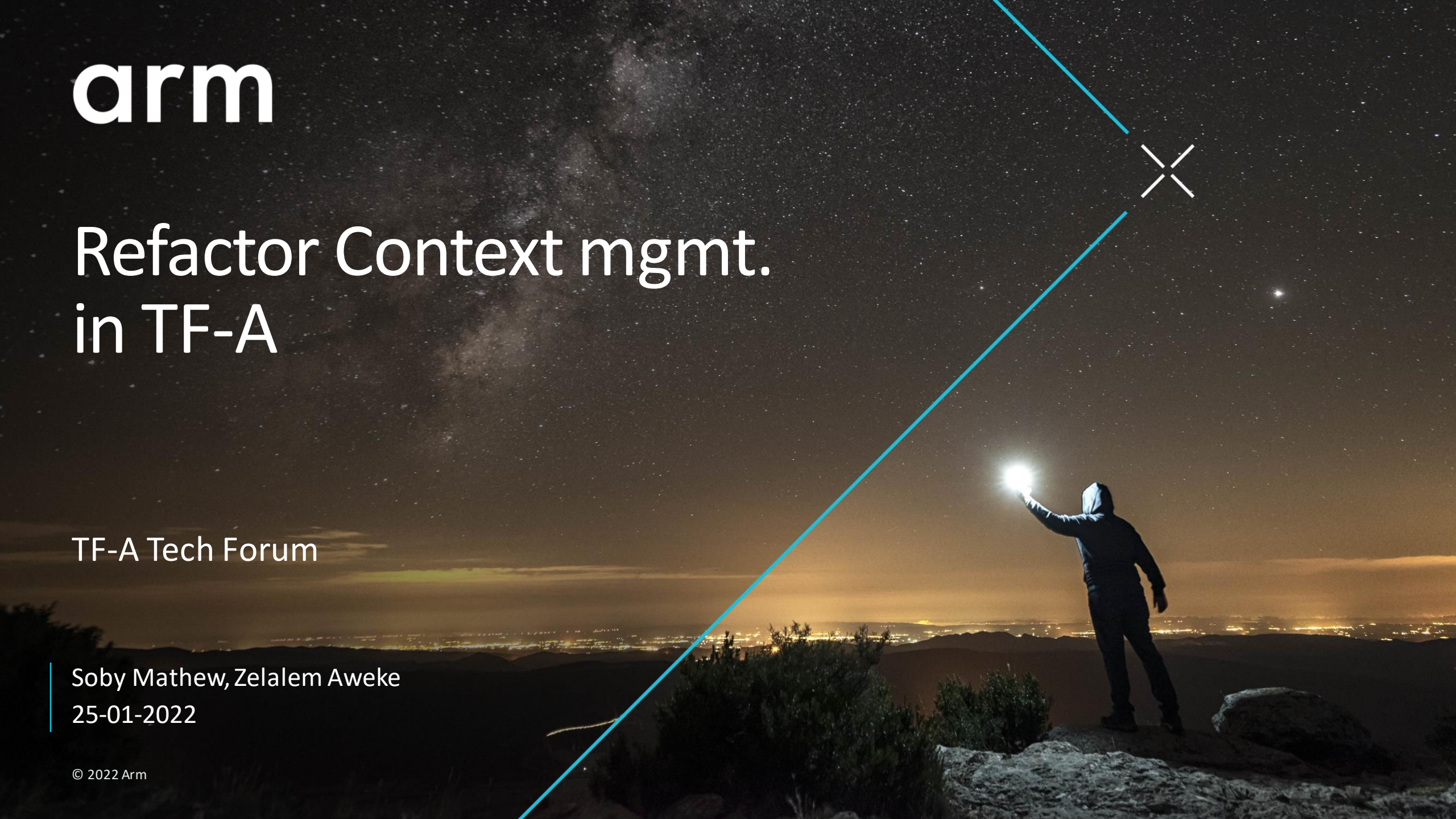

Refactor Context mgmt. in TF-A

TF-A Tech Forum

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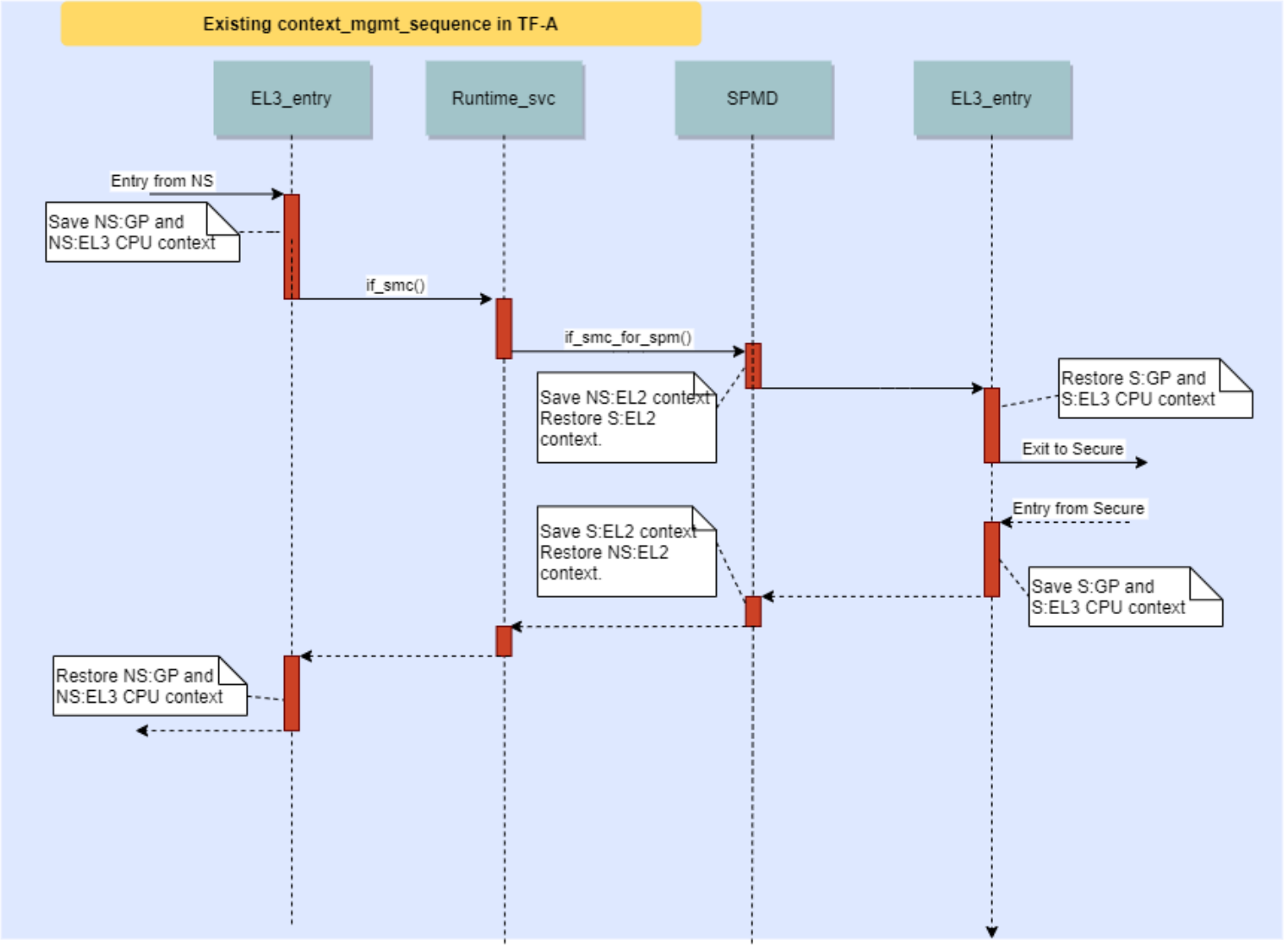
Introduction

- The context management library in TF-A provides helper routines for initialization and switching CPU context during world switch.
  - BL31 maintains CPU Context for each world which is initialized during cold boot. CPU features are enabled depending on the EL3 sysregs programmed.
  - At runtime, depending on the SMC/event, SPMD/RMMD invokes context management helpers to save and restore the context.
- Due to the gradual evolution of this library over time, the current state has made it a maintenance hazard and prone to programming errors.
- The agenda is to discuss the overall design direction on how to refactor the lib.
  - Some of the details may undergo further refinement if implementation shows difficulties.

