

Future-proofing IoT development with the nRF Connect SDK

Nordic Tech Webinar

Tiago Monte / Developer Marketing Manager

Bjørn Kvaale / Product Marketing Engineer

January 2023

Today's hosts

Bjørn Kvaale



Product Marketing Engineer
Product Management



Tiago Monte

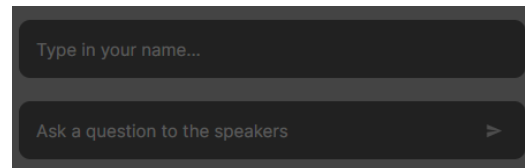


Developer Marketing Manager
Product Management

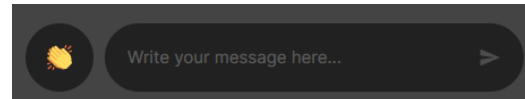


Practicalities

- Duration: 45 min presentation, 15 min Q&A
- Questions are encouraged!
 - Please type questions on the top of the right sidebar
 - All questions are anonymous
 - Try to keep them relevant to the topic
 - We will answer them toward the end
- The chat on the bottom of the right sidebar is not anonymous, and it should not be used for questions.
- Go to DevZone if you have more questions
- A recording of the webinar will be available together with the presentation at webinars.nordicsemi.com/on-demand



Two dark grey input fields stacked vertically. The top field contains the placeholder text "Type in your name...". The bottom field contains the placeholder text "Ask a question to the speakers" and a right-pointing arrow icon.



A dark grey input field with a rounded left side containing a yellow sun icon. The rest of the field contains the placeholder text "Write your message here..." and a right-pointing arrow icon.



The DevZone logo, featuring a large yellow curly brace on the left and the word "DevZone" in a dark blue sans-serif font to its right.

Agenda

- Trends in IoT Embedded Development
- nRF Connect SDK intro
- Zephyr RTOS
- Development Tools
- Q&A

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Python, Javascript


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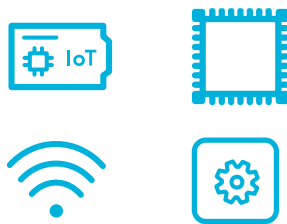
Trends in IoT Embedded Development

IoT Embedded Device

~Technology 10 years ago



+



Hardware

- 16 MHz Arm Cortex-M0
- 256 kB Flash
- 32 kB RAM
- (Flash/RAM ratio 8:1)

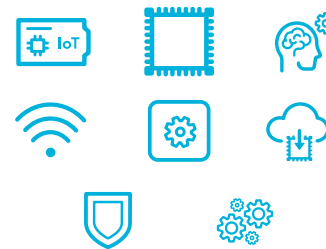
Software

- Application
- Wireless Stack
- HAL

Technology Today



+



Better Hardware

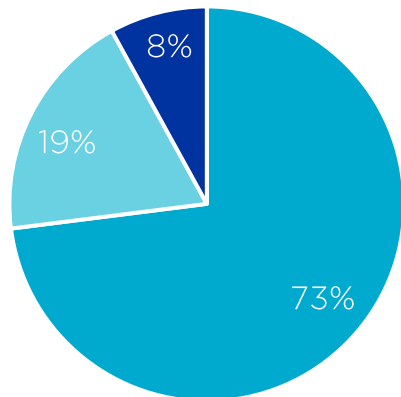
- 128/64 MHz Arm Cortex-M33 (dual core)
- 1024 kB Flash
- 512 kB RAM
- (Flash/RAM ratio 2:1)

More Software

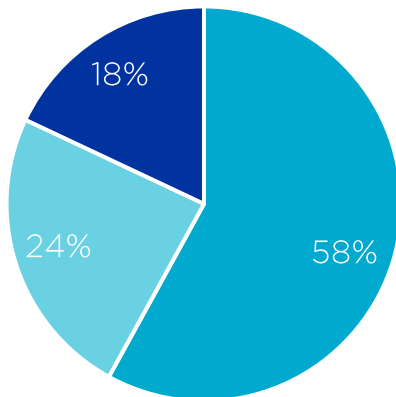
- Application
- Wireless Stacks (plural)
- Bootloader/OTA DFU
- Machine Learning
- Security
- RTOS

IoT Embedded Device Product Design

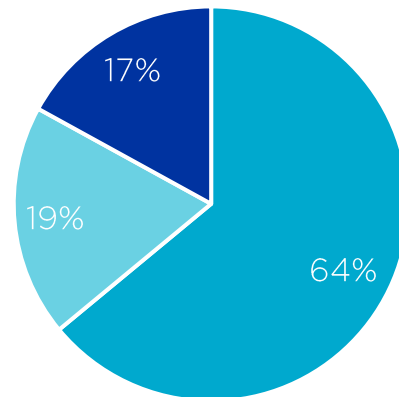
Designs are becoming
more complex and
sophisticated



