



PARTNER
WEBINAR



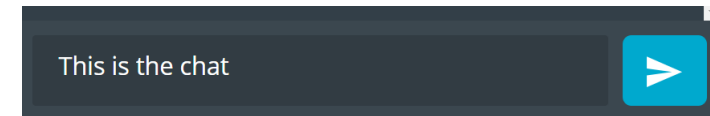
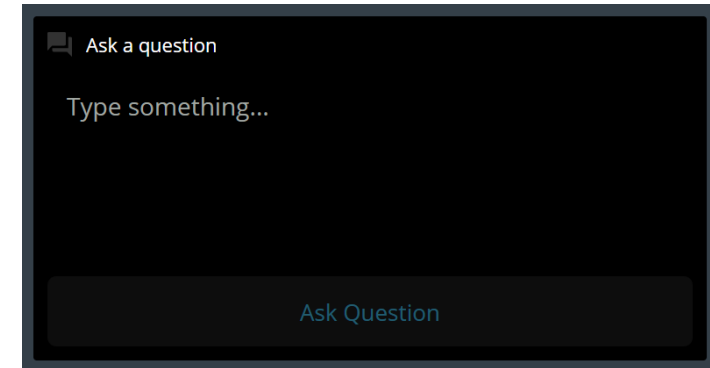
NORDICTECH
WEBINARS



Boost your Edge AI
development with Zephyr
and TFLite Micro

Practicalities

- Duration: 50-60 mins
- Questions are encouraged!
- Please type questions in the top of the right sidebar
 - All questions are anonymous
 - Try to keep them relevant to the topic
- We will answer questions towards the end
- The chat is not anonymous, and should **not** be used for questions
- If you have more questions:
 - Go to [DevZone](#) for Nordic related questions
 - Go to <https://antmicro.com/about/contact/> for Antmicro related question
 - A recording of the webinar will be available together with the presentation at webinars.nordicsemi.com



Today's hosts

Ali Aljaani



Product Marketing
Engineer

Piotr Zierhoffer



Engineering Manager at
Antmicro



ANTMICRO

- Founded in 2009, Antmicro provides engineering services, open source tools, platforms and strategic R&D for high-tech products.
- Software-driven, open source based, industrial edge-to-cloud AI-capable systems
- Introducing new design methodologies and workflows based on open source
- Autonomous vehicles, defense, security, broadcasting, mining, agriculture, robotics, medical, aerospace, industrial automation, smart home & office



WHAT DO WE DO

Antmicro offers end-to-end system development services **based on open source** including:



FPGA & ASIC

Custom IP blocks, SiP development, soft SoCs, heterogeneous processing systems



DEVELOPMENT PLATFORMS

Proof of Concepts (PoC), PCB design, BSPs, prototyping, open platforms



EDGE AI & SOFTWARE

OS porting, drivers, build systems, device management, edge AI algorithms, data fusion



CLOUD SYSTEMS

CI setups, cloud builders, OTA update systems, AI/ML pipelines

WE'RE MEMBERS OF LEADING OPEN SOURCE INITIATIVES

We actively participate in multiple organizations pushing forward next-generation platforms based on open collaboration and help our customers stay up to date with latest developments in the technology space.



