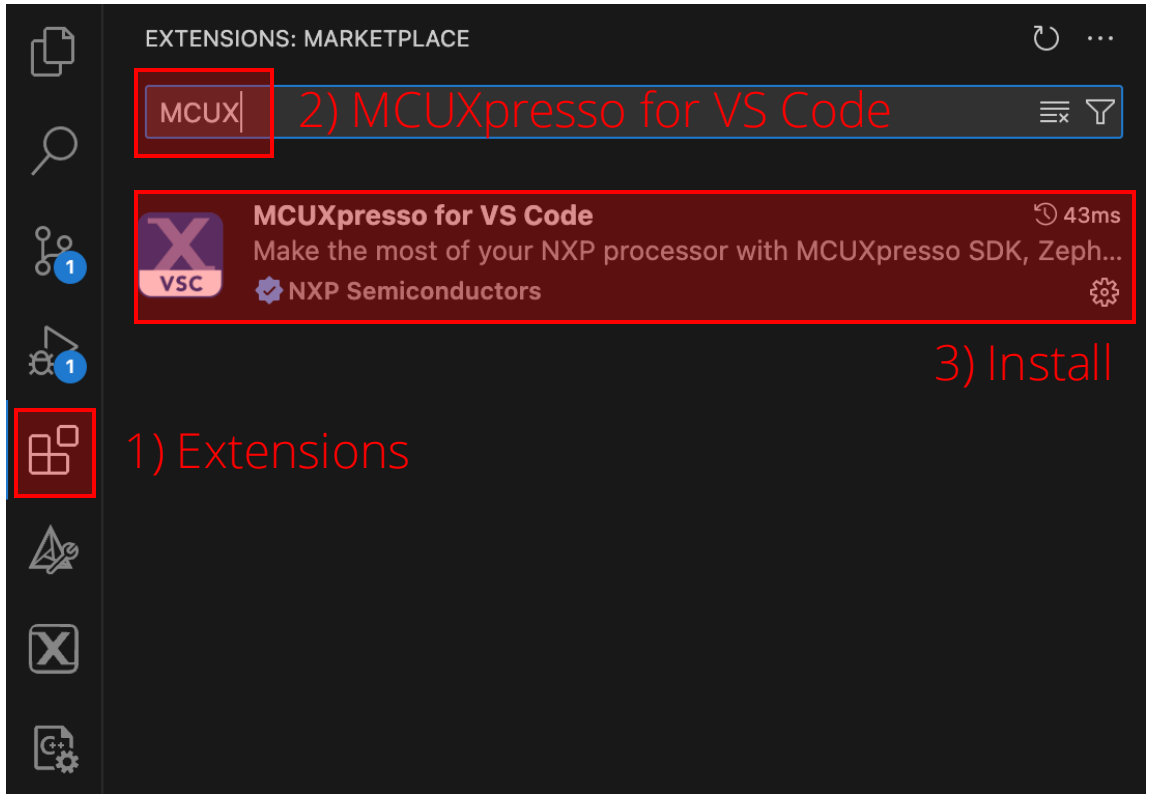
cd $Env:HOMEPATH\zephyrproject\zephyr

west sdk install

Installing Zephyr with Vendor Tools

Visual Studio Code offers an integrated environment to streamline development.

