



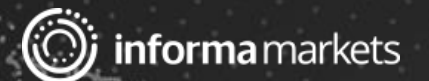
DesignNews

Mastering Zephyr RTOS

DAY 1: Welcome to Zephyr RTOS

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Webinar Logistics

- Turn on your system sound to hear the streaming presentation.
- If you have technical problems, click “Help” or submit a question asking for assistance.
- Participate in ‘Group Chat’ by maximizing the chat widget in your dock.

THE SPEAKER



Jacob Beningo

Jacob@beningo.com

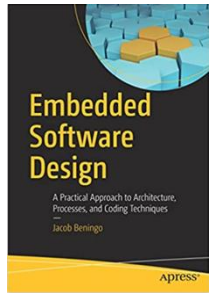


[jacobbeningo](#)

Beningo Embedded Group – CEO / Founder

Focus: Software Architecture, Processes, and Dev Skills

At Beningo Embedded Group, we believe everyone deserves the skills to confidently advance their careers, meet deadlines, and deliver quality embedded systems. We provide modern strategies, insights, and hands-on training to equip developers and teams with the tools they need to succeed.



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This week's topics:

Welcome to Zephyr RTOS

Build Systems, Kconfig, and Device Tree

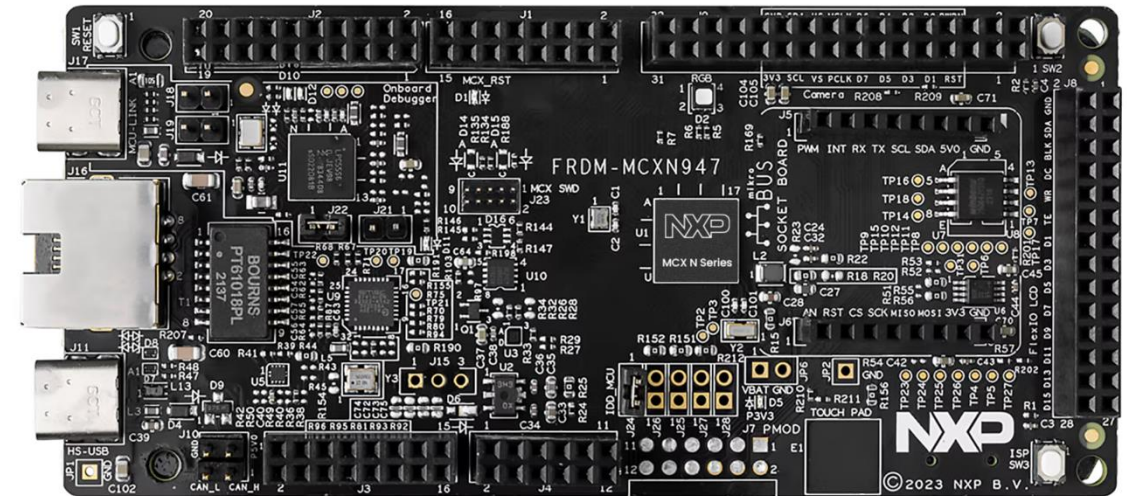
Threads, Scheduling, and RTOS Primitives

Drivers, Peripherals, and Customization

Debugging, Logging, and Best Practices

NXP FRDM-MCXM947

- 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#>

780+ supported boards... and growing



 docs.zephyrproject.org/latest/boards/

•• 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.

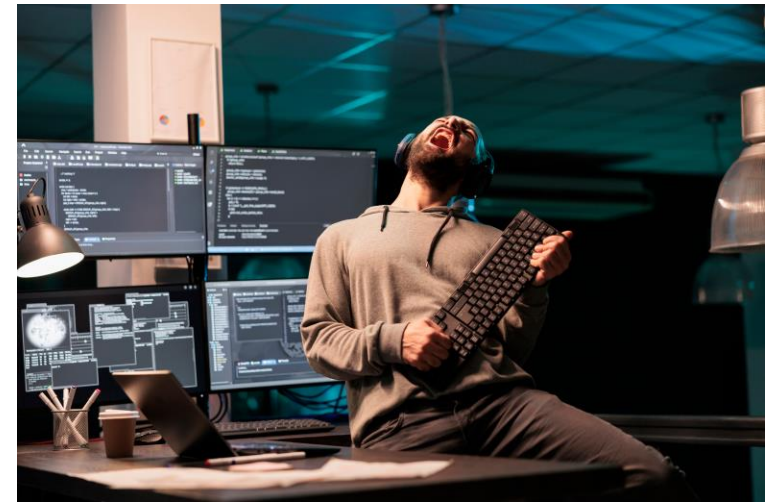
(Board Check-out)

