



# M-mode Secondary Context Extension

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information see: <https://riscv.org/spec-state>

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# Chapter 1. Motivation

The major goal of M-mode trusted context extension is to offer a way for trusted Oses/Services/Drivers to run on M-mode, isolated from the secure monitor/firmware and from each-other, on M/U-only systems.

**Threat model:** Having all those elements running at the highest privilege together with the secure monitor, without memory isolation between them, increases the attack surface of the system. Also some or all of these elements may be 3rd party proprietary binaries, outside the vendor's control / trust domain. On a system with S-mode available we'd have the secure monitor on M-mode and those elements on S-mode but on an M/U-only system we are constrained and have to come up with another solution.

## Chapter 2. M-Mode Secondary Context Extension

### 2.1. Requirements

The proposal currently has two requirements:

- ePMP must be implemented
- `mseccfg.MMWP` (i.e., Machine Mode Whitelist Policy) must be hardwired to 1

### 2.2. Proposal

The proposal introduces new fields in `mseccfg` and `pmpcfg`, which together implement the trusted context extension.

First, we add two new fields in `mseccfg`: SCP (Secondary context extension) and PC (Primary context) fields, as shown in the following Figure.

TODO: figure-1 to show `mseccfg` extension

- `mseccfg.SCP` (Secondary context extension): SCP is hardwired to 1 in case this extension is implemented.
- `mseccfg.PC` (Primary context): represents whether the current M-mode is in Primary context (its value is 1) or in Secondary Context (its value is 0).

Primary context has more permissions than secondary context (see next section for details). On hart reset, `mseccfg.PC` is set to 1. Any writes to `mseccfg.PC` are ignored (WARL).

Second, we add one new field in each `pmpcfg`: S (rules for the Secondary context), as shown in the following Figure.

TODO: figure-2 to show `pmpcfg.S` extension

- `pmpcfg.S`: the rule is applied to a secondary context.

The combination `pmpcfg.S == 1 && pmpcfg.L == 0` is reserved for future use.

If this extension is not implemented, `mseccfg.SCP` is hardwired to 0, and `mseccfg.PC` and `pmpcfg.S` are not defined, the bits remain reserved for other uses.

### 2.3. Permission and isolation

We clarify the permission differences between primary context and secondary context here.

When M-mode is in secondary contexts (i.e., `mseccfg.PC == 0`):

- any writes to M-mode CSRs are ignored (read-only access)
- accessing a region with `pmpcfg.S == 0` is denied

When M-mode is in the primary context (i.e., `mseccfg.PC == 1`):

- accessing a region with `pmpcfg.S == 1` is denied

Others:

- On trap / interrupt (when we jump to `mtvec`), hardware sets `mseccfg.PC` to 1
- On `mret`, hardware sets `mseccfg.PC` to 0

## 2.4. Changes on enforcement of M-mode-only PMP rules

An M-mode-only PMP rule (i.e., `pmpcfg.L == 1`) is enforced on Machine mode and denied in Supervisor or User mode, as defined in ePMP.

- Rules with `pmpcfg.S == 0` are processed first, ignoring rules with `pmpcfg.S == 1` (backwards compatible, no changes there)
- Rules with `pmpcfg.S == 1` are processed afterwards, with lower priority

This means if there is a rule matching the same region with `pmpcfg.S == 0`, the rule with `pmpcfg.S == 1` is ignored) Within each PMP ruleset, the standard PMP/ePMP priority is followed.

In other words it's as if we had 2 separate ePMP tables merged into one (1 table, 2 rulesets).

## 2.5. Changes on locking of PMP rules

- Rules with `pmpcfg.S == 0` follow the locking rules as defined on ePMP (backwards compatible, no changes there)
- Rules with `pmpcfg.S == 1` can be added/deleted/modified when `mseccfg.PC == 1`, regardless of `mseccfg.RLB` and `pmpcfg.L`

## 2.6. Operations

We explain the usual operations with the extension. Assuming `mseccfg.MML` is set.

Firmware (or secure monitor) allocates a region for each trusted OS, services, and driver, verifies and unpacks them in memory. It can then context-switch between them on M-mode by dynamically adding or removing PMP rules with `pmpcfg.L == 1 && pmpcfg.S == 1`. Depending on the security requirements there can be multiple rules active at the same time, allowing for example the OS to perform direct calls to a driver or a service, or share data regions, without going through the secure monitor.

Alternatively only one region may be active at a time, and switching between the OS and a service goes through the secure monitor. Establishing communication channels between trusted OSes, services, and drivers is up to the software implementation. Note that shared regions between the trusted OSes, services, drivers and the firmware are not available.

On context-switching, the firmware (secure monitor) sets `mepc` to a trusted region or user region and performs `mret`, setting `mseccfg.PC` to 0 and allowing access to the non-firmware regions while blocking access to the firmware code. Once inside the trusted OSes, services, drivers, it won't be possible to modify any PMP rules with `pmpcfg.L == 1` (assuming `mseccfg.RLB` is disabled as it should), nor access firmware's memory. It can only manage U mode regions.