"Vanilla" Debian On An Industrial Embedded Device

Presented by
Francesco Dolcini <francesco.dolcini@toradex.com>

About Me

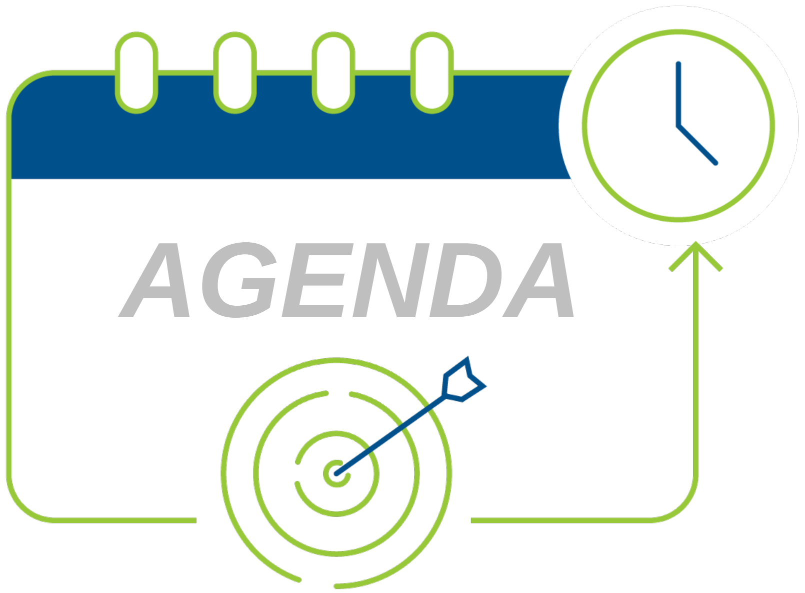
- Embedded Linux @ Toradex
  - U-Boot
  - Linux
  - OpenEmbedded
- Debian user since Slink
- francesco.dolcini@toradex.com

WHAT WE'LL COVER TODAY…

We'll try to answer the following question

- Can I just download Debian, follow the "Installation Guide" and get my industrial embedded device up and running? What is required to get there?

- ARM/ARM64 Embedded Devices
- U-Boot bootloader
- U-Boot OS interfaces (*distroboot*, *standardboot* and UEFI)
- Debian Installer (d-i)
- Debian Linux kernel



Typical Simplified Bootflow

- Firmware initialize and configure the HW (this can be quite complicated on modern systems)
- Prepare binaries (Linux, DT, ...) in memory
- Jump to the kernel entry point

- Linux: https://docs.kernel.org/arch/arm/booting.html
- U-Boot: arch/arm/lib/bootm.c:boot_jump_linux()

U-Boot `distroboot`

- We need a way for to tell the firmware how to load the OS (Linux Kernel / Command Line / DT)
- `distroboot` tries to solve this in a generic way

```
#define BOOT_TARGET_DEVICES(func) \
          func(MMC, mmc, 1) \
          func(MMC, mmc, 0)
#include <config_distro_bootcmd.h>
```

- It uses scripts and environment variables.
- It's very easy to integrate in a board.
- It execute a distribution provided boot script or an `extlinux.conf`.

- https://github.com/u-boot/u-boot/blob/master/doc/develop/distro.rst

Debian flash-kernel

- Glue between Debian and the firmware
- Integrate with the kernel packages with hook
- Can create U-Boot boot.scr
- Integrated into ARM d-i

- https://salsa.debian.org/installer-team/flash-kernel/-/blob/master/bootscript/all/bootscr.uboot-generic
- https://salsa.debian.org/installer-team/flash-kernel

Try #1: Installing Debian Over Network

- Let’s use a Colibri iMX6ULL as an example
  … and …
- follow the instructions

  https://www.debian.org/releases/stable/armhf/index.en.html

```
# on the host
user:/srv/tftp
$ wget
http://ftp.it.debian.org/debian/dists/bookworm/mai
n/installer-armhf/current/images/netboot/
netboot.tar.gz -O - | tar xz

# on the target
setenv fdtfile imx6ull-colibri-emmc-aster.dtb
tftpboot ${scriptaddr}
/debian-installer/armhf/tftpboot.scr
source ${scriptaddr}
```

- Not really working … let’s fix it

  https://salsa.debian.org/installer-team/flash-kernel/-/merge_requests/40

- https://asciinema.org/a/mAy7WUEpnzMBINmWqDVLMNvF0

U-Boot `standardboot`

- In very brief this is a generalization and re-implementation in C of distroboot.

- Very easy to enable and configure

```
// env variables
#define BOOT_TARGETS "mmc1 mmc0"
"boot_targets=" BOOT_TARGETS "\0"

// kconfig
CONFIG_BOOTSTD_FULL=y
CONFIG_BOOTSTD_DEFAULTS=y
```

- https://github.com/u-boot/u-boot/blob/master/doc/develop/bootstd.rst

Try #2: Installing Debian (sid) Using deboostrap

- Let’s use a Colibri iMX7 as an example

  … and …
- follow the instruction

  https://www.debian.org/releases/stable/armhf/index.en.html

- Let’s use U-Boot UMS

- Not really working … let’s fix it

  https://salsa.debian.org/kernel-team/linux/-/commit/1764200859103d382a353b6634dad834df71362c

- https://docs.u-boot.org/en/v2021.07/usage/ums.html
- https://asciinema.org/a/d0dvh07PjLPyJiqtycUzrRtFy

U-Boot EFI

- With ARM64, d-i, just expect to use EFI
- U-Boot supports a subset of EFI, targeting Embedded Base Boot Requirements (EBBR)
- Does not support *SetVariable* at runtime
- Boot from UEFI System Partition (ESP)