- Firmware Engineers



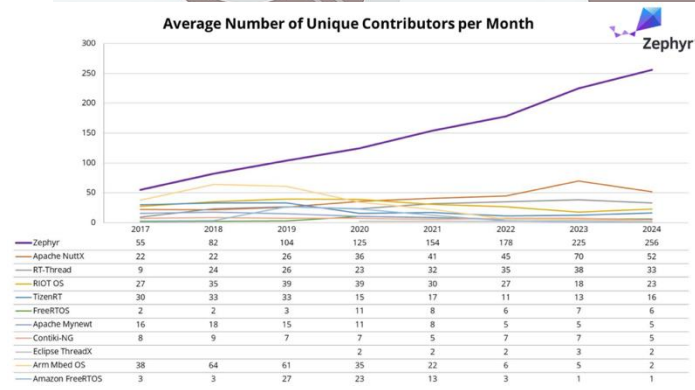
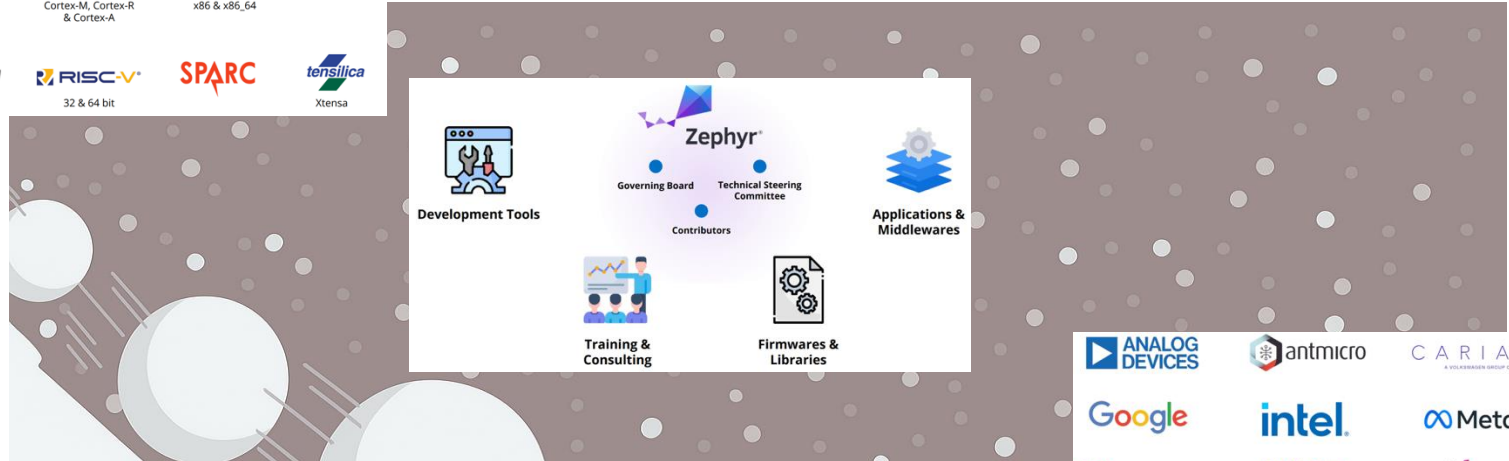
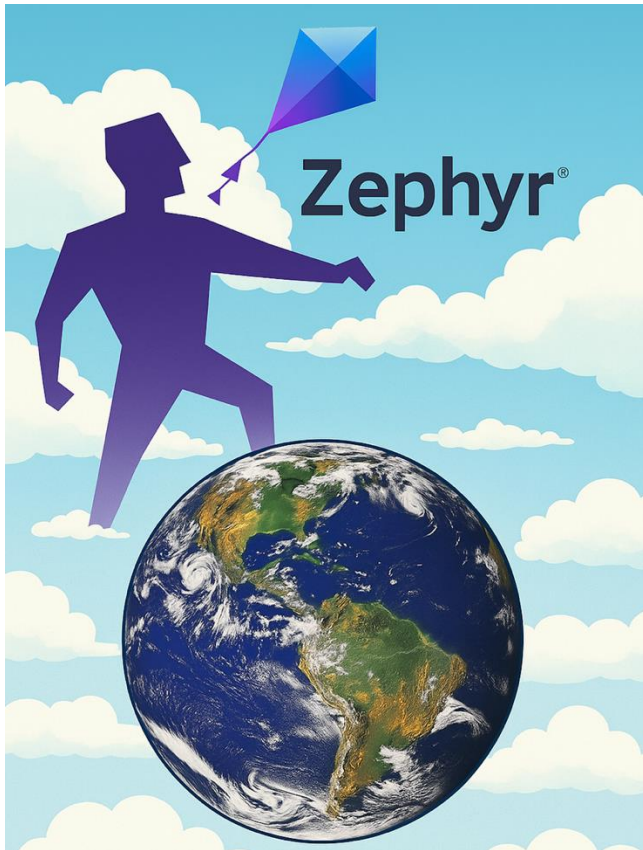
Work up and down the software stack including low-level including DTS, drivers, subsystems, etc.

- 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

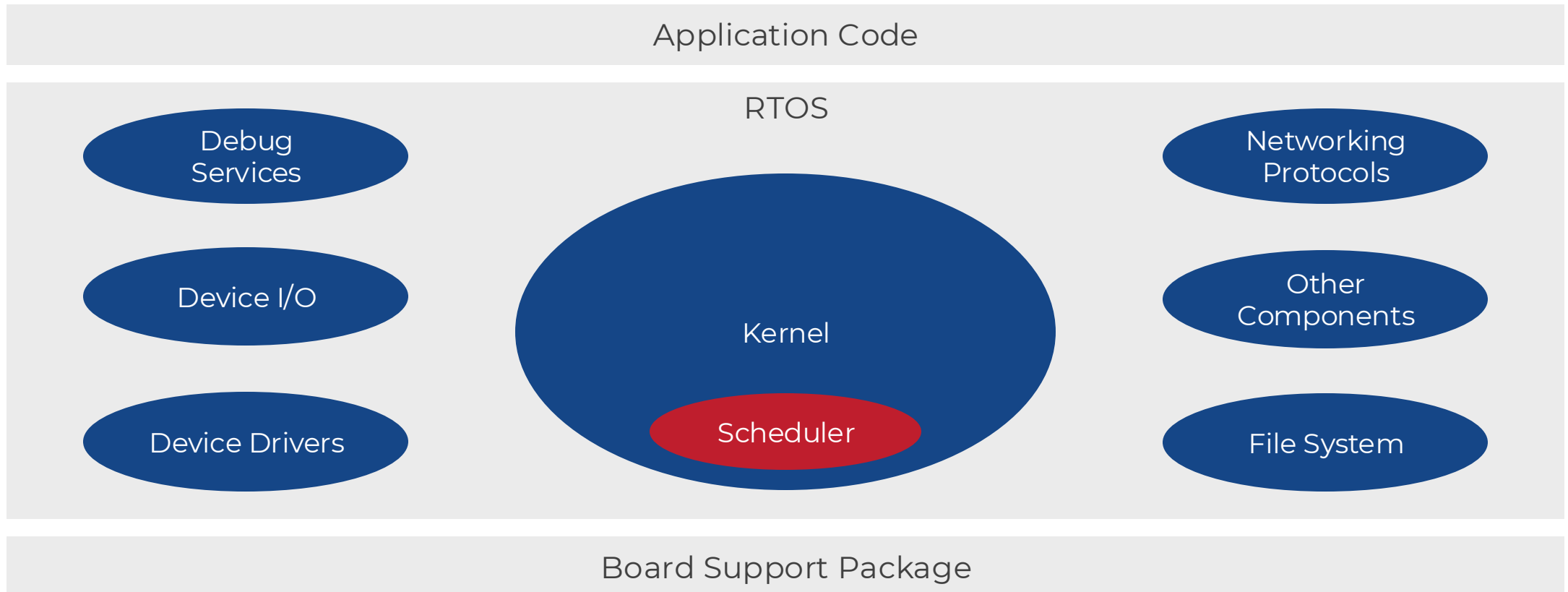
Which of the following best describes you?

