Zephyr RTOS Roasting Party!

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$whoami (and disclaimers ☺)

- Nearly 20 years doing open source & IoT
- Developer Advocate for the Zephyr Project
- Not an embedded developer “veteran”
- Also a baker, potter, photographer

Zephyr RTOS in a nutshell

- Open source (circa 2015, Apache License)
- 140+ maintainers
- 2,500+ contributors
- 109,478 commits (and counting)
- Scales from very small MCUs to complex SoCs

Zephyr is...

- A real-time operating system
- An über-HAL
- An embedded application framework
- A connectivity framework
- A development environment
- ...

Some products running Zephyr RTOS

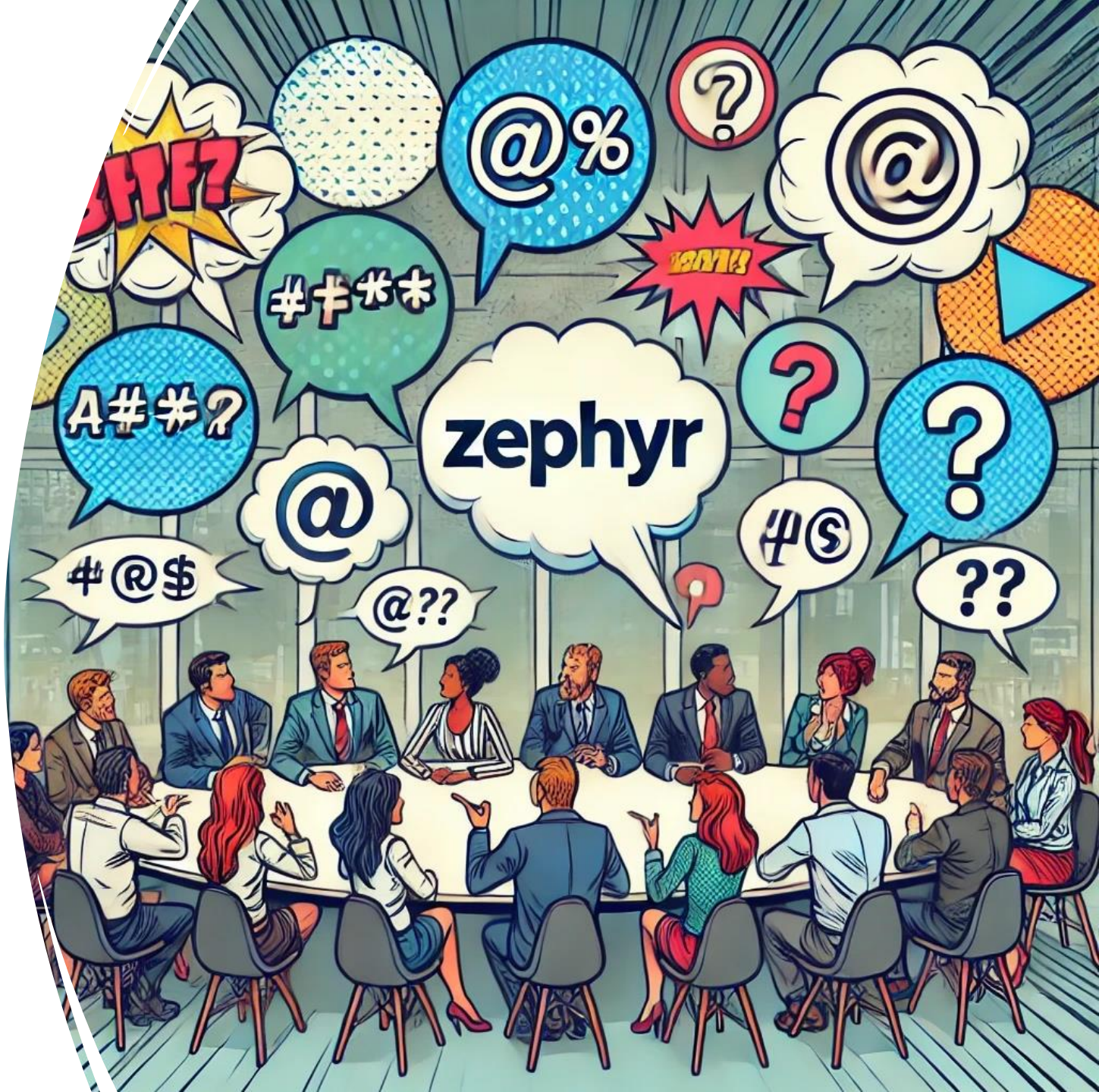
- Oticon hearing aids
- Framework laptop (embedded controller)
- Samsung Galaxy Ring
- Gardena radio gateway
- …

Why a roasting party?