Design cycles
are shrinking



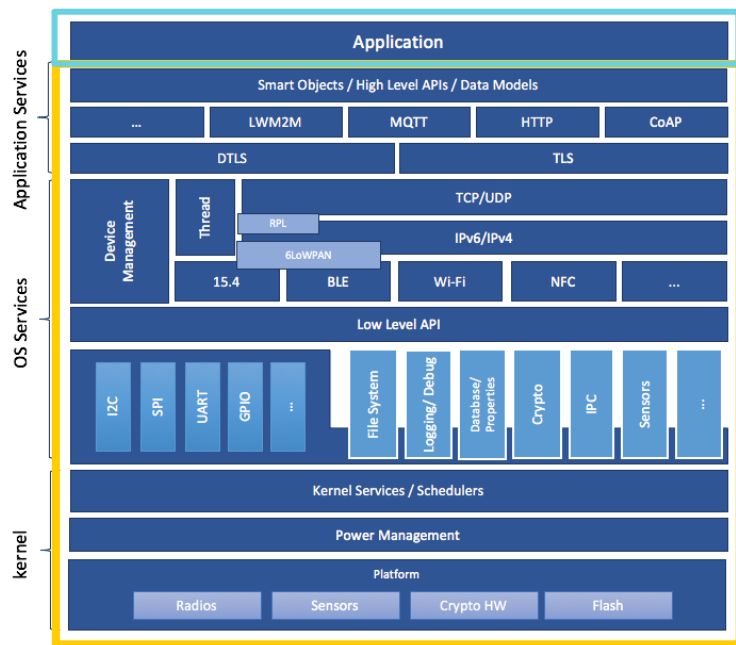
There is more time-to-
market pressures



■ Agree ■ Neutral ■ Disagree

Developing for the IoT

Abstraction is key



- Roll-your-own does not scale
- Select the functionality you need
- Focus on your product

■ Your product

■ Not your product

nRF Connect SDK

Introduction



nRF Connect



nRF Connect



nRF Connect SDK

Samples and Applications

Middleware

RTOS

Libraries

Hardware drivers



nRF Connect for Desktop

Toolchain Manager

Bluetooth Low Energy

Programmer

LTE Link Monitor

Power Profiler

Trace Collector



nRF Connect for VS Code

nRF Terminal

nRF Debug

Memory Report

Command-line (CLI)
and GUI interfaces

Create new board wizard



Mobile Applications

nRF Connect for Mobile

nRF Mesh

nRF Toolbox

Nordic Thingy

nRF Cloud Gateway

nRF Connect SDK



- One code base and toolchain for nRF91, nRF70, nRF53, nRF52 and nRF21 Series
 - Optional for nRF52 Series (\geq v1.3.0)
- Includes ANT, Bluetooth Low Energy, Wi-Fi, LTE-M, NB-IoT, GNSS, Bluetooth mesh, Thread, Zigbee, Matter, ESB, Gazell, NFC
- Bluetooth v5.3 qualified Host and Controller stack since v2.0.0



Code base

- Contains app code, connectivity protocols, wireless stacks and peripheral drivers
- Code is organized into several repositories (Nordic - blue and Open Source (OS) code - purple)



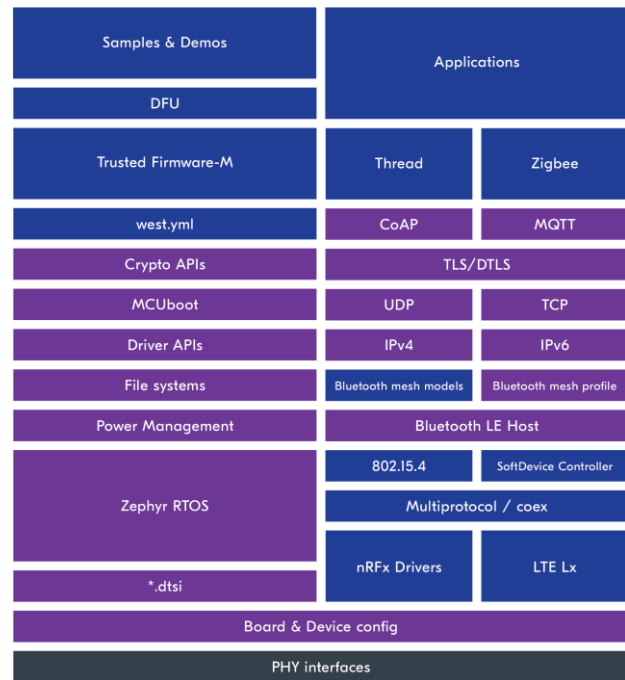
nRF Connect SDK repositories

- nRF: Application & connectivity protocols
- nrfxlib: compiled libraries where Nordic cannot distribute source code
- nrfx: peripheral drivers
- Zephyr: RTOS & board configuration (OS)
- MCUboot: Secure Bootloader (OS)
- Other repositories
 - Trusted Firmware-M, Matter, etc.



Code base in detail

- A wide range of wireless technologies and applications is supported by one integrated code base
- Code management, build and configuration tools allow developers to focus on the components required for their specific designs while having a powerful solution toolbox available



Nordic Software

- The main SDK repositories with samples, applications and connectivity stacks
- Source code exclusively written by Nordic Semiconductor
- Licensed with permissive Nordic 3-clause or 5-clause BSD license



Open-source SW

- nRF Connect SDK re-distributes OS for standard platform components
- Nordic collaborates with communities of industry experts to deliver these components as part of the nRF Connect SDK
- OS repositories are licensed with permissive license (e.g. Apache 2.0)