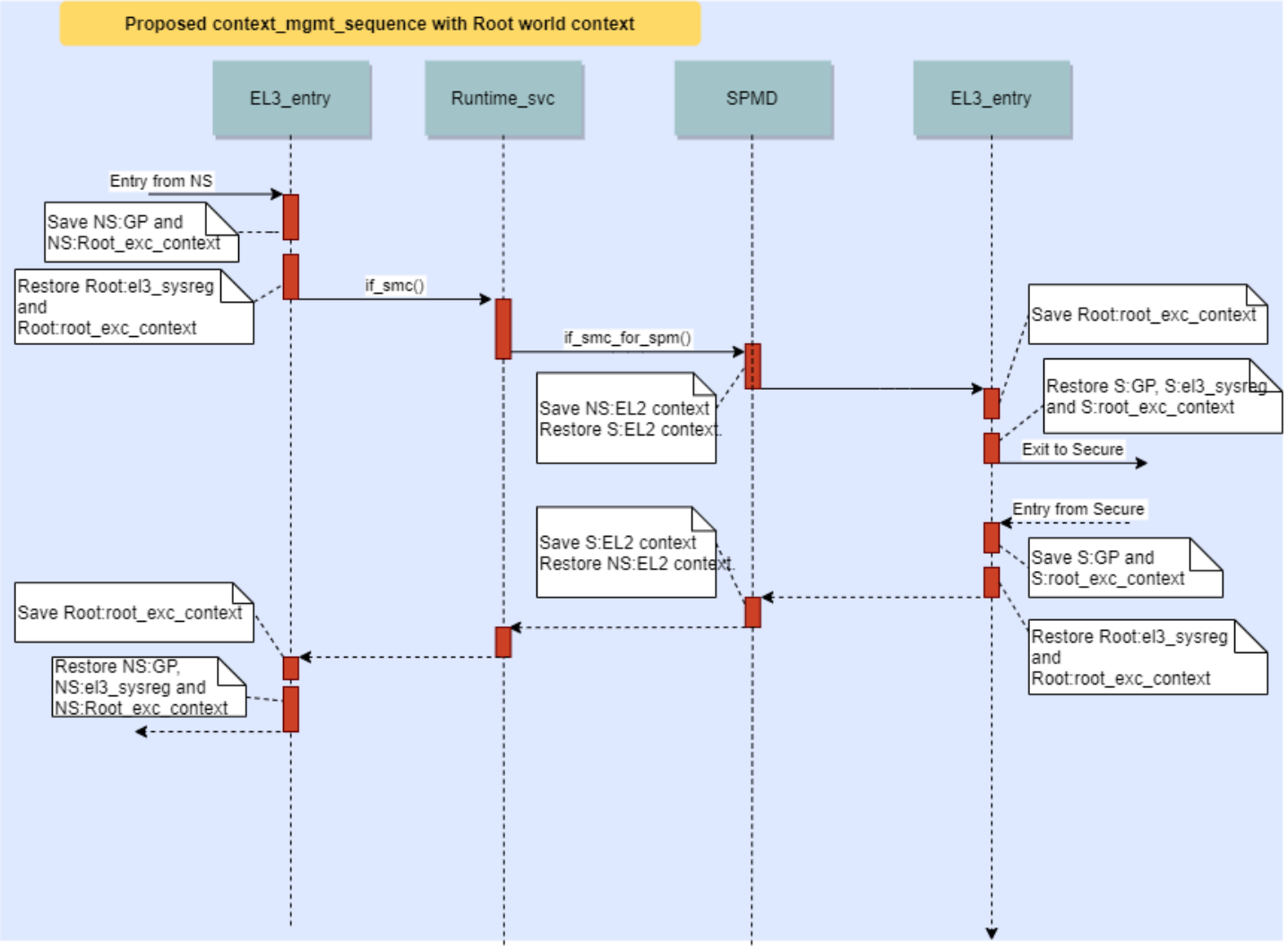
Design Principles

- **Decentralized model for context mgmt.**
  - **See cm_setup_context()**
  - **Move world responsibility to world dispatcher and decentralize the management.**
- **EL3 should only initialize immediate used lower EL**
  - **Since it is likely that EL2 is managing the EL1 context , EL3 need not initialize this.**
  - **To maintain confidentiality between worlds, it may be necessary to restore EL1 context.**
    - **Depends on how SPM and RMM is managing EL1 context.**
- **Maintain EL3 sysregs which affect lower EL within CPU context**
  - **Allows per-world control of traps/feature enablement.**
  - **This is the pattern followed more or less in code today.**
- **Allow more flexibility for Dispatchers to select feature set to save and restore**
  - **See el2_sysregs_context_save()**
  - **Break up the monolithic into several smaller functions and allow dispatchers to choose.**

Introducing the Root Context – why is it needed ?



Context mgmt. with Root context



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Proposed Changes

1. Cleanup context registers

Cleanup EL3 context

- Add more registers that control features/traps for lower Els to EL3 context