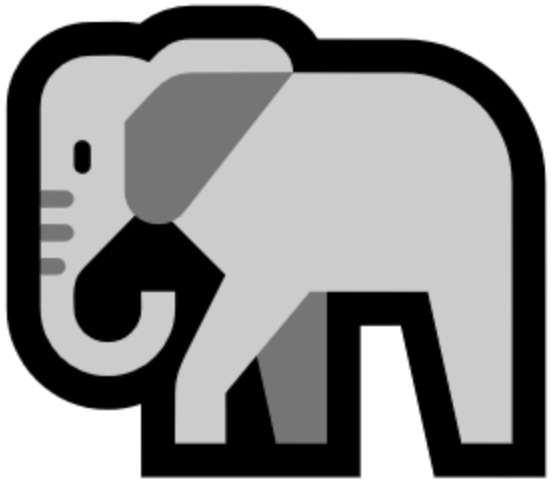
- I (we?) love Zephyr, but it's not perfect
- Just like any big open source projects, Zephyr can have some pain points
- I'll try to be as transparent as possible about the issues, but try to show you the light at the end of the tunnel ☺

Common critics

- Zephyr is too big
- Zephyr is too slow
- YAHAL?
- Devicetree is hard / doesn't make sense for embedded
- Why are you forcing me to use west?



Zephyr is too big



Initial setup is actually *very* easy

```
# 1. Initialize a local workspace for
#    developing against upstream Zephyr
west init

# 2. Fetch all modules, install SDK
west update && west sdk install

# 3. Profit!
west build -b <my_board> samples/hello_world
```

~/zephyrproject $ du * -sh

```
14M     bootloader
5.2G    modules
20M     tools
1.1G    zephyr
```

~/zephyrproject $ du modules/hal/* -sh

```
42M     modules/hal/adi
1.3M    modules/hal/altera
30M     modules/hal/ambiq
87M     modules/hal/atmel
...
264M    modules/hal/espressif
3.4M    modules/hal/xtensa
```

~/zephyr-sdk-0.17.0 $ du * -sh

```
250M    aarch64-zephyr-elf
646M    arc-zephyr-elf
291M    arc64-zephyr-elf
1.1G    arm-zephyr-eabi
...
183M    xtensa-sample_controller_zephyr-elf
```

