School of Computer Science & Engineering

Trustworthy Systems Group

Two new frontiers for seL4's refinement proofs: Time protection and OS service verification

Dr Robert Sison

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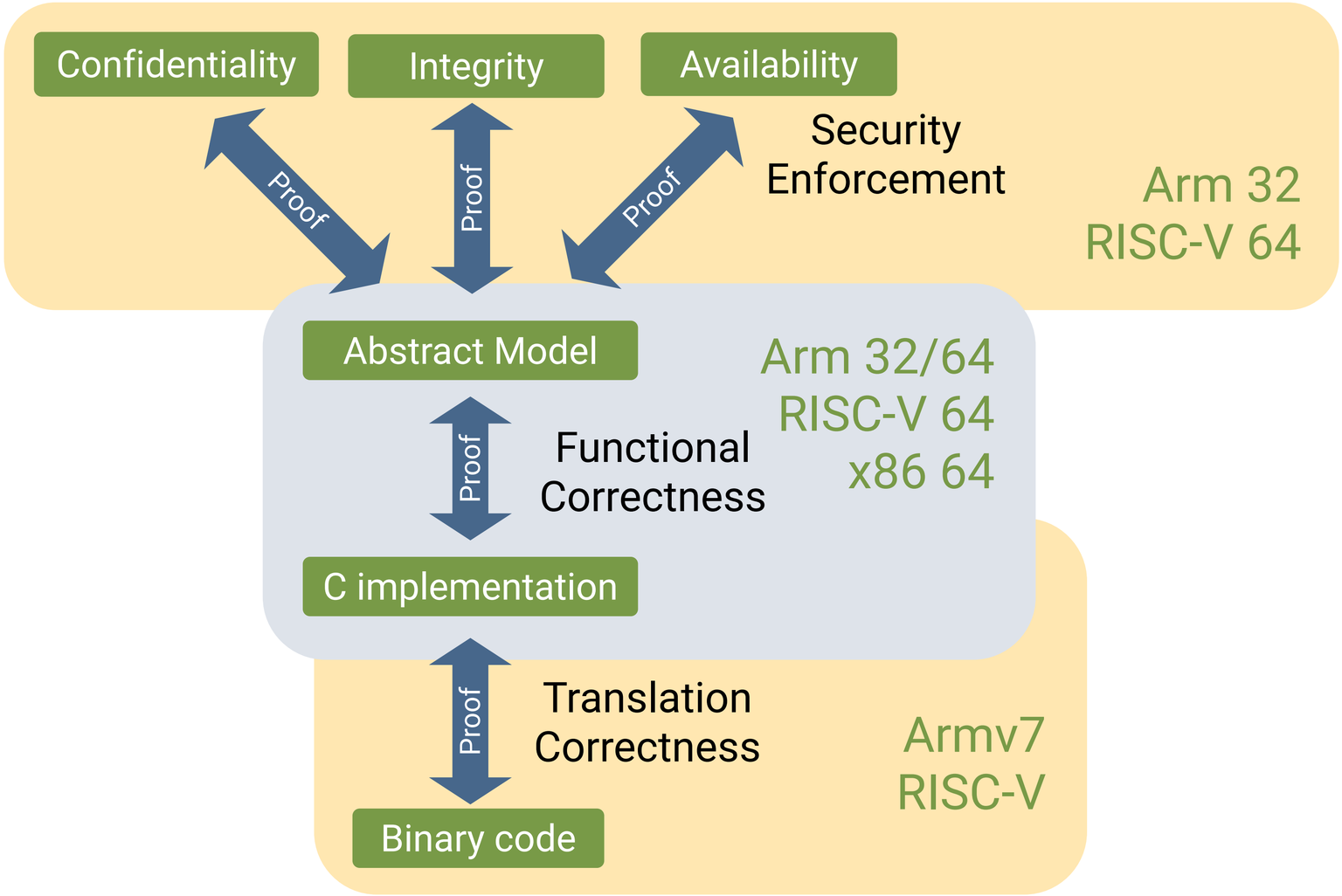
What is seL4?



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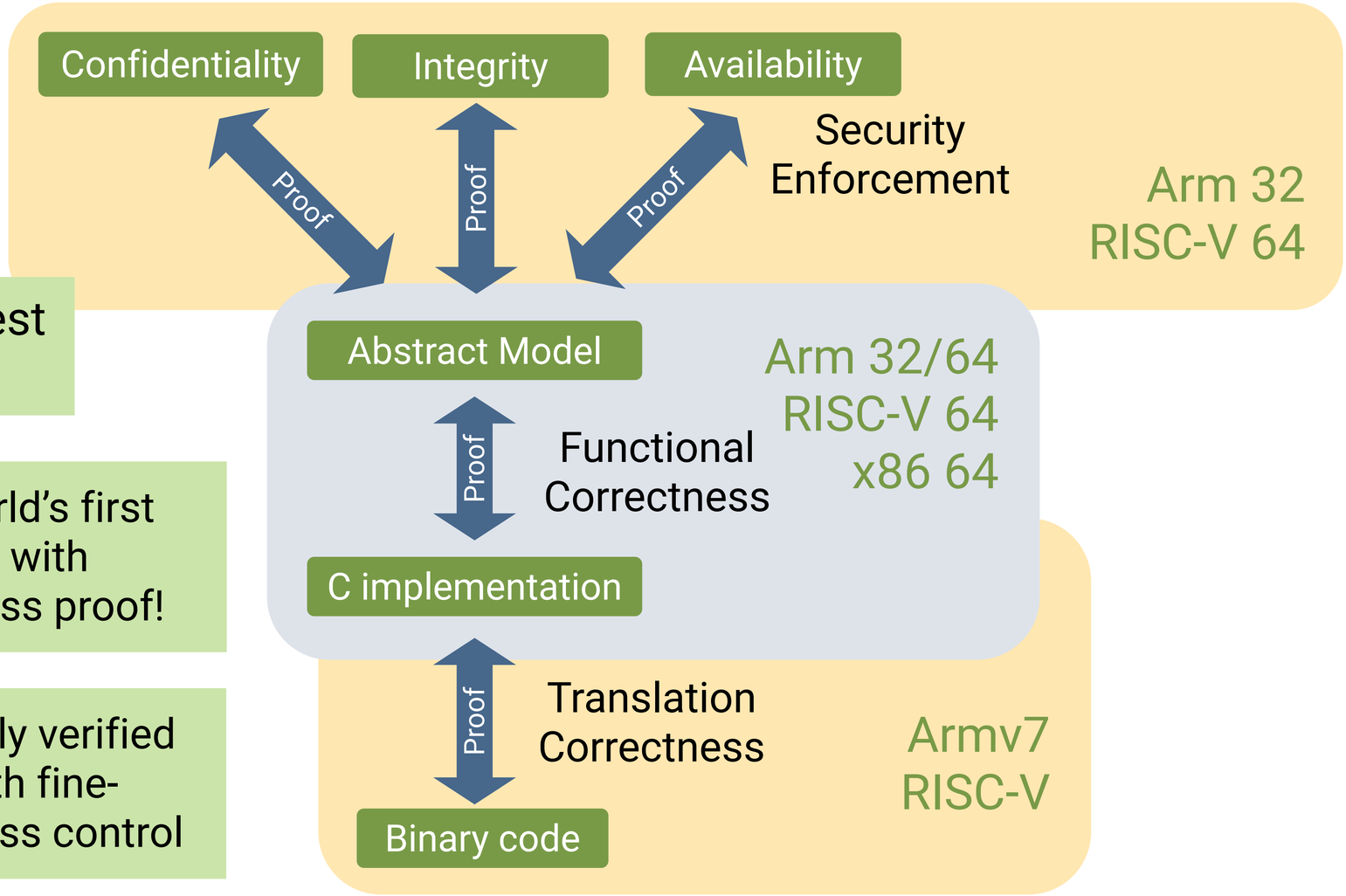

World's fastest microkernel!

seL4: World's first OS kernel with correctness proof!

seL4: Still only verified OS kernel with fine-grained access control

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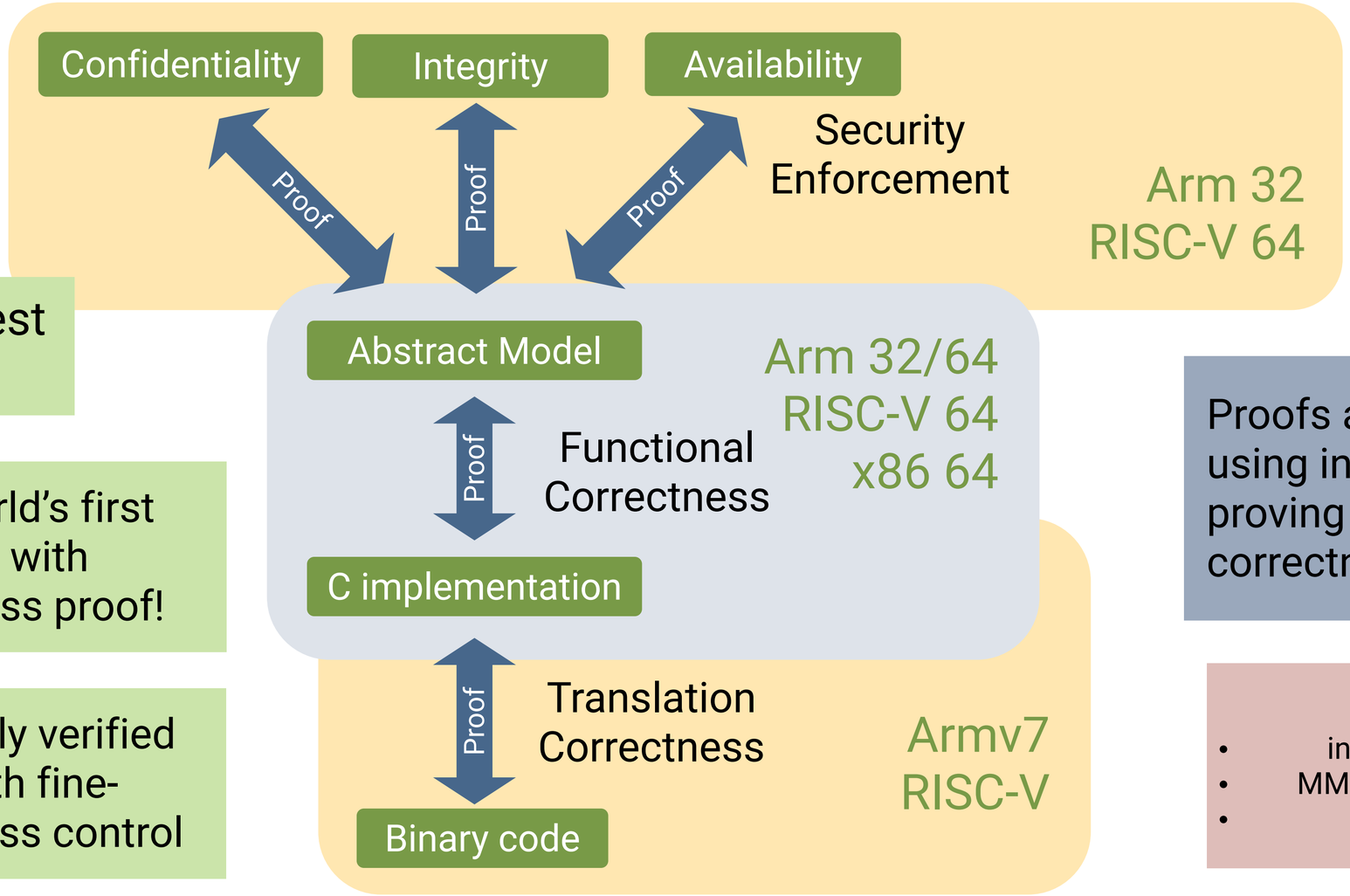

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Proofs are machine-checked, using interactive theorem proving (translation correctness fully automated)

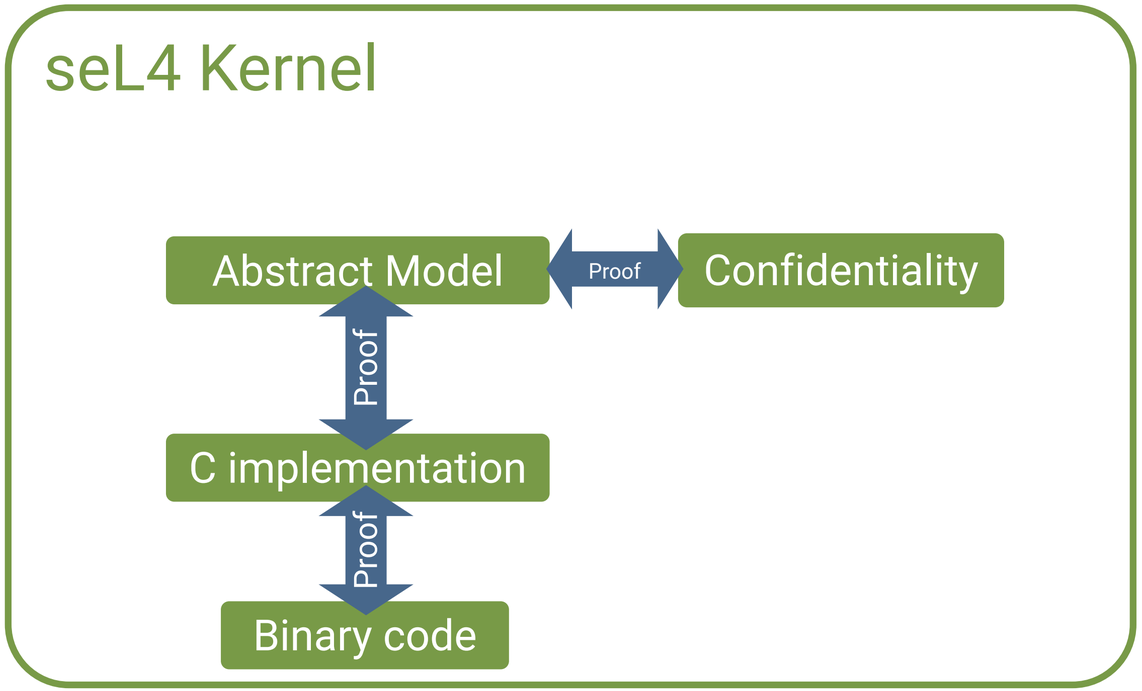
Present limitations
- initialisation code not verified
- MMU, caches modelled abstractly
- Multicore not yet verified

Two new frontiers for seL4 refinement

Functional Correctness

+

Security Enforcement



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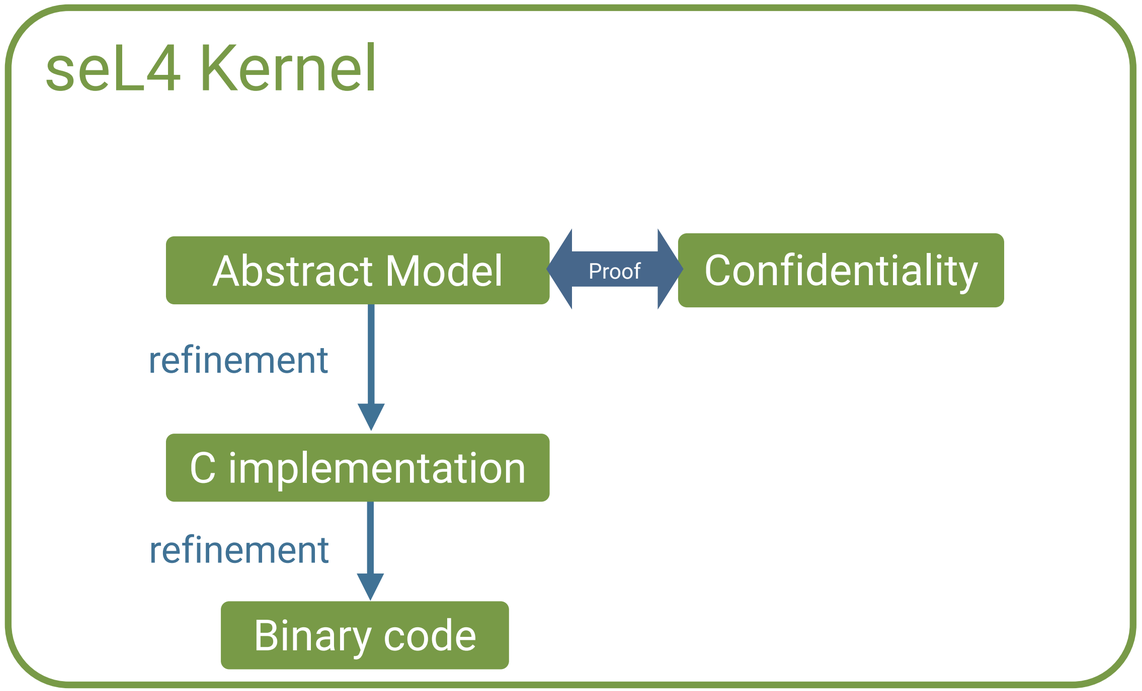

