TF-A Tech Forum
Secure EL2 firmware

Olivier Deprez (Arm)

Andrew Walbran (Google)

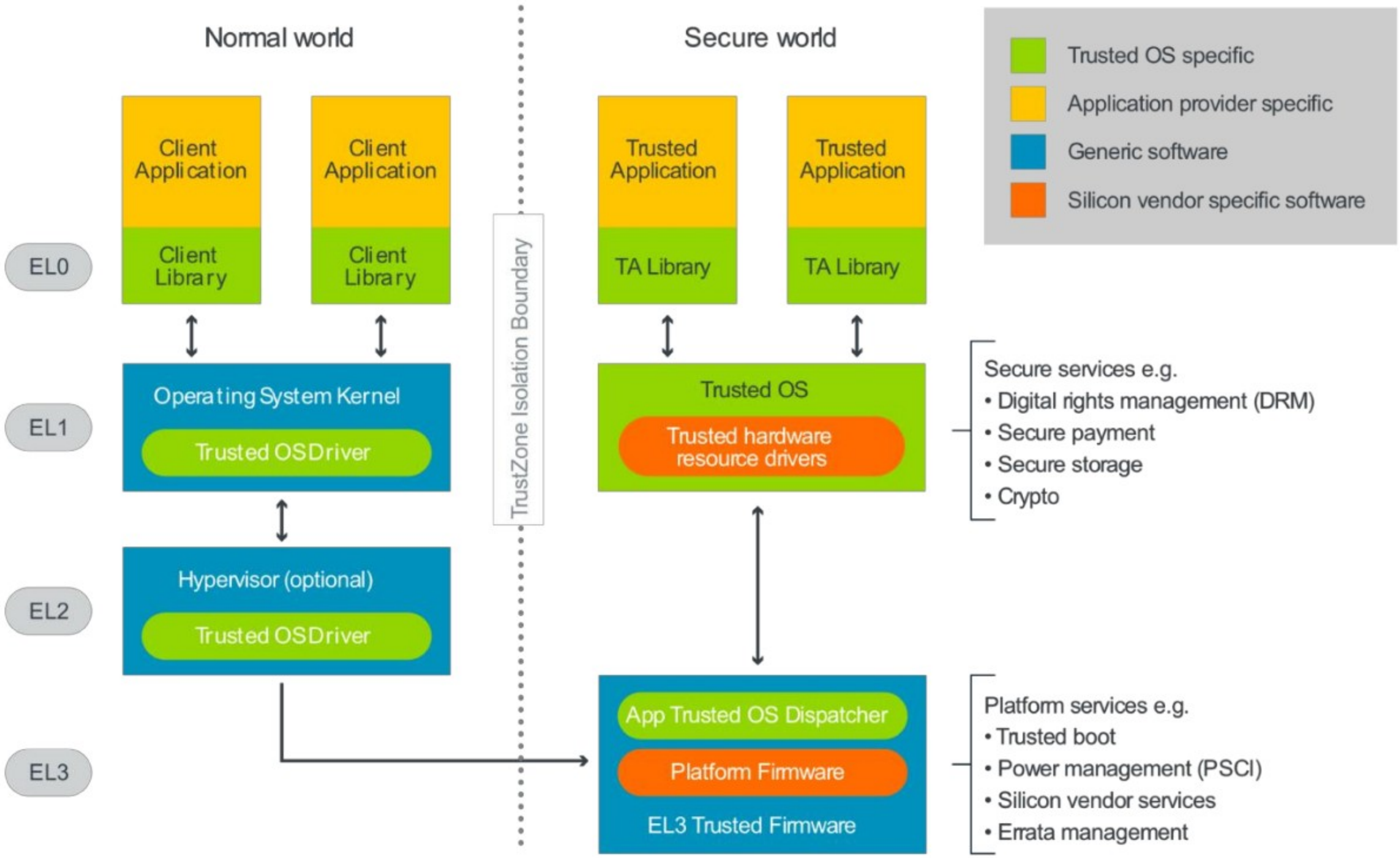
July 2020

Agenda

- Why an S-EL2 firmware ?
- What is Hafnium ?
- Hafnium as the S-EL2 firmware
- Project goals and status
- TF-A release contents
- PSA FF-A adoption
- CI and testing
- Upstream activity
- Q&A

Why an S-EL2 firmware?