Supporting Product Development

Sample



Shows how it works

Simple examples

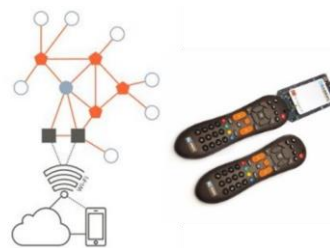
Demo



See what it does

Proof of concept

Application



Build a product

Fully integrated code
for an application

Connectivity



Complete, verified
and optimized
wireless stacks,
drivers and protocols

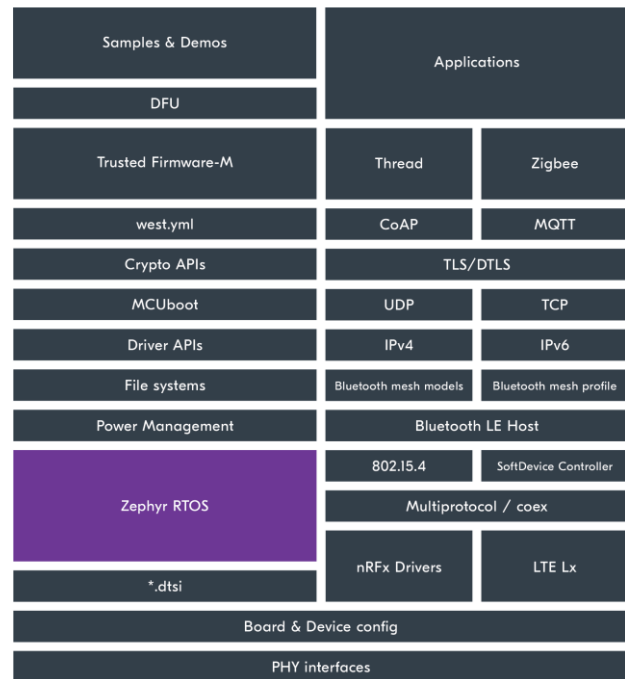


RTOS

Introduction

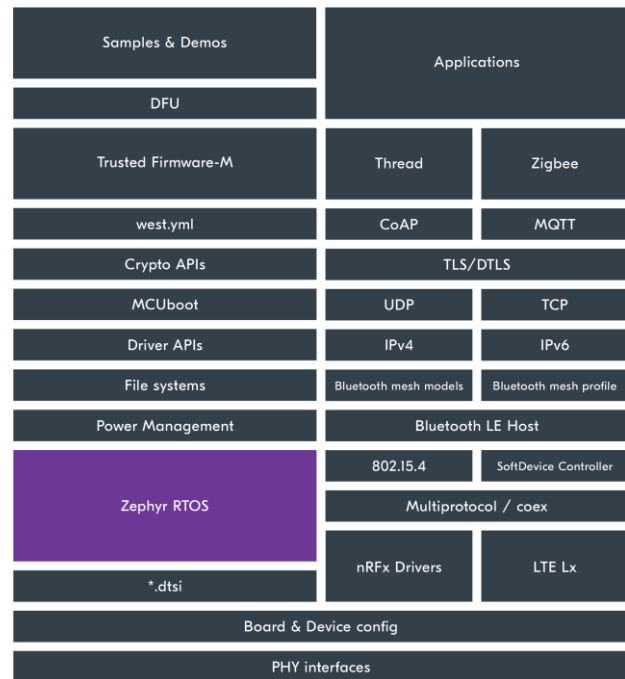
What is an RTOS?

- Real Time Operating System
 - Goal is to ensure predictable/deterministic execution pattern
 - Embedded systems often have strict timing requirements
 - Scheduler decides which task to execute at which time
 - Achievable by setting a priority for each execution thread



Why use an RTOS?

- How does an RTOS help a product developer?
 - Separation of Concern
 - More portable & re-usable applications
 - Controls application complexity in large memory devices
- Higher-level programming model
 - -> faster time to market



Why the Zephyr RTOS?

- Zephyr is designed & built for low-power wireless
- Open source
- Vendor-neutral governance (Linux Foundation)
- Similar projects exist
 - Driver model, connectivity stacks, modular design, build system included
- Vibrant community



Why the Zephyr RTOS?

- Zephyr is scalable
 - Very small configurations for memory-constrained devices (min 8 kB e.g. simple LED blinking application)
 - Powerful, feature-rich, configurations for large memory, high-processing power devices (multiple MBs)
- Developed with a focus on security
 - Have their own Product Security Incident Response (PSIRT) team
 - PSIRT team fixes security vulnerabilities and notifies customers and public



Vibrant community

The screenshot displays the GitHub interface for the Zephyr Project repository. At the top, it shows the current branch as 'main', 157 branches, and 167 tags. A 'Go to file' button and a 'Code' button are visible. The repository is owned by 'sambhurst' and 'carlescufi', with a recent commit 'usb_c: Fix comments before "else" statements' by 'd9c4ec3' 13 hours ago, and a total of 73,870 commits.

The commit list on the left includes:

- .github: ci: doc-build: use Doxygen 1.9.6 (2 days ago)
- arch: arm: aarch32: Use proper sys functions for cache maintenance (yesterday)
- boards: gd32f450i_eval: Enable DMA transfer for nor-flash (14 hours ago)
- cmake: BOARD_REVISION_CONFIG setting for Kconfig revision fragments (15 hours ago)
- doc: doc: update stale references to boilerplate.cmake (yesterday)
- drivers: spi: gd32: Add support DMA transfer (14 hours ago)
- dts: ITE dts/riscv/ite: separate dtsi node to it81xx2 from it8xxx2 (yesterday)
- include/zephyr: drivers: udc: remove no more required pending state flag (14 hours ago)
- kernel: kernel: banner: Remove unnecessary header (2 days ago)
- lib: lib: os: Fix note on fdttable.c (yesterday)
- misc: misc: generated: update configs.c template with <zephyr/> prefix (8 months ago)
- modules: tinyccor: Remove deprecated/obsolete module (2 days ago)
- samples: samples: subsys: usb_c: sink: Add USBC_CSM_SINK_ONLY Config to prj.c... (13 hours ago)
- scripts: twister: package artifacts for testing (15 hours ago)
- share: cmake: BOARD_REVISION_CONFIG setting for Kconfig revision fragments (15 hours ago)
- soc: Revert "soc: intel_adsp/ace: fix CPU halting" (19 hours ago)
- submanifests: west.yml: allow users to easily add more modules (last year)
- subsys: usb_c: Fix comments before "else" statements (13 hours ago)