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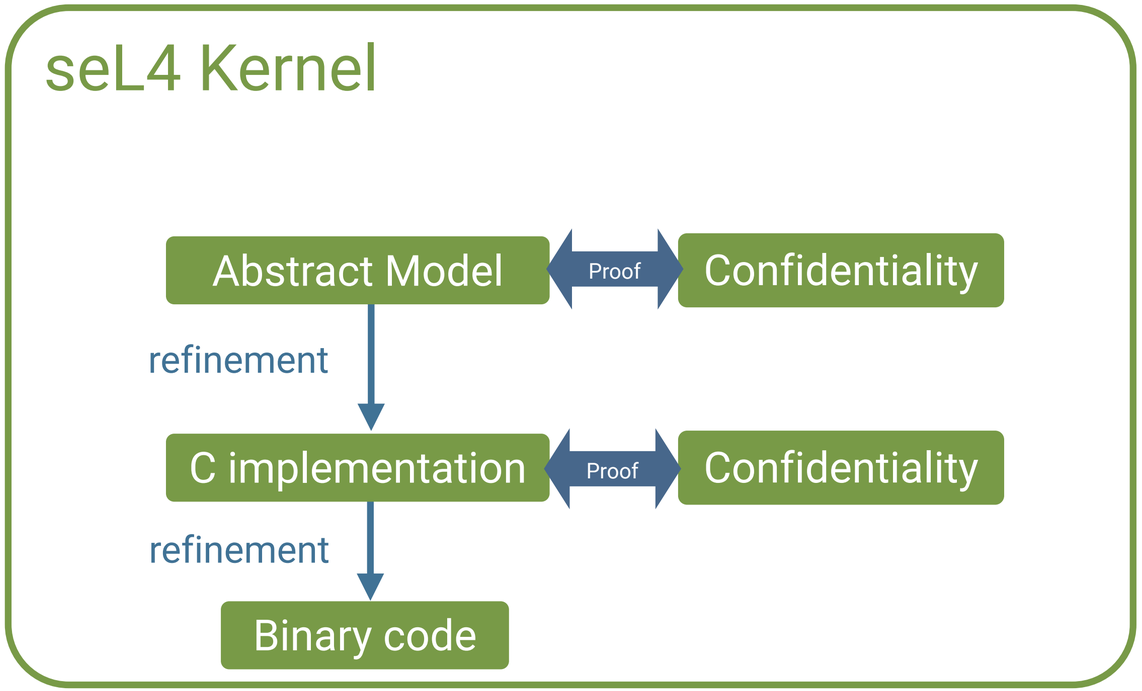

Two new frontiers for seL4 refinement

Frontier #1:

Functional Correctness of OS services

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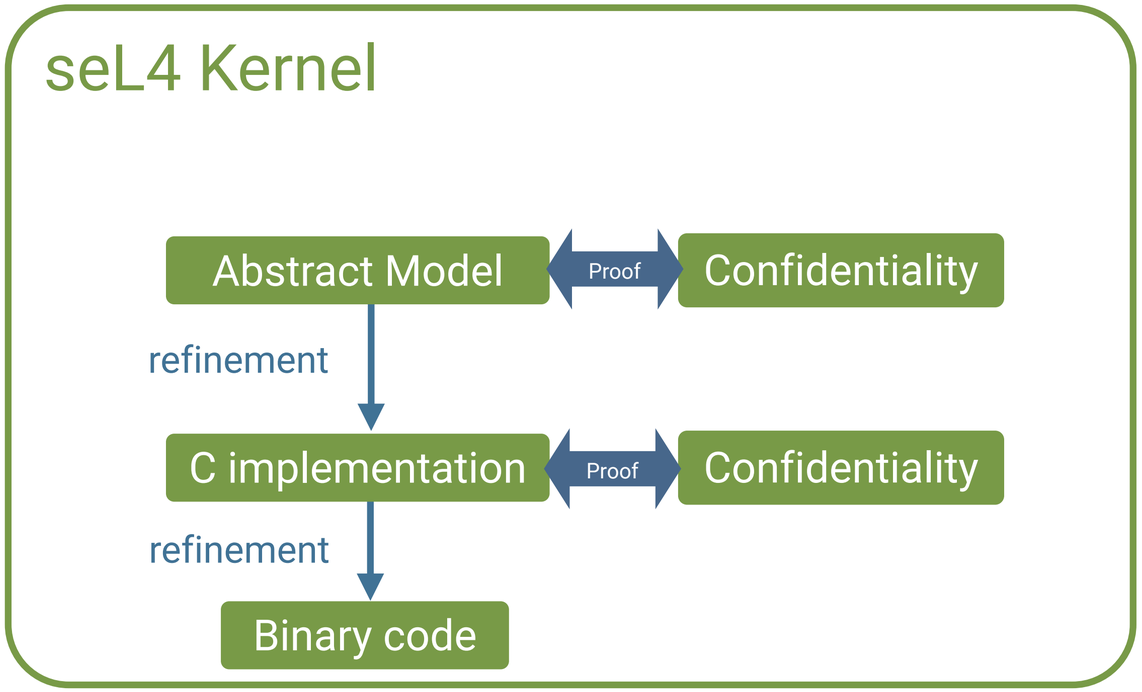

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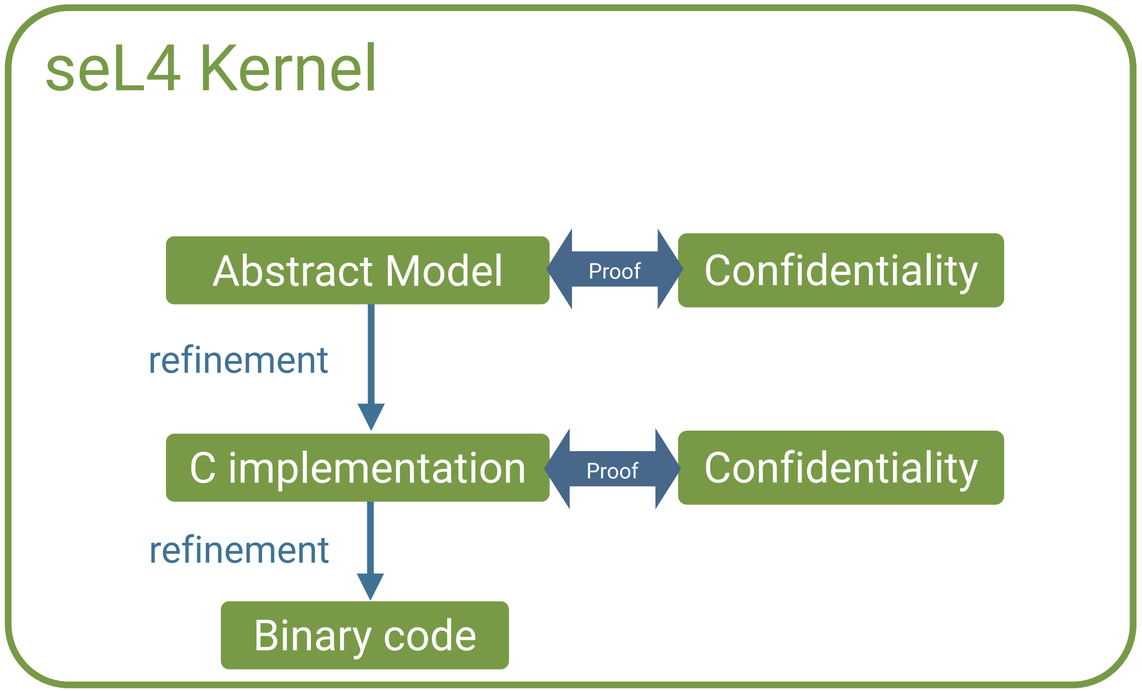

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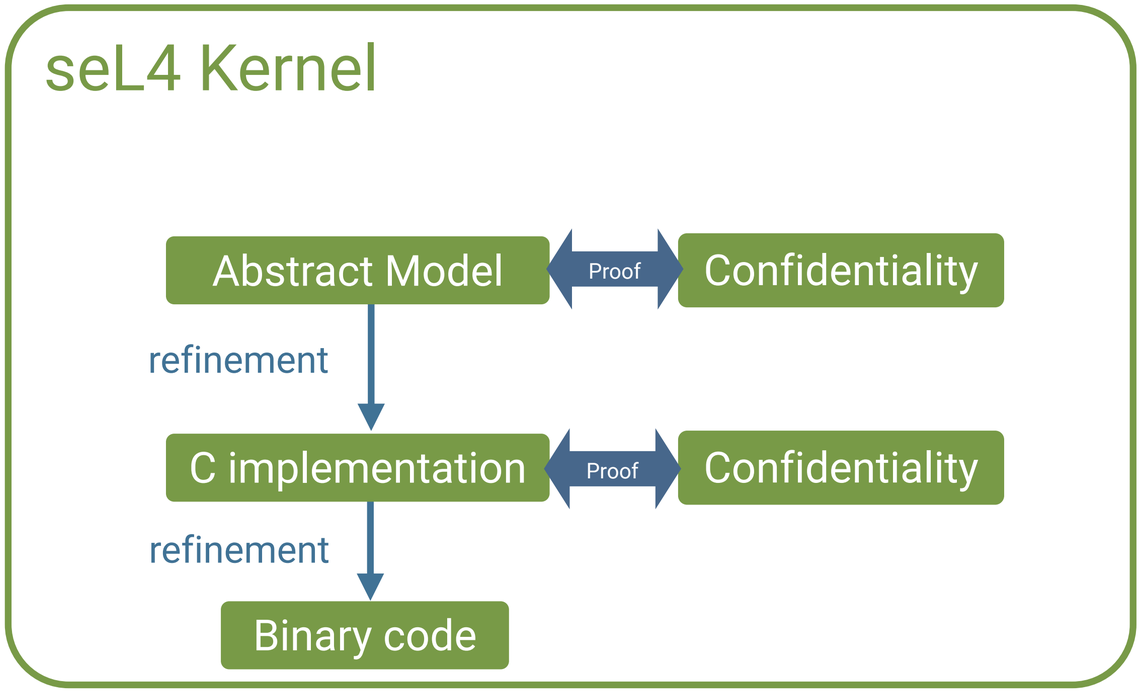

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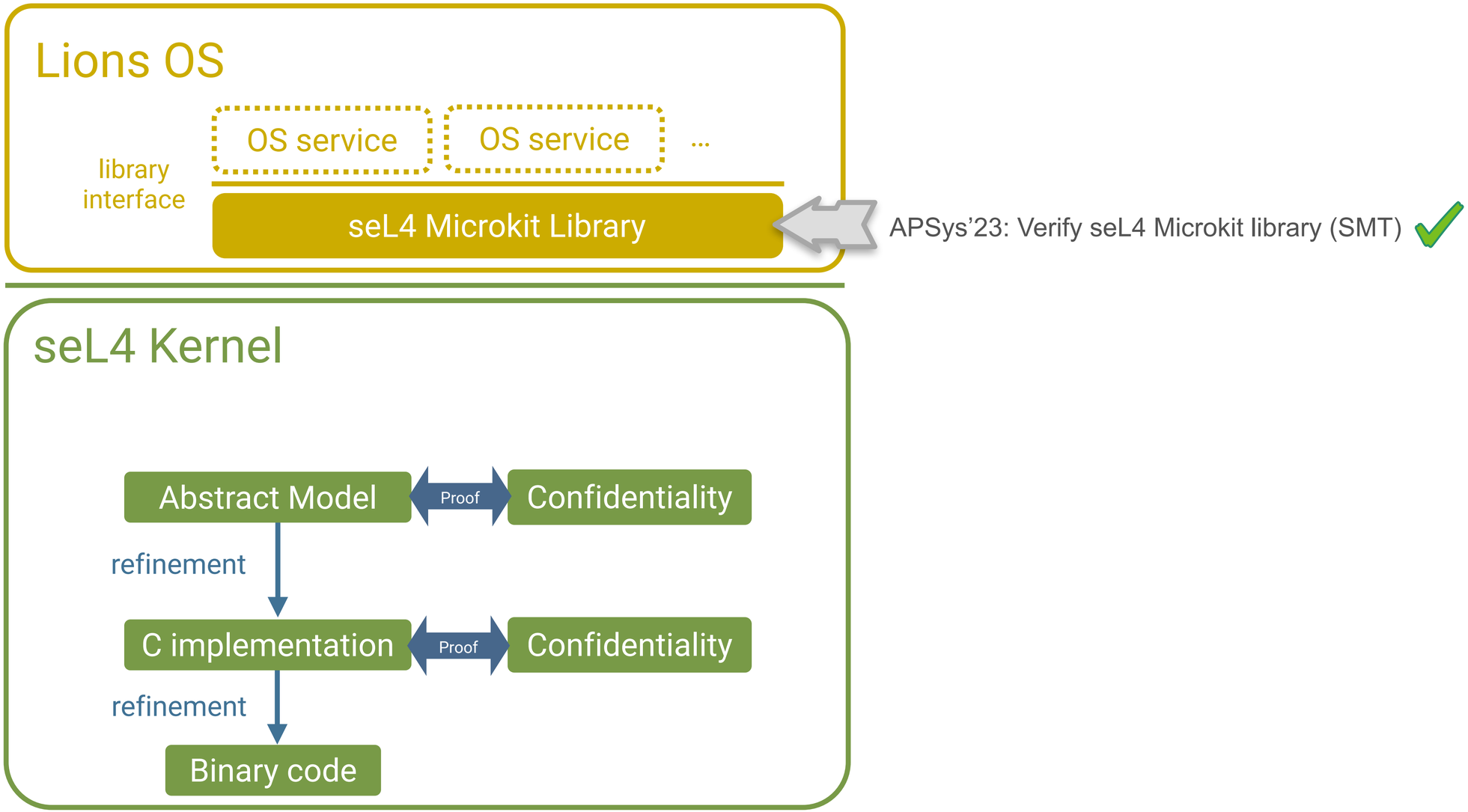

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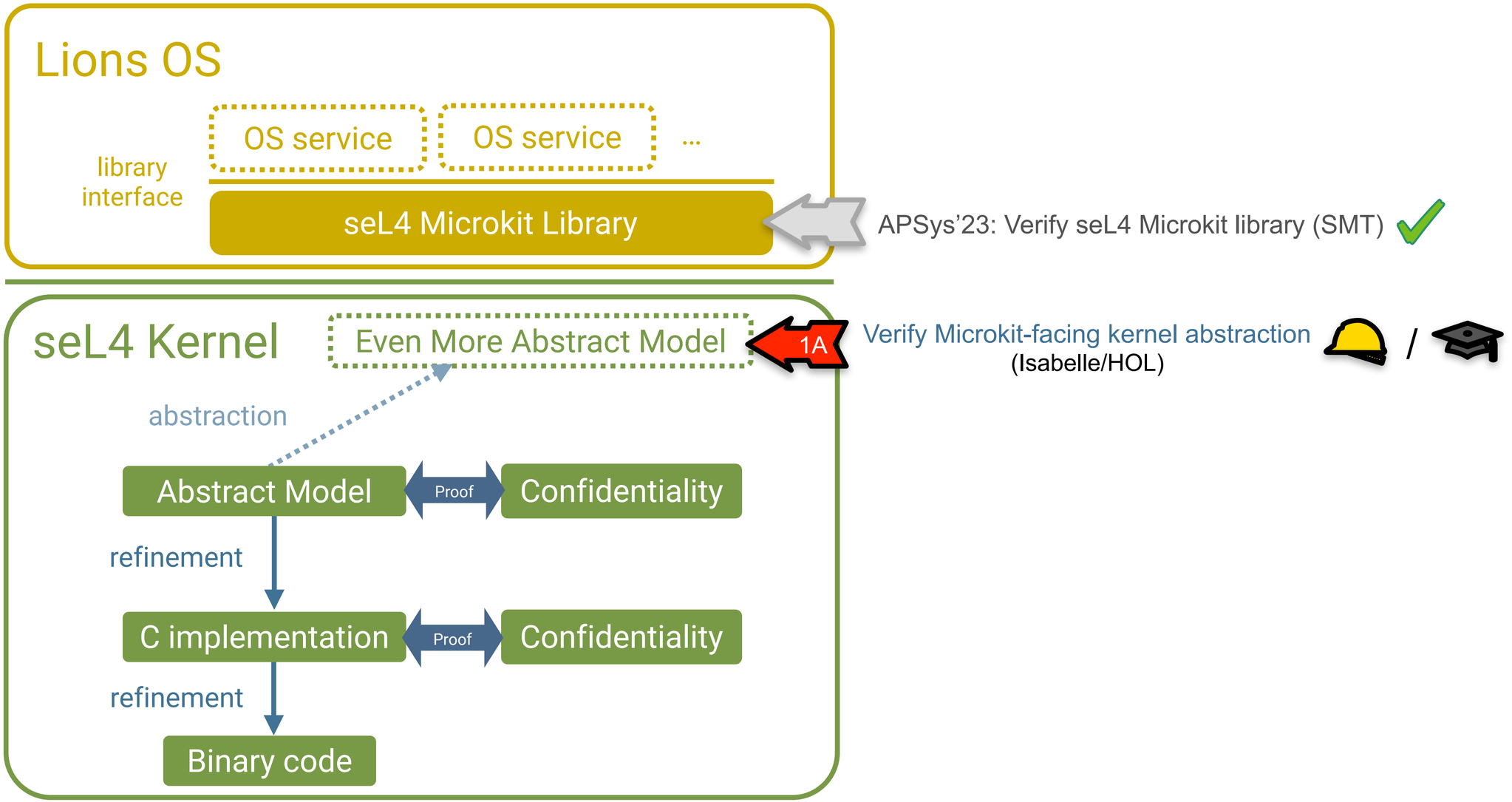