- “Isolation using virtualization in the Secure world” white paper
  - https://community.arm.com/developer/ip-products/processors/b/processors-ip-blog/posts/architecting-more-secure-world-with-isolation-and-virtualization
- Current architecture



Why an S-EL2 firmware?

- Challenges
  - Trusted Applications ecosystem
  - Integration of code from multiple vendors in the secure world
  - Principle of least privilege
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- Solution
  - Isolation between multiple mutually mistrusting Trusted OSes
    - Leverage “Secure EL2” Armv8.4-SecEL2 extensions
  - PSA FF-A (formerly SPCI)
    - Secure Partition Manager at S-EL2
    - Standard APIs across boundaries (Hypervisor/VMs, SPM/SP, Hypervisor/SPM)

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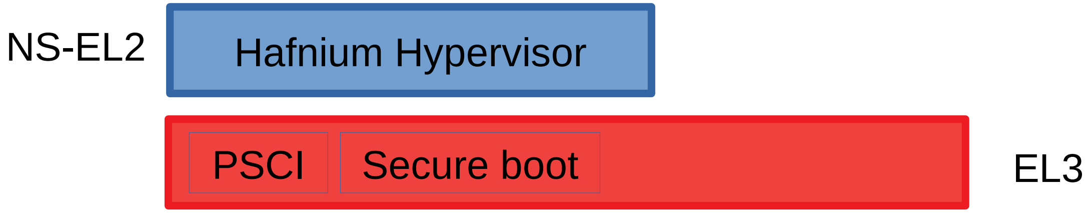
- Type-1 “bare-metal” Hypervisor running in the Normal World
- Supports AArch64 NS-EL2



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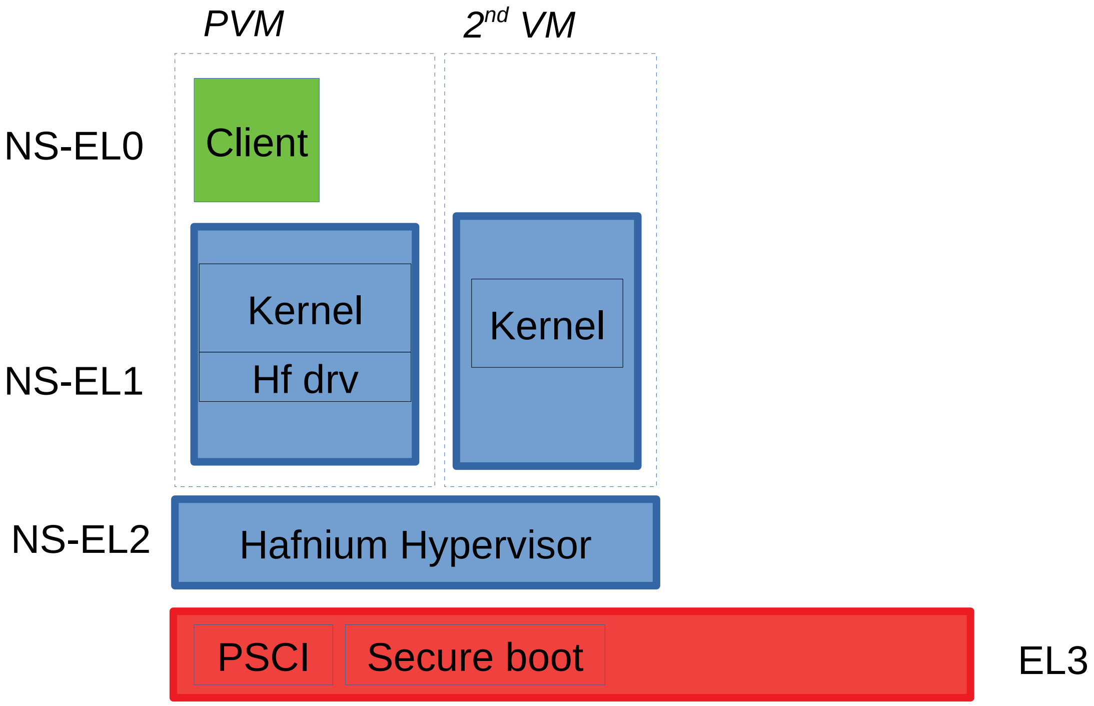
- Instantiates untrusted VMs at NS-EL1
- Isolates VM memory through Stage-2 MMU
- Provides VM-to-VM communication
- Low latency primary VM schedules secondary VMs



