STR22 - STM32WBA (BLE 5.4)

This course describe the STM32 WBA (BLE 5.4)) architecture and practical examples

Objectives

- Understand STM32WBA SoC (Cortex-M33 + single-core BLE stack).
- Bring up CubeWBA projects and verify the BLE stack.
- Build GAP/GATT apps (services, security, notifications).
- Use BLE 5.x features: Extended/Periodic Advertising, Coded PHY, BLE 5.4 (PAwR, EAD).
- Optimize throughput, latency, and low-power with RF active.
- Prepare OTA/DFU, NVM/bonding, keys, and a production checklist.

Course Environment

- Theoretical course
  - PDF course material (in English) supplemented by a printed version for face-to-face courses.
  - Online courses are dispensed using the Teams video-conferencing system.
  - The trainer answers trainees' questions during the training and provide technical and pedagogical assistance.
- Practical activities
  - Practical activities represent from 40% to 50% of course duration.
  - Code examples, exercises and solutions
  - For remote trainings:
    - One Online Linux PC per trainee for the practical activities.
    - The trainer has access to trainees' Online PCs for technical and pedagogical assistance.
    - QEMU Emulated board or physical board connected to the online PC (depending on the course).
    - Some Labs may be completed between sessions and are checked by the trainer on the next session.
  - For face-to-face trainings:
    - One PC (Linux ou Windows) for the practical activities with, if appropriate, a target board.
    - One PC for two trainees when there are more than 6 trainees.
  - For onsite trainings:
    - An installation and test manual is provided to allow preinstallation of the needed software.
    - The trainer come with target boards if needed during the practical activities (and bring them back at the end of the course).
- Downloadable preconfigured virtual machine for post-course practical activities
- At the start of each session the trainer will interact with the trainees to ensure the course fits their expectations and correct if needed

Target Audience

- Any embedded systems engineer or technician with the above prerequisites.

Course Outline

Day 1

SoC & wireless overview

- Cortex-M33 core (app + BLE stack in single core).
- Memory map & RF shares.
- Radio supply (SMPS/LDO).
- TX power path & limits.
- Board RF layout notes.

Exercise: Stack/version check

Project bring-up (CubeWBA)

- CubeWBA package layout.
- MX config for clocks/GPIO.
- Minimal BLE app skeleton.
- Assert/log policy.
- Build & debug checklist.

Exercise: App skeleton

Clocking & RF setup

- HSE/LSE choices.
- PLL to SYSCLK.
- RF timing sources.
- CCIPR selectors.
- MCO for validation.

Exercise: MCO verify

BLE GAP basics

- Roles: peripheral/central.
- Advertising parameters.
- Scan & connect flow.
- PHY select (1M/2M/Coded).
- Conn params update.

Exercise: Peripheral advert

GATT basics

- Services & characteristics.
- UUIDs (16/128-bit).
- Properties & CCCD.
- MTU exchange.
- Read/write ops.

Exercise: Custom service

Security & privacy

- Pairing/bonding (LESC).
- Passkey/Numeric Compare.
- Re-pair vs re-use bonds.

- Privacy (RPA) basics.
- Key store/NVM notes.

Exercise: Bond & resume

Day 2

Notifications & throughput

- Notify vs indicate.
- ATT_MTU & data length.
- App buffering strategy.
- Connection interval impact.
- Error/retry counters.

Exercise: Notify meter

Extended & Periodic Advertising

- Extended ADV sets.
- PHY/Tx power per set.
- Periodic ADV (PA sync).
- Sync loss handling.
- App timing notes.

Exercise: Periodic scan

BLE 5.4 features (focus)

- PAwR concept & roles.
- Subevents & responses.
- EAD (encrypted ADV).
- Scheduling constraints.
- Practical use cases.

Exercise: PAwR demo

PHY & range options

- 1M vs 2M trade-offs.
- Coded PHY (S=2/S=8).
- TX power steps.
- RSSI/SNR hints.
- Basic link budget.

Exercise: Coded PHY walk

Central role (scanner/client)

- Filtered scanning.
- Auto-connect policy.
- GATT discovery.
- Client reads/writes.
- Multi-link basics.

Exercise: Simple central

Day 3

Power profiles with RF

- Idle vs advertising vs connected.
- Conn interval/latency effects.

- PHY & Tx power impact.
- Sleep policies & wake.
- Measurement method.

Exercise: Power sweep

OTA/DFU workflow

- App OTA over BLE.
- Image slots & versioning.
- Rollback basics.
- Failure recovery plan.
- Minimal release notes.

Exercise: OTA update

NVM & keys

- Bond/key storage.
- Privacy data handling.
- App params in Flash.
- Wear considerations.
- Backup/erase policy.

Exercise: Persist check

RF & production notes

- Antenna keep-outs.
- Match network hints.
- Crystal accuracy.
- Tx power/regulatory.
- Coexistence basics.

Exercise: RSSI sweep

Robustness checklist (wrap-up)

- Stack version fixed.
- BD_ADDR policy set.
- Error counters logged.
- Low-power numbers saved.
- Version/CRC tags added.

Exercise: Self-audit sheet