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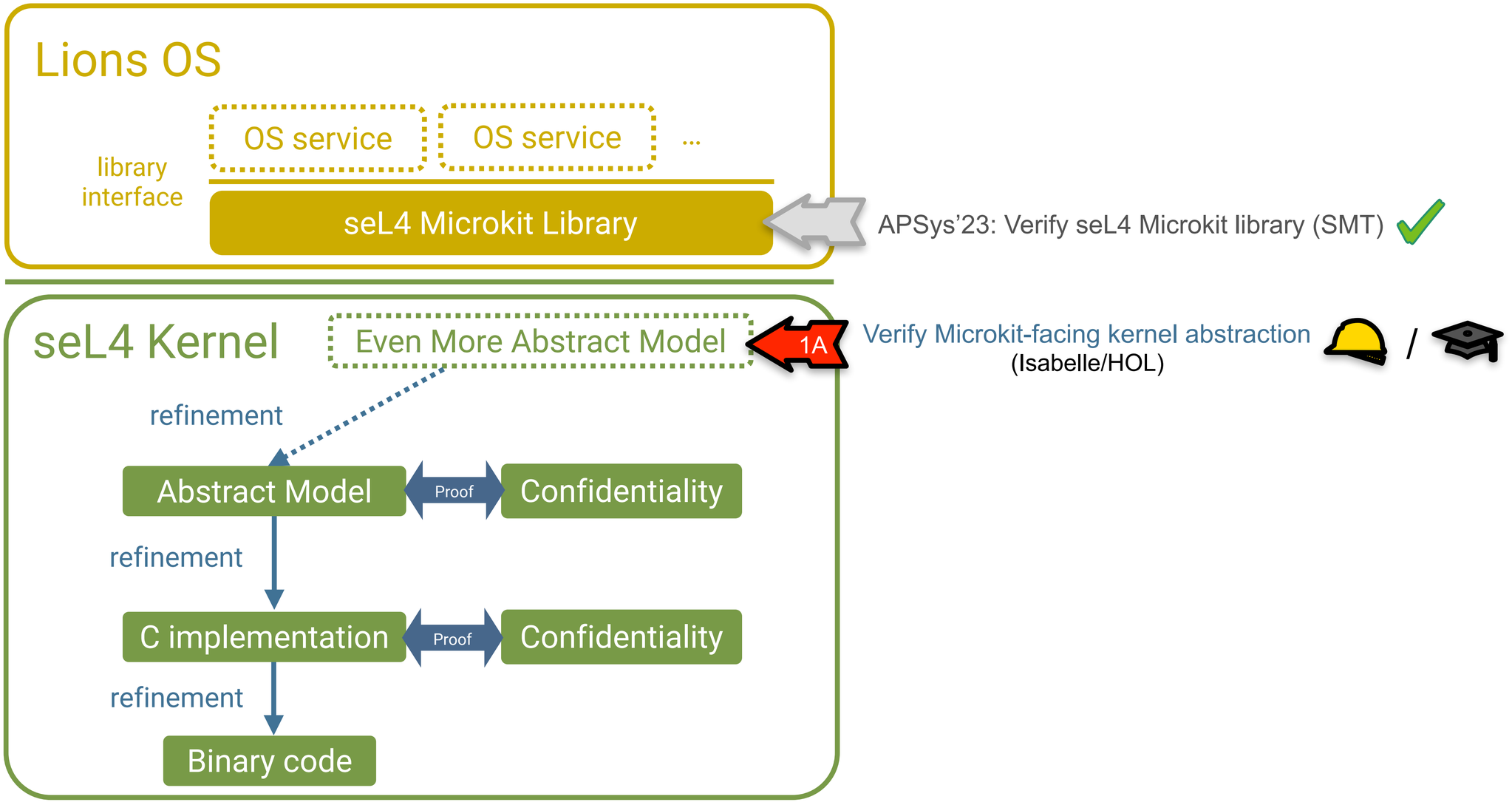

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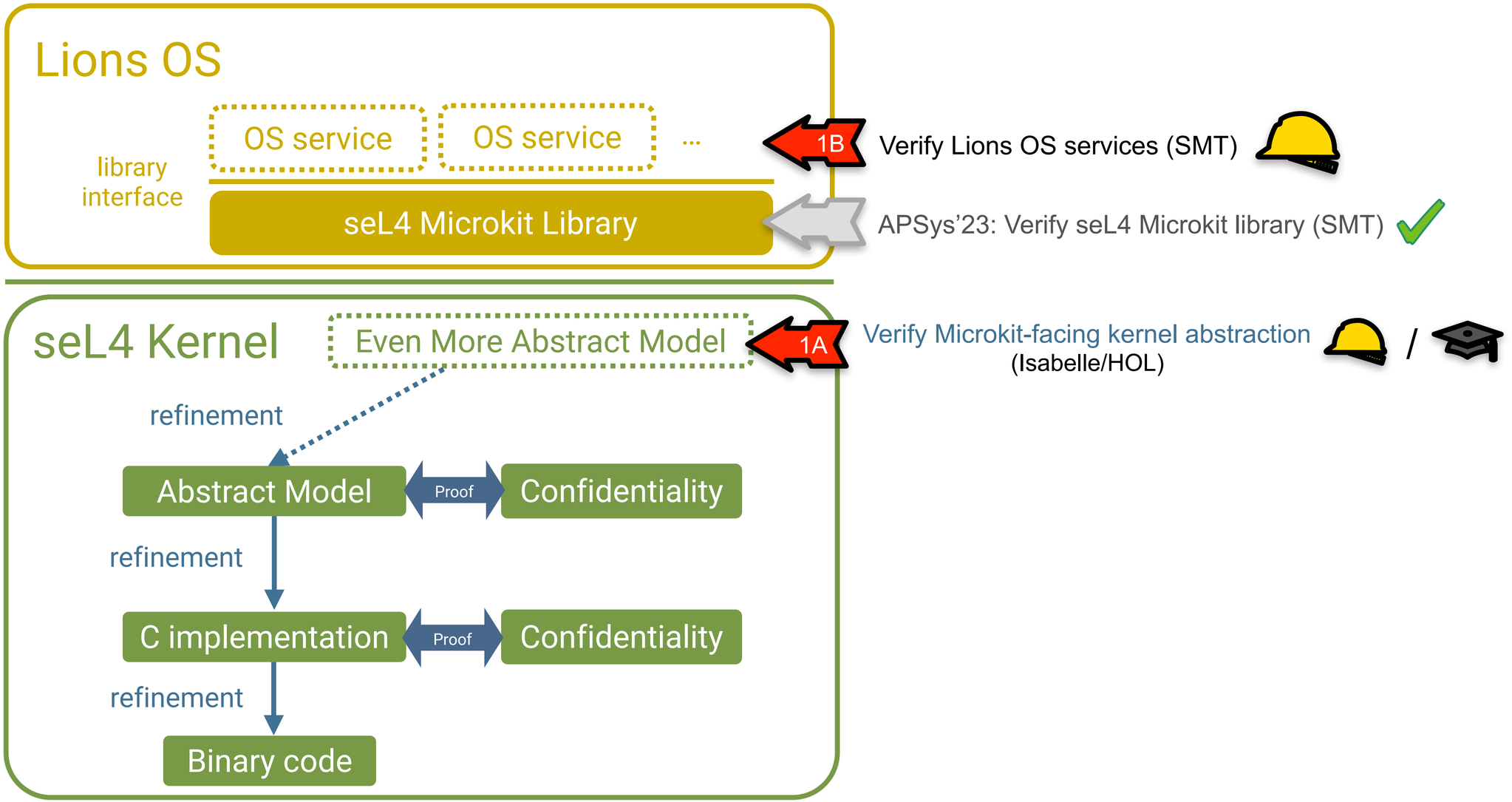

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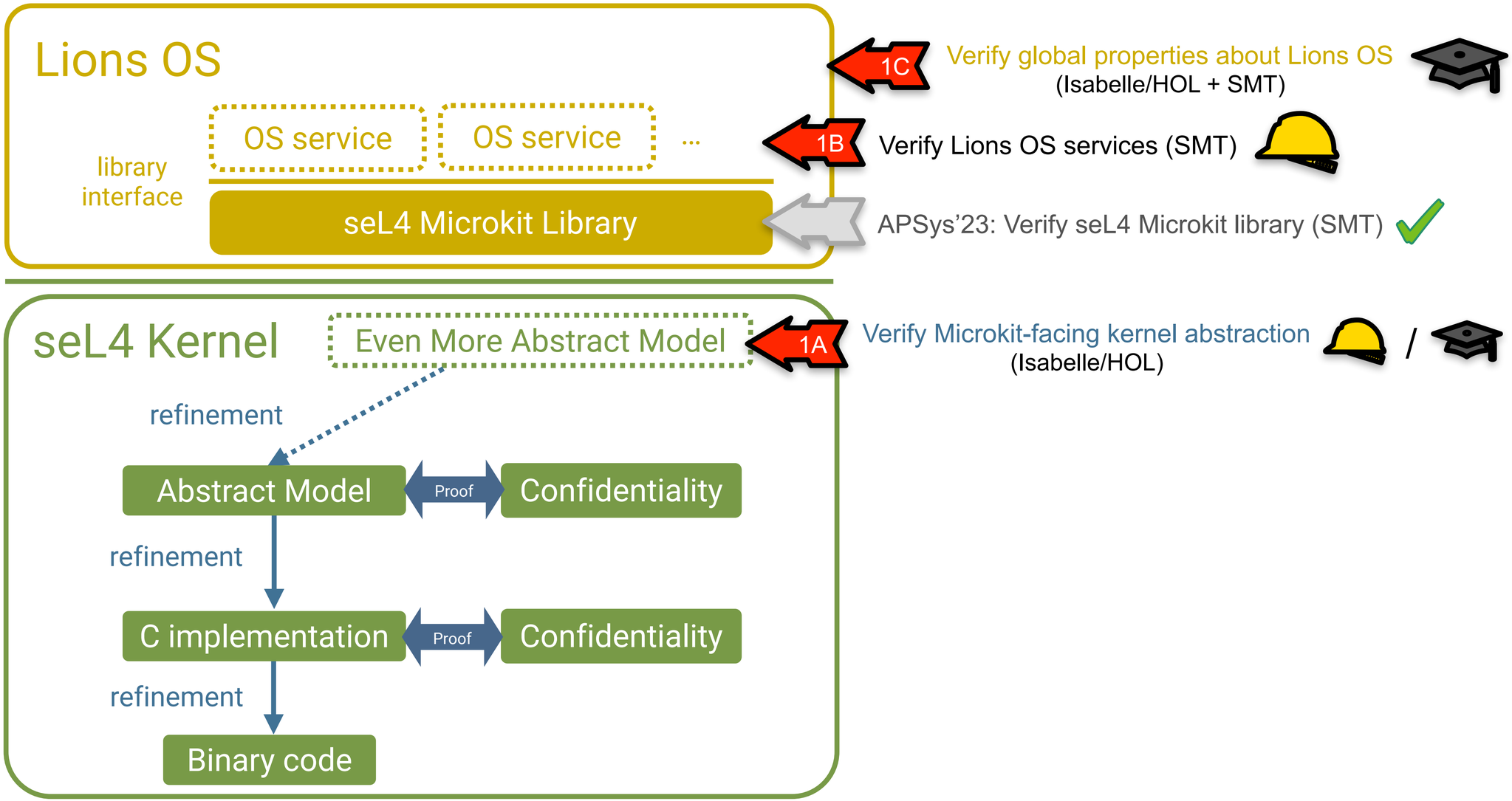

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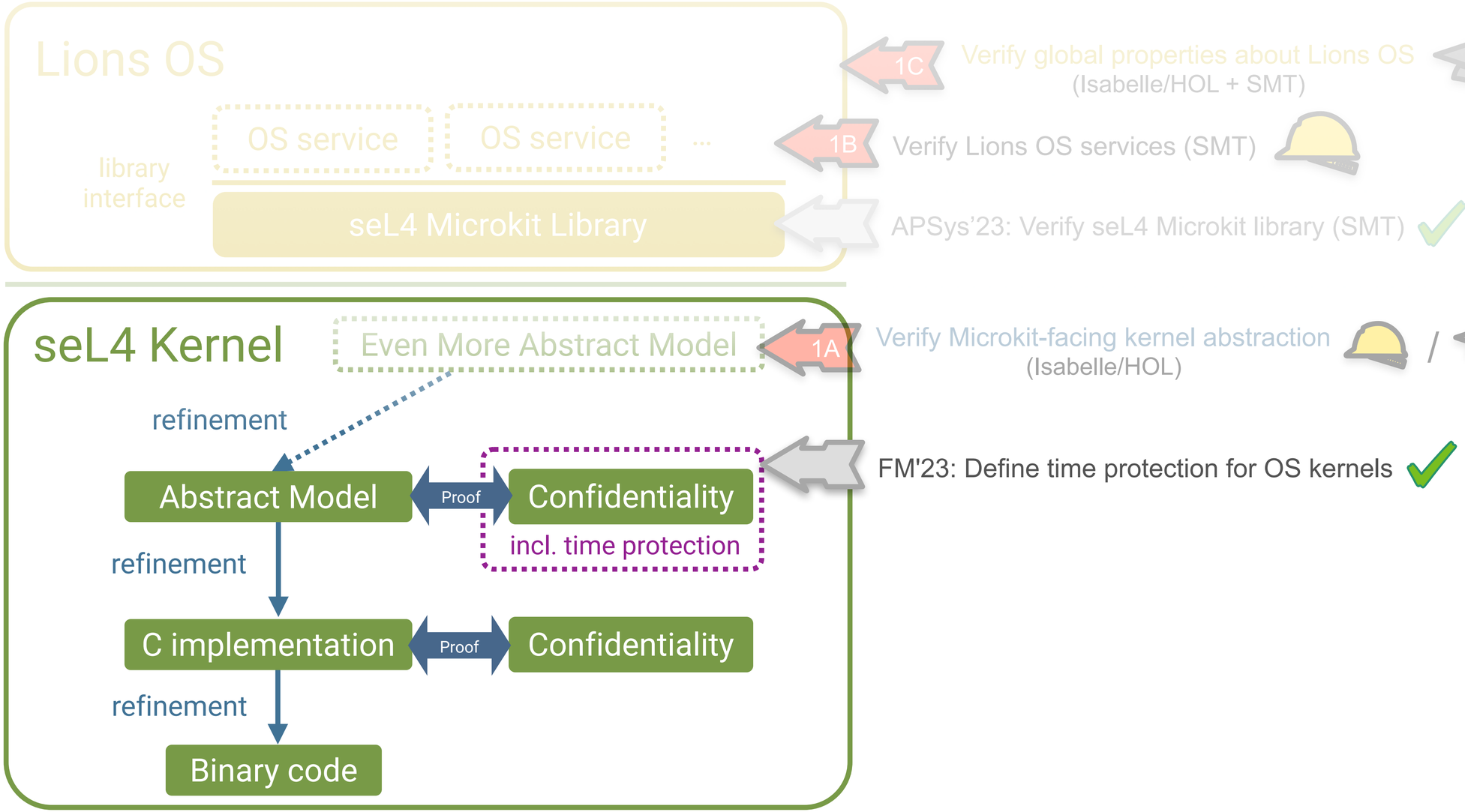
Frontier #1:

Functional Correctness of OS services

Frontier #2:

Security Enforcement of time protection



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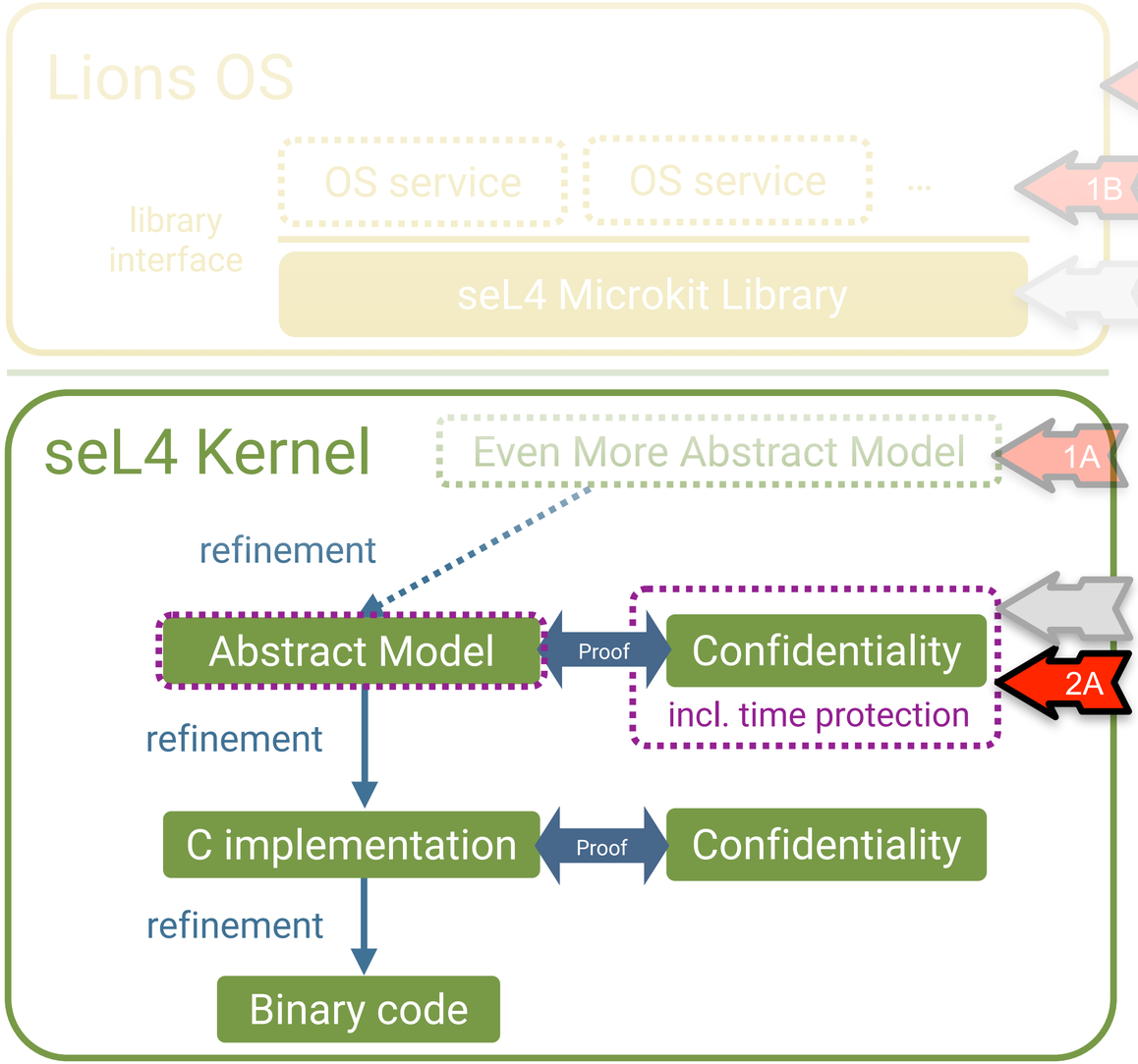

1C Verify global properties about Lions OS (Isabelle/HOL + SMT)

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FM'23: Define time protection for OS kernels +