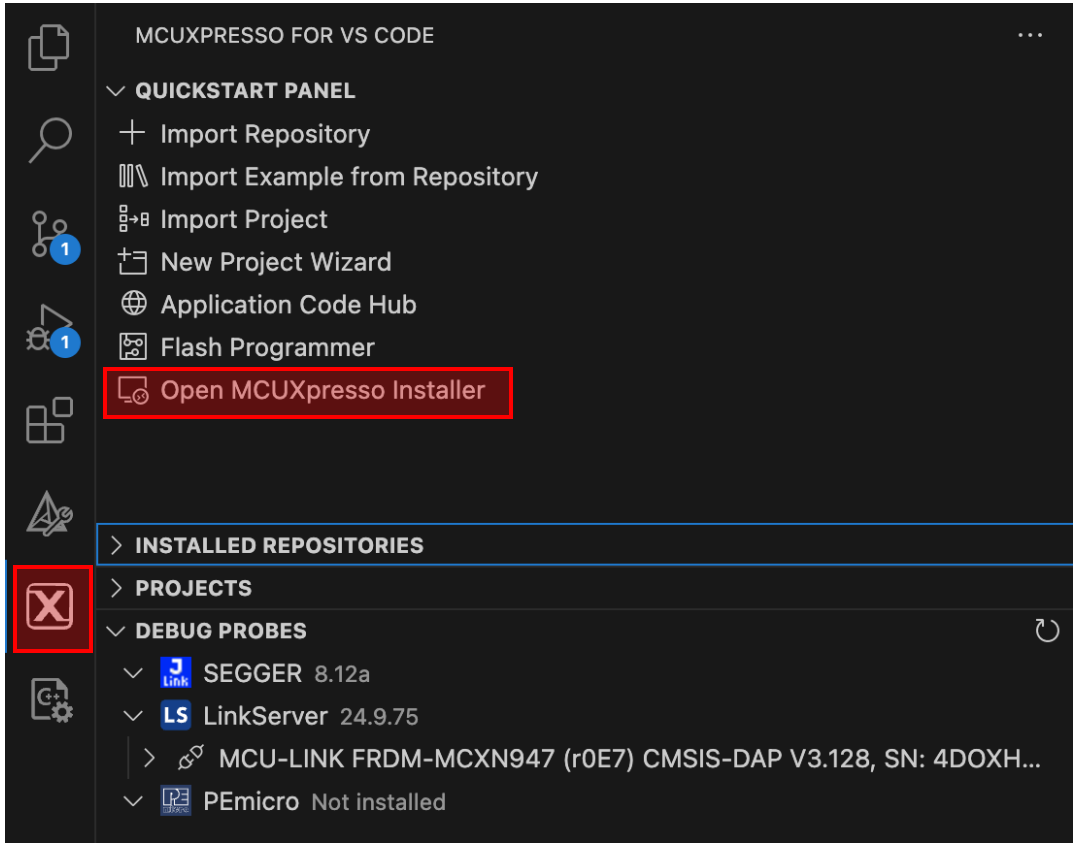
- Customizable with extensions
- Cross-Platform
- Simplified build tools
- Terminal integration
- etc



Installing Zephyr with Vendor Tools

- Installing MCUXpresso Tools

1)