- Registers that don't need to have different values across the worlds can be removed from this context

Cleanup EL2 context

- Remove registers that are only accessible from Secure state from EL2 context

2. Cleanup *cm_setup_context*

- Split *cm_setup_context* and move security state specific logic to corresponding functions:
  - *cm_setup_common* – common inits
  - *cm_setup_secure_context* – Secure state specific inits, used by SPMD
  - *cm_setup_realm_context* – Realm state specific inits, used by RMMD
  - *cm_setup_ns_context* – NS state specific inits, used by PSCI/BL31
- Same interface as *cm_setup_context*
- Legacy code can keep using *cm_setup_context* and can transition gradually

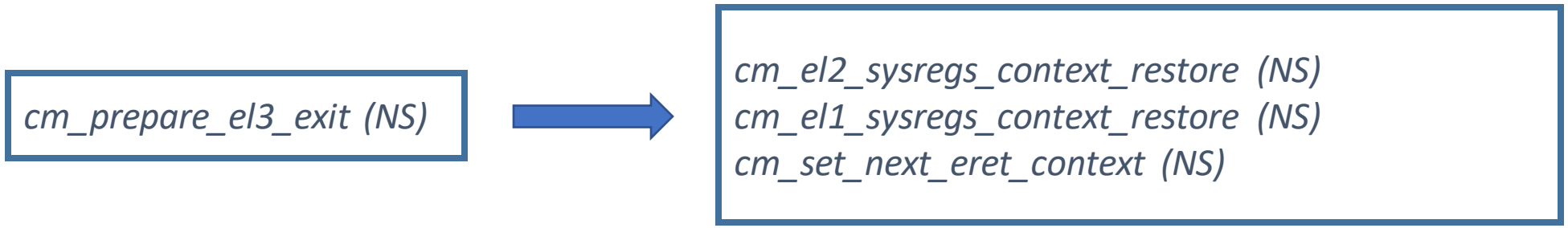
3. Alternative flow for first exit to NS world

- Today *cm_prepare_el3_exit* is used to exit to NS world from EL3 the first time

- Current implementation does the following:
  1) Directly initializes EL2 registers for two NS cases:
     - For exiting to NS-EL2 (HYP mode)
     - For exiting to NS-EL1 (SVC mode) - skip EL2 config
  2) Enables features for non-secure case
  3) Restores EL1 context with *cm_el1_sysregs_context_restore* for all cases (secure/non-secure)
  4) Sets next context with *cm_set_next_eret_context*