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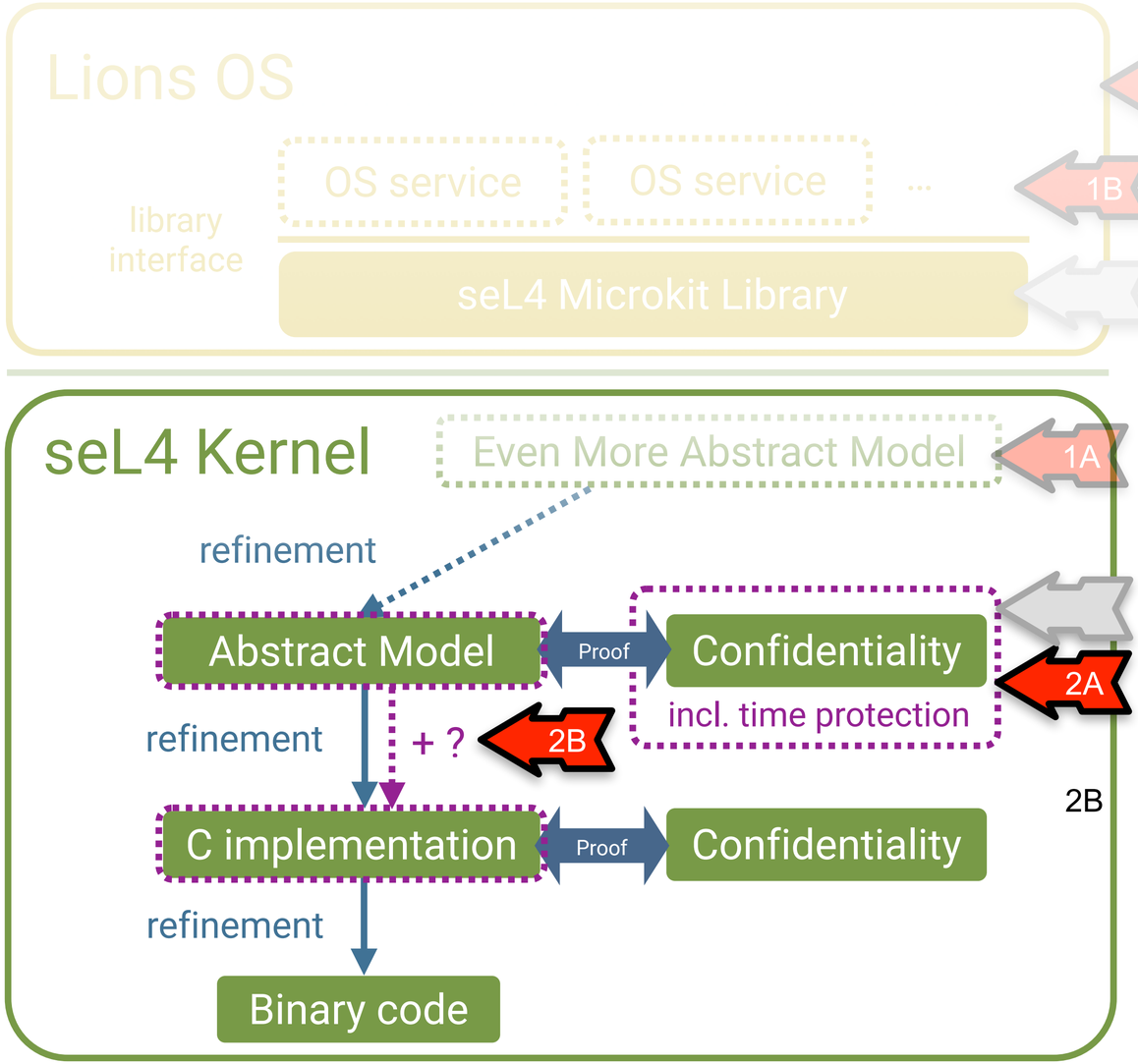

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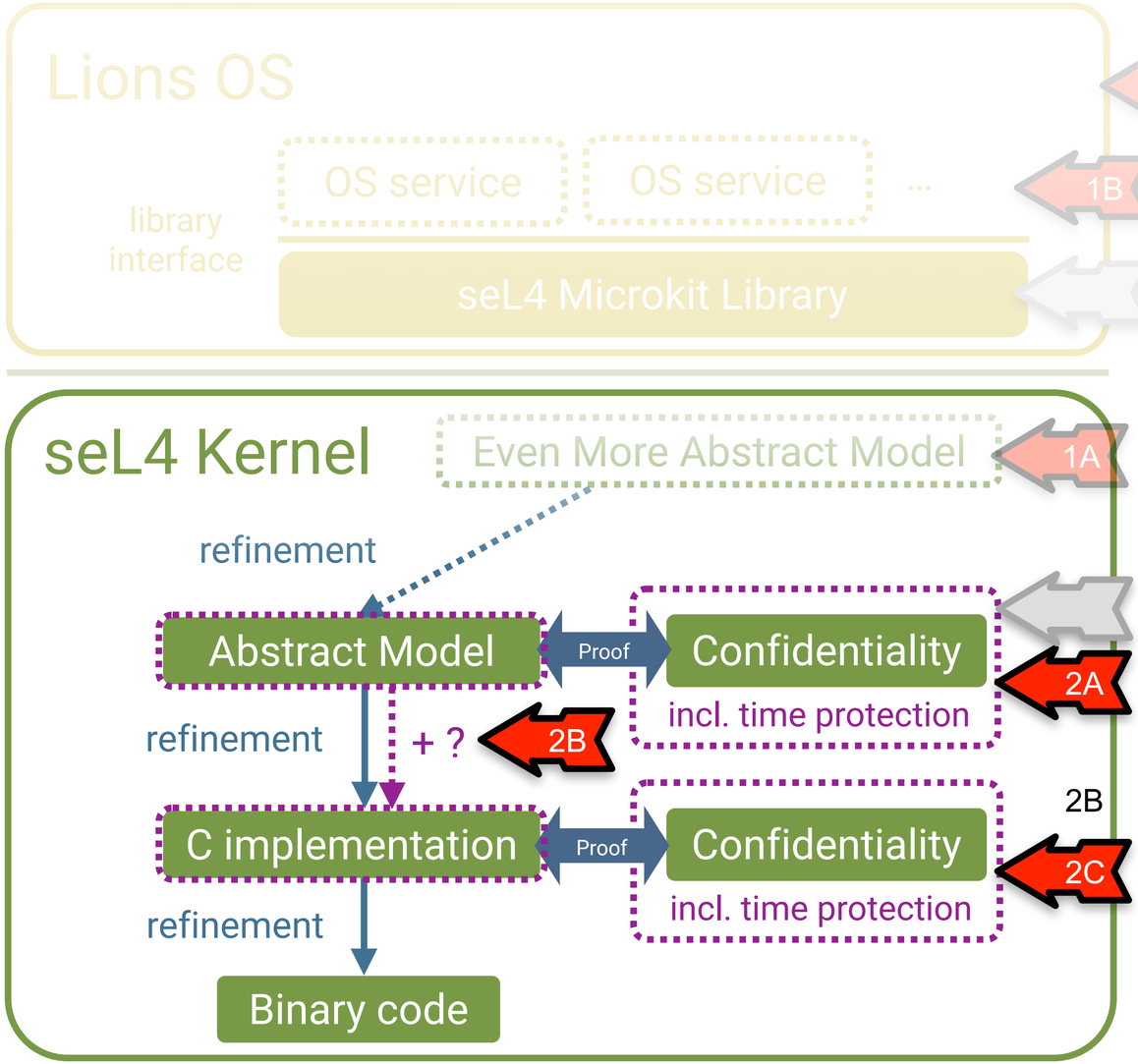

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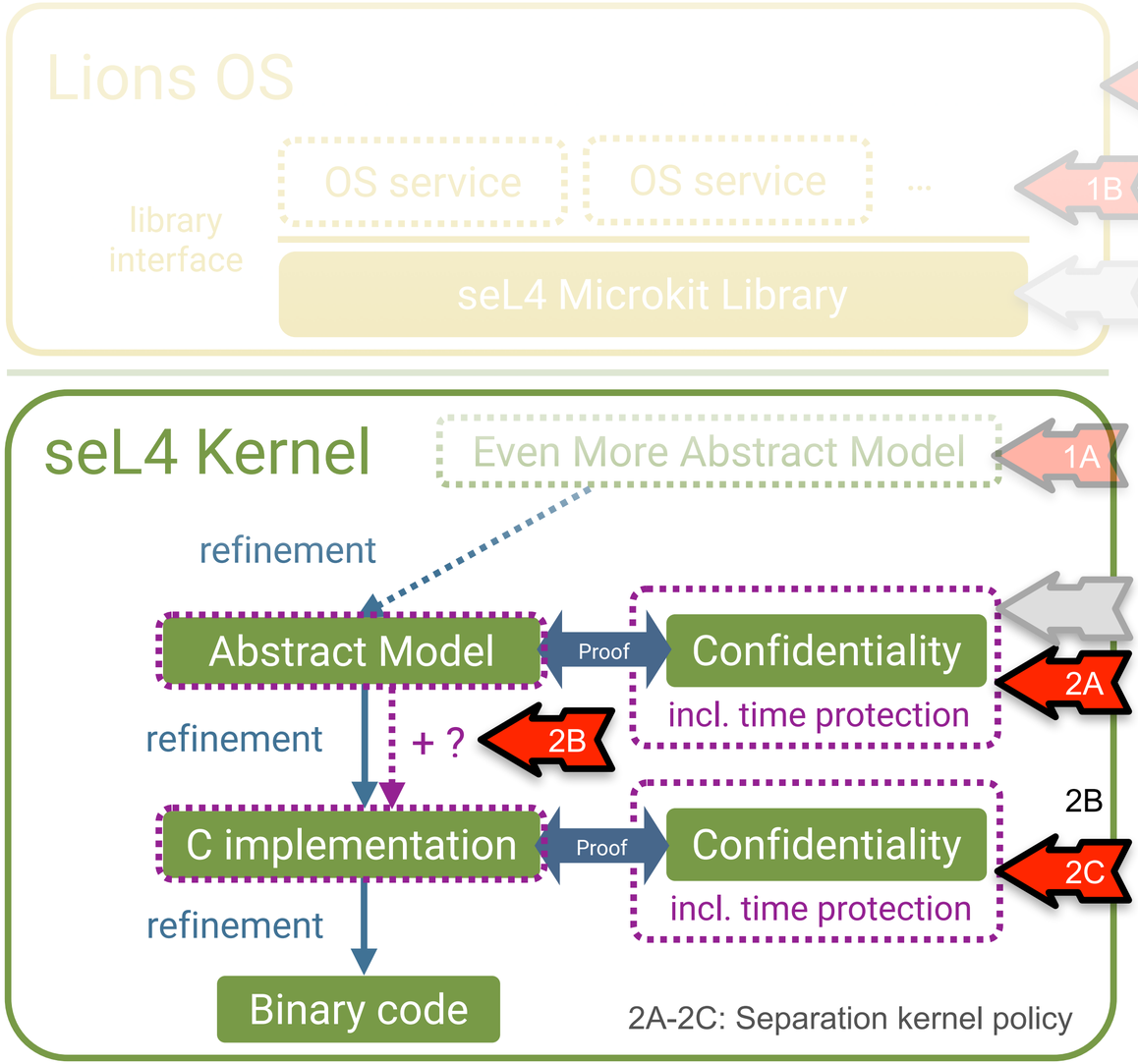

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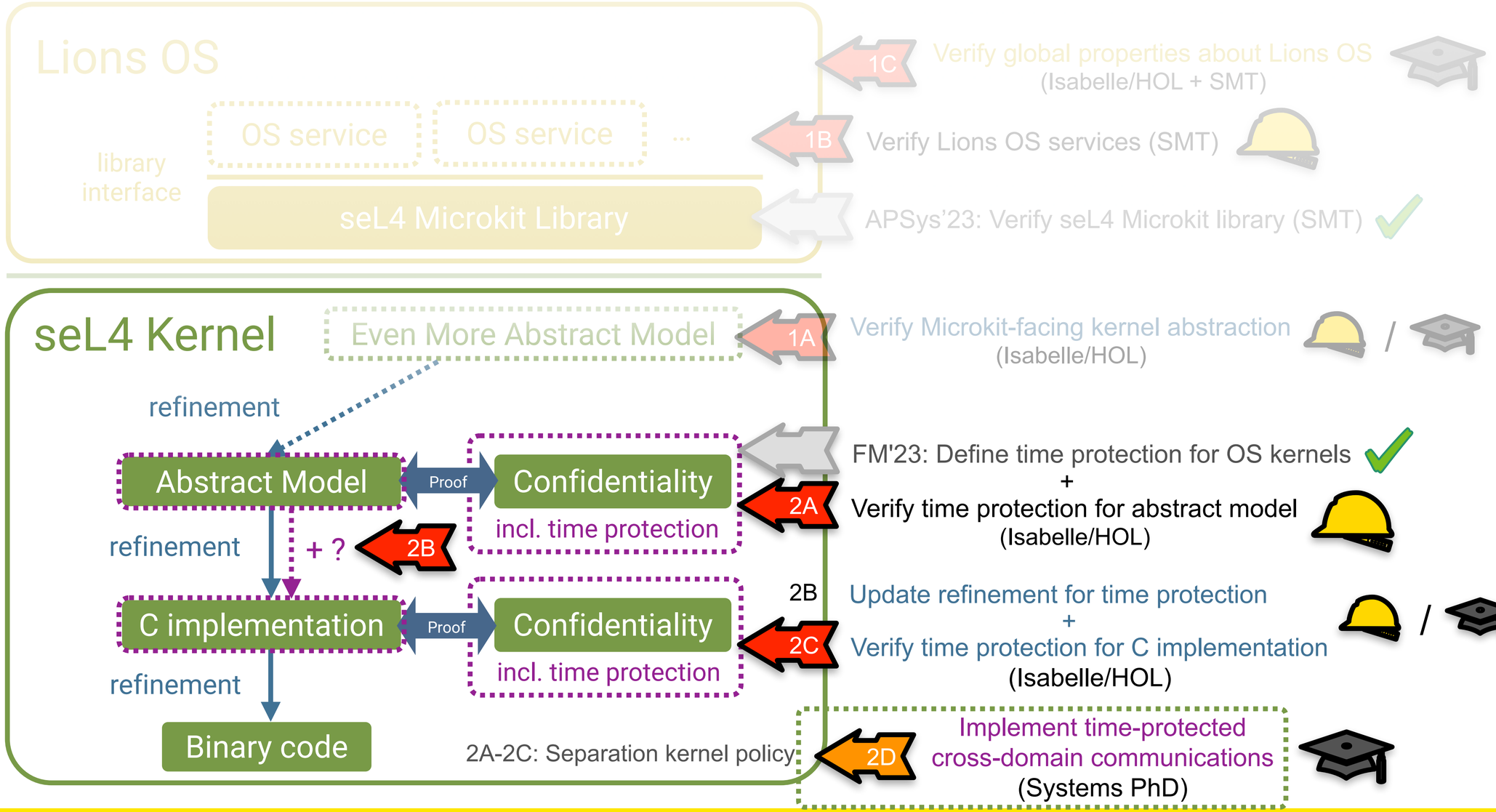

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of OS services

syscall interface

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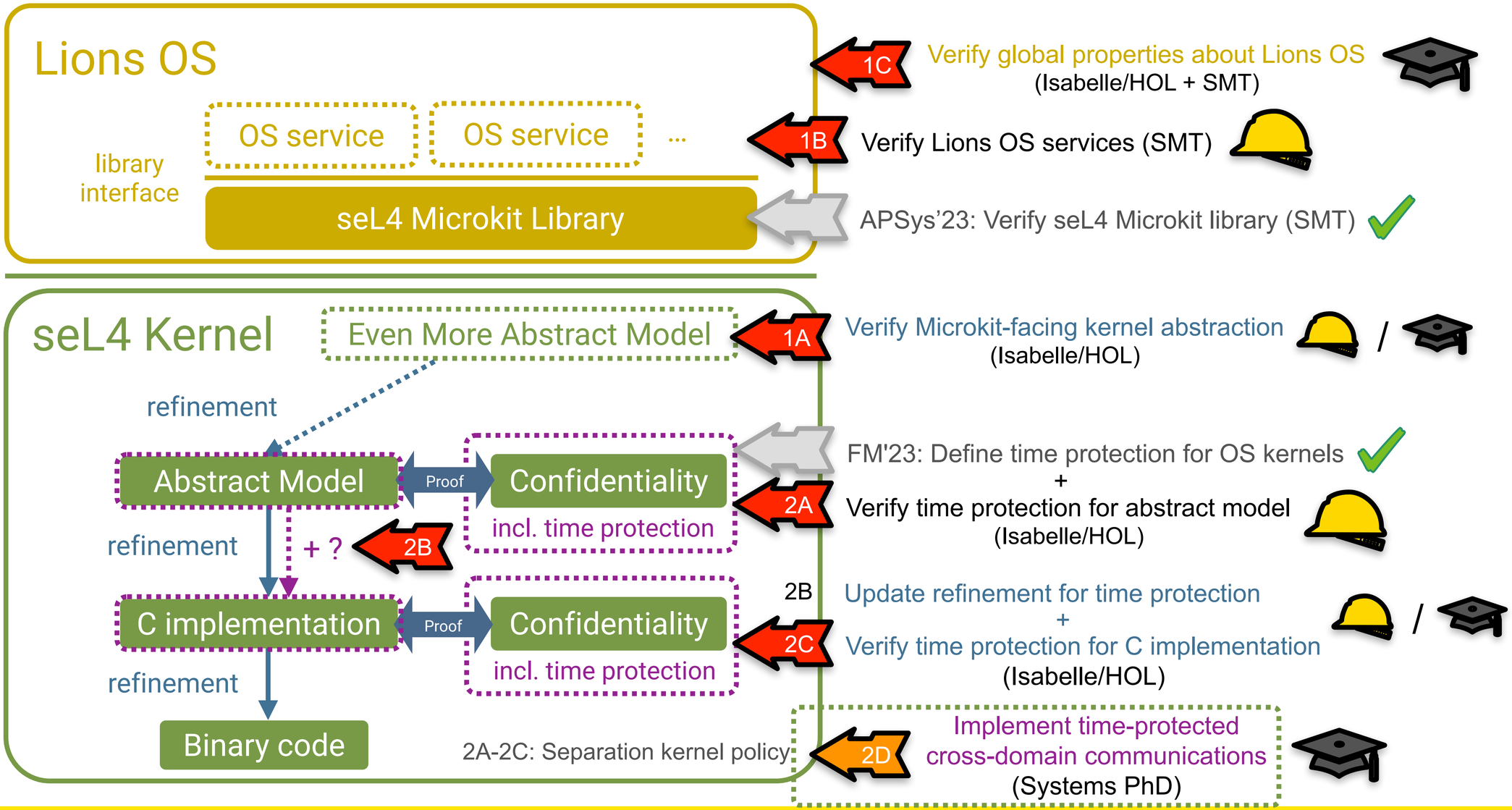