- Not enabled on board I have available, let's just do it.

```
+CONFIG_BOOTM_EFI=y
+CONFIG_CMD_BOOTEFI=y
+CONFIG_CMD_NVEDIT_EFI=y
+CONFIG_CMD_EFIDEBUG=y
+CONFIG_CMD_GPT=y
+CONFIG_EFI_PARTITION=y
+CONFIG_EFI_LOADER=y
+CONFIG_EFI_DEVICE_PATH_TO_TEXT=y
+CONFIG_EFI_UNICODE_COLLATION_PROTOCOL2=y
+CONFIG_EFI_UNICODE_CAPITALIZATION=y
+CONFIG_EFI_HAVE_RUNTIME_RESET=y
+CONFIG_CMD_EFI_VARIABLE_FILE_STORE=y
+CONFIG_DM_RTC=y
+CONFIG_EFI_GET_TIME=y
+CONFIG_EFI_SET_TIME=y
+CONFIG_FAT_WRITE=y
+CONFIG_FS_FAT=y
+CONFIG_CMD_PART=y
+CONFIG_PARTITIONS=y
+CONFIG_DOS_PARTITION=y
+CONFIG_ISO_PARTITION=y
+CONFIG_PARTITION_UUIDS=y
```

Try #3: Installing Debian Using a USB flashdrive

- Let’s use a Verdin iMX8MM as an example
  … and …
- follow the instruction

  https://www.debian.org/releases/stable/arm64/index.en.html

- The installation went (almost) smoothly …
  but ...
- https://salsa.debian.org/kernel-team/linux/-/merge_requests/969
  and
- Which device tree is being used?

Some EFI firmware implementations do not meet the EFI specification

(i.e. they are buggy!) and do not support proper configuration of

boot options from system hard drives.

- https://asciinema.org/a/69ZMkZ16MWOAPnJOqtQP76VAV

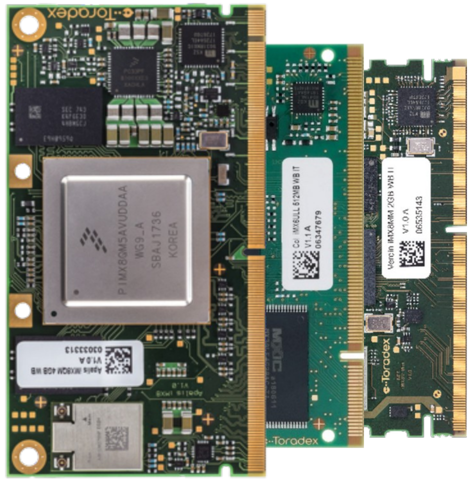
Next Steps, Open (and Pain) Points

- Everything in this presentation assumed working upstream support in U-Boot and Linux.
- EFI works, but not being able to set variable (`BootOrder`) is just affecting the user experience (solutions are in the work, there is awareness of this!).
- Device tree selection. Where is the DT supposed to come from? From the firmware, but …
- DT overlay (binary patches to the DT).

Toradex
Swiss. Embedded. Computing.

Q&A

WHAT WE DO



Arm® System on Modules

Reliable

Long-Term Maintenance

Scalable

From Stock

Production-Ready Software

Yocto-Based Linux

Windows Embedded Compact

Development Tools

Long-Term Maintenance

Ease-of-Use

Support

Ecosystem

RELIABLE AND EASY-TO-USE EMBEDDED SOLUTIONS FOR YOU

Toradex

Swiss. Embedded. Computing.

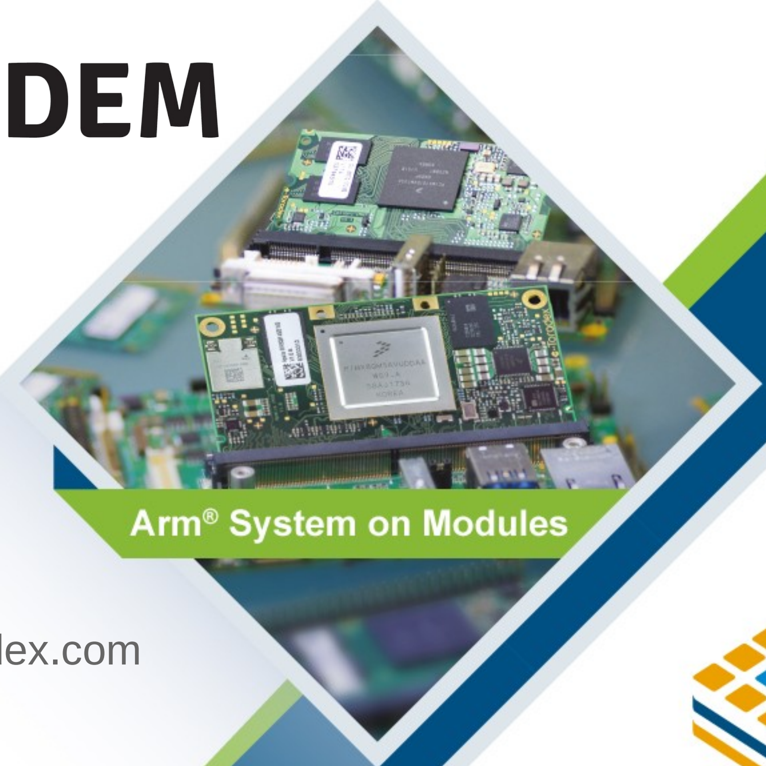
FOSDEM

THANK YOU

FOR YOUR INTEREST

www.**toradex**.com | www.**torizon**.io | **developer**.toradex.com

community.toradex.com | **labs**.toradex.com



Torizon™

Demo

- Update kernel on armhf running Debian SID