- 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

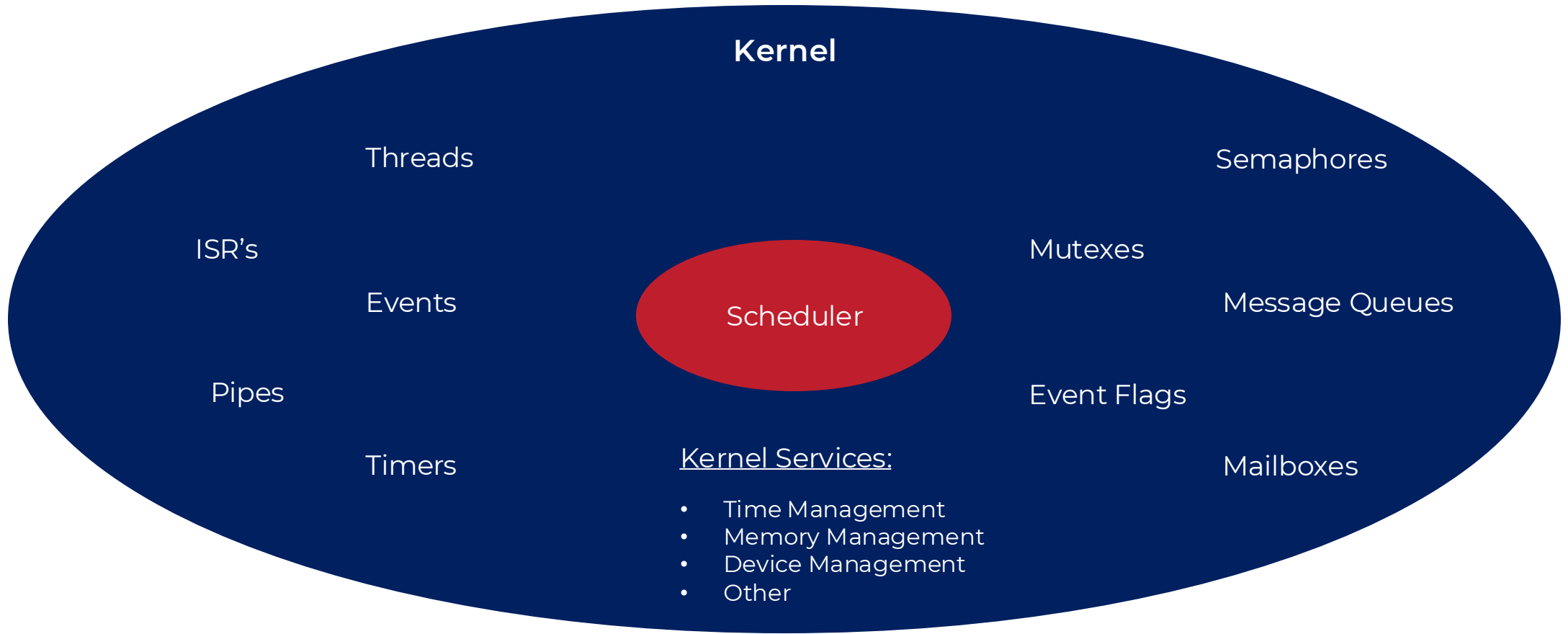
•• The Zephyr Kernel

01

Real-time Operating Systems

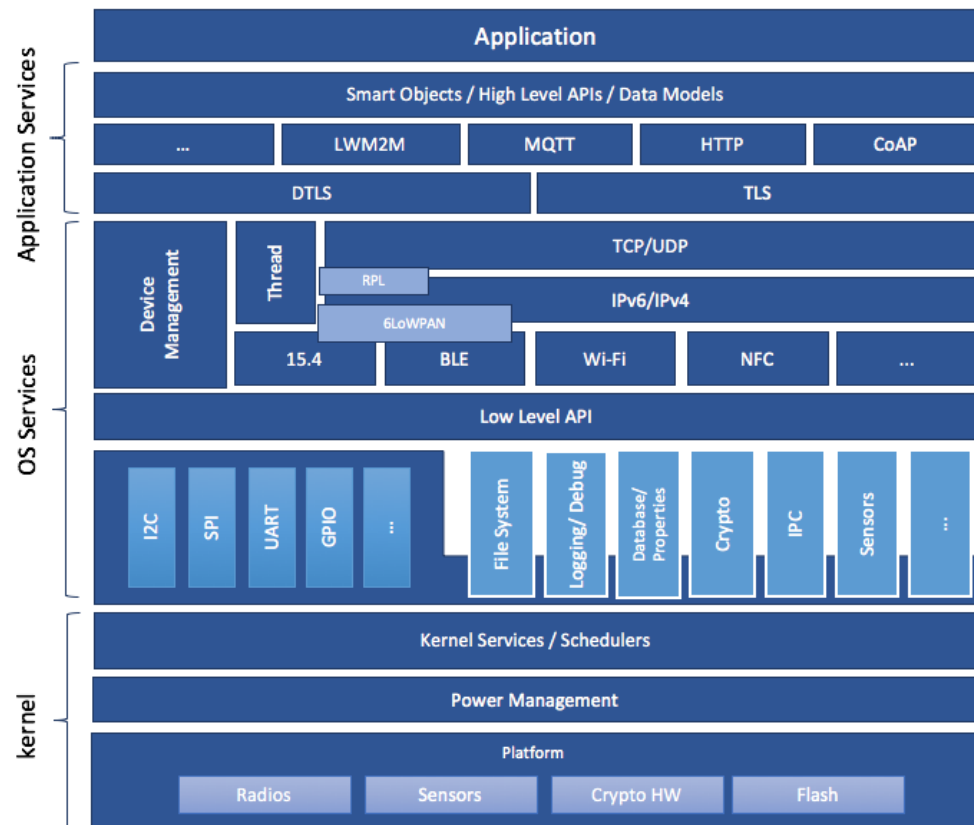


What is a Kernel