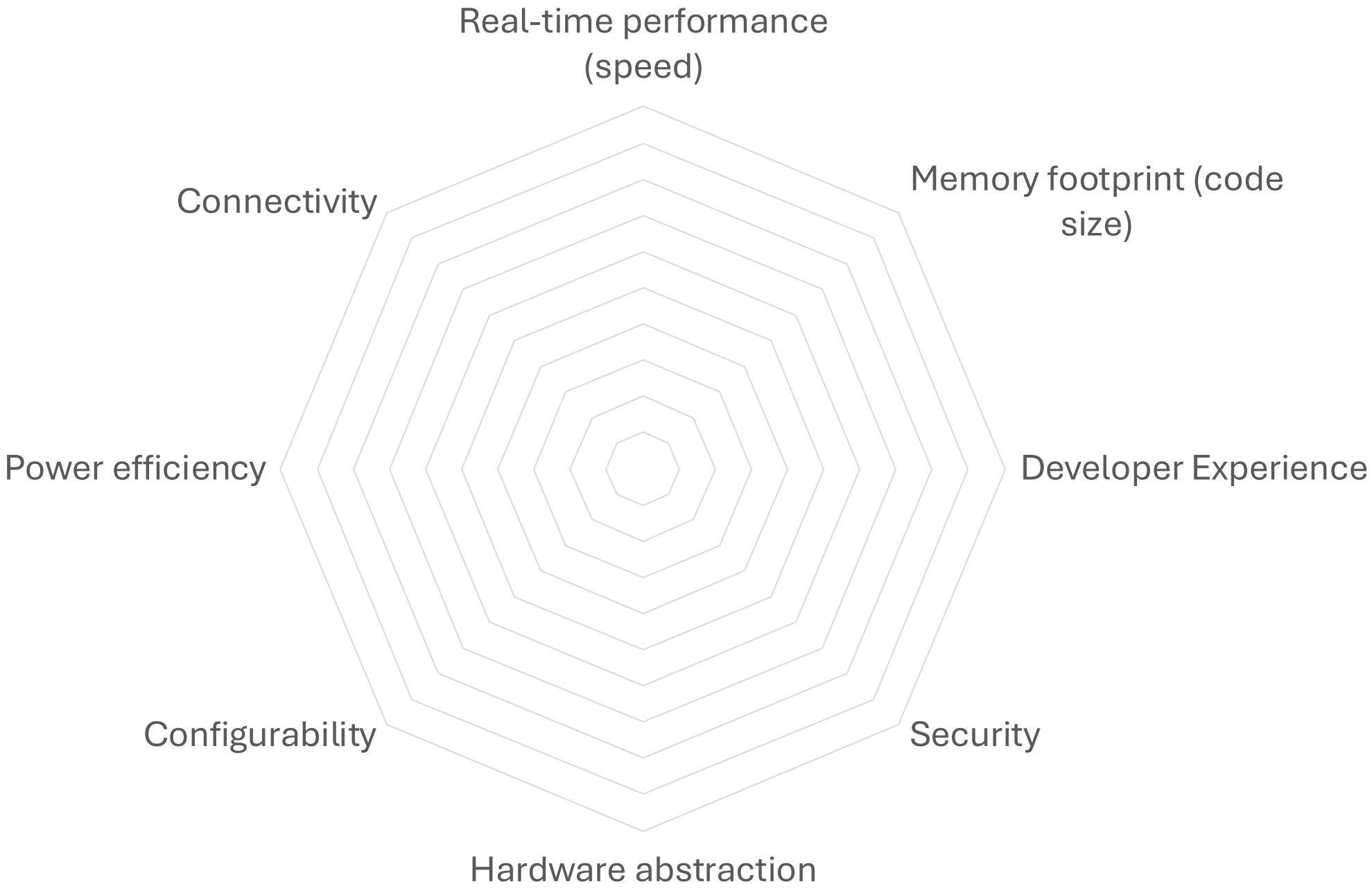
~/zephyr-sdk-0.17.0 $ du . -sh

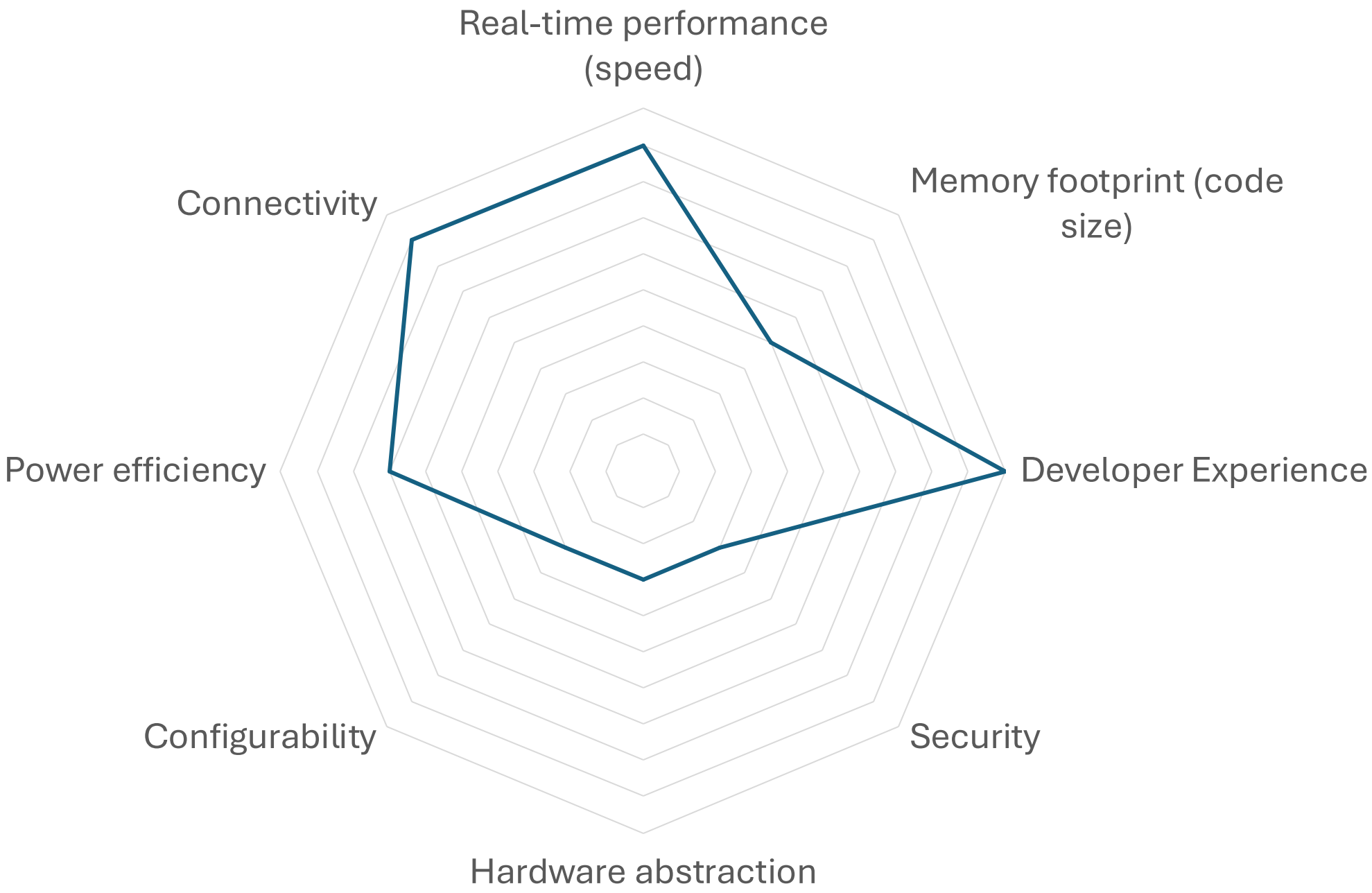
8.2G .

Why do I need 15 GB of %&$@ to blink an LED?

- It's convenient when you work on Zephyr itself, less so when you just want to build an app on top of it
- Look into enabling only modules you actually need (e.g. HAL)
  - "`allow-list`" property in West manifest
  - https://github.com/zephyrproject-rtos/example-application
- `west sdk` to the rescue for provisioning only the SDK(s) you need