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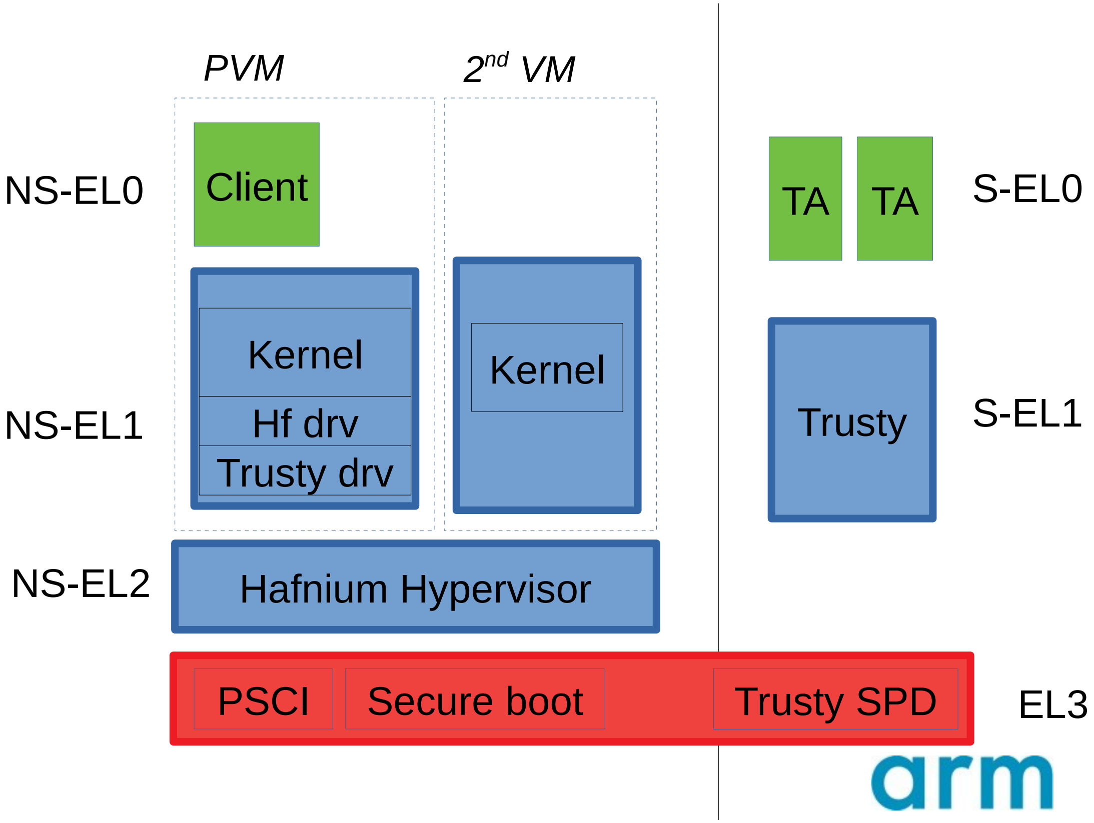