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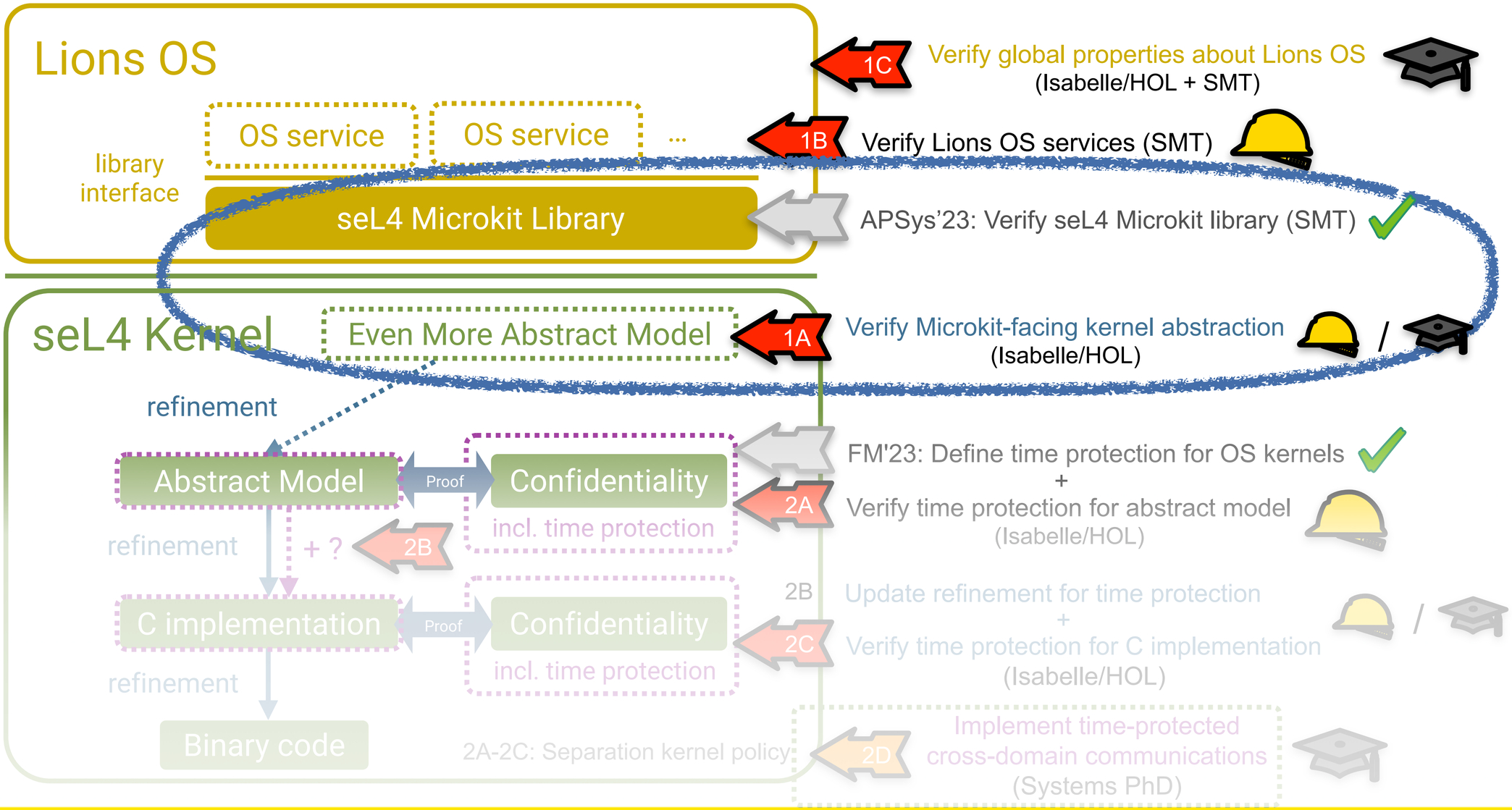
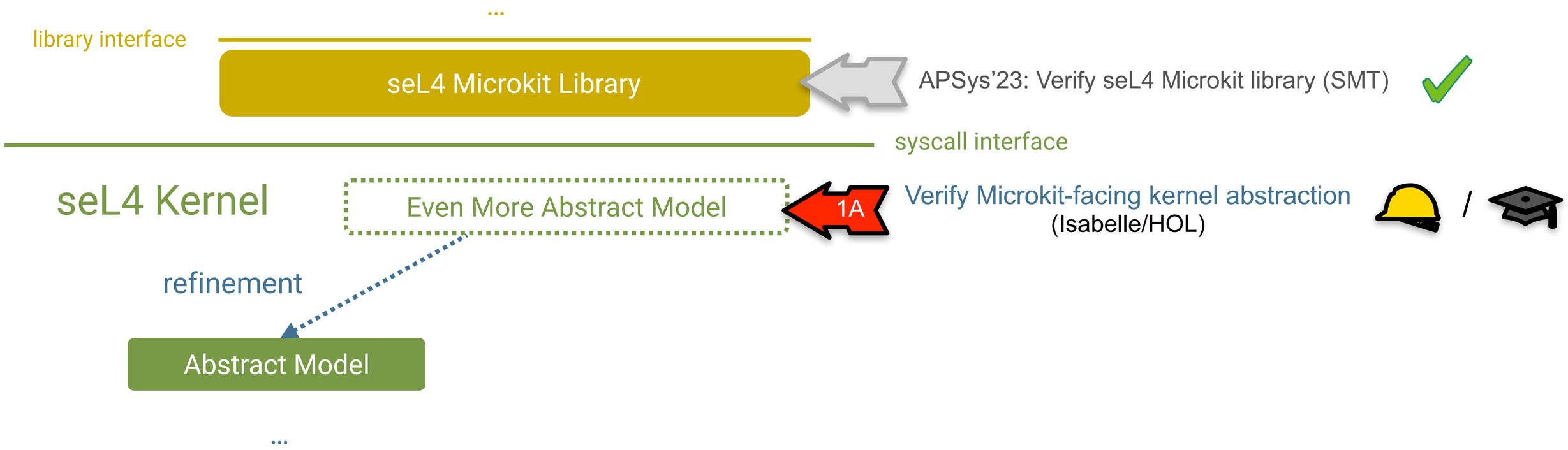


Proving an OS kernel implements its syscall interface



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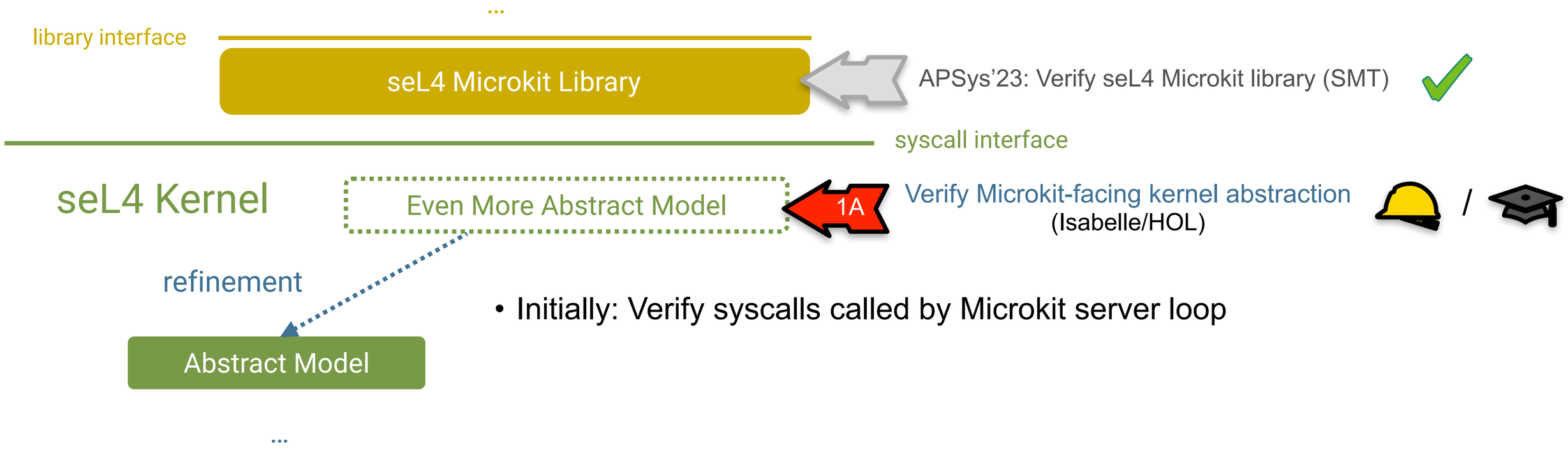

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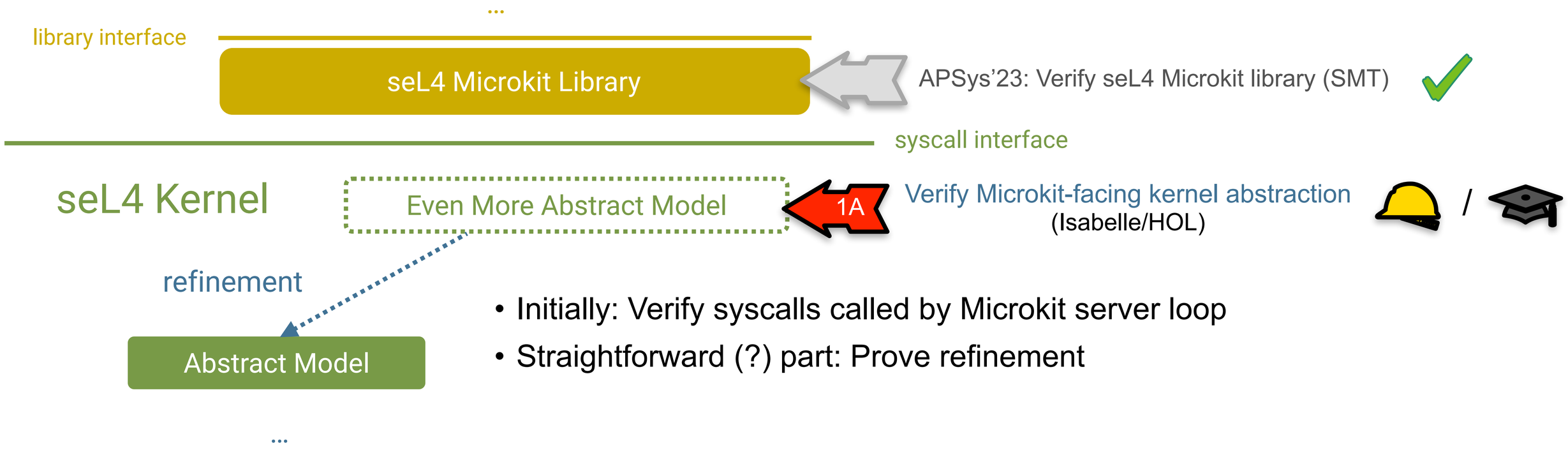

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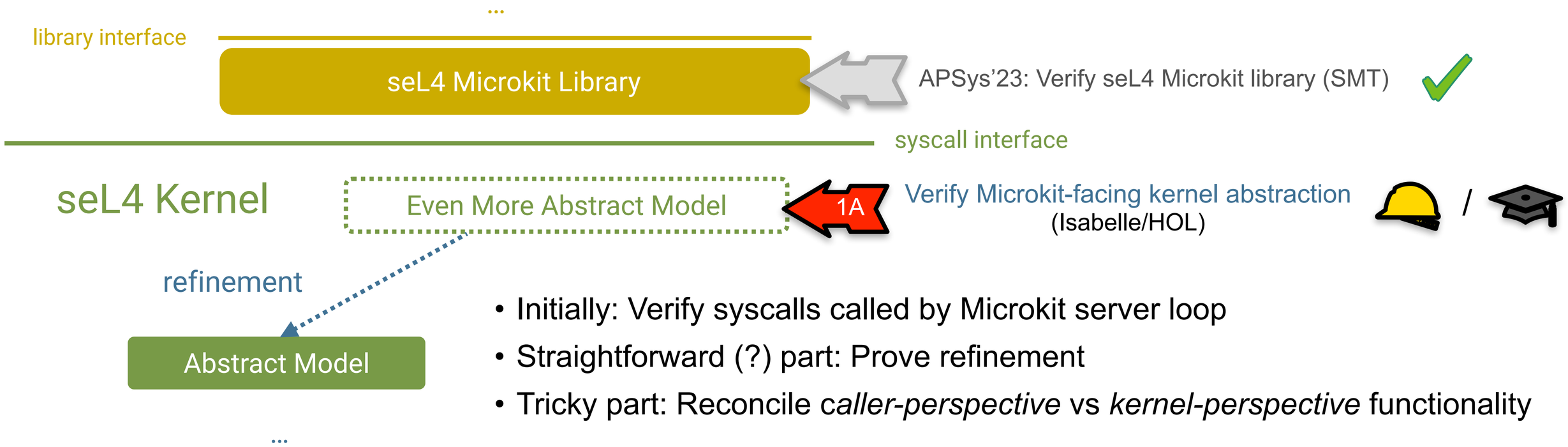

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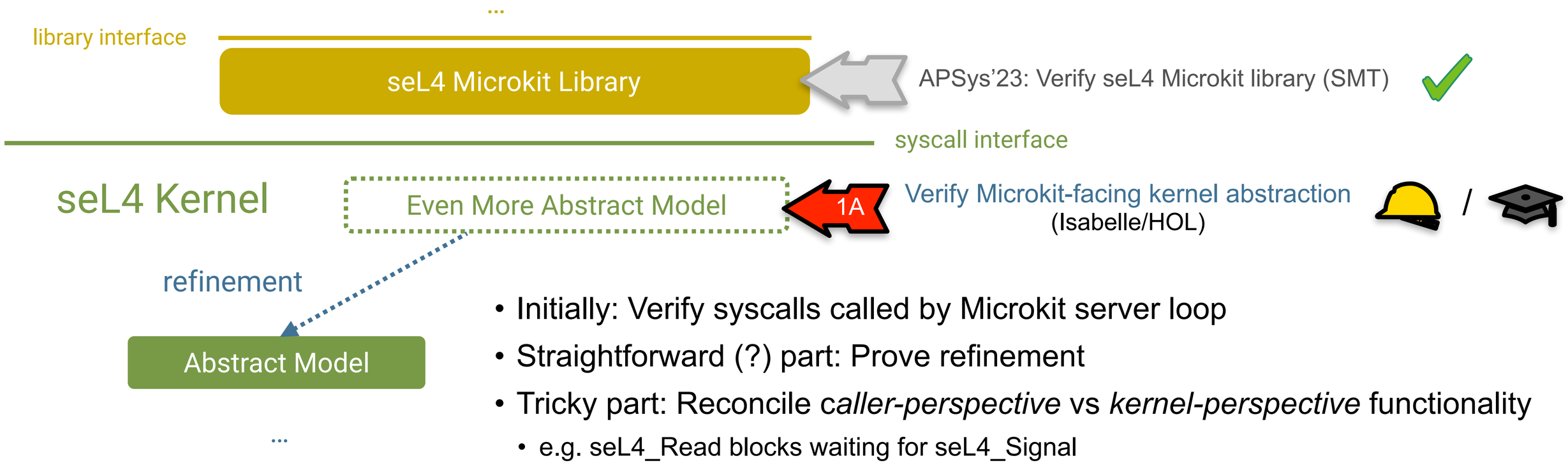

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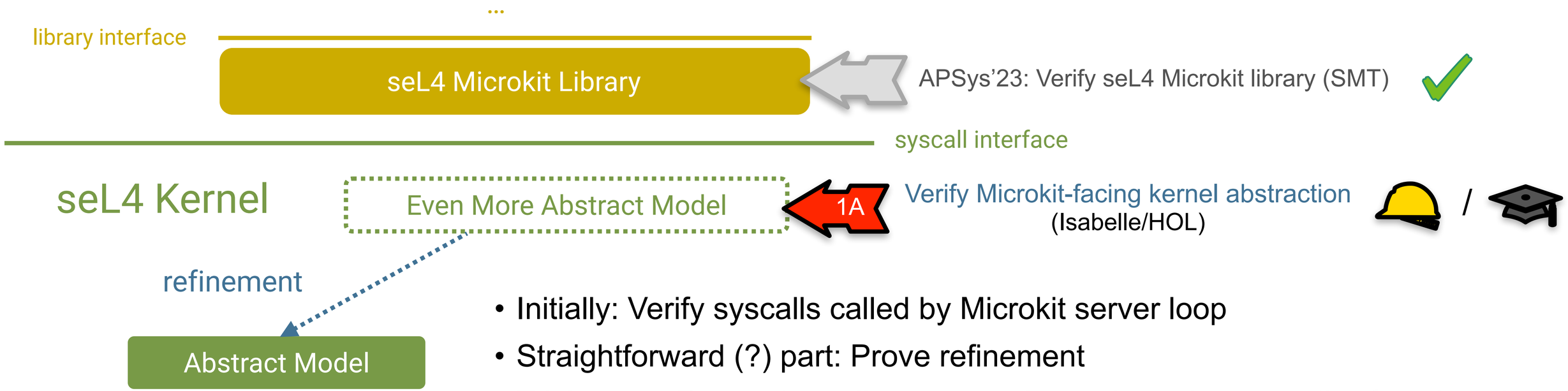