Alternative flow when CTX_INCLUDE_EL2_REGS is enabled

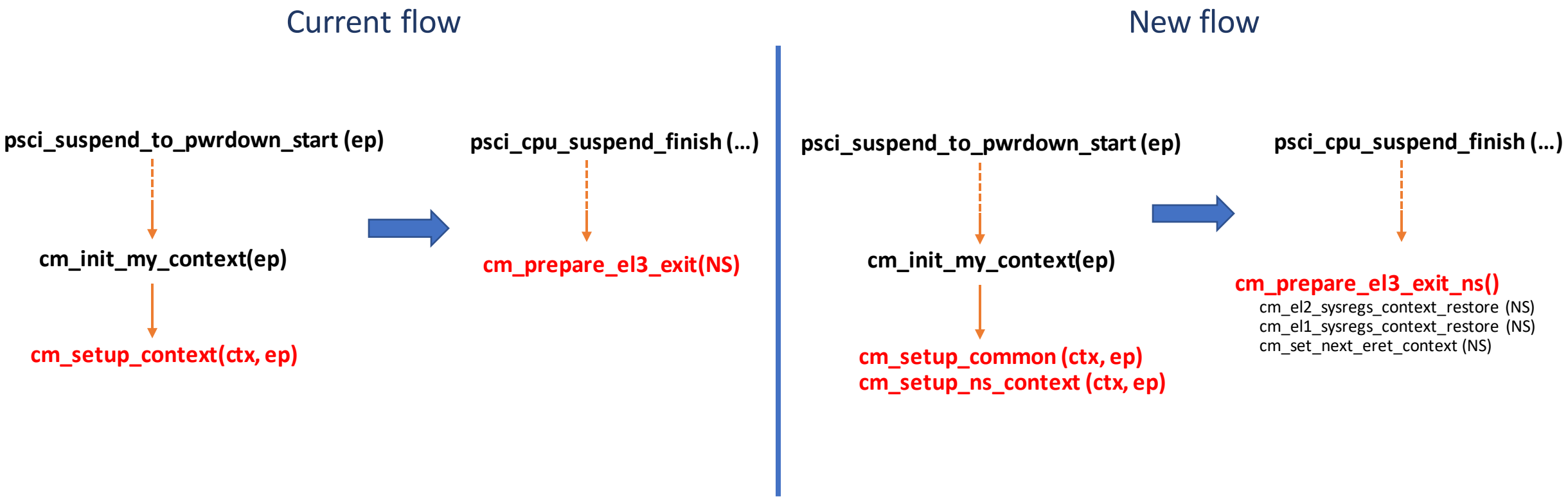
- Move (1) and (2) to *cm_setup_ns_context* and do the initializations **using context registers**
- Then later restore NS context, similar to what SPMD and RMMD do:



**cm_el1_sysregs_context_restore (NS) is needed for exit to EL2 to clear any latent values in EL1 regs after Secure world initialization. But this can likely be optimized.*

- If legacy cannot be supported after rework, a variant *`cm_prepare_el3_exit_ns` will be created.*

e.g. PSCI CPU power down



4. Cleanup *cm_el2_sysregs_context_save/restore*

- Currently these functions call *el2_sysregs_context_save/restore* assembly functions which do all EL2 register saving/restoring

- New proposal:
  - Use *el2_sysregs_context_save/restore* only for common registers (maybe rename to *el2_sysregs_context_save/restore_common*)
  - Move feature specific register save/restore out of *el2_sysregs_context_save/restore* into their own assembly functions eg : *el2_sysregs_context_feat_xxx_save/restore*
  - *SPMD and RMMD* can choose which functions to call dynamically or using feature build flags

5. Add Root context

- Prototype the changes and assess the impact on the code base
  - Identify registers that should be part of *root_exc_context*
  - Implement prototype to assess the impact on binary size and SMC call response latency
- Depending on results, we need to see how best to take it forward

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Thank You
Danke
Gracias
Grazie
谢谢
ありがとう
Asante
Merci
감사합니다
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Kiitos
شكرًا
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