Zephyr is bloated


Real-time performance (speed)
Memory footprint (code size)
Developer Experience
Security
Hardware abstraction
Configurability
Power efficiency
Connectivity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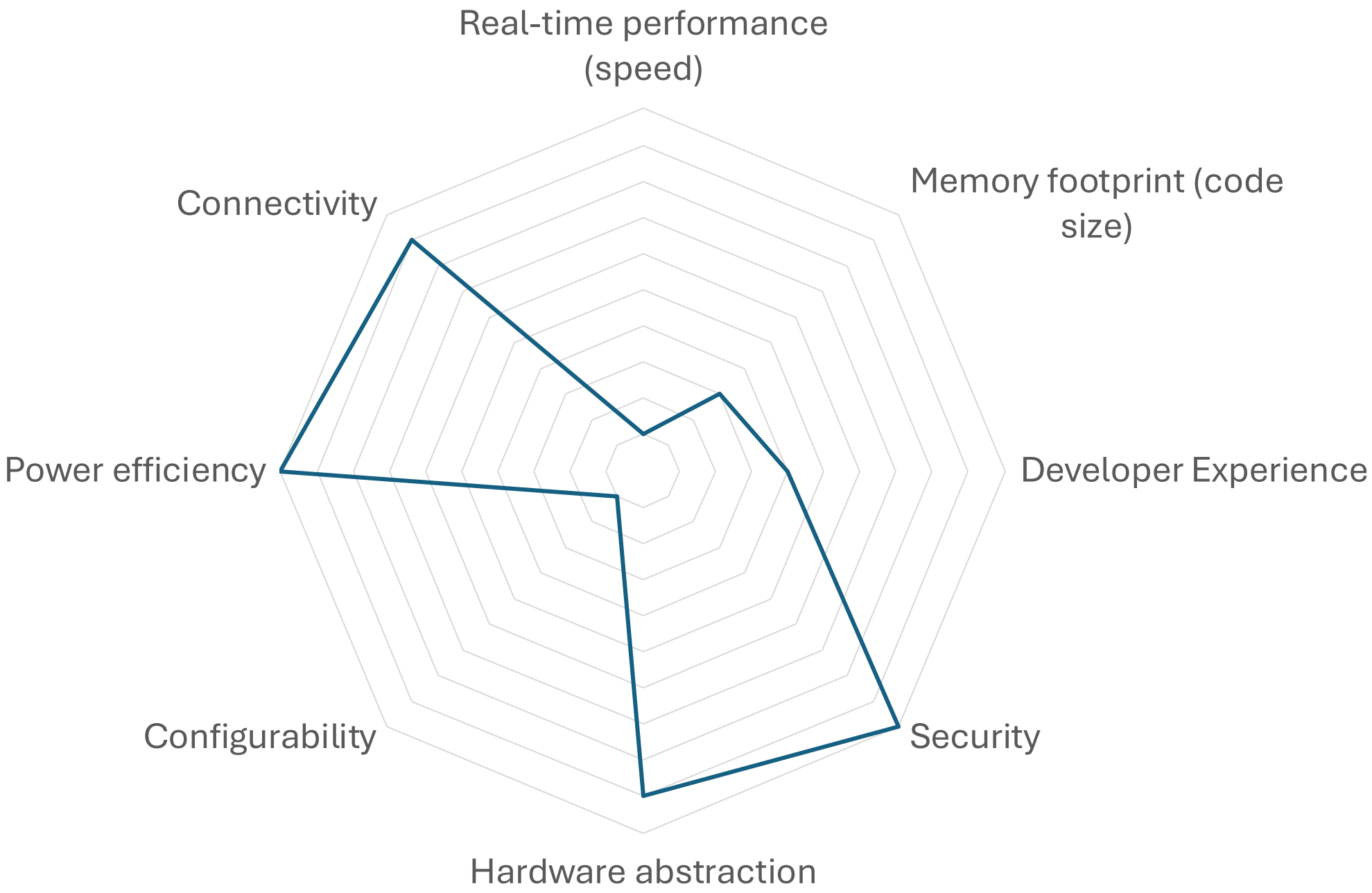
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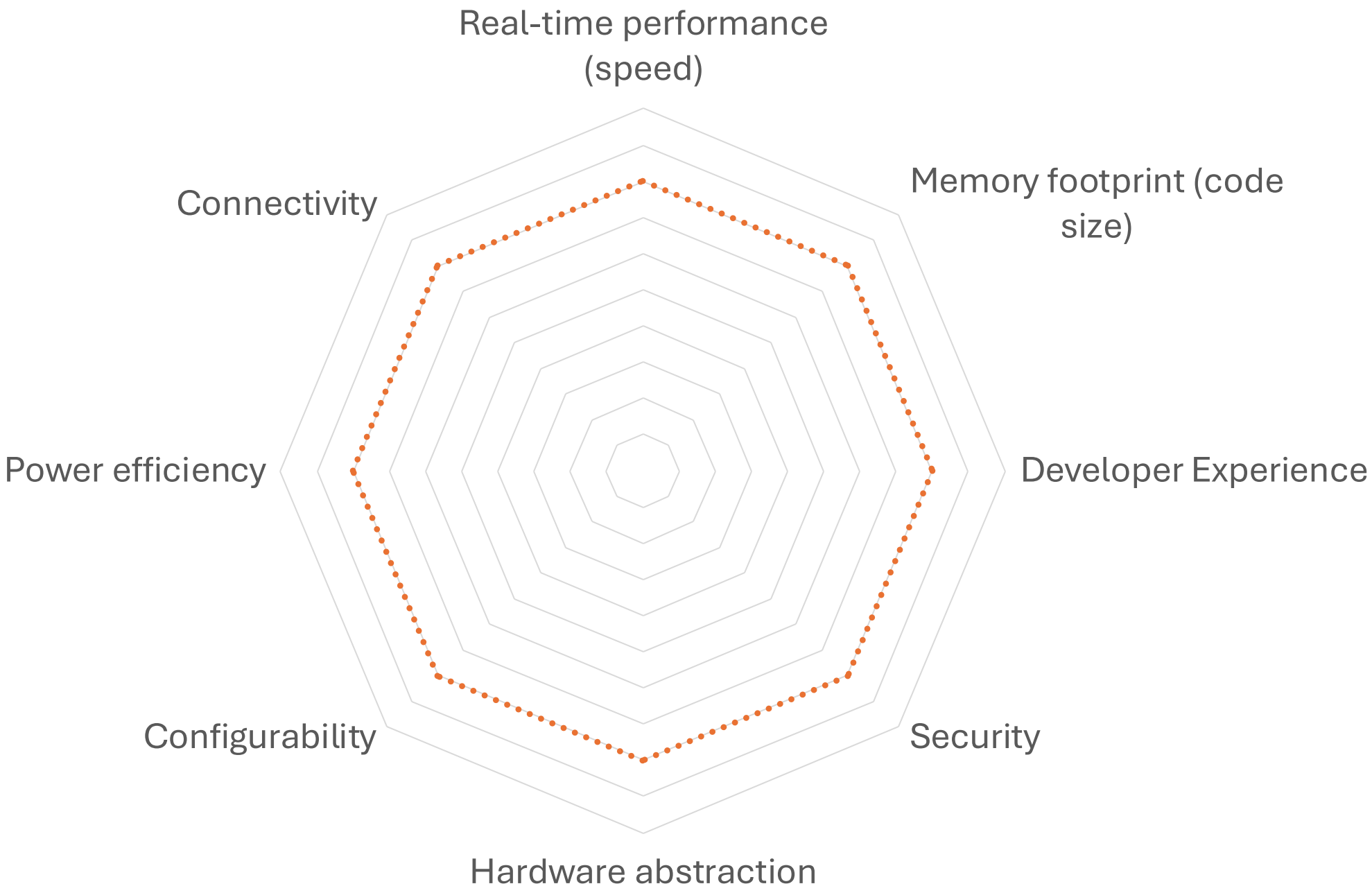
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Zephyr's default options are a starting point