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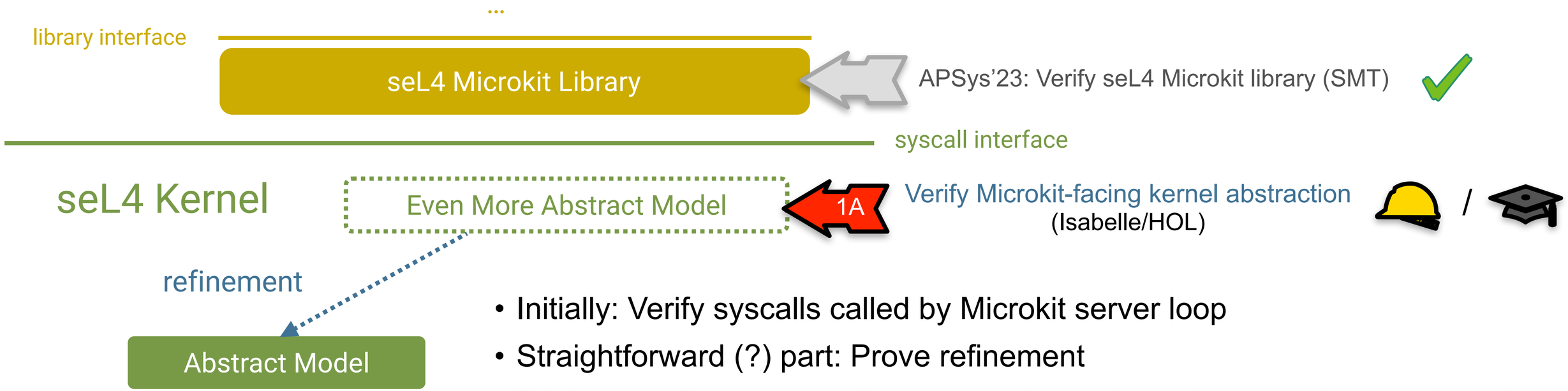

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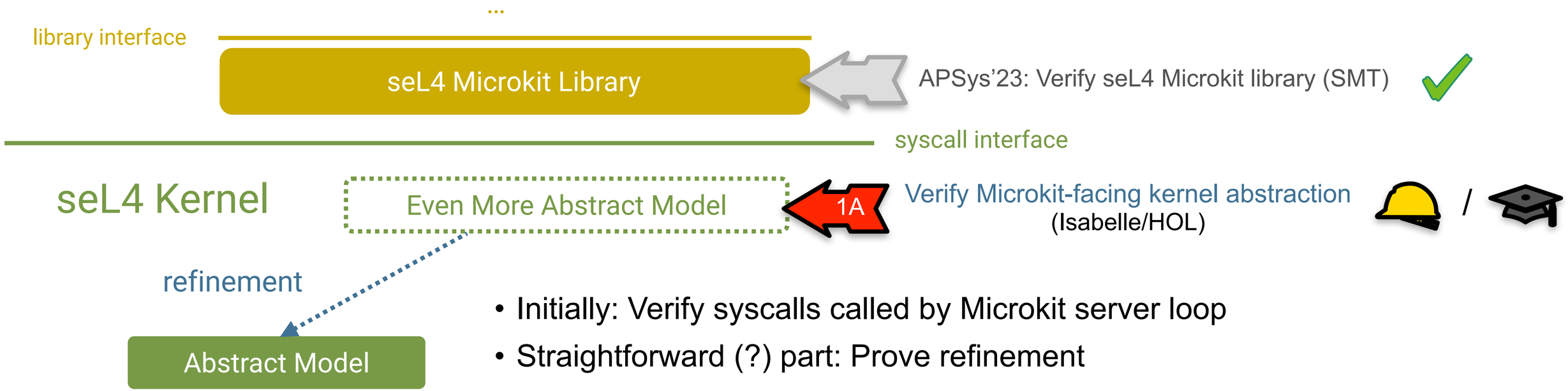

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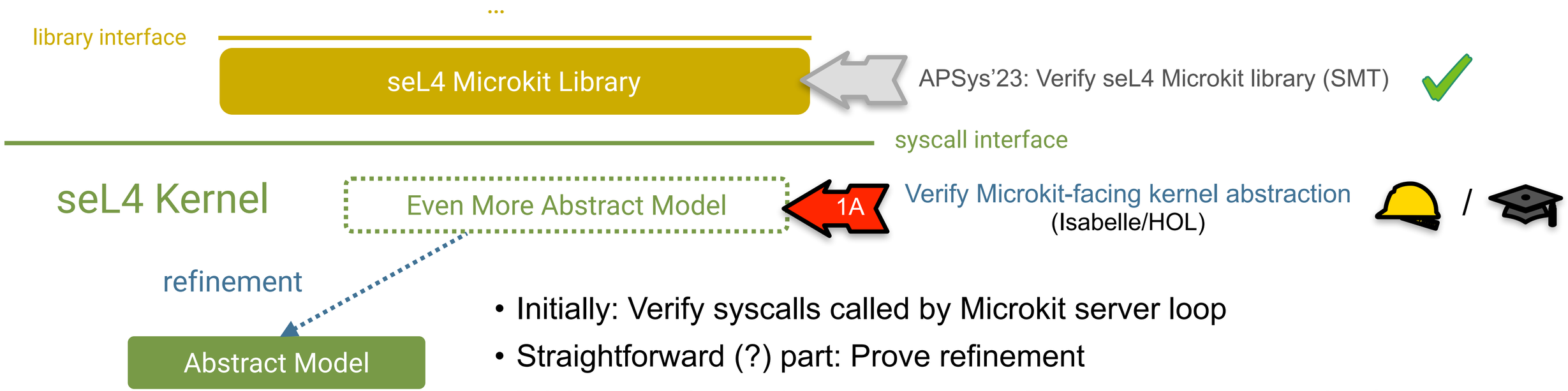

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  - cf. CertiKOS ESOP'20 - blocks on IO, not another user

Two new frontiers for seL4 refinement

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Frontier #2:
Security Enforcement
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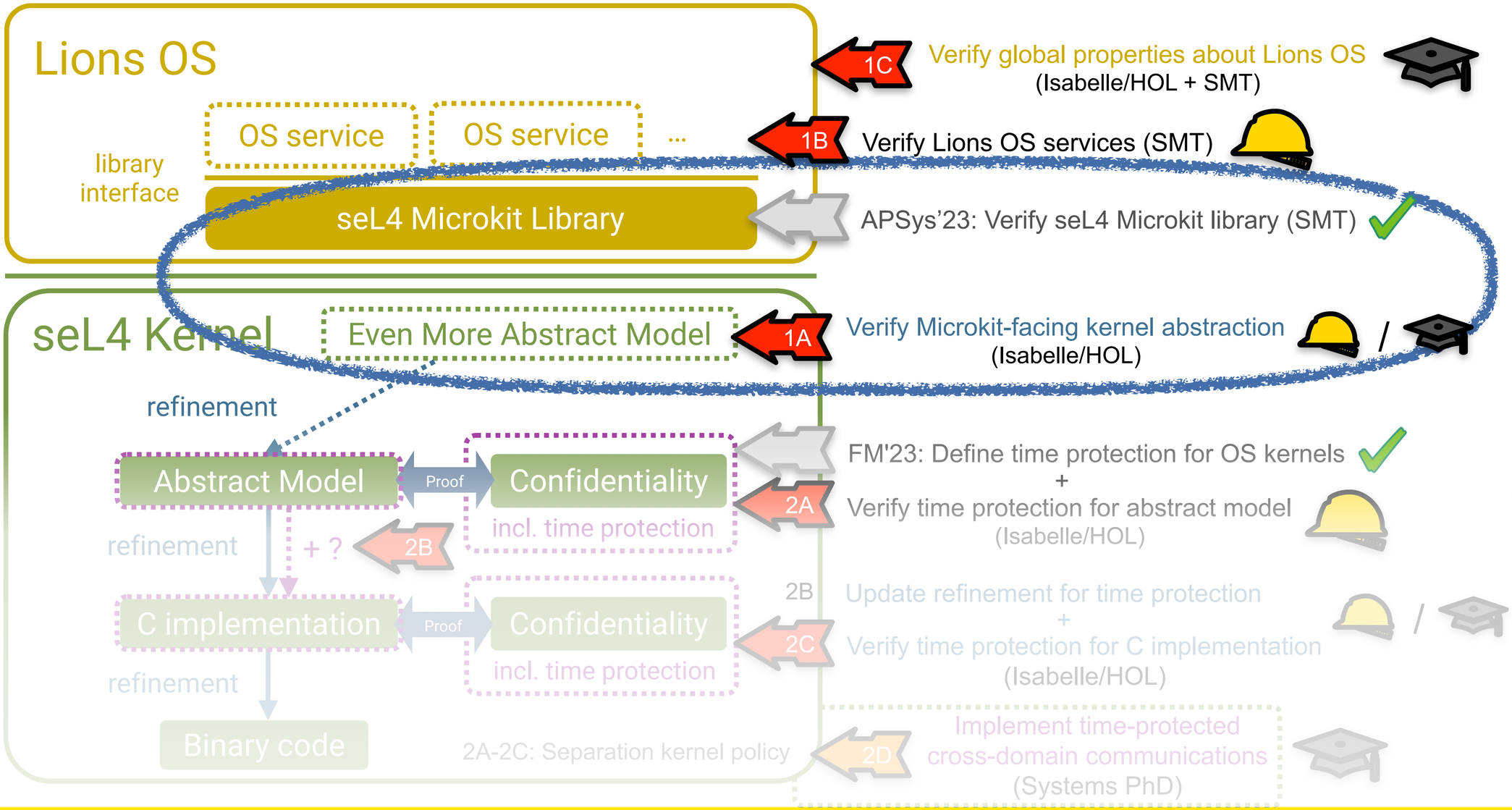

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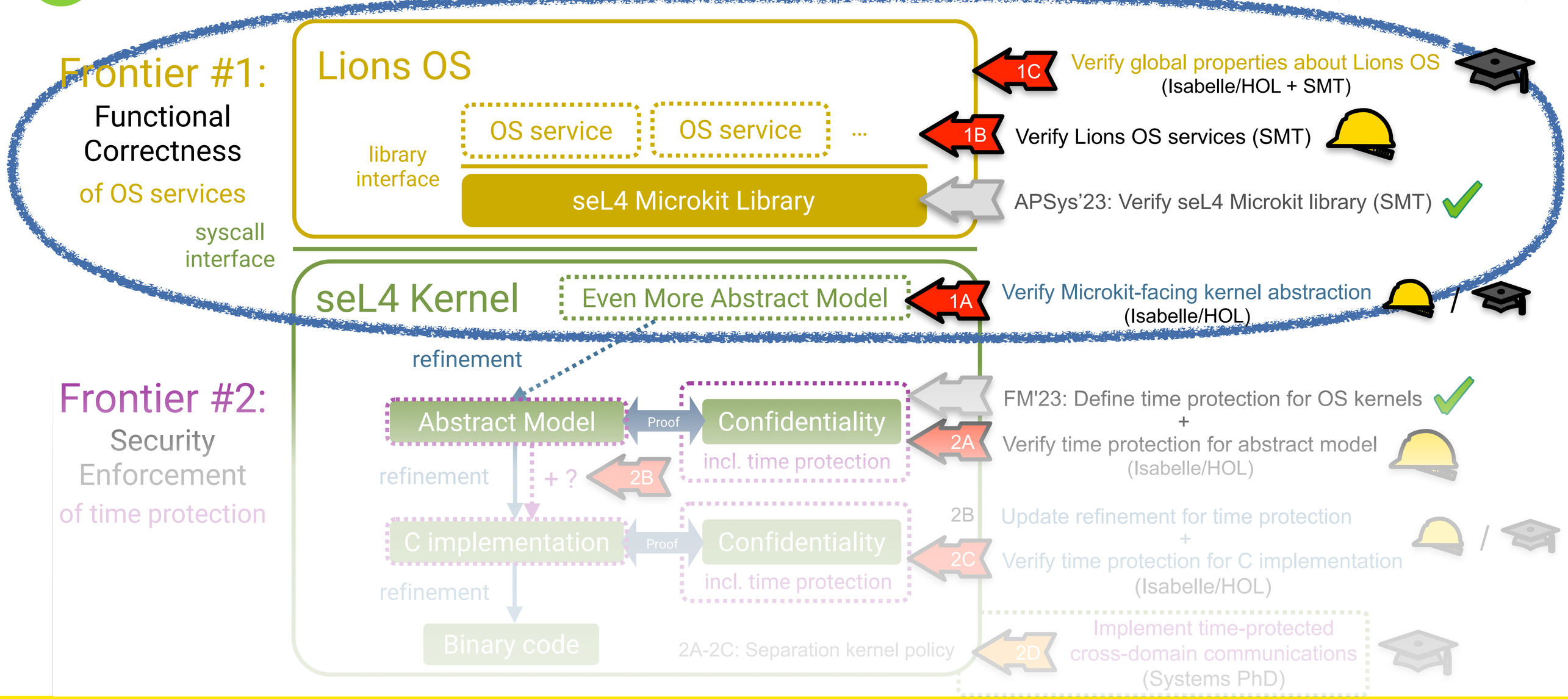
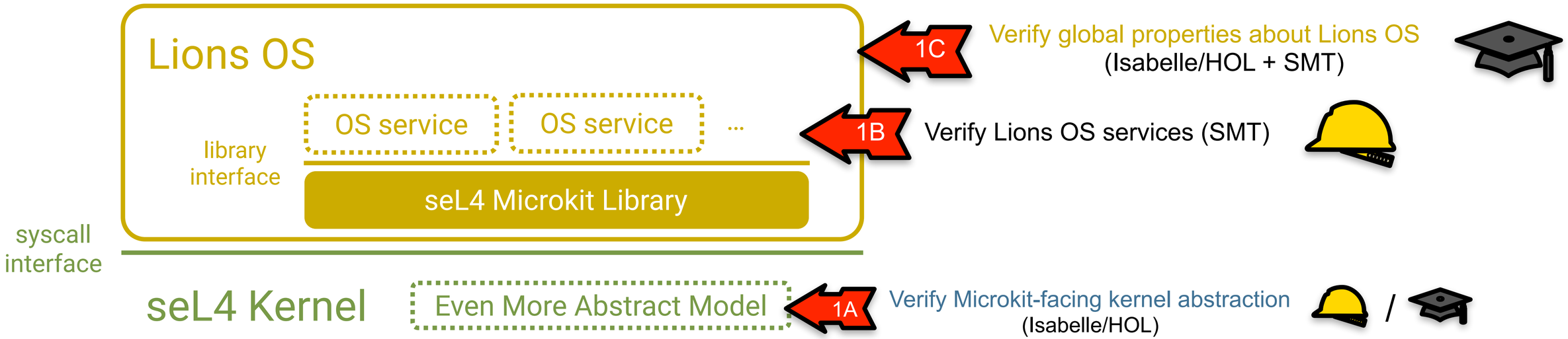


Proving OS services provide functional + security properties



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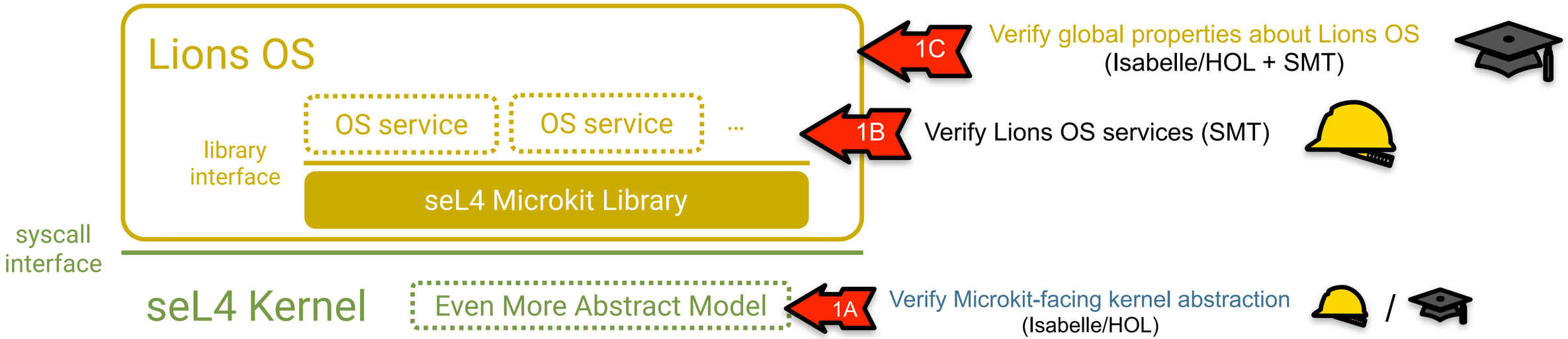
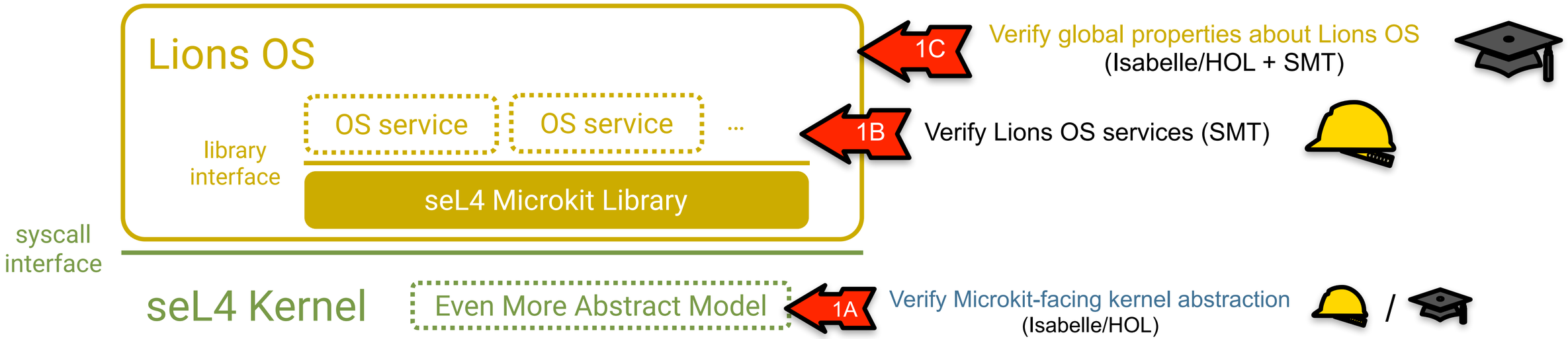