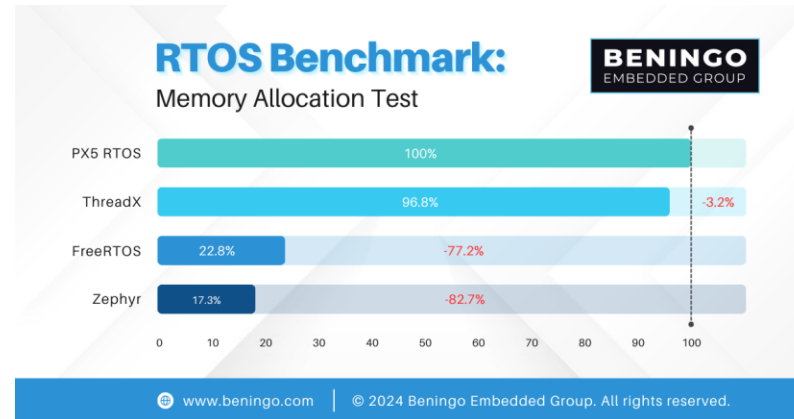
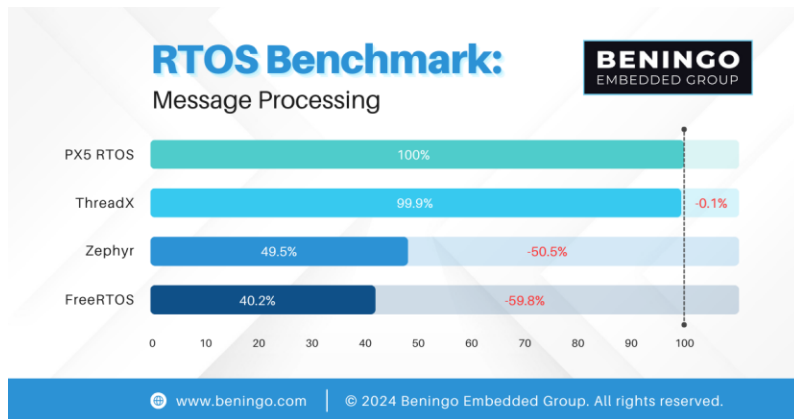
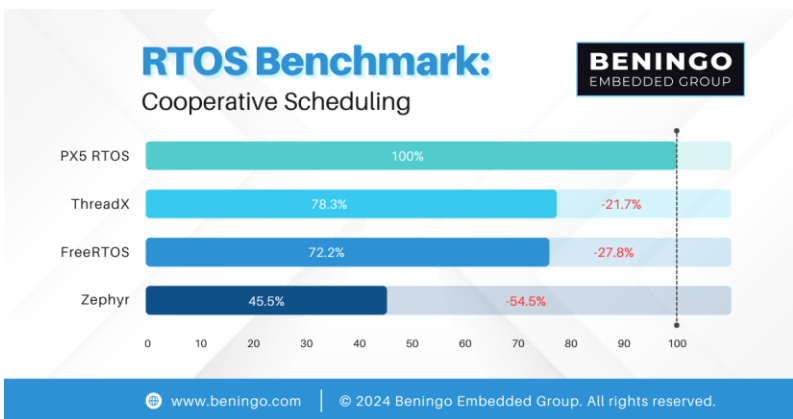
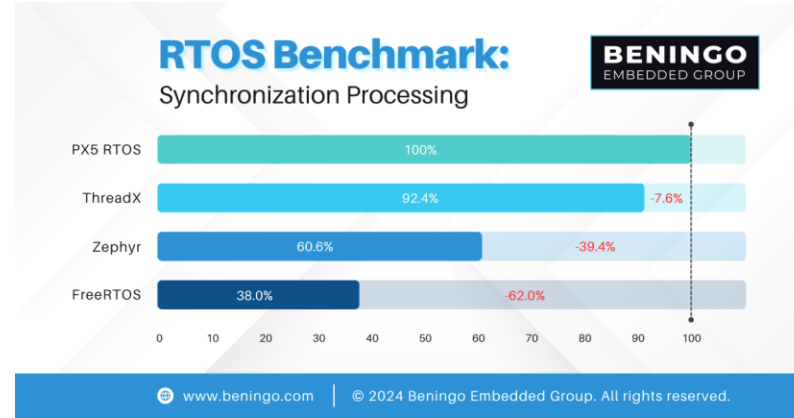
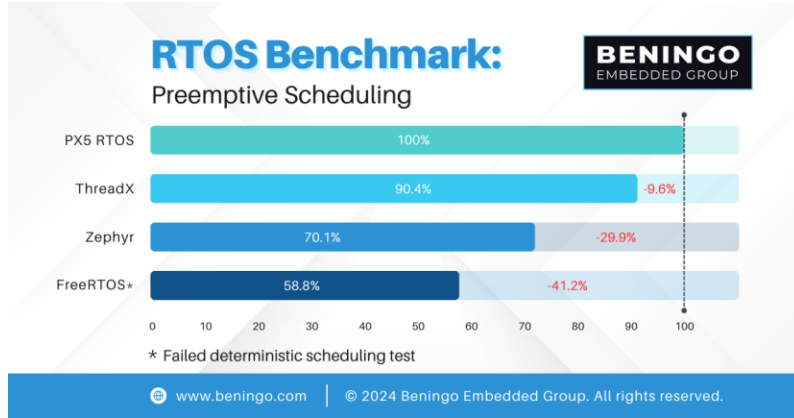
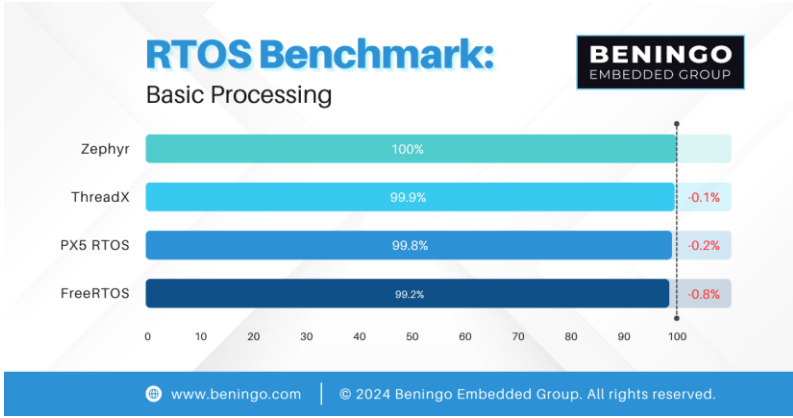