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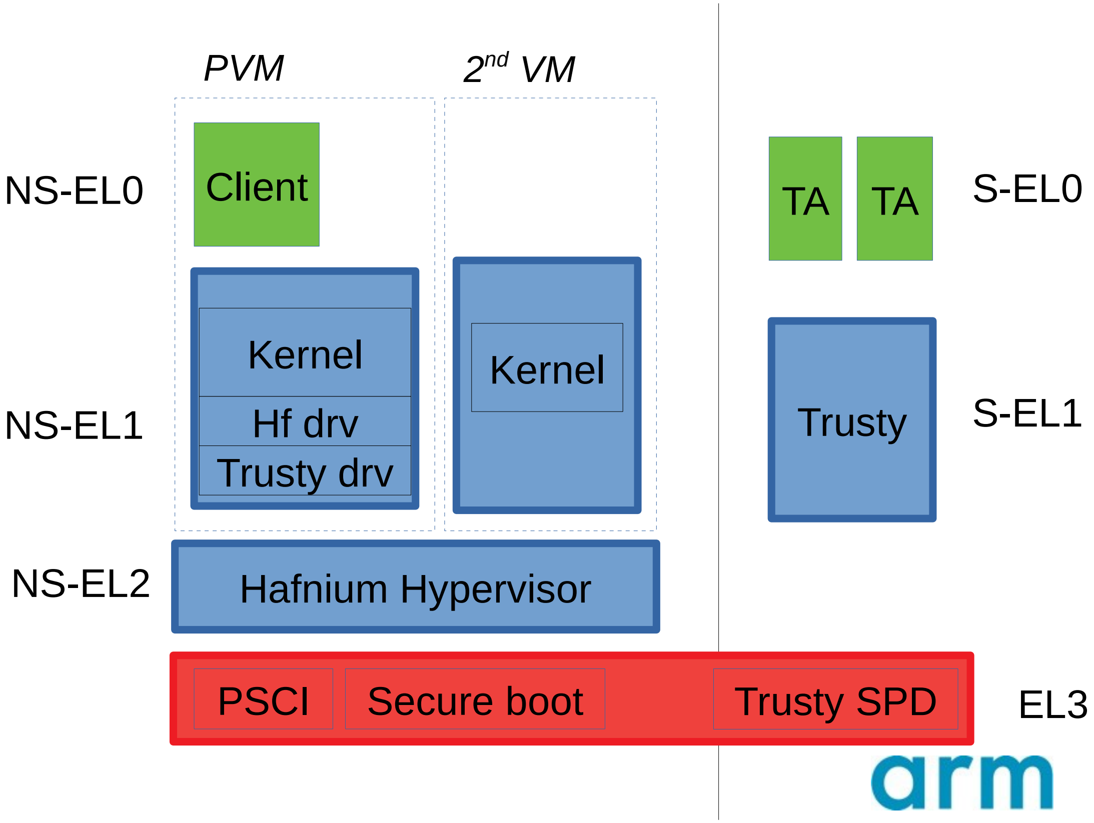
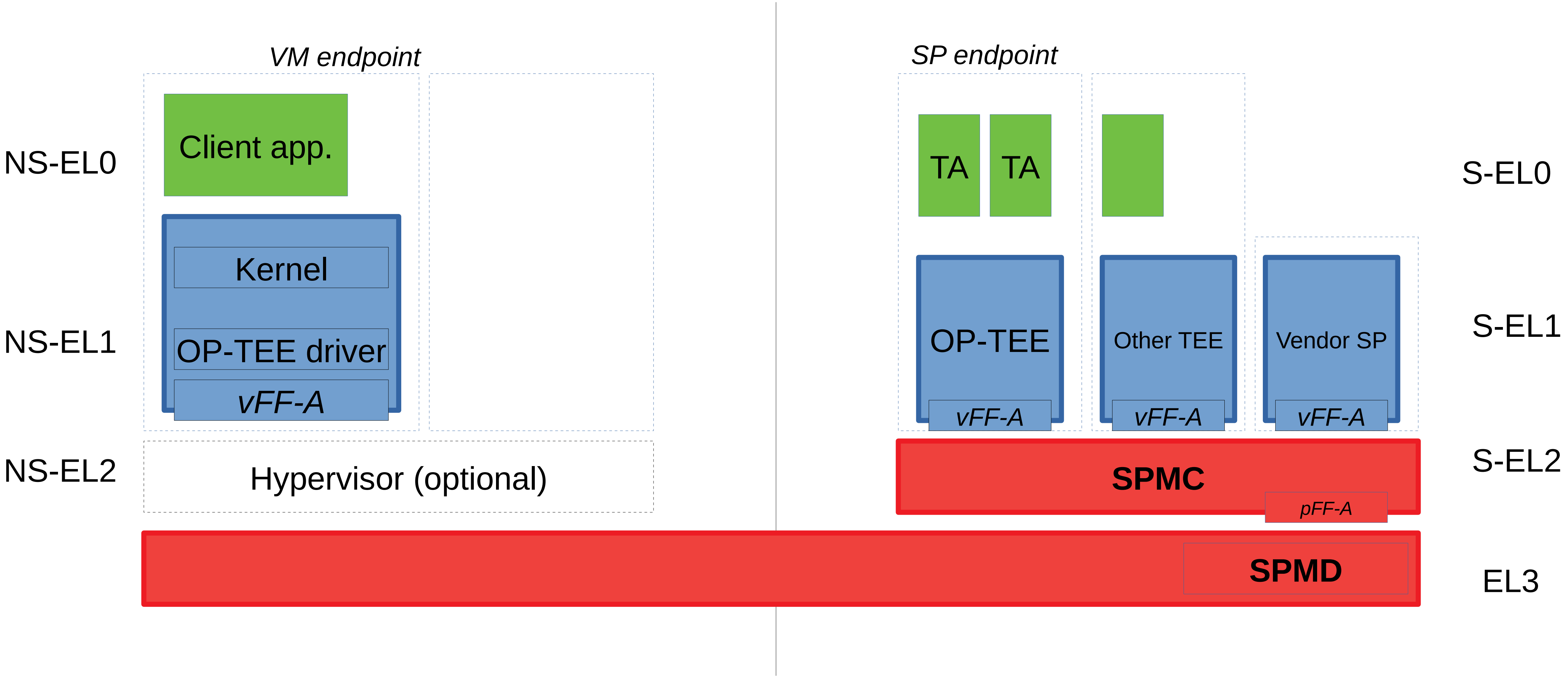
- Fast build system
- Build targets FVP, QEMU, Rpi
- Hafnium test suite