- Initially: Verify functional, safety properties (local + global)

Proving OS services provide functional + security properties



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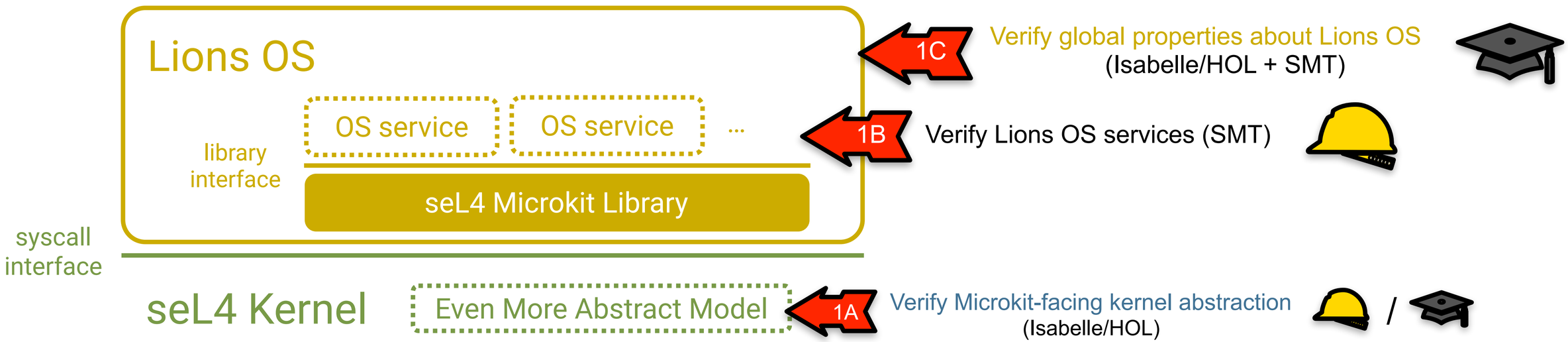
Proving OS services provide functional + security properties



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- Guiding questions for all phases:
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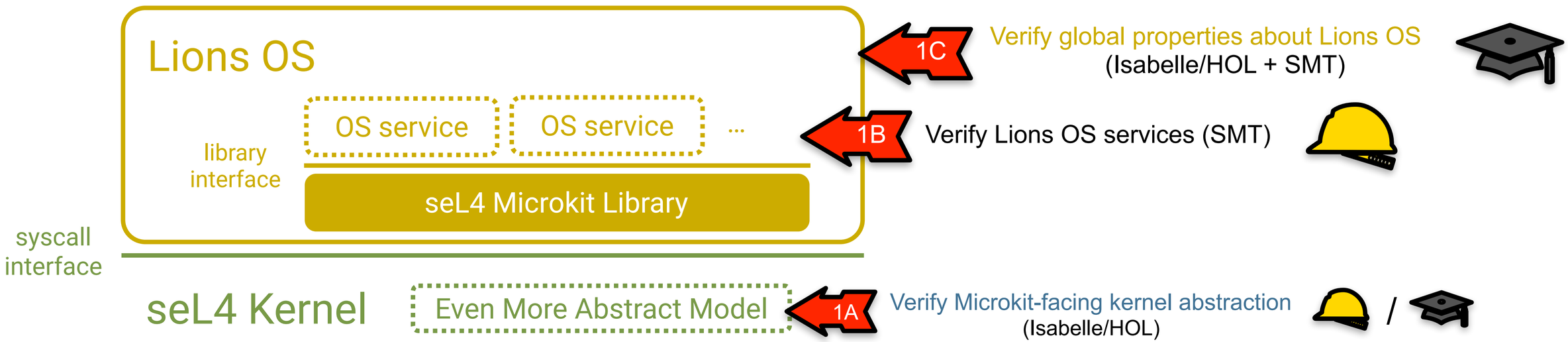

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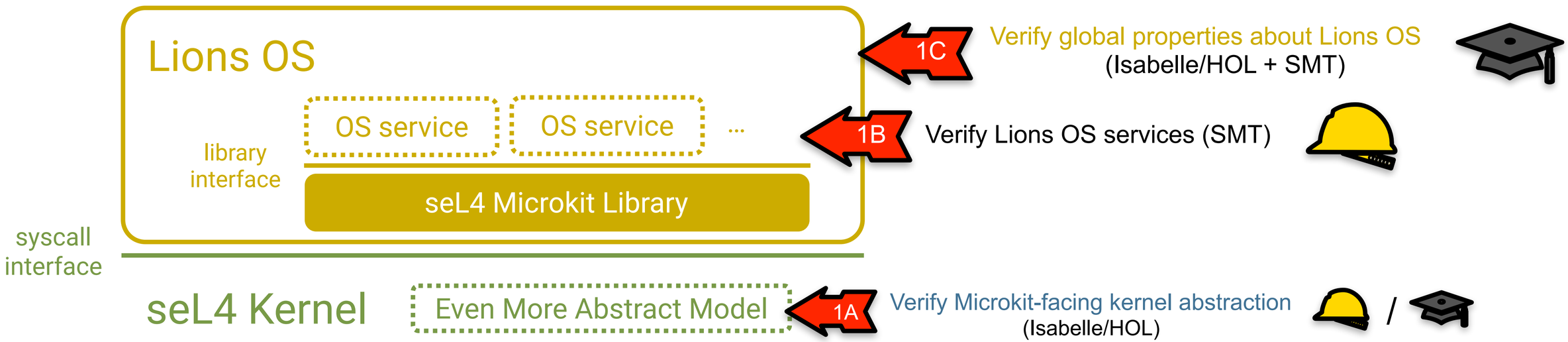

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- May demand further proofs of syscall properties (i.e. additions to 1A)

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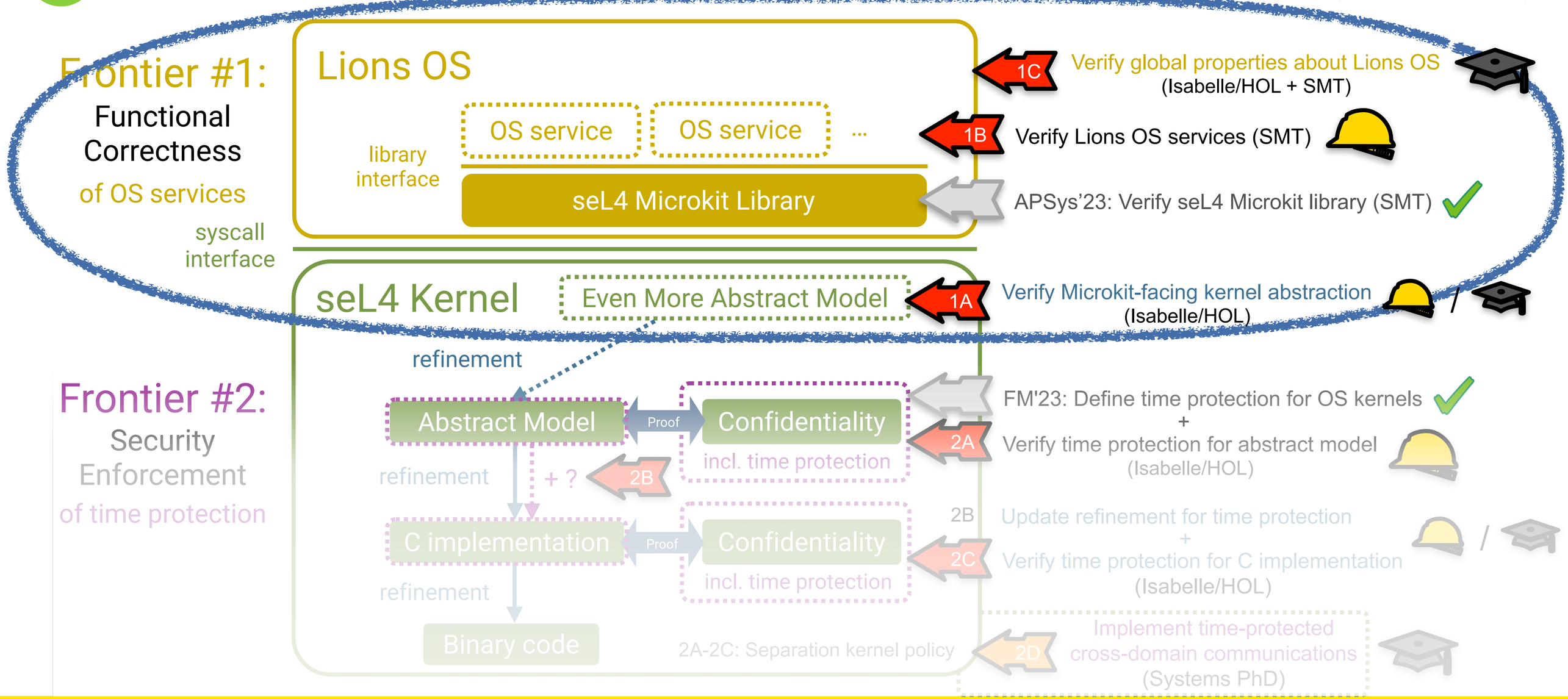

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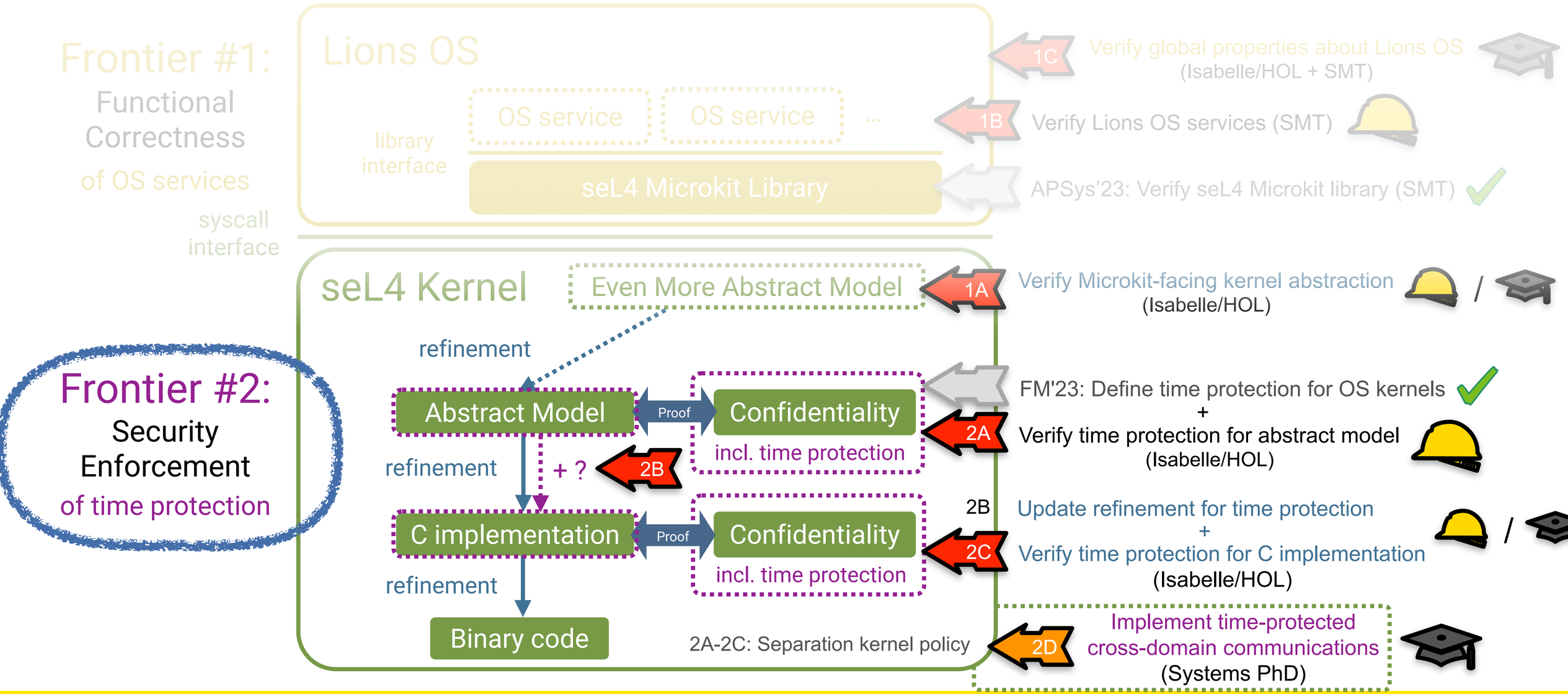
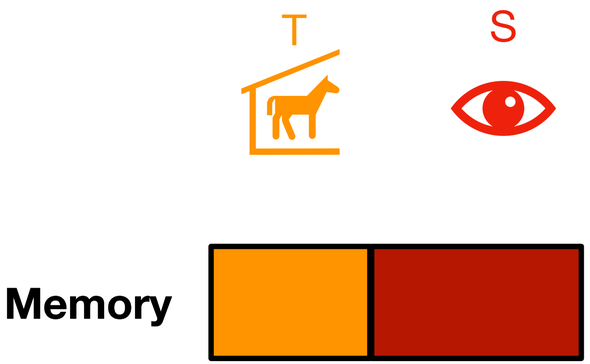
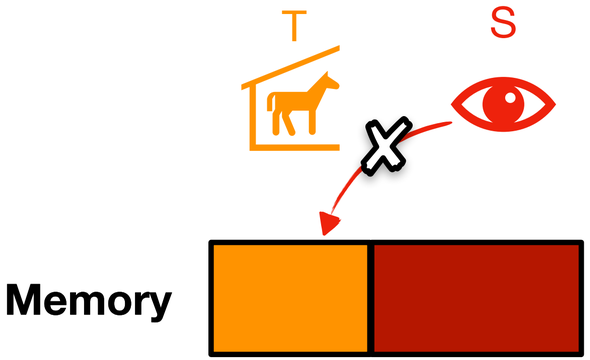


What is time protection?



What is time protection?

- OSes typically implement *memory protection.*



What is time protection?

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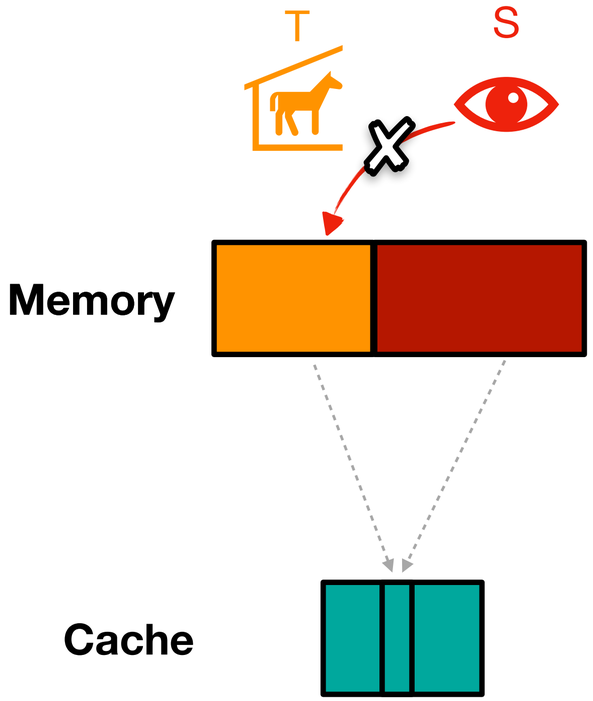
- But: Mere memory access changes microarchitectural state — this affects timing.