Zephyr Architecture

- 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

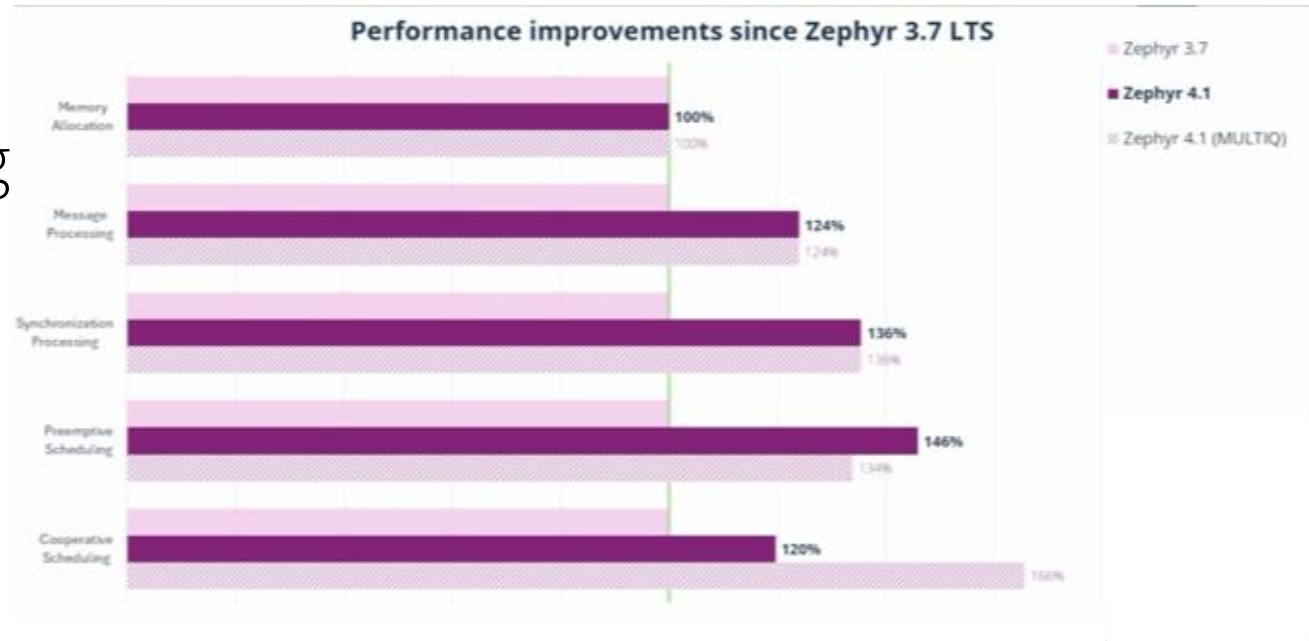


Kernel Performance – Zephyr 4.1

Major Performance Increases

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

Experimental MUTLIQ scheduling



source: <https://www.youtube.com/watch?v=TOIwl9XrHZM>

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](#)