Hafnium as the S-EL2 firmware

- Proposed TF-A end-to-end stack



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  - Project relicensed to BSD-3. Linux driver GPLv2
  - Co-maintained by Arm and Google
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- NWd Hypervisor codebase mainly maintained and used as:
  - a test vehicle to schedule SPs
  - a sanity checker for PSA FF-A in the NWd (Hypervisor)

Project goals

- Open-source S-EL2 “Secure Partition Manager” reference firmware
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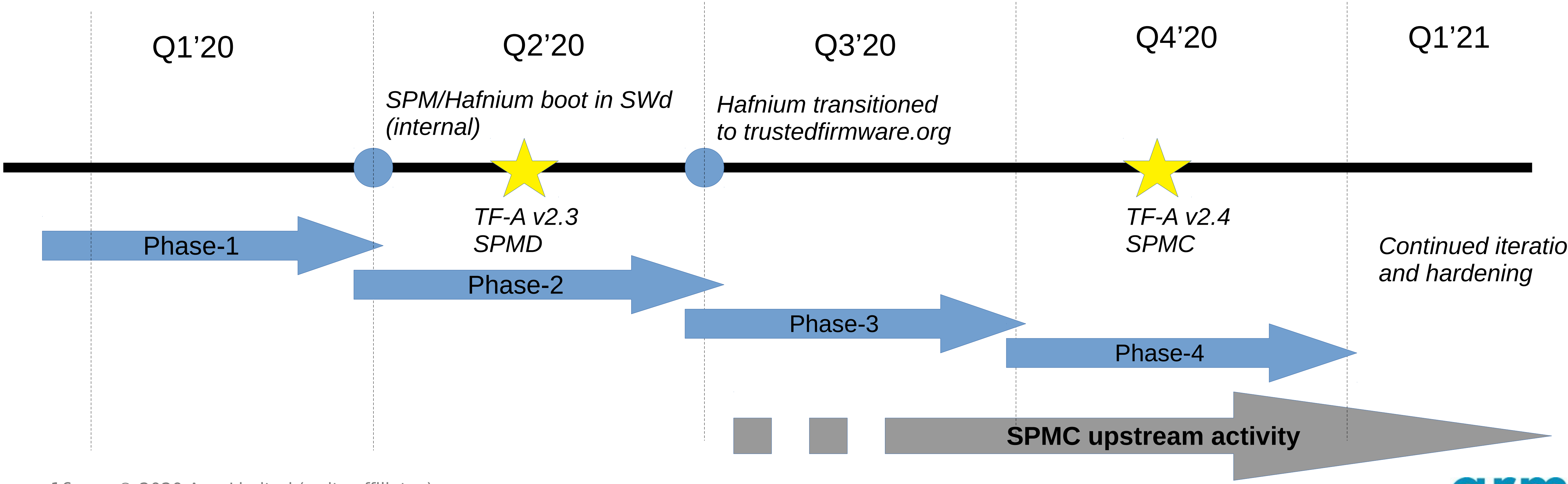
- Adopt PSA FF-A in Hafnium code base
- Well progressed on the NWd side and benefits SWd
- But still requires further additions/adaptations:
  - Booting in the SWd
  - Power management
  - Missing FF-A ABIs
  - World switch through SPMD
  - Memory sharing (VM-SP / SP-SP)
  - Interrupt handling

