Building a System that “Just Works” – The Arm Firmware Ecosystem

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Meet the Presenters

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Agenda

- Arm Base Boot Requirements (BBR)
- Arm Open Source Firmware Projects
- Case Study: SBBR on Edge Devices
Arm Base Boot Requirements (BBR)
• Define a BBR spec to cover ‘A’ profile markets beyond server
• Continue the current EBBR spec with the community development approach
  – BBR spec refers to EBBR spec as needed
• BBR Spec
• Recipes
  – SBBR
  – ESBBR
  – EBBR
  – LBBR

• Establish interface requirements
  - PSCI, SMCCC (Common for all)
  - UEFI (for SBBR recipe)
  - ACPI (for SBBR recipe)
  - Exceptions (for ESBBR recipe)
  - SMBIOS
  - Devicetree (reference DT Spec)
System Firmware Landscape

Vertical

Custom Linux

Horizontal

ESBBR  SBBR

Vertical

trustedfirmware.org

Edge

Cloud & Datacenters

arm
Recipes

• SBBR
  – PSCI, SMCCC, UEFI, ACPI, SMBIOS interfaces
  – Windows Client/Server, RHEL require
  – SLES, Ubuntu, CentOS, Fedora, OpenSUSE, Debian, VMware ESXi, NetBSD, FreeBSD support

• ESBBR
  – SBBR with exceptions
  – VMware ESXi, Windows (IoT), SLES, Ubuntu, CentOS, Fedora, OpenSUSE, Debian, NetBSD, FreeBSD support

• EBBR
  – PSCI, SMCCC, UEFI, DT interfaces
  – Fedora, OpenSUSE, Ubuntu, Debian, OpenWRT, Yocto, Windriver, Mentor

• LBBR
  – PSCI, SMCCC, LinuxBoot, DT or ACPI interfaces
  – Google, Facebook
Arm Specs

- PSCI
- SMCCC
- TF-A
- Arm FFH
- Arm MM


- Firmware requirements for Windows, Red Hat, VMWare, SUSE, etc..
- **Horizontal Integration** requires standard firmware interfaces. Focus on interface requirements, not implementation

**Industry Standards**

- UEFI
- ACPI
- SMBIOS
- TCG FW spec
- PCIe FW spec
EBBR

Arm Specs

- PSCI
- SMCCC
- TF-A

[https://github.com/ARM-software/ebbr](https://github.com/ARM-software/ebbr)

The goal is to establish consistent boot ABIs and behavior so that supporting new hardware platforms does not require custom engineering work.

EBBR is a subset of SBBR requirements. EBBR requirements have been implemented by the U-Boot project with Devicetree.
LinuxBoot (https://www.linuxboot.org/) is system firmware implemented with the Linux kernel and a userspace runtime instead of EDK2 or U-Boot.

LinuxBoot on Arm normally replaces all non-secure firmware and can directly call TF-A APIs to control the platform. It still provides an ACPI or DT description.

LinuxBoot doesn't implement all of SBBR. OSes that require the UEFI ABI may not be supported, unless UEFI ABI is also implemented in LinuxBoot.
Recipe Relationships

<table>
<thead>
<tr>
<th>Operating Systems</th>
<th>UEFI</th>
<th>ACPI</th>
<th>SMBIOS</th>
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<td>U-Boot</td>
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<td>EDK2</td>
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<td>PSCI, SMCCC</td>
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<tr>
<td>Trusted Firmware</td>
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Recipe Relationships
SBMR - Server Base Manageability Requirements


• Hardware and Firmware requirements for standard system management of SBSA/SBBR compliant servers.
• v1.0 Release March 2020
• Provides Foundation for standardized common capabilities, and allows value-add on top
• Builds on top of prevalent industry standards for systems management
  • DMTF Redfish
  • DMTF Management Component Transport Protocol (MCTP)
  • DMTF Platform Level Data Model (PLDM)
  • OCP Hardware Management
  • IPMI
Open Source System Firmware on Arm
Arm Open Source Firmware

- Arm systems support firmware solutions with **multiple boot models**, and that can be **open source OR commercial**.
- Arm’s strategy is to encourage partners to provide **full open source** firmware implementations, regardless of the boot model.
- Open source firmware options on Arm systems include:
  - **TrustedFirmware** • Open source for Secure World firmware
  - **TianoCore / EDK2** • Open source for UEFI, ACPI, SMBIOS standard system firmware
  - **U-Boot** • Open source for embedded systems firmware
  - **LinuxBoot** • Open source for cloud providers Linux-based firmware
  - **OpenBMC** • Open source BMC firmware
Trusted Firmware

- [https://trustedfirmware.org/](https://trustedfirmware.org/)
- Open Source, Open Governance Community Project
- Evolution of former Open Source “Arm Trusted Firmware” project
- Reference implementation of Secure world software for Armv7 & Armv8 architectures (both A/M-Profiles)
- Membership open to all
- Governance overseen by a board of member representatives
- Technical direction overseen by TSC
TrustedFirmware Diverse Community