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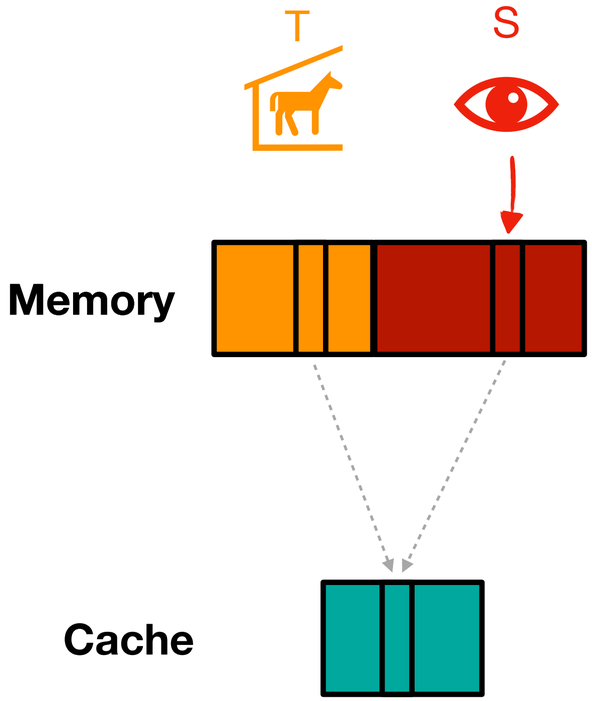

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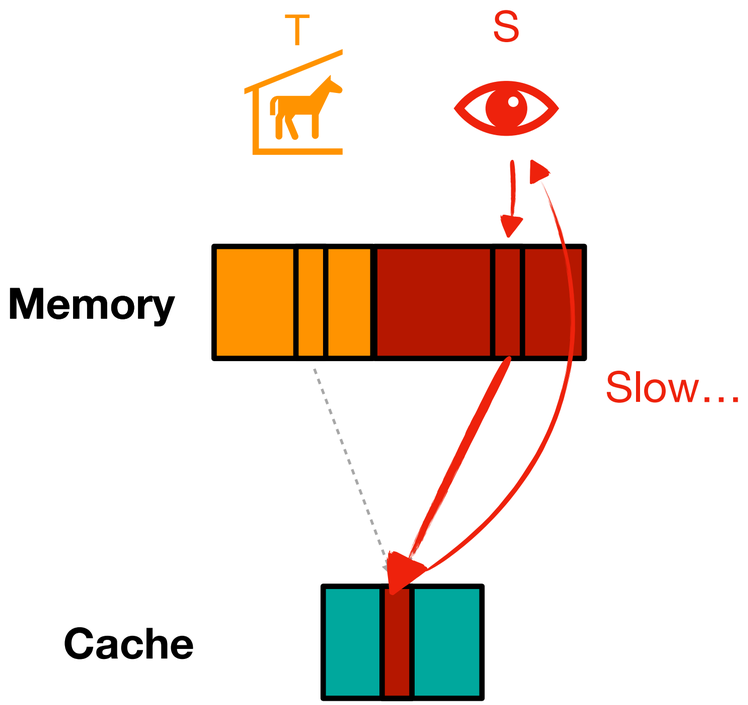

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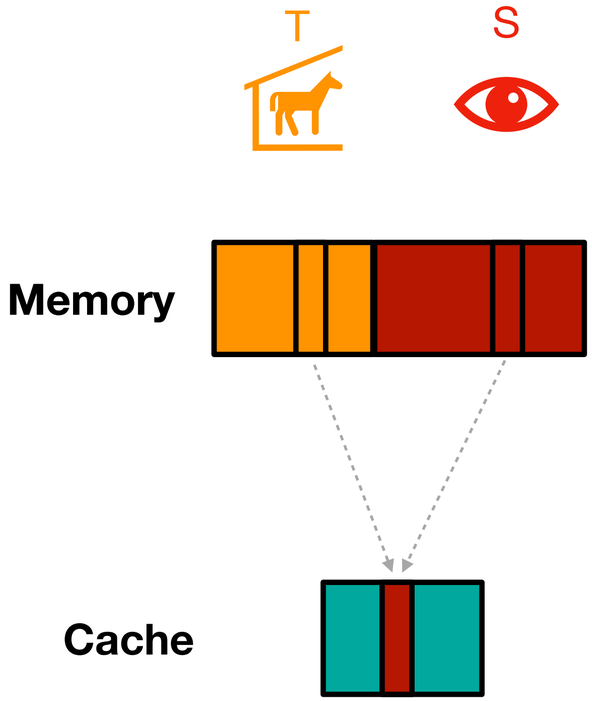

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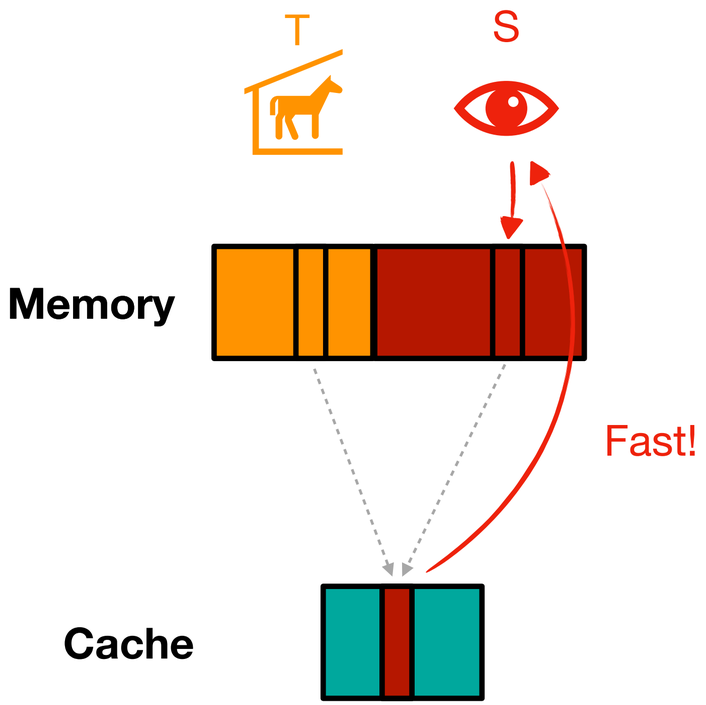

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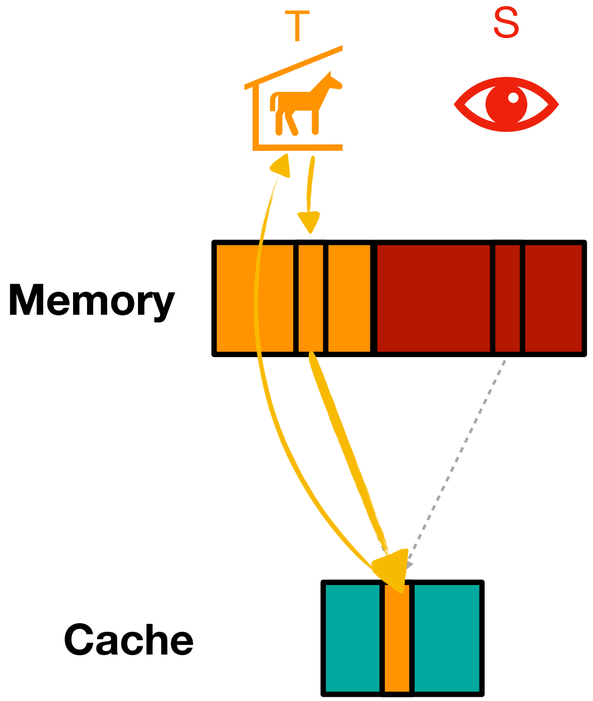

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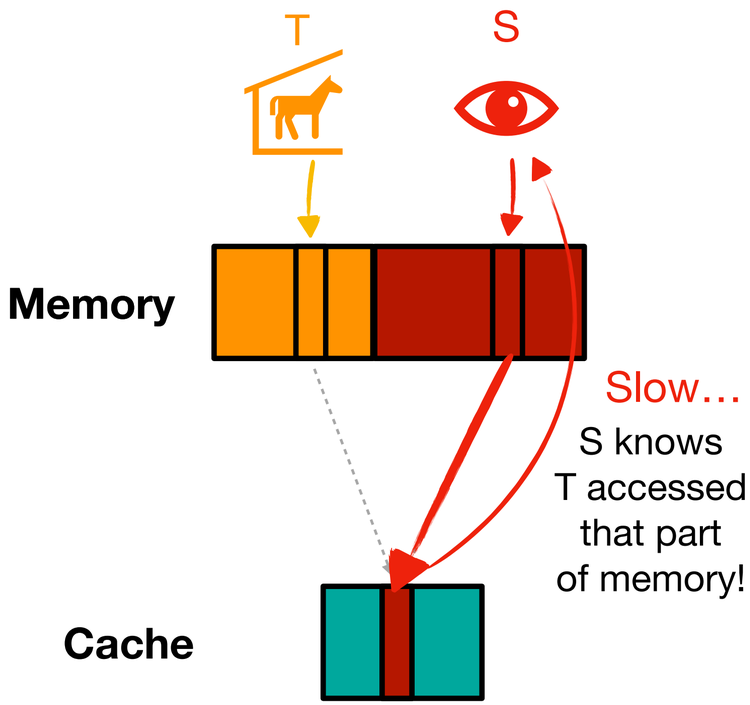

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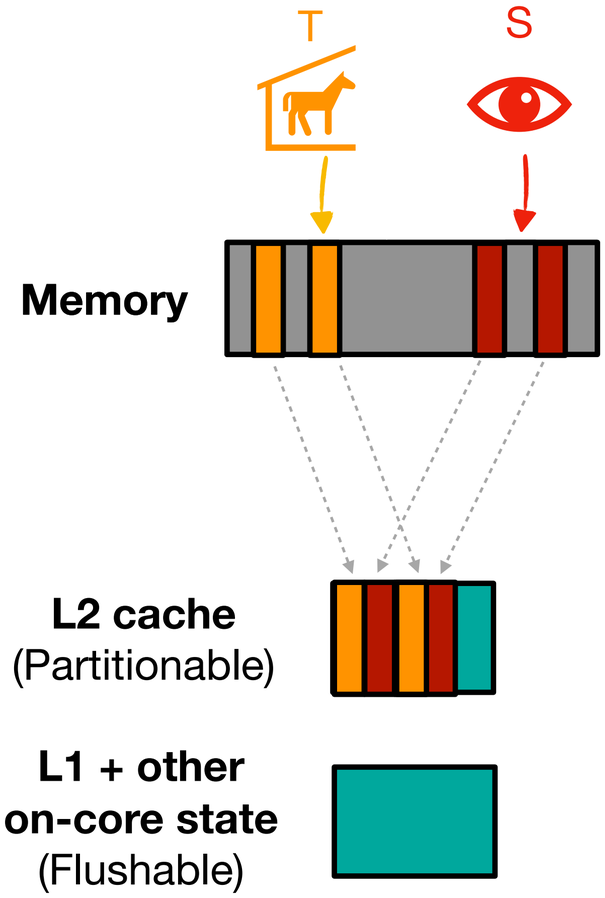

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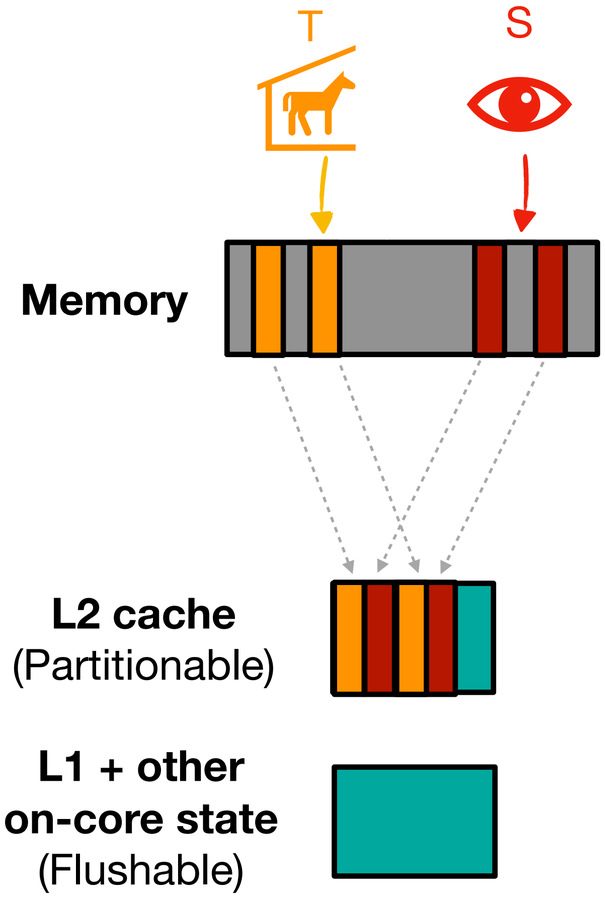

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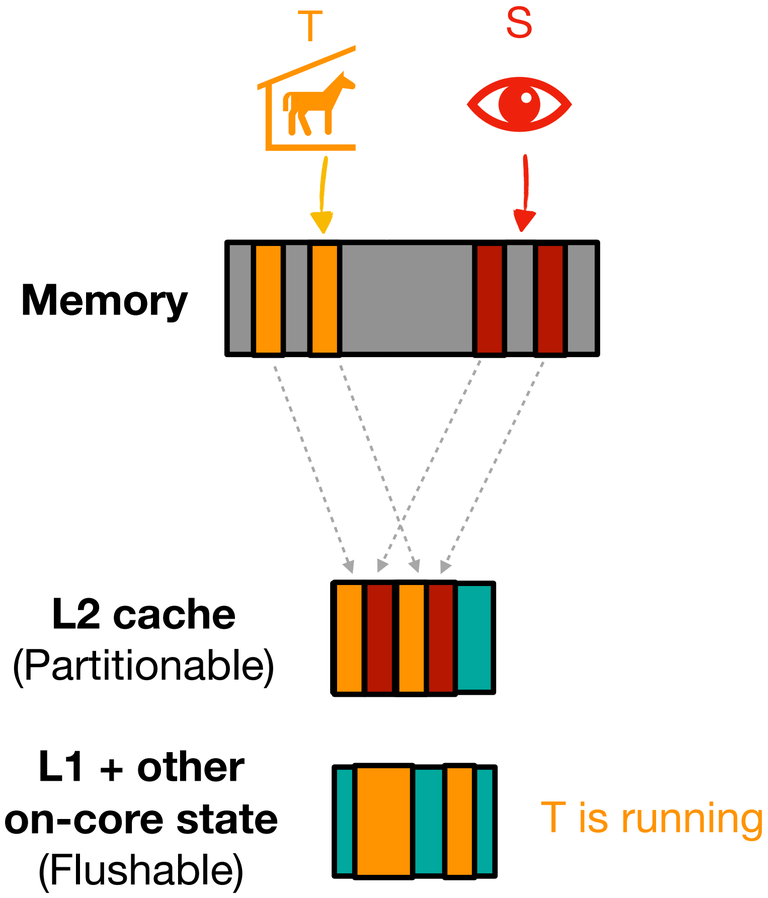

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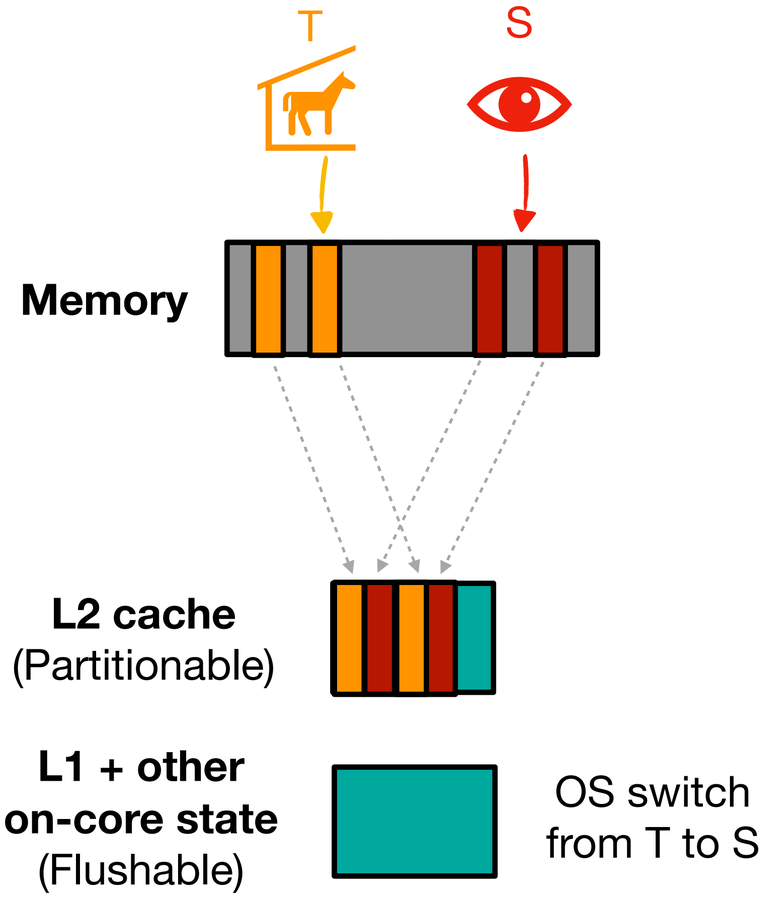

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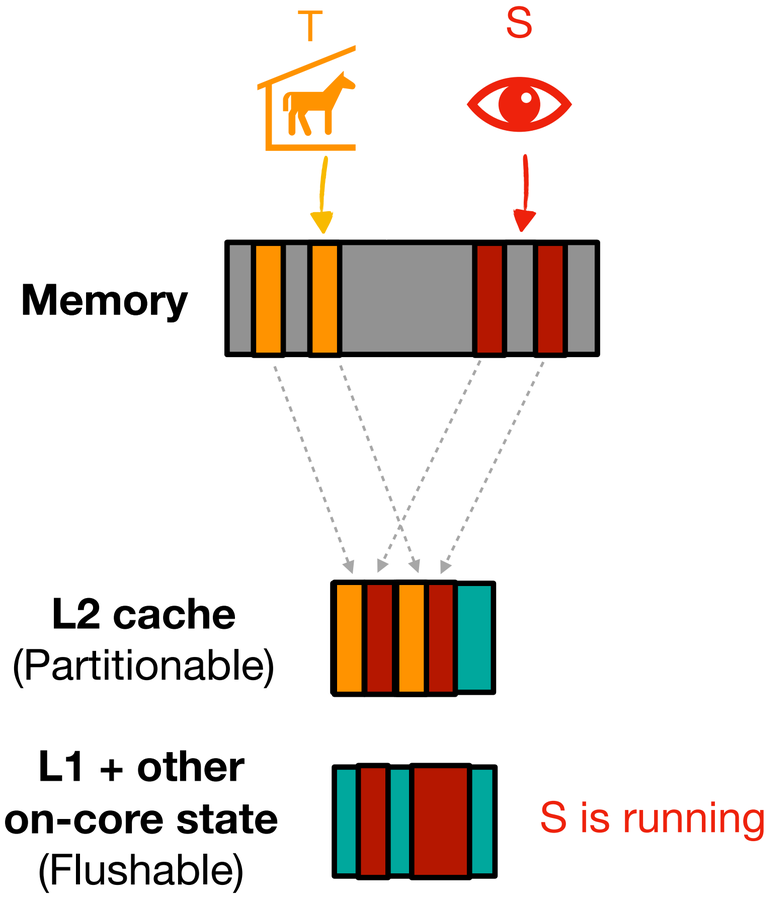

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