Project status

- Phased development started in the open
  - SPM boot story, prototyping
  - Secure boot enablement, FF-A setup and discovery, patch upstream kick-off
  - Multicore boot, Multiple secure partitions, Interrupt management, memory sharing
  - IO/SMMU support, S-EL0 only partitions, AArch32 SPs


Q1’20
Q2’20
Q3’20
Q4’20
Q1’21
SPM/Hafnium boot in SWd (internal)
Hafnium transitioned to trustedfirmware.org
TF-A v2.3 SPMD
TF-A v2.4 SPMC
Continued iterations and hardening
Phase-1
Phase-2
Phase-3
Phase-4
SPMC upstream activity

TF-A releases contents

- v2.3
  - Armv8.4-SecEL2 extension support
  - SPMD supports SPMC at S-EL1 or S-EL2
  - EL2 context save/restore in SWd
  - Platform changes to boot Hafnium/SPMC at S-EL2
  - Secure Partitions packaging
- v2.4 (planned by Q4)
  - Secure boot of Secure Partitions
  - SPMC first tag in a TF-A release
    - FF-A setup and discovery interfaces
    - Minimum support to boot OP-TEE as a SP + NWd driver probing
    - Reproducible builds and CI

PSA FF-A adoption

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- Generic SPMD
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- SMC service forwarding to SPMC
  - Former EL3 SPM using MM interface
  - Hooks for new services

CI

- Hafnium CI
  - Host unit tests, arch tests, VM API tests, Linux tests
  - Run manually on the developer machine, possibly using docker
  - jenkins job run on any patch submission, requires Verified+1 to merge

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- Daily TF-A CI test runs
- Expect to improve both “CIs” integration as part of OpenCI project

Description	Configuration
Boot OPTEE as SPMC at S-EL1 (pre-Armv8.4)	TFTF at NS-EL2 + SPMD at EL3 + OP-TEE/SPMC at S-EL1
Check Hafnium/SPMC boot using Armv8.4-SecEL2 extensions	TFTF at NS-EL2 + SPMD at EL3 + Hafnium/SPMC at S-EL2 + Cactus at S-EL1
Hafnium Hypervisor and SPMC using Armv8.4-SecEL2 extensions Bare-metal secure partitions, check Linux boot in PVM	Linux PVM at NS-EL1 + Hafnium/Hypervisor at NS-EL2 + SPMD at EL3 + Hafnium/SPMC at S-EL2 + Cactus at S-EL1
Boot OP-TEE as a Secure Partition on top of SPMC	TFTF at NS-EL2 + SPMD at EL3 + Hafnium/SPMC at S-EL2 + OP-TEE Secure Partition at S-EL1
OP-TEE as a Secure Partition on top of SPMC, Linux boot and OP-TEE kernel module init.	*(under development)* Linux at NS-EL1 + SPMD at EL3 + Hafnium/SPMC at S-EL2 + OP-TEE Secure Partition at S-EL1
Secure boot of secure partitions using dual root key CoT	
Secure boot of secure partitions using TBBR single root key CoT	