The right sidebar contains the 'About' section, describing Zephyr as a new generation, scalable, optimized, secure RTOS for multiple hardware architectures. It includes links to the documentation (docs.zephyrproject.org) and a list of supported hardware architectures: **iot**, **real-time**, **microcontroller**, **embedded**, **bluetooth**, **bluetooth-le**, **mcu**, **rtos**, **zephyr**, **zephyros**, **embedded-c**, and **zephyr-rtos**.

Other repository statistics include: **Readme**, **Apache-2.0 license**, **Code of conduct**, **Security policy**, **7.1k stars**, **378 watching**, and **4.5k forks**.

The **Releases** section shows 105 releases, with the latest being **Zephyr 3.2.0** (marked as 'Latest') released on Sep 30, 2022, and a total of **+ 104 releases**.

The **Contributors** section shows 1,439 contributors.

Back to nRF Connect SDK

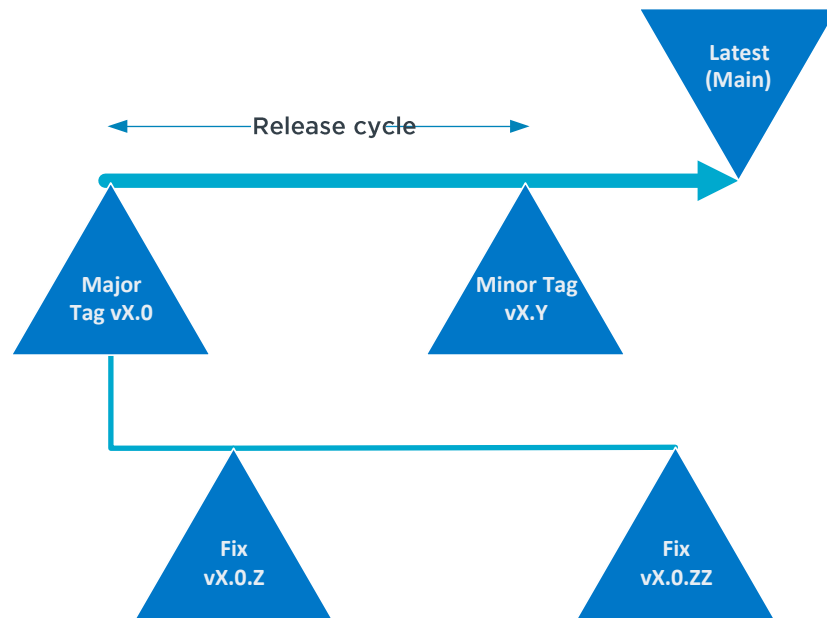


Tagged vs main branch

- Tagged versions of nRF Connect SDK are stable releases
 - <https://github.com/nrfconnect/sdk-nrf/tags>
 - V2.2.0 is latest tagged revision
 - Technical support is available
 - Use as starting point for development
- Main branch is most current development status
 - Newest version of nrf repository, not a stable release
 - No technical support available
 - Use if you need to test latest features earlier

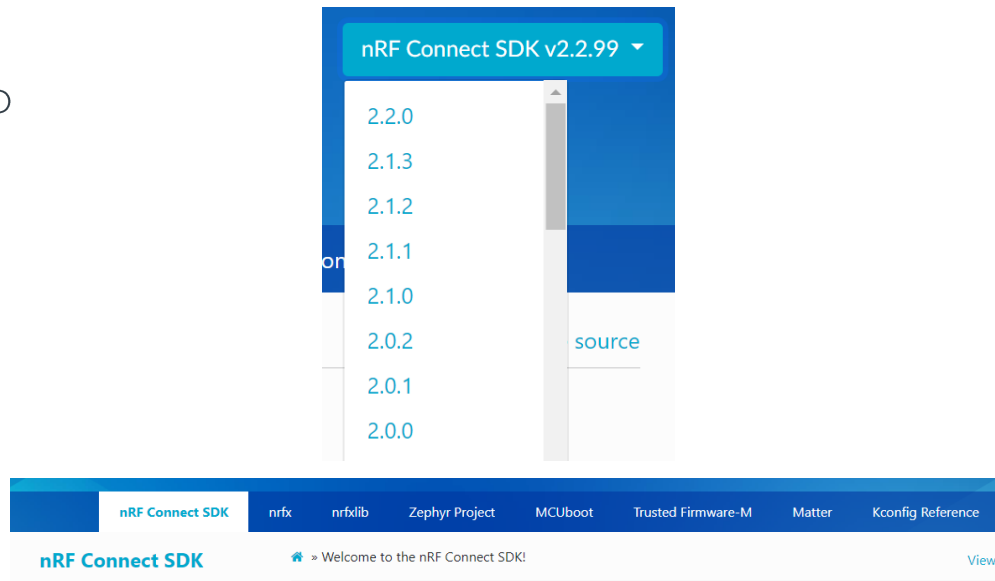
Release cycles

- Regular releases (e.g. quarterly)
- Publicly hosted on [GitHub](#)
- Fixes released as needed
 - Long term supported releases can have fixes applied and delivered after new releases
- Latest development version available
- Version control management with Git:
 - manage new version and fix adoption
 - tool supported merging



nRF Connect SDK documentation

- [Documentation link](#)
- Click on arrow in top right to choose documentation tag
 - 2.x.99 refers to main branch
 - Latest tag is 2.2.0
- Click on the tabs on the top banner to switch to nrfxlib, Zephyr, MCUboot or other documentation pages