West Cheat Sheet:
From Setup to Advanced



JACOB BENINGO
CEO & Founder

BENINGO
EMBEDDED GROUP

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SOFTWARE ACADEMY

➔ SETUP AND INITIALIZATION

- **west init <directory>**
Initialize a new west workspace in <directory>.
`Example: west init zephyrproject`
- **west update**
Clone or update the repositories defined in west.yml.
`Example: west update`

➔ MANAGING REPOSITORIES

- **west list**
List all repositories in the west workspace.
`Example: west list`
- **west clone <name>**
Clone a specific repository by name.
`Example: west clone zephyr`
- **west fetch <name>**
Fetch updates for a specific repository.
`Example: west fetch my-app`
- **west forall -c '<command>'**
Run a shell command for all repositories.
`Example: west update`

➔ ADVANCED

- **west manifest --freeze**
Freeze the manifest to include exact revision SHAs.
`Example: west manifest --freeze > west-locked.yml`
- **west topdir**
Print the absolute path of the workspace top directory.
`Example: west topdir`

➔ BUILDING PROJECTS

- **west build -b <board>**
Build the project for the specified <board>.
`Example: west build -b nrf52dk_nrf52832`
- **west build -p <num>**
Rebuild the project; <num> specifies the number of jobs for parallelism.
`Example: west build -p auto`
- **west build -t <target>**
Build a specific target (e.g., clean, menuconfig).
`Example: west build -t clean`

➔ RUNNING AND DEBUGGING

- **west flash**
Flash the compiled firmware to the connected board.
`Example: west flash`
- **west debug**
Start a debugging session with the default debugger.
`Example: west debug`
- **west debugserver**
Launch a debug server without connecting a debugger.
`Example: west debugserver`

➔ HELP AND CONFIGURATION

- **west help**
Display help information for west commands.
`Example: west help build`
- **west config <key> <value>**
Set or get configuration values.
`Example: west config build.generator ninja`
- **west version**
Display the installed west version.
`Example: west version`



Cheat Sheet Notes

- Replace <board>, <directory>, and <name> with your specific project values.
- Always run commands from the top directory of the west workspace unless specified otherwise.



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

Getting Started Guide

Follow this guide to:

- Set up a command-line Zephyr development environment on Ubuntu, macOS, or Windows (instructions for other Linux distributions are discussed in [Install Linux Host Dependencies](#))
- Get the source code
- Build, flash, and run a sample application

Select and Update OS

Click the operating system you are using.

Ubuntu

macOS

Windows

On macOS Mojave or later, select *System Preferences > Software Update*. Click *Update Now* if necessary.

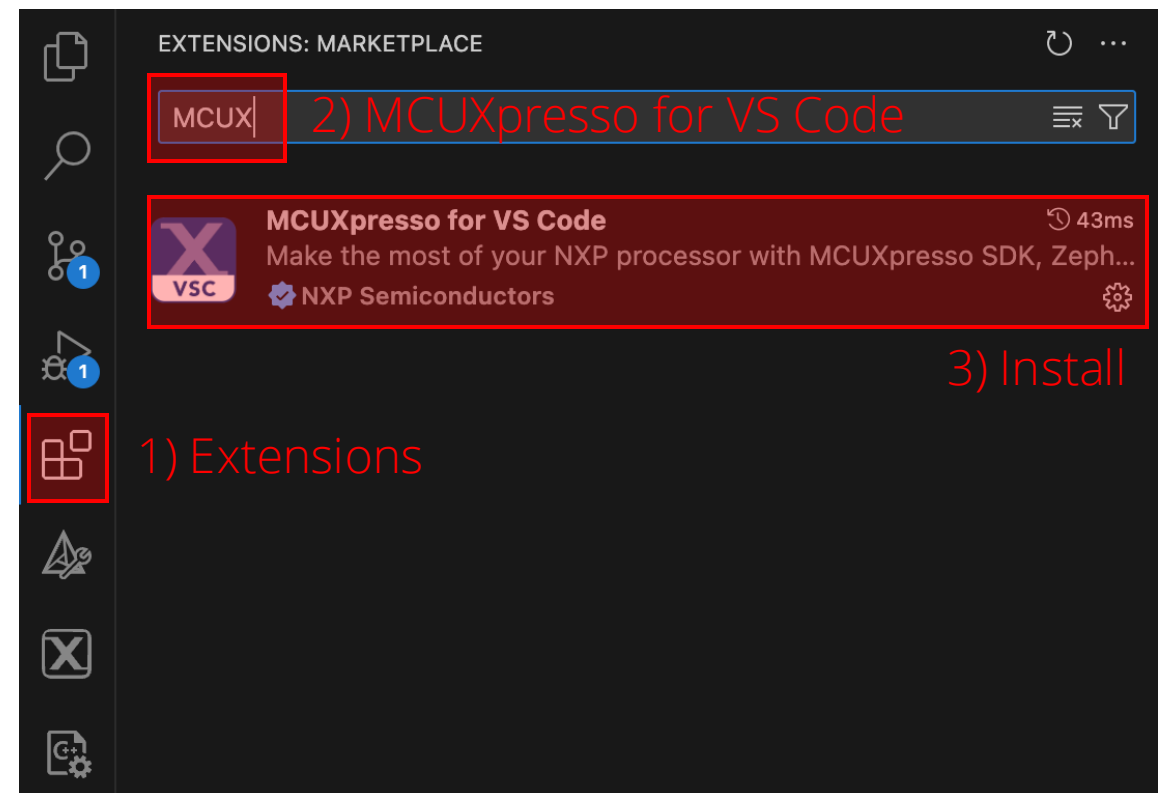
On other versions, see [this Apple support topic](#).