Upstream activity

- Now happening through https://review.trustedfirmware.org
- 3 patches merged
- 15 WIP/under review
  - Early bring up patches
  - Direct messaging implementation
  - FF-A manifest parsing
  - Partition info get FF-A ABI
  - https://review.trustedfirmware.org/q/topic:%22spm-wip%22+(status:open%20OR%20status:merged
)

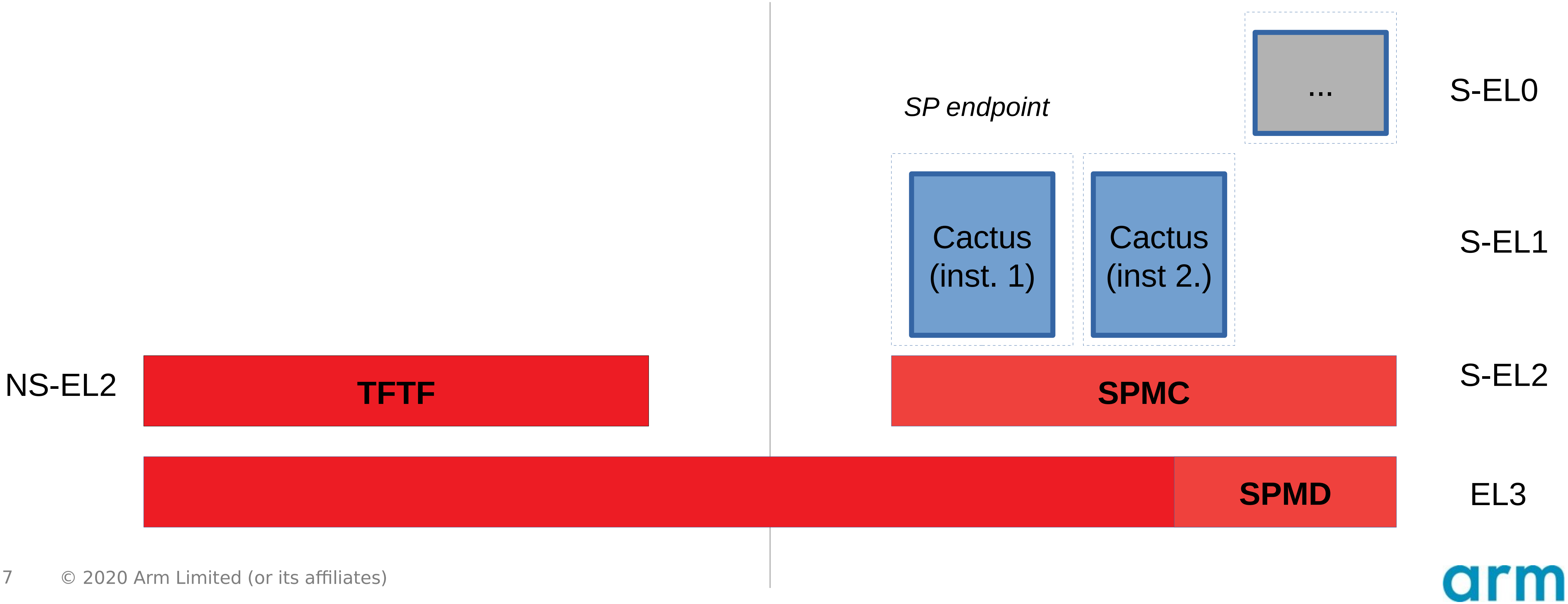
Resources

- Meet at Linaro Virtual Connect September 2020
- Hafnium documentation
  - https://review.trustedfirmware.org/plugins/gitiles/hafnium/hafnium/+/HEAD/README.md
- PSA FF-A
  - https://developer.arm.com/documentation/den0077/latest
- TF-A SPM documentation
  - https://review.trustedfirmware.org/c/TF-A/trusted-firmware-a/+/4637
- Gerrit code reviews
  - https://review.trustedfirmware.org/q/status:open+project:hafnium/hafnium
- ML
  - https://lists.trustedfirmware.org/mailman/listinfo/hafnium
- Phabricator
  - https://developer.trustedfirmware.org/tag/hafnium/