- 30+ platform ports from 16+ vendors!
- 25+ partners contributing
Trusted Firmware-A (TF-A)

- Secure world reference software for all Arm Cortex-A & Neoverse processors across all market segments.
- Trusted boot flow and runtime firmware providing standard implementation of Arm specifications:
  - SMCCC (SMC Calling Convention)
  - TBBR (Trusted Board Boot Requirements)
  - PSCI (Power State Coordination Interface)
  - SCMI (System Control & Management Interface)
  - SPCI (Secure Partitions Client Interface)

[Diagram showing the relationship between Guest A, Guest B, App 1, App 2, Guest Linux Kernel A, Guest Linux Kernel B, Trusted OS, and Boot Firmware]

https://git.trustedfirmware.org/TF-A/trusted-firmware-a.git/about/
TF-A Boot Flow

MCP Runtime Firmware
  System & Power Control

BL30
SCP Runtime Firmware
  System & Power Control

BL0
SCP Boot ROM
  Platform Boot Initialization

BL2
Trusted Boot Firmware
  Trusted Board Boot

BL1
AP Boot ROM
  Trusted Board Boot

BL32
Secure-EL1 Payload
  Trusted OS Kernel

BL31
EL3 Runtime Firmware
  SMCCC
  PSCI
  World Switch Library
  S-EL1 Payload Dispatch

BL33
Non-Trusted Firmware (e.g. UEFI, UBoot)

MCP Boot ROM
Platform Boot Initialization

OS Boot Loader

Application Processor (AP)

SCP Boot ROM
Platform Boot Initialization

Reset
MCP
Reset
SCP

1st Level Boot Loader (BL1) loads 2nd level image
2nd Level Boot Loader (BL2) loads all 3rd level images

Boot progress
TianoCore

- [https://www.tianocore.org/](https://www.tianocore.org/)
- Community project supporting open source implementation of Unified Extensible Firmware Interface (UEFI) firmware
- Covering multiple standards: UEFI, PI, ACPI, SMBIOS, UEFI Shell, etc.
- Main project: **EDK2**. Modern, feature-rich, cross-platform firmware development environment for the UEFI and PI specifications.
- BSD-2-Clause-Patent license
Arm support on TianoCore

- Growing Arm implementations on edk2 and edk2-platform
  - Complete/partial platforms, silicon drivers, libraries, support code
  - Diverse community participation, continuous increase
Arm on UEFI Showcase – Raspberry Pi

- [https://rpi4-uefi.dev/](https://rpi4-uefi.dev/)
- Arm64 standards firmware for Raspberry Pi
  - RPi3: EBBR (EDK2 UEFI + Devicetree)
  - RPi4 : SBBR (EDK2 UEFI + ACPI), with Devicetree option
- Goal is to make the Pi "ServerReady" - Support standard OSes
- Fully open source (TianoCore + TF-A)
- Community driven collaboration (including VMware, Arm, and others in the community)
  - EDK2 up-stream: [https://github.com/tianocore/edk2-platforms/tree/master/Platform/RaspberryPi/](https://github.com/tianocore/edk2-platforms/tree/master/Platform/RaspberryPi/)
  - Discord community channel: #rpi4-uefi-dev ([https://discordapp.com/invite/fqRhc8y](https://discordapp.com/invite/fqRhc8y))
U-Boot Firmware

- [https://www.denx.de/wiki/U-Boot](https://www.denx.de/wiki/U-Boot)
- “Universal Bootloader.” Open source, GPL
- Supports multiple architectures (including Arm/Arm64)
- Portable, easy to port/debug
- Many (100s) boards up-streamed
- Suitable for embedded devices (predominantly vertically integrated ecosystem)
- U-Boot implements UEFI ABI as required by EBBR
  - Support both Arm64 and x64
  - Allows standard OS bootloader (like GRUB) to load and boot standard OS
LinuxBoot

- [https://linuxboot.org/](https://linuxboot.org/)
- LinuxBoot is a firmware for servers that replaces specific firmware functionality like the UEFI DXE phase with a Linux kernel and runtime
- Re-use existing Linux drivers code (without the need to write DXE/UEFI drivers)
- Two approaches on Arm servers:
  - LinuxBoot in UEFI FV (replace UEFI Shell binary with LinuxBoot binary)
  - Direct load from TF-A to LinuxBoot (no UEFI)
- It is still possible to implement UEFI/APCI/SMBIOS/DT ABIs (or carry “blobs”) in LinuxBoot for final OS consumption
LinuxBoot and UEFI

- In addition to ACPI/SMBIOS/DT payloads pushed to the final OS, LinuxBoot *could* publish UEFI ABI to the final OS
  - UEFI is an API spec. DXE/PI are not required to implement UEFI (or UEFI Runtime Services)
  - Similar to U-Boot's UEFI implementation (EBBR)
  - Enables OS functionality that depends on UEFI runtime APIs
Questions?
Thanks for attending the UEFI 2020 Virtual Plugfest

For more information on UEFI Forum and UEFI Specifications, visit http://www.uefi.org

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