Install dependencies

Installing Zephyr with Vendor Tools

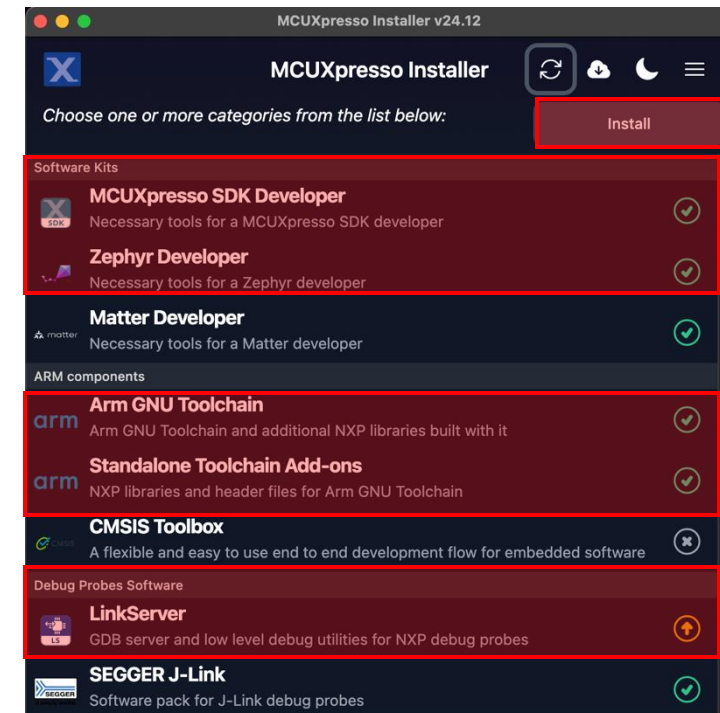
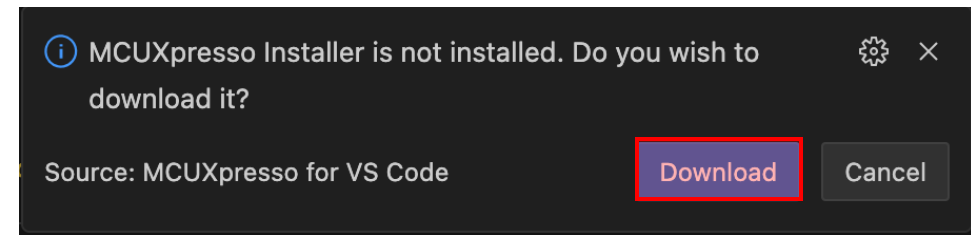
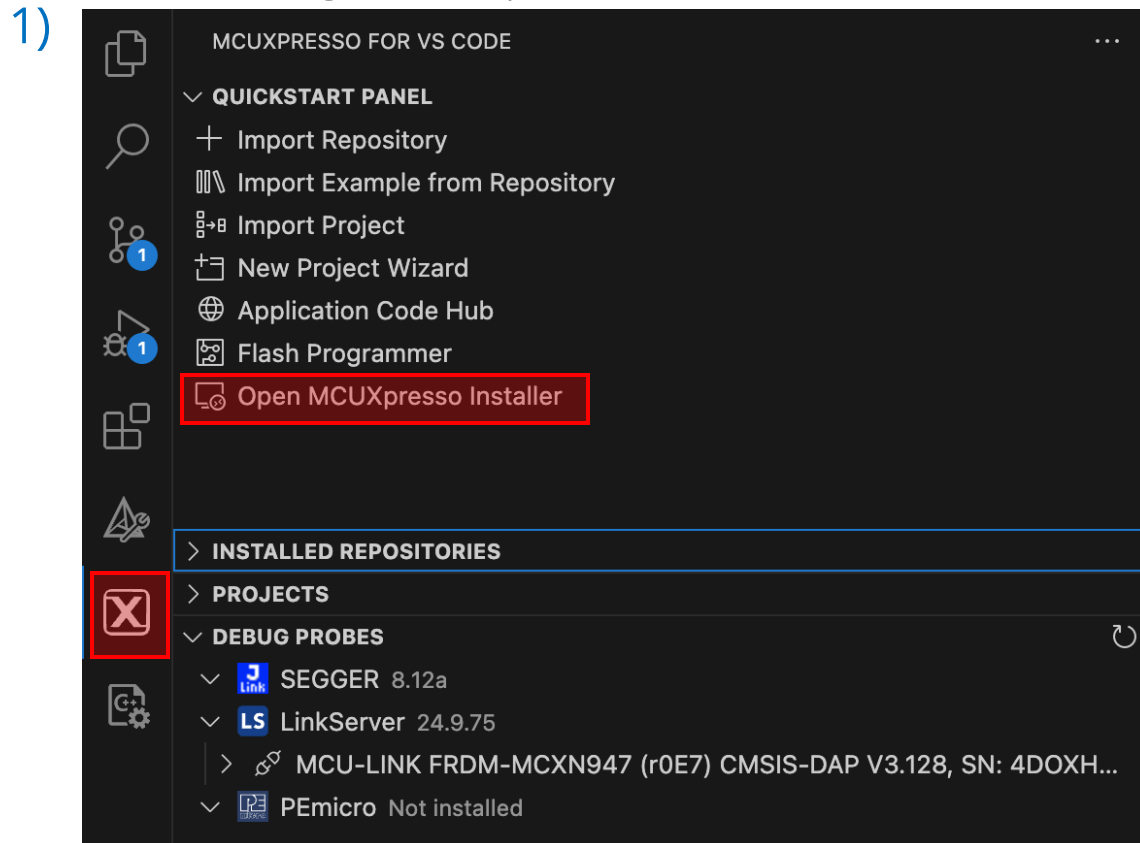
Visual Studio Code offers an integrated environment to streamline development.