- Hardware stack protection enabled
- Optimize for size (not speed)
- A few on-by-default defensive programming patterns

Take benchmarks with a grain of salt

- Out-of-the-box Zephyr is NOT fine tuned
- Latency/performance is obviously important in an embedded real-time context but...
- ... your actual application / use case is what should drive your RTOS selection process.

See `tests/benchmarks/thread_metric` **in the Zephyr tree**

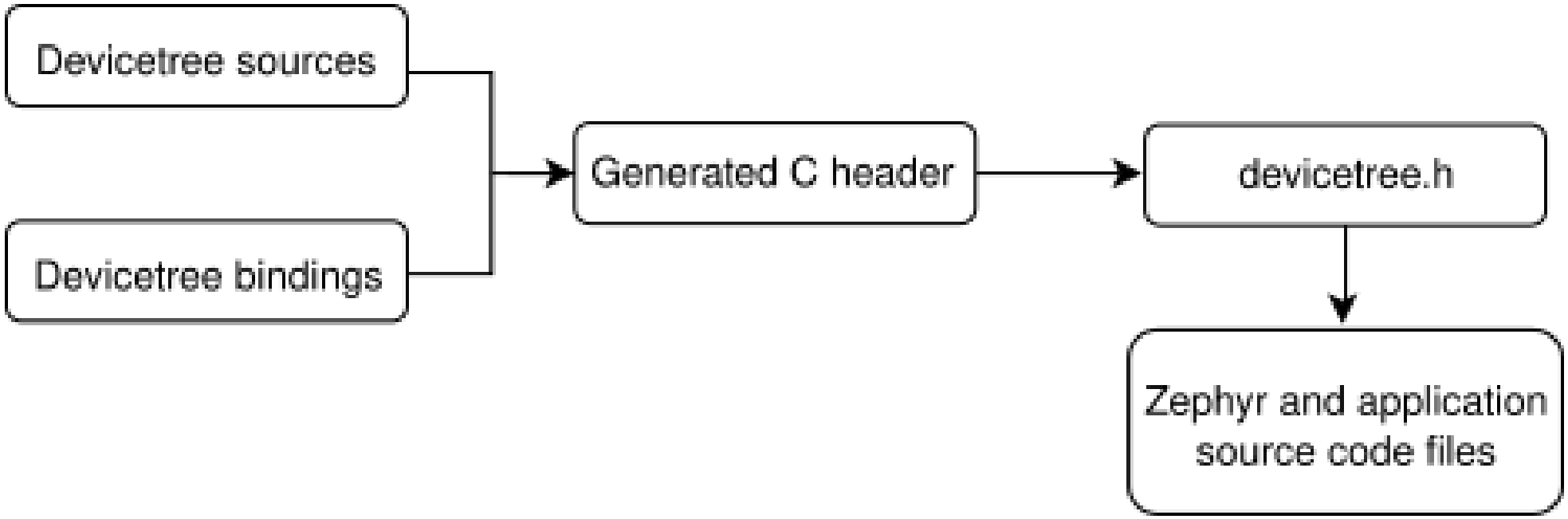
“Devicetree for embedded, seriously?”

Devicetree in Zephyr

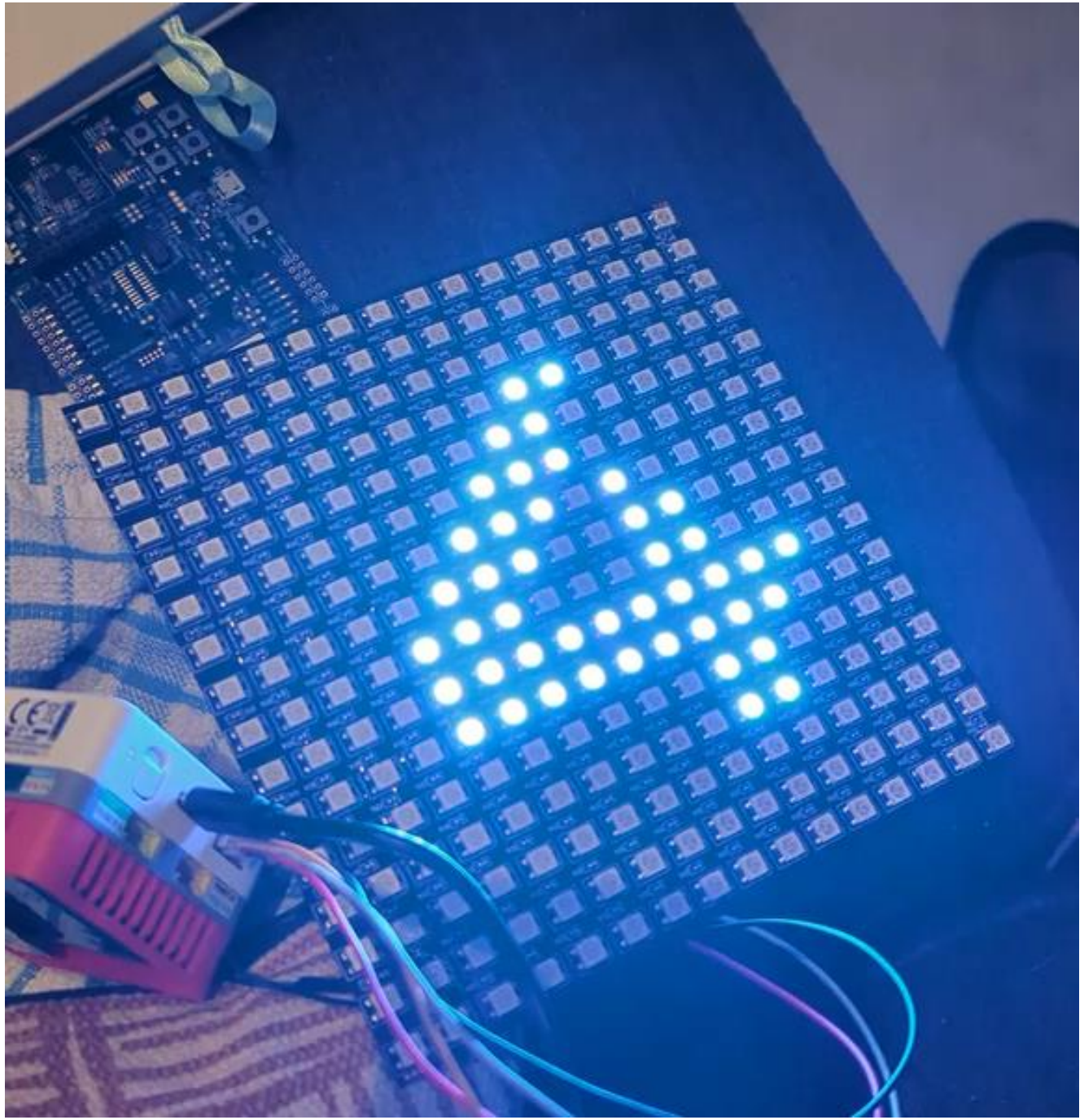
- Describe hardware (duh!)
- Provide hardware initial configuration
- Compile-time only!

```
&i2c1 {
    pinctrl-0 = <&i2c1_scl_pb8 &i2c1_sda_pb9>;
    pinctrl-names = "default";
    clock-frequency = <I2C_BITRATE_FAST>;
    status = "okay";

    lsm6dsl@6a {
        compatible = "st,lsm6dsl";
        reg = <0x06a >;
    };

    hts221@5f {
        compatible = "st,hts221";
        reg = <0x5f >;
    };

    // …
};
```