Manage source code and configurations

West

Multi-repository
management tool

Kconfig

Source module / feature
configuration for compile

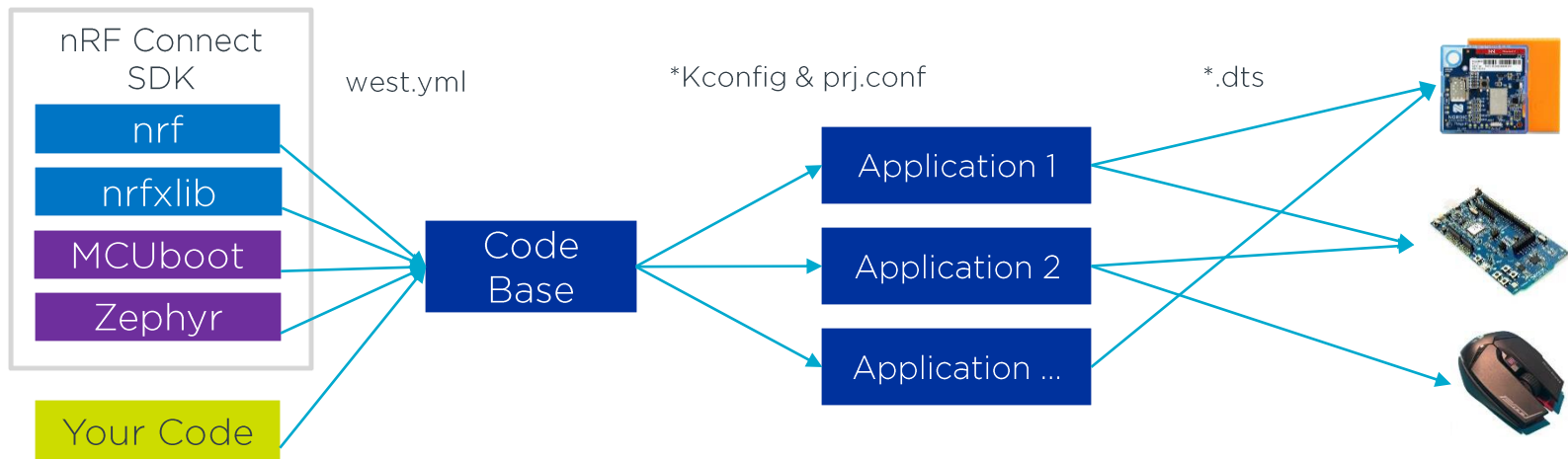
DeviceTree

Target Board / Device
description

Clone / update

Configure features

Configure target



Demo hardware setup

BME680

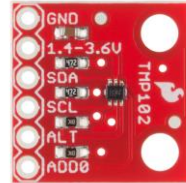


I²C: 0x77

(1)

(2)

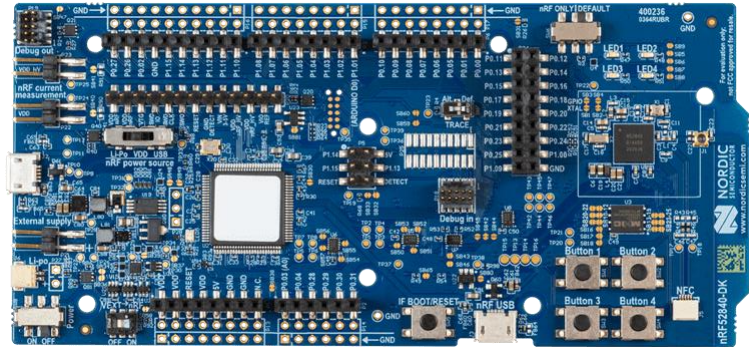
TMP102



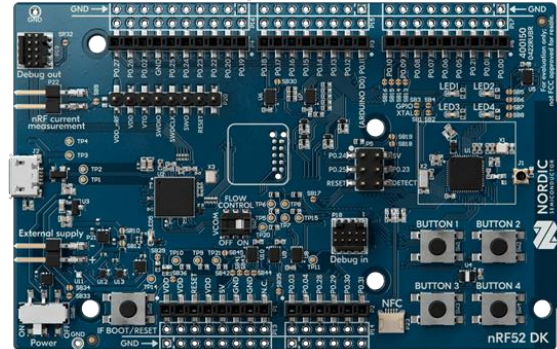
I²C: 0x48

(3)