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



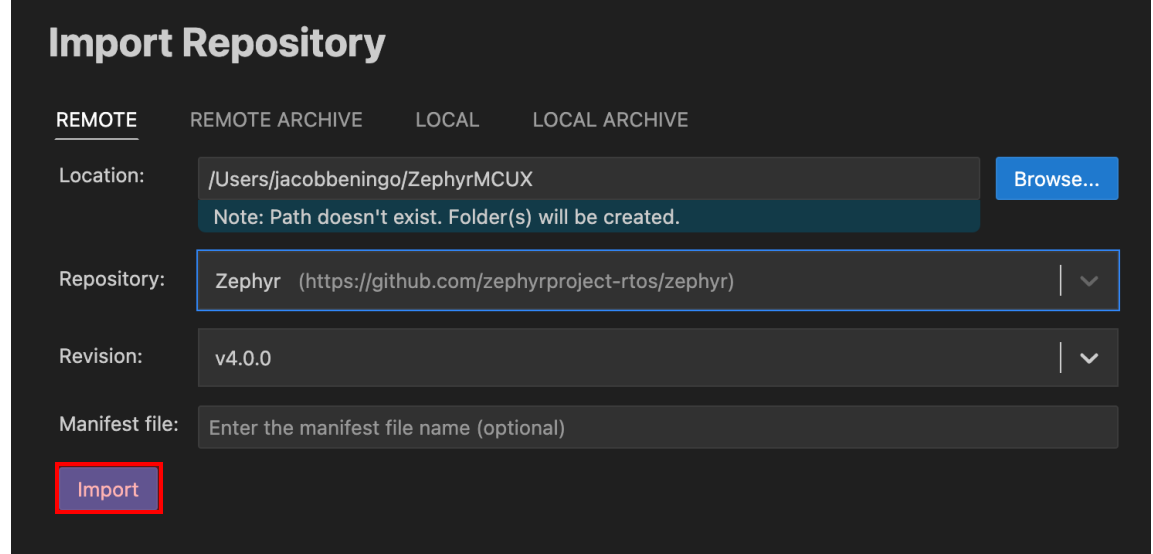
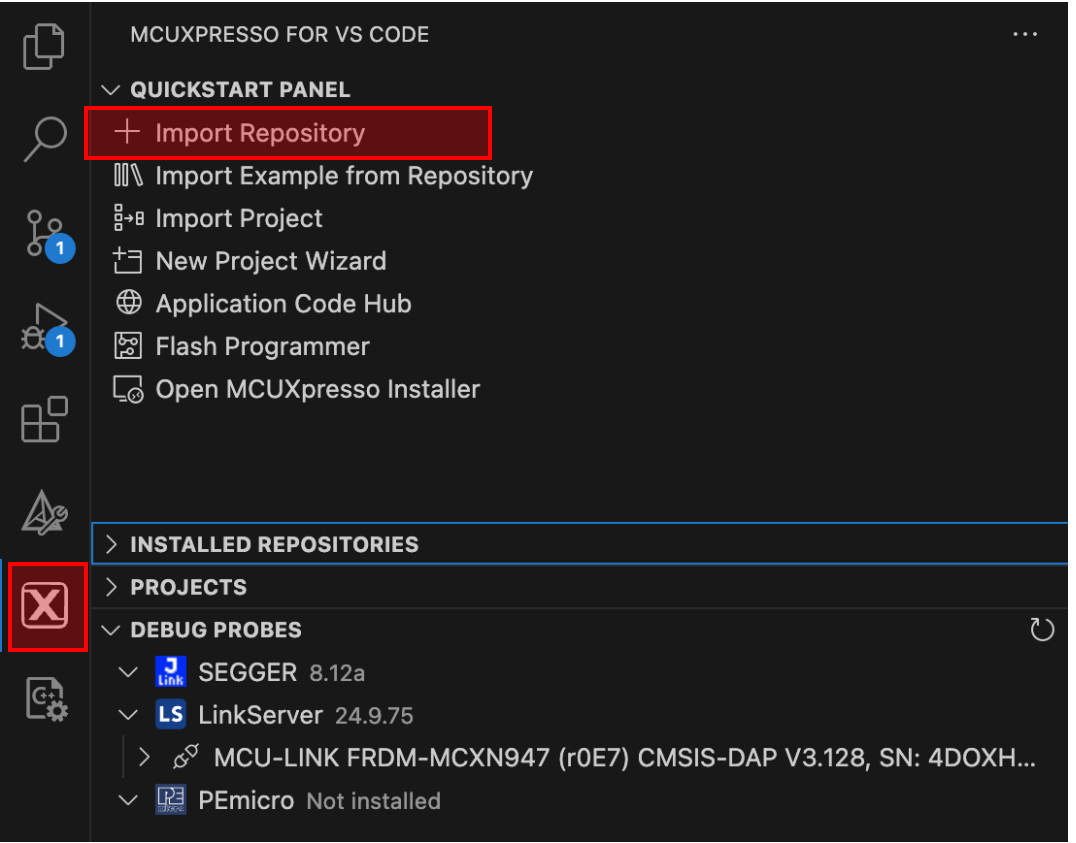
Installing Zephyr with Vendor Tools ²⁾

- Installing MCUXpresso Tools



Installing Zephyr with Vendor Tools – Importing Zephyr

1)



Audience POLL Question

Which Zephyr workflow do 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



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Build Systems, Kconfig, and Device Tree

Threads, Scheduling, and RTOS Primitives

Drivers, Peripherals, and Customization

Debugging, Logging, and Best Practices



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