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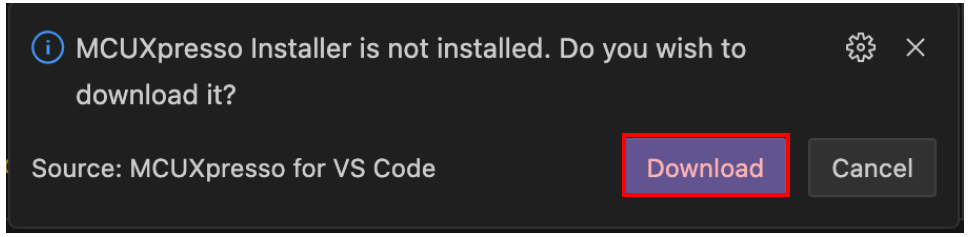
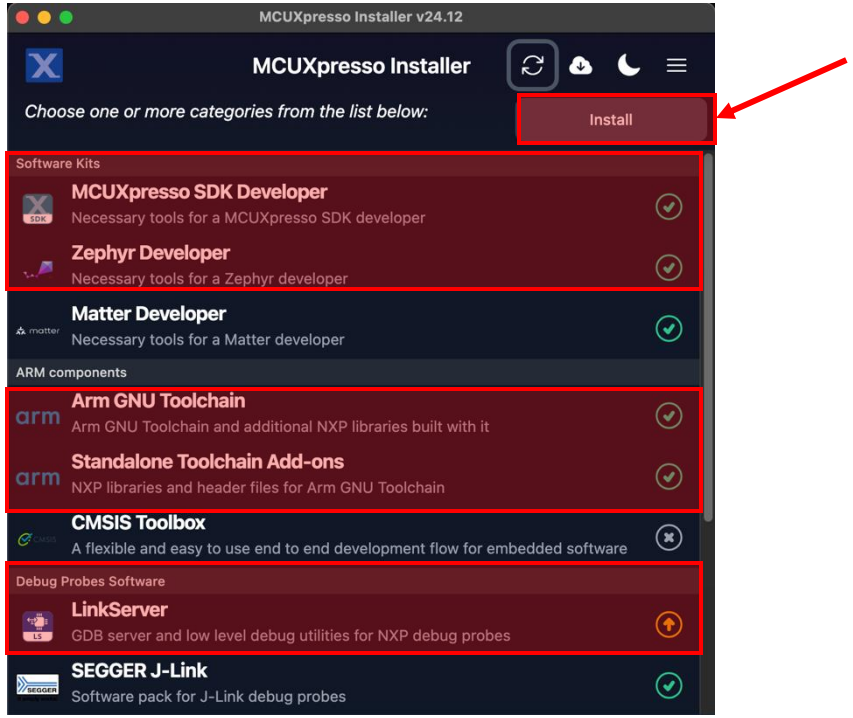
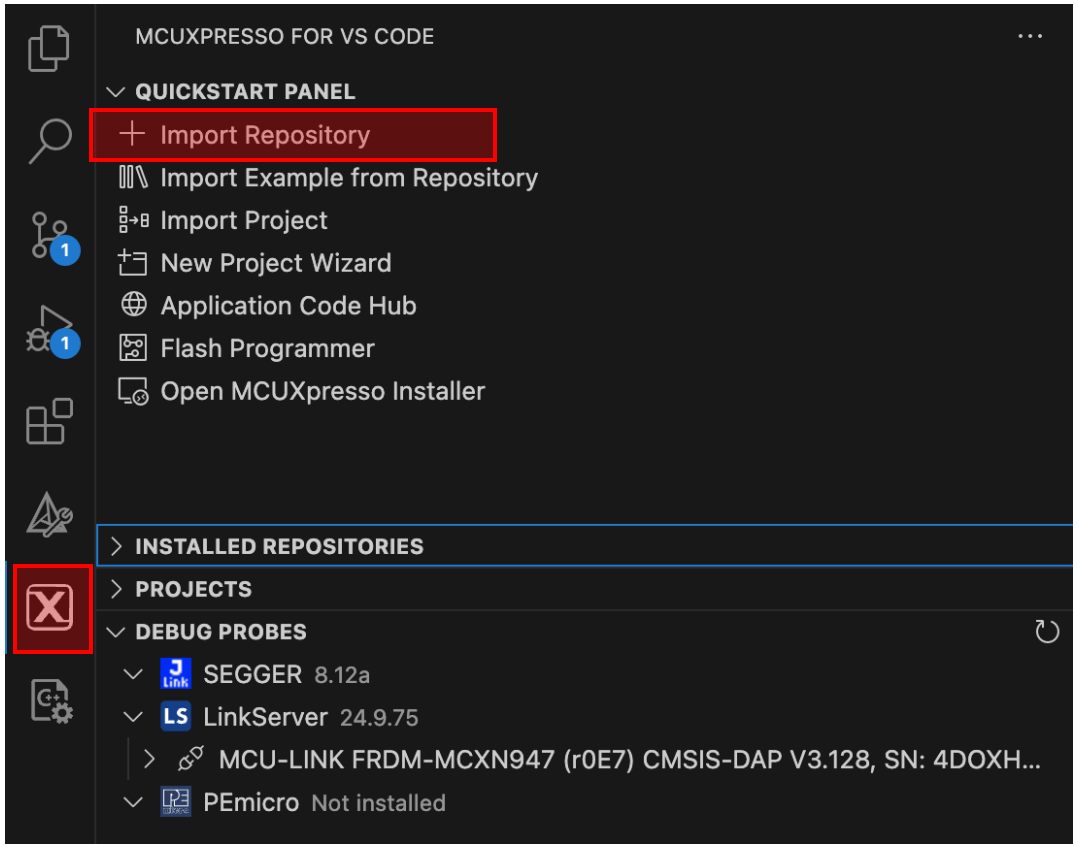
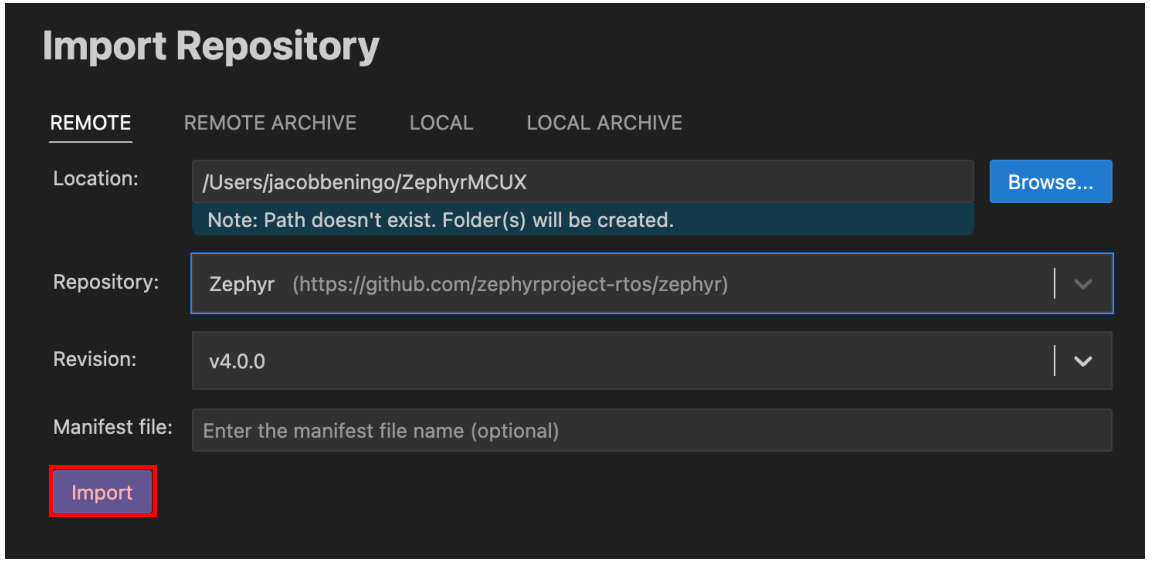




Installing Zephyr with Vendor Tools – Importing Zephyr

1)





Audience POLL Question

Which Zephyr workflow to you think you prefer?

a) Using vendor-provided tools to install and manage
b) Directly using west and the command line
c) I'm not sure yet, too new at this
d) I like to use both

Next Steps

04

Going Further

Download the extra resources:

- https://beningo.short.gy/jVGeiDNZephyrLP

Zephyr Documentation:

- Zephyr Getting Started Documentation
- Getting Started with Zephyr RTOS: Hello Blinky! (Webinar)

Downloadable Resources:

- West Cheat Sheet (High-Resolution)
- RTOS Performance Guide
- Application Code Examples
- Zephyr Docker Container
- VS Code Debug Launch Script

Additional Resources

Please consider the resources below:

- Jacob's Blogs
- Jacob's CEC courses
- Embedded Software Academy

- Embedded Bytes Newsletter
  - http://bit.ly/1BAHYXm

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Next Steps

- ✓ Welcome to Zephyr RTOS
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- Drivers, Peripherals, and Customization
- Debugging, Logging, and Best Practices

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