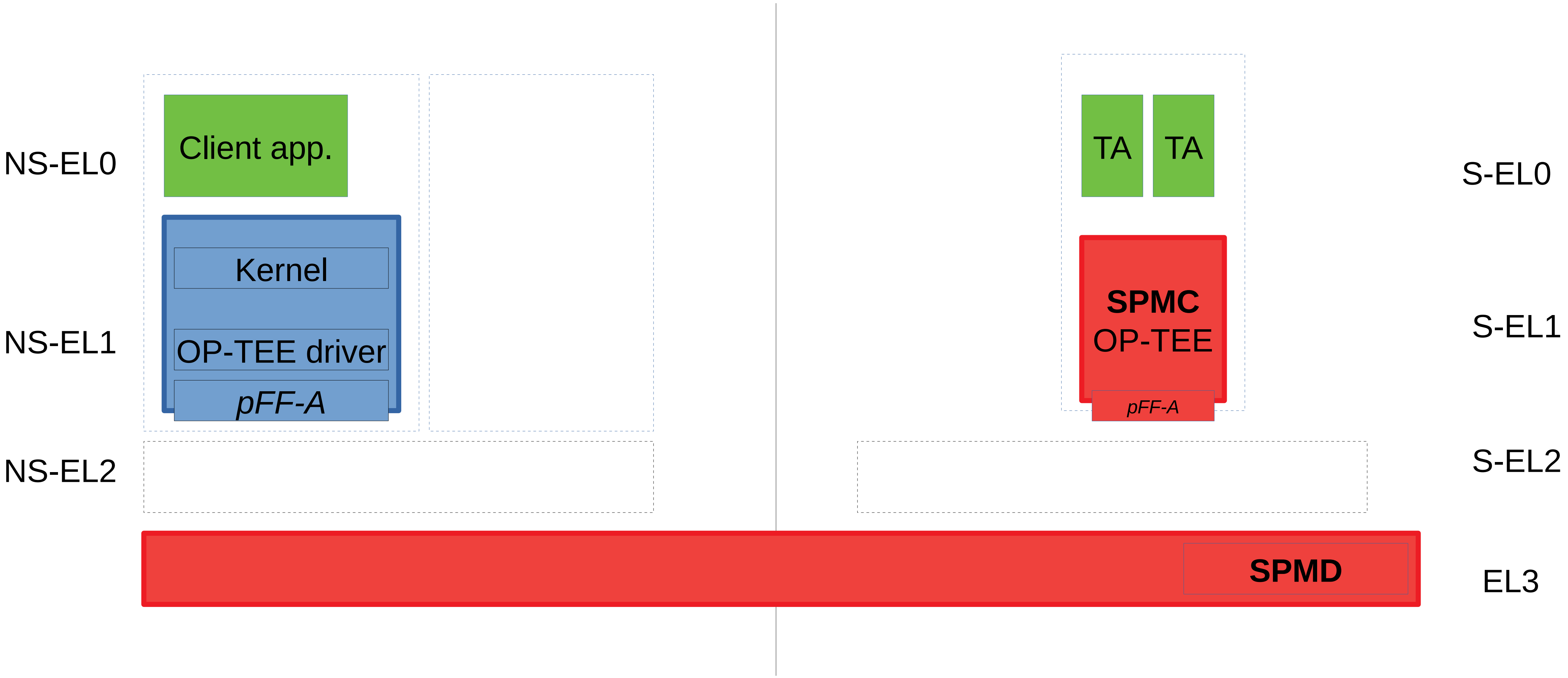
Backup

TFTF and Cactus TF-A-tests test harness

- Testing at NS physical FF-A interface
- Cactus bare-metal partitions



SPMD support for pre-Armv8.4 systems


NS-EL0
Client app.
Kernel
NS-EL1
OP-TEE driver
pFF-A
NS-EL2
TA
TA
S-EL0
SPMC
OP-TEE
pFF-A
S-EL1
S-EL2
SPMD
EL3