RENODE™

Reshape Reload Rethink
Regenerate Remake

**Develop your IoT product
with Renode™**

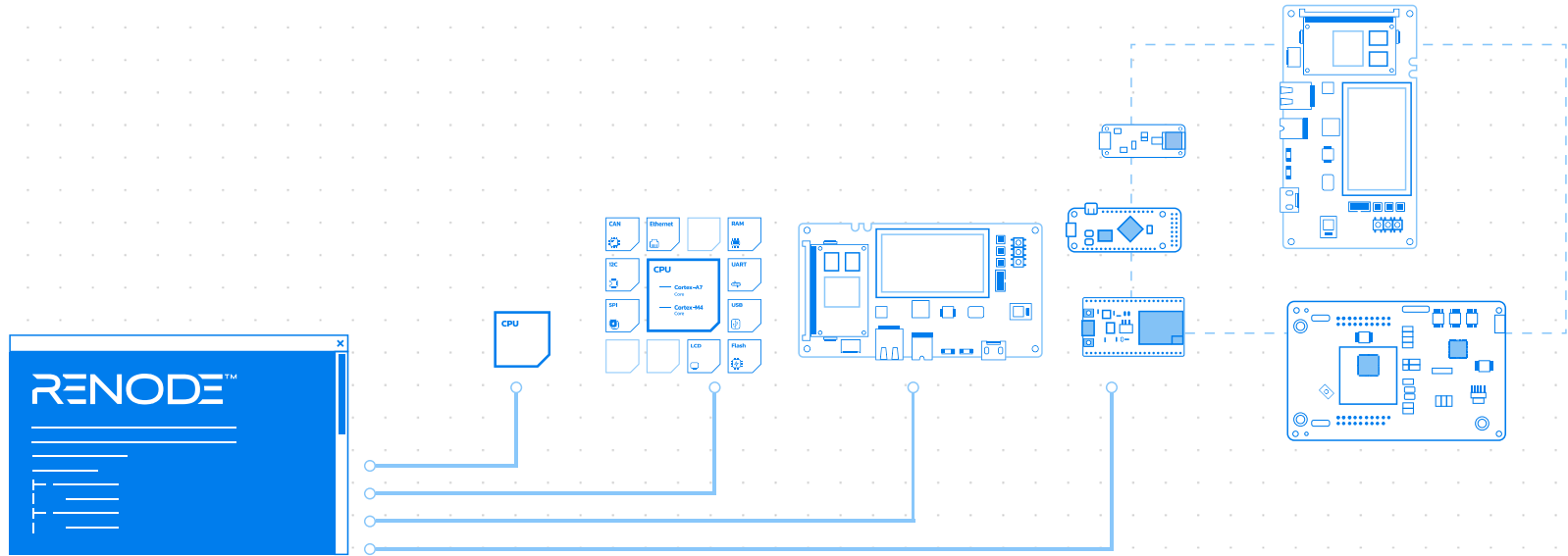
Renode in short

- Open-source, **software-agnostic, multi-architecture** hardware simulator
- Provides **plug-and-play building blocks** to create custom virtual hardware setups
- **Full determinism** of execution, shared virtual time
- **Extensive debugging**, tracing, analysis features
- **Made for automated tests and CI integration**, inter-team company-wide collaboration

Software agnostic – run whatever you want



Simulate complex systems, including multi-node



What you can do with Renode



IoT development, operating systems porting



Architectural exploration, pre-silicon development



Network protocols implementation and validation



TinyML development



Continuous Integration, testing



Security analysis

Renode in Zephyr

- Zephyr RTOS
 - RTOS of choice for Antmicro
- Renode used by Twister/buildkite

```

497 INFO - 56/357 mec1501modular_assy6885 tests/subsys/pm/power_mgmt_soc/subsys.pm.pm_soc PASSED (build)
498 INFO - 57/357 mec1501modular_assy6885 tests/kernel/common/kernel.common PASSED (build)
499 INFO - 58/357 mec1501modular_assy6885 samples/synchronization/sample.kernel.synchronization PASSED (build)
500 INFO - 59/357 m2gl025_miv tests/ztest/error_hook/testing.ztest.error_hook SKIPPED (filter)
501 INFO - 60/357 m2gl025_miv tests/ztest/error_hook/testing.ztest.error_hook.no_userspace PASSED (renode 15.530s)
502 INFO - 61/357 m2gl025_miv tests/subsys/pm/device_runtime/subsys.pm.device_pm PASSED (renode 10.266s)
503 INFO - 62/357 m2gl025_miv tests/subsys/portability/cmsis_rtos_v1/portability.cmsis_rtos_v1 PASSED (renode 46.289s)
504 INFO - 63/357 m2gl025_miv tests/subsys/modbus/subsys.modbus.rtu.build_only PASSED (build)
505 INFO - 64/357 m2gl025_miv tests/subsys/debug/coredump_backends/coredump.backends.logging SKIPPED (filter)
506 INFO - 65/357 m2gl025_miv tests/subsys/debug/coredump/coredump.logging_backend SKIPPED (filter)
507 INFO - 66/357 m2gl025_miv tests/subsys/fs/fs_api/filesystem.api PASSED (renode 9.846s)
508 INFO - 67/357 m2gl025_miv tests/posix/eventfd_basic/posix.eventfd_basic.posix_api PASSED (renode 11.366s)
509 INFO - 68/357 m2gl025_miv tests/posix/eventfd_basic/posix.eventfd_basic PASSED (renode 7.624s)
510 INFO - 69/357 m2gl025_miv tests/posix/eventfd/portability.posix.eventfd PASSED (renode 8.922s)