nRF52840 DK



nRF52 DK



West tool

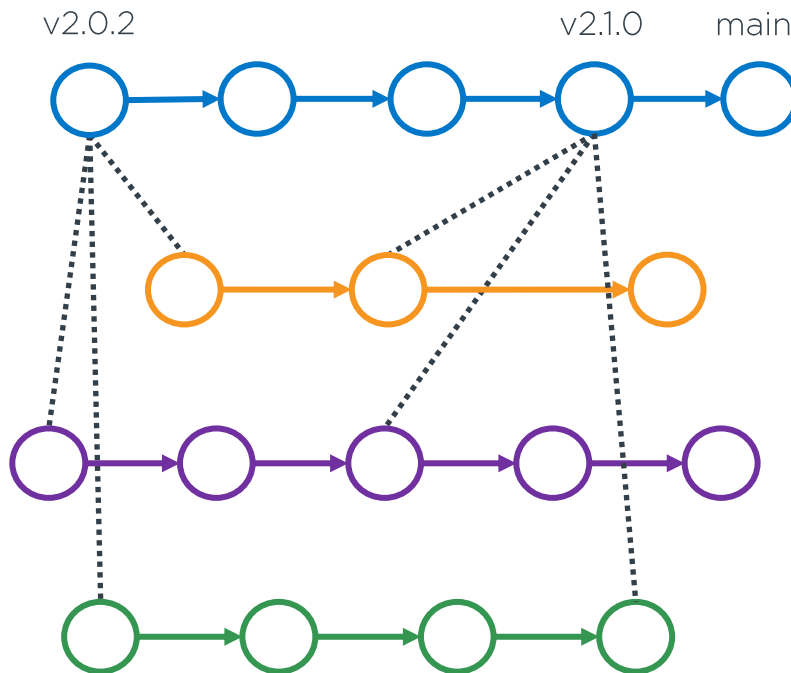
- West init
 - Initialize a new west installation
- git checkout <tag>
 - e.g. git checkout v2.1.0
- West update
 - Used to update the four repositories

nRF Connect SDK

nrfxlib

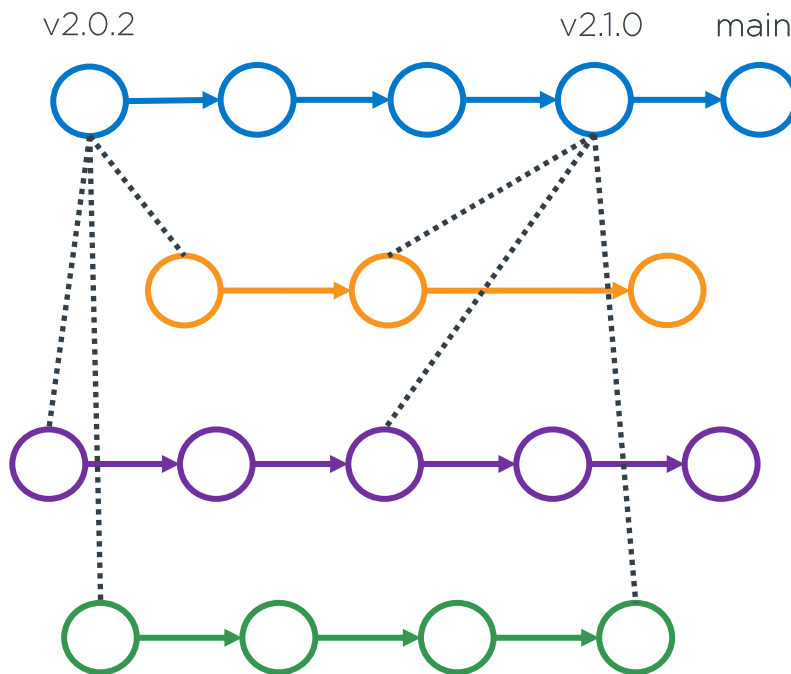
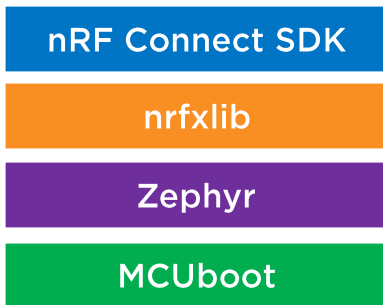
Zephyr

MCUboot



West tool

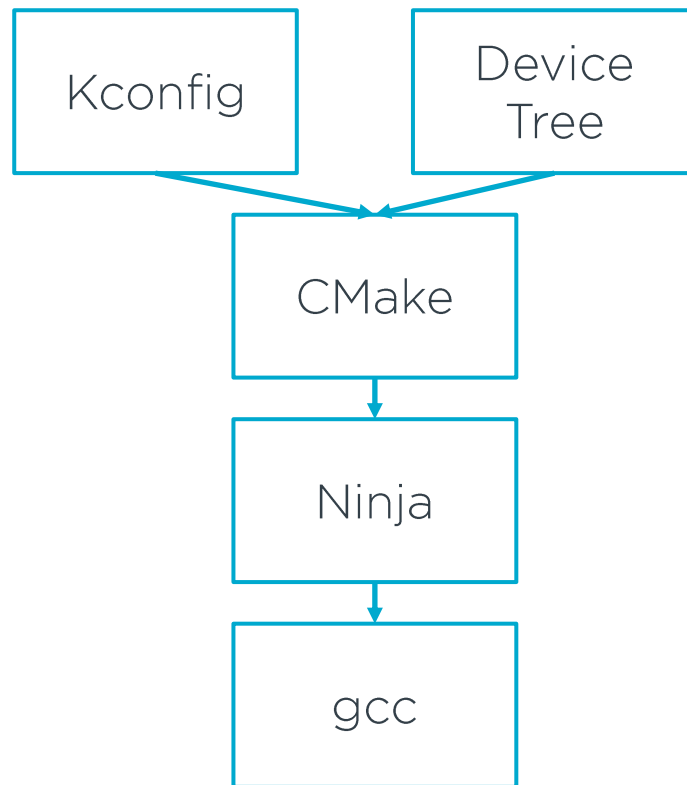
- Using git and west simplifies multi repository management by making it seem you are only updating one repo
- Simple to migrate between different tags