Devicetree in Zephyr



```
display_dev = DEVICE_DT_GET(DT_CHOSEN(zephyr_display));
```



Devicetree macro hell (a.k.a macrobatics)

- **Theory**

```
static const struct gpio_dt_spec led =
GPIO_DT_SPEC_GET(LED0_NODE, gpios);
```

- **Practice**

```
error: '__device_dts_ord_12' undeclared here
(not in a function); did you mean
'__device_dts_ord_13'?
```

When it fails

- **Compiler error**
  - You're using a Devicetree macro that ends up not existing due to a node missing or being disabled in your Devicetree.
- **Linker error**
  - Devicetree probably OK, but driver not actually enabled in Kconfig.

Troubleshooting Devicetree
docs.zephyrproject.org/build/dts/troubleshooting.html

I don’t want to use west

west, a.k.a Zephyr's Swiss Army knife

- **Module Management**
  - Simplifies versioning and integration of various modules/libraries in the build system
- **Build**
- **Flash / Debug**
- **Extensible CLI**
  - e.g. custom commands for specific board
  - Static code analysis, RAM/ROM reports, SBOM generation

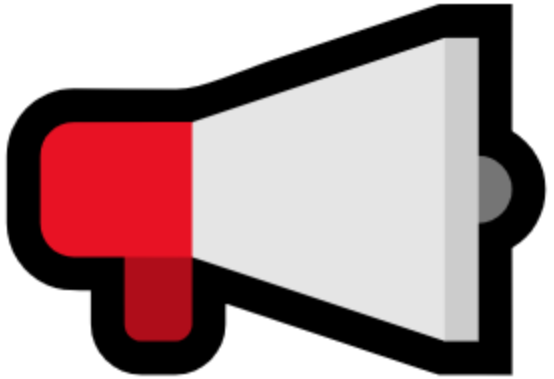
It is optional!

- You can always use CMake/Ninja (or make)
  … it's just going to be more painful with little benefits 🙂

See docs.zephyrproject.org/latest/develop/west/without-west.html

My board/sensor is not supported! ... open source FTW

Anything else?



Visit the Zephyr table
in Building K! (Level 1)

Thanks!

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zephyrproject.org