```

Renode Zephyr Dashboard

- About 16 Zephyr examples in upstream Renode
- What if we employed DTS data?
- zephyr-dashboard.renode.io

arm (305) ▾

BUILT		Nuvoton NPCX9M6F EVB	npcx9m6f_evb	no uart selected in dts	nuvoton/npcx9m6f
PASSED		nRF21540-DK-NRF52840	nrf21540dk_nrf52840	cpus/nrf52840.repl (matched)	nordic/nrf52840_qiaa
PASSED		BLE400	nrf51_ble400	automatically generated	nordic/nrf51822_qfaa
PASSED		BLE Nano	nrf51_blenano	automatically generated	nordic/nrf51822_qfaa
PASSED		nRF51-VBLUno51	nrf51_vbluno51	automatically generated	nordic/nrf51822_qfac
PASSED		nRF51-DK-NRF51422	nrf51dk_nrf51422	automatically generated	nordic/nrf51822_qfac
PASSED		nRF51-Dongle-nRF51422	nrf51dongle_nrf51422	automatically generated	nordic/nrf51822_qfac
BUILT		nRF52832-MDK	nrf52832_mdk	automatically generated	nordic/nrf52832_qfaa
PASSED		nRF52833-DK-NRF52820	nrf52833dk_nrf52820	automatically generated	nordic/nrf52820_qdaa
PASSED		nRF52833-DK-NRF52833	nrf52833dk_nrf52833	automatically generated	nordic/nrf52833_qiaa
PASSED		Electronut Labs Blip	nrf52840_blip	automatically generated	nordic/nrf52840_qiaa

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BUILT						Nuvoton NPCX9M6F EVB	npcx9m6f_evb	no uart selected in dts		nuvoton/npcx9m6f
PASSED						nRF21540-DK-NRF52840	nrf21540dk_nrf52840	cpus/nrf52840.repl (matched)		nordic/nrf52840_qiaa
PASSED						BLE400	nrf51_ble400	automatically generated		nordic/nrf51822_qfaa
PASSED						BLE Nano	nrf51_ble_nano	automatically generated		nordic/nrf51822_qfaa
PASSED						nRF51-VBLUno51	nrf51_vbluno51	automatically generated		nordic/nrf51822_qfac
PASSED						nRF51-DK-NRF51422	nrf51dk_nrf51422	automatically generated		nordic/nrf51822_qfac
PASSED						nRF51-Dongle-nRF51422	nrf51dongle_nrf51422	automatically generated		nordic/nrf51822_qfac
BUILT						nRF52832-MDK	nrf52832_mdk	automatically generated		nordic/nrf52832_qfaa
PASSED						nRF52833-DK-NRF52820	nrf52833dk_nrf52820	automatically generated		nordic/nrf52820_qdaa
PASSED						nRF52833-DK-NRF52833	nrf52833dk_nrf52833	automatically generated		nordic/nrf52833_qiaa
PASSED						Electronut Labs Blip	nrf52840_blip	automatically generated		nordic/nrf52840_qiaa

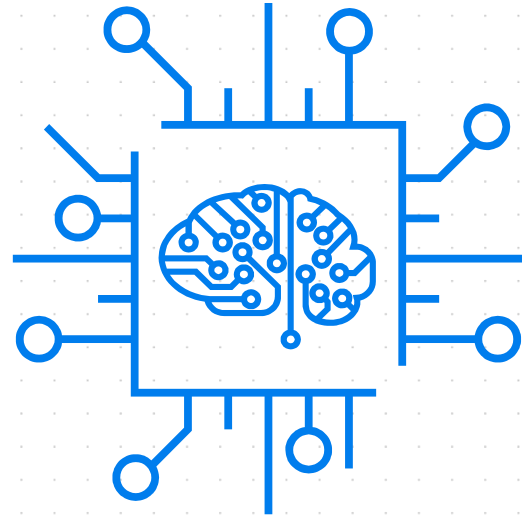
94!

Tiny machine learning

- Operating at the edge / in-field
- Processing directly after data acquisition
- Immediate effects
- Real-time applications
- Very, very small chips...
- ... but there are 250 bln of them!

What does it take to do tiny ML?

- Computation
- Input - one or two sensors
- Output - UART? Network?
- ...
- That's it!



TensorFlow Lite Micro (TFML)

- Optimized for devices “with only kilobytes of memory”
- Relies on similar models as TFLite
- Allows running inference on resource constrained MCUs
- Provides basic TF functionality
- Cross-platform - requires HAL
- Allows for platform-specific optimizations on kernel level
- Works as an interpreter
- Supports benchmarking



TensorFlow Lite

— Demo

Basic Renode usage

Debugging with GDB

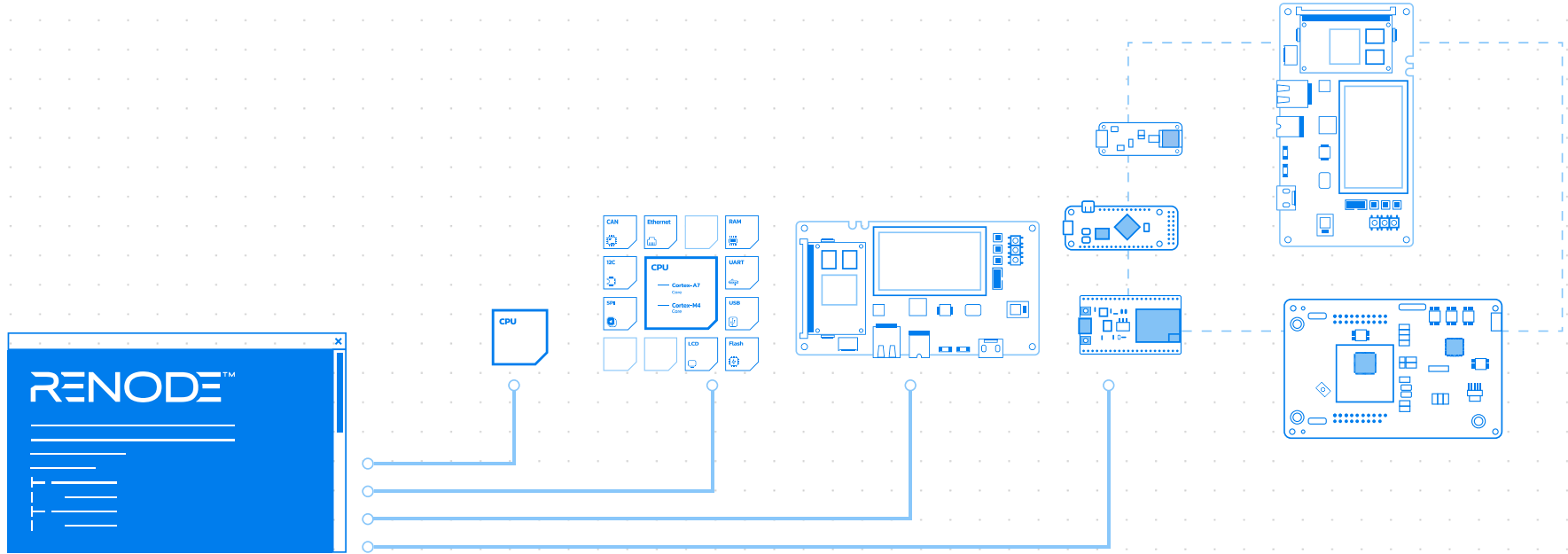
- Renode allows you to debug applications running on emulated machines using GDB
- Uses the GDB remote protocol
- Breakpoints, watchpoints, stepping, memory access etc
- Virtual time does not progress when the emulated CPU is halted



— Demo

Interactive debugging

Simulate full systems

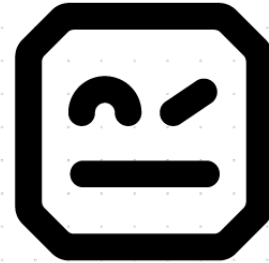


— Demo

BLE support

Robot Framework

- Robot interface for writing tests either in Python or “natural” language
- Renode provides keywords enabling various testing scenarios
- Whole Renode CLI is also exposed
- Readable reports and artifacts after each run



```
Should Print To Uart
  Setup Machine
  Start Emulation
  Wait For Line On Uart
  Provides
```

```
The LEDs show the ASCII code of the last character.
initialization
```

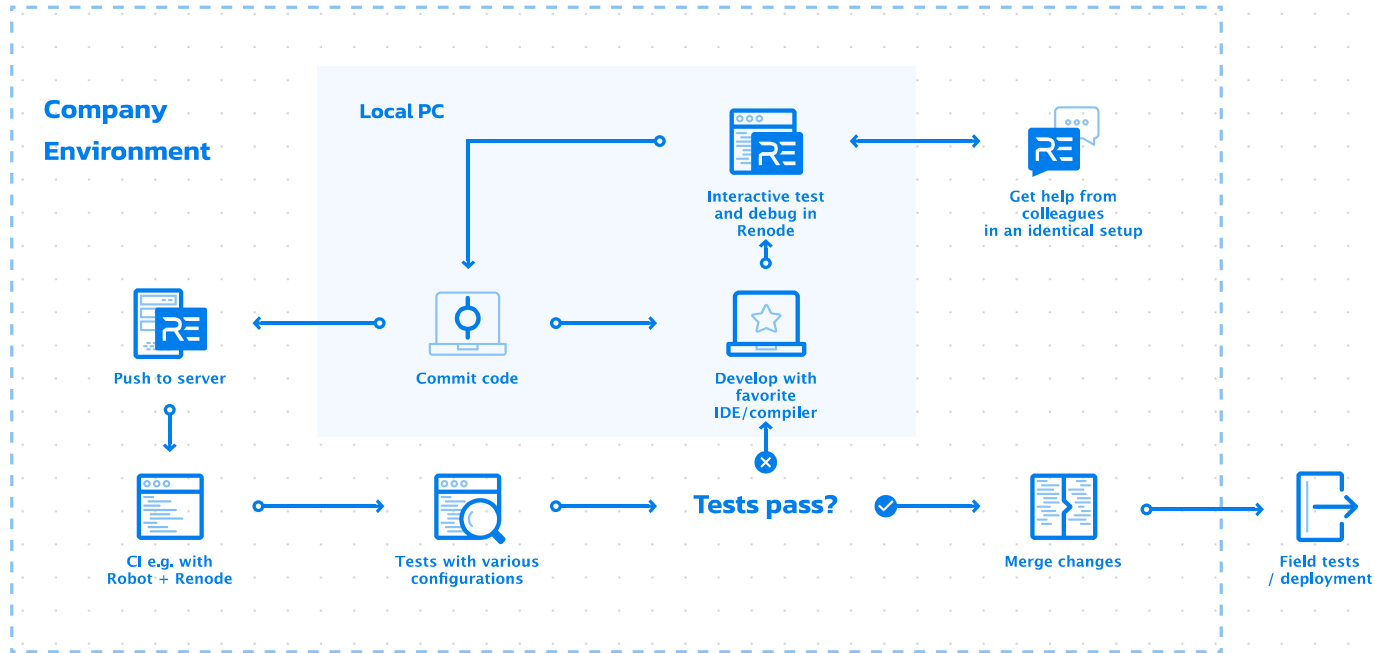
```
Should Echo On Uart
  Requires
  Write Line To Uart
  Provides
```

```
initialization
Testing testing 1-2-3
working-uart
```

— Demo

Automated tests

Renode-based Continuous Integration workflow for IoT systems



Simple case

- github.com/antmicro/renode-zephyr-nrf52840
- GitHub actions-based
 - Dedicated Renode action
 - Trivial usage
- Running Zephyr shell on nRF52840

```
1 name: Test action
2
3 on: [push,pull_request,workflow_dispatch]
4
5 jobs:
6   test:
7     runs-on: ubuntu-20.04
8     steps:
9       - uses: actions/checkout@v2
10      - name: Prepare Zephyr dependencies
11        run: |
12          python -m pip install --upgrade pip
13          pip install west
14      - name: Prepare Zephyr codebase
15        run: ./prepare_zephyr.sh
16        shell: bash
17      - name: Build Zephyr sample binaries
18        run: ./build_binaries.sh
19        shell: bash
20      - name: Run tests
21        uses: antmicro/renode-test-action@v1.0.0
22        with:
23          renode-version: 'latest'
24          tests-to-run: 'nrf52840.robot'
25      - name: Archive results
26        uses: actions/upload-artifact@v2
27        with:
28          name: test-results
29          path: |
30            report.html
31            log.html
32            robot_output.xml
33      - name: Output sample binaries
34        uses: actions/upload-artifact@v2
35        with:
36          name: build-artifacts
37          path: |
38            artifacts/zephyr-hello_world.elf
39            artifacts/zephyr-shell_module.elf
```

Arduino CI for TFLM

- TFLM tests rely on mock data
- Only the inference part is effectively tested
- Solution: use full board simulation
 - Hello World
 - Magic Wand
 - Microspeech
 - Person detection
- Provide real data through simulated sensors
- github.com/antmicro/tensorflow-arduino-examples



TensorFlow Lite

— Demo

Visual experience

— Get Renode

renode.io

builds.renode.io

docs.renode.io

github.com/renode/renode

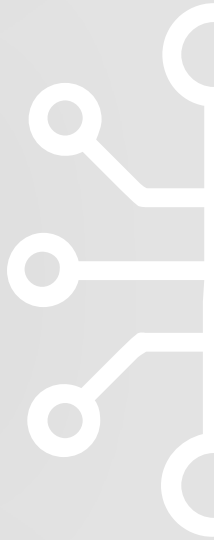
— Interested?

Reach out to us:
contact@renode.io



**THANK YOU
FOR YOUR ATTENTION!**

pzierhoffer@antmicro.com



Q&A

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