nRF Connect SDK

Toolchain

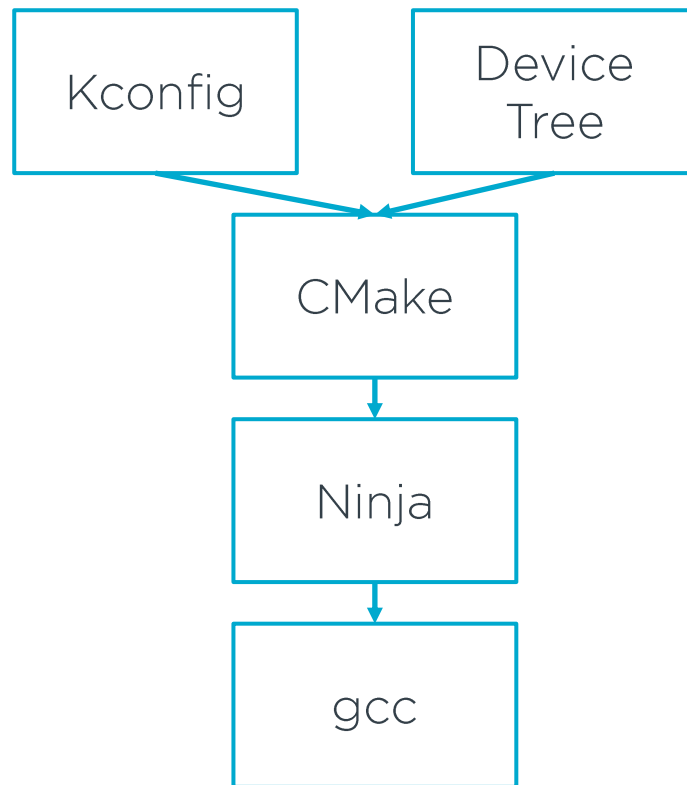
- Kconfig
 - Generates definitions to configure the system (e.g. GPS, MQTT settings)
 - Generally located in an example folder
 - Software features defined in Kconfig, enabled in prj.conf file
 - Kconfig and prj.conf files merged into one .config file for CMake
 - → Configure software features without changing source code



nRF Connect SDK

Toolchain

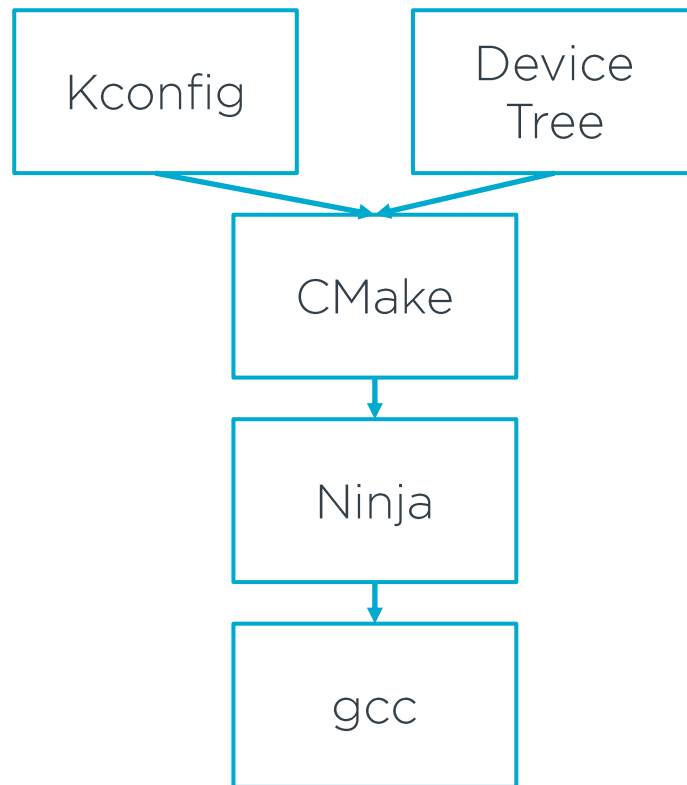
- DeviceTree (dts, dtsi)
 - Describes HW, pin layout
 - Allows for flexible HW modification via an overlay file
 - → Build for different PCB designs and SoCs without changing source code



nRF Connect SDK

Toolchain

- CMake
 - Generates build files
- Ninja
 - Similar to make
 - Faster than make when performing incremental builds
 - Requires CMake in order to generate build files
- gcc
 - Creates executables (hex file)



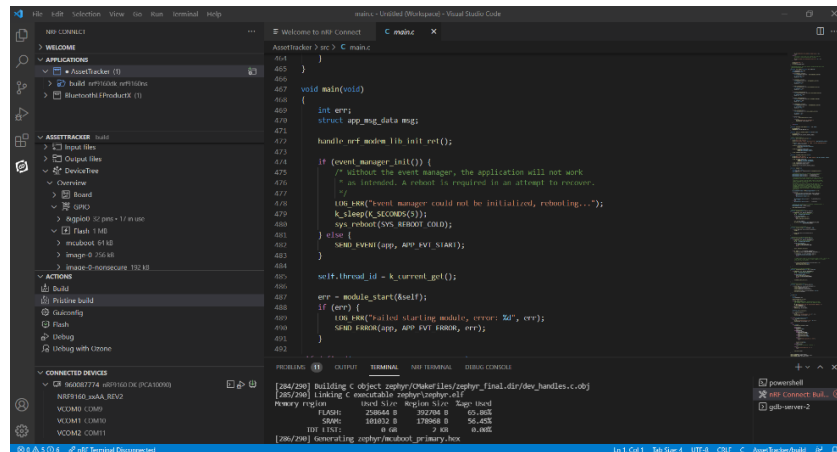


Development Tools

Supporting the full development cycle

IDE support

- [nRF Connect for Visual Studio Code](#)
 - Installed via the Toolchain Manager
 - Built from the ground up for nRF Connect SDK
 - Highly extendable and configurable
 - CLI and GUI Interfaces
 - Create new board wizard
 - Built-in terminal
 - nRF Debug and Memory Report
 - Rich set of [tutorial videos](#)



Power Profiler Kit II



- High measurement range
- Measure and analyze any embedded HW, including all Nordic DKs
- Supported by a Power Profiler app in [nRF Connect for Desktop](#)
- Kit content
 - One [PPK2](#)
 - 4-pin current measurement cable
 - 10-pin logic port cable

Power Profiler App



What is the Nordic Thingy:53

- Prototyping platform integrating
 - nRF5340 SoC
 - Multiple sensors
- Multiprotocol wireless connectivity
 - Bluetooth LE, Bluetooth mesh, NFC
Zigbee, Thread → Matter
- Internal battery to make it truly wireless
- Fully supported by the nRF Connect SDK



What is the Nordic Thingy:91

- A rapid prototyping kit for cellular IoT projects.
- iBasis SIM included (10MB free data)
- Works immediately and easily 'Out-of-the-box'.
- Fits a very broad range of use-cases.
- An extensible platform for further development and adaptation.



Mobile Apps

- For Android & iOS
- Demonstrates Bluetooth SIG and proprietary services and profiles
- Plenty of apps available on Google Play and App Store:
 - nRF Connect for Mobile
 - nRF Toolbox for Bluetooth LE
 - nRF Mesh
 - And more...
- Source code available on GitHub

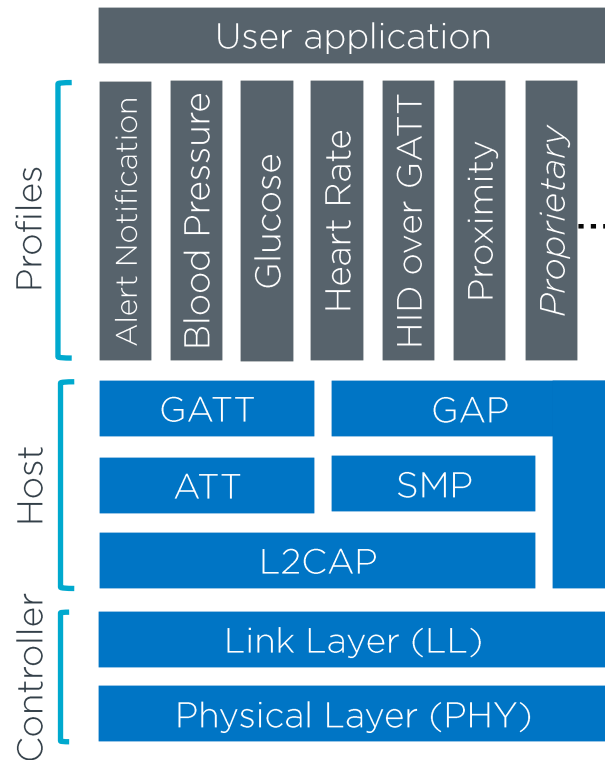


nRF Connect SDK

Evolution

Ported SoftDevice Controller

- Market leaders in Bluetooth LE in large part to our nRF5 SDK + SoftDevice
- Link Layer (LL) enables best in class interoperability between SoC and smartphones and is difficult to get right
- Ported the SoftDevice LL to nRF Connect SDK
 - Ensures best in class smartphone interoperability in nRF Connect SDK vs nRF5 SDK + SoftDevice



SoftDevice Controller

- The standalone SoftDevice Controller library is now the default Bluetooth LE Controller for Bluetooth samples



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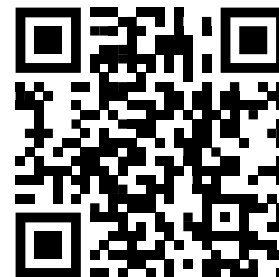
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nRF Connect SDK fundamentals course

- Self-paced hands-on online course focusing on learning the essentials of nRF Connect SDK.
- Lots of hands-on exercises.
- Centralized up-to-date content.
- Protocol agnostic (cellular IoT, Bluetooth LE, Bluetooth mesh, etc..).
- Supports all our DKs and the Thingy:91.
- Ideal for new users of nRF Connect SDK or users switching from nRF5 SDK to nRF Connect SDK.
- Test your knowledge through interactive quizzes.



DevAcademy



Q&A