



STR23 - STM32MP2 Implementation

This course describe the STM32MP2 Implementation and practical examples

Objectives

- Understand the STM32MP2 architecture (dual Cortex-A35 + Cortex-M33) and memory/interconnect map.
- Bring up the full boot chain: TF-A & U-Boot & Linux, and read meaningful boot logs.
- Configure and validate DDR and clock trees; confirm frequencies and governors on real hardware.
- Build and customize OpenSTLinux (Yocto) images; add a simple layer/recipe.
- Enable devices via Device Tree (pinmux, clocks, regulators) and debug with dmesg/sysfs.
- Set up storage and flashing flows (eMMC/SD/USB-DFU) with safe partitioning.
- Bring up key I/O: Ethernet/TSN, USB (host/gadget), and PCIe; run quick throughput checks.
- Configure graphics and media: DRM/KMS + GPU, VPU pipelines, CSI-2 camera and DSI/RGB display.
- Offload real-time work to the M33 core; exchange data with Linux via OpenAMP/RPMsg.
- Run a small Edge-AI sample (CPU/GPU/NPU) and compare performance/latency.
- Apply platform security: secure boot options, OP-TEE services, keys/OTP, tamper basics.
- Implement OTA/rollback strategy (SWUpdate/Mender concepts) and a practical recovery path.
- Tune power management (cpufreq/cpuidle) and record simple power profiles.
- Produce a production checklist: versioning, UID/serial, crash/reset logs, diagnostics, and update policy.

Day 3

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

MP2 SoC overview (A35/M33, interconnect)

- Dual A35 cluster; M33 real-time core.
- AXI/AHB fabric; memory regions.
- GPU / VPU / NPU blocks (high-level).
- Display (RGB/LVDS/DSI), CSI-2 camera.
- High-speed I/O: PCIe, TSN GbE, USB

Exercise: SoC map quick tour

Boot chain & security foundation

- ROM & TF-A (FSBL) & OP-TEE (S-EL1) & U-Boot (SSBL) & Linux.
- Boot media: eMMC/SD/USB-DFU/NAND (board-dep).
- Device trees passed by U-Boot.
- Secure boot hooks & fuses (overview).
- Recovery & UART/USB consoles.

Exercise: Hello boot

DDR & clock/power bring-up

- DDR type (LPDDR4/DDR4/DDR3L) basics.
- TF-A DDR init vs board tuning.
- RCC & PLL trees; kernel/Peripheral clocks.
- DVFS/cpufreq overview.
- MCO/clock probes for validation

Exercise: Clock sanity

Pinmux & device-tree basics

- Linux pinctrl: groups/functions.
- DTS vs DT overlay structure.
- Regulators/GPIO/IRQ nodes.
- Clocks/resets in DT.
- Common mistakes & dmesg hints.

Exercise: DTS tweak

Storage & flashing

- Partitioning (boot/rootfs/data).
- eMMC vs SD vs NAND trade-offs.
- WIC/SD-card images vs dfu-util.
- U-Boot mmc/fatload/env tips.
- Filesystem choices (ext4/squashfs).

Exercise: Flash flow

Day 2

OpenSTLinux (Yocto) workflow

- Layers: meta-st-openstlinux, machine configs.
- repo init, bitbake targets.
- SDK/cross-toolchain export.
- Image types (core/weston/minimal).
- Incremental rebuilds & sstate.

Exercise: Build & boot

Kernel enablement

- Kconfig vs DTS responsibilities.
- Out-of-tree driver basics.
- Debug: dmesg, trace-cmd, devlink.
- UIO/GPIO-chardev access.
- Packaging modules in Yocto.

Exercise: LED/GPIO driver

Connectivity: Ethernet/TSN, USB, PCIe

- PHY setup; TSN capabilities (high-level).
- ip link, ethtool, iperf3 checks.
- USB gadget vs host roles.
- PCIe root complex basics.

Exercise: Net bring-up

Security & isolation (high-level)

- Resource isolation framework.
- TZC/ETZPC-like gates (periph/DDR).
- OP-TEE secure services.
- Keys/OTP and tamper (overview).
- Secure storage story

Exercise: OP-TEE ping

Day 3

Updates & recovery

- Dual-A/B rootfs strategy.
- SWUpdate/mender (concepts).
- U-Boot env for rollback.
- DFU recovery path.
- Factory vs field flows.

Exercise: Safe update sim

Graphics stack (DRM/KMS + GPU)

- DRM/KMS planes/connectors.
- 3D GPU overview (1080p UIs).
- Mesa/Wayland (Weston).
- Performance tips (buffers).
- Multi-display notes

Exercise: Weston demo

Video pipeline (VPU)

- Formats & pixel planes.
- H.264 decode/encode HW.
- GStreamer pipelines.
- Zero-copy paths idea.
- Storage & bandwidth tips

Exercise: GStreamer test

Camera input (MIPI-CSI2)

- CSI-2 lanes & DT nodes.
- Sensor drivers & controls.
- ISP blocks (conceptual).
- V4L2 capture basics.
- Sync/exposure notes.

Exercise: Camera capture

Display outputs (RGB/LVDS/DSI)

- Connector DT bindings.
- Mode setting (EDID/timings).
- Backlight/panel drivers.
- VSYNC/TE considerations.
- Tear & bandwidth checks

Exercise: Panel bring-up

Edge AI accelerators (CPU/GPU/NPU)

- NPU
- Toolchains (TFLite/ONNX).
- Delegate selection (CPU/GPU/NPU).
- Pre/post-processing tips.

Exercise: Demo

Day 4

Cortex-M33 side (STM32CubeMP2)

- CubeMP2 HAL/LL layout.
- Project templates in CubeIDE.
- Clocks/IRQs on M33.
- Bare-metal vs FreeRTOS.
- Debug attach options

Exercise: M33 hello

A-core & M-core IPC

- VirtIO/RPMsg concepts.
- Shared memory carve-outs.
- Mailbox/interrupt routing.
- Message framing policy.

Exercise: RPMsg ping-pong

Field buses & timers (Linux + M33)

- UART/I²C/SPI from Linux.
- Offloading real-time to M33.
- PWM/capture (M33 side).
- DMA pipelines.
- Latency budgeting.

Storage, filesystems & performance

- eMMC/SD tuning (HS modes).
- ext4 vs squashfs trade-offs.
- I/O schedulers & fio.
- Wear leveling & logs.
- Mount options & journaling.

Exercise: I/O bench

Networking polish & security

- Firewalling basics (nftables).
- Secure shells/keys.
- Time sync (PTP/NTP).
- TSN concepts (sched/queues).
- Logging & metrics.

Exercise: Net hardening

Day 5

Power management

- cpufreq/governors.
- cpuidle/suspend-to-RAM.
- Peripheral low-power.
- Display blanking strategy.

Exercise: Power sweep

Robust boot & tamper

- OTP/fuses & boot keys.
- Active tamper inputs.
- Secure RTC/monitors.
- Rollback prevention.
- Audit logging

Exercise: Tamper demo

Production flashing & tests

- Golden image layout.
- Serial/UID/keys injection.
- Manufacturing scripts.
- Boundary/functional tests.
- Field diagnostics hooks.

Exercise: Factory script

Wrap-up & roadmap

- BSP update policy.
- Yocto release strategy.
- Security CVE handling.

- Backup & recovery docs.
- Next steps & references.

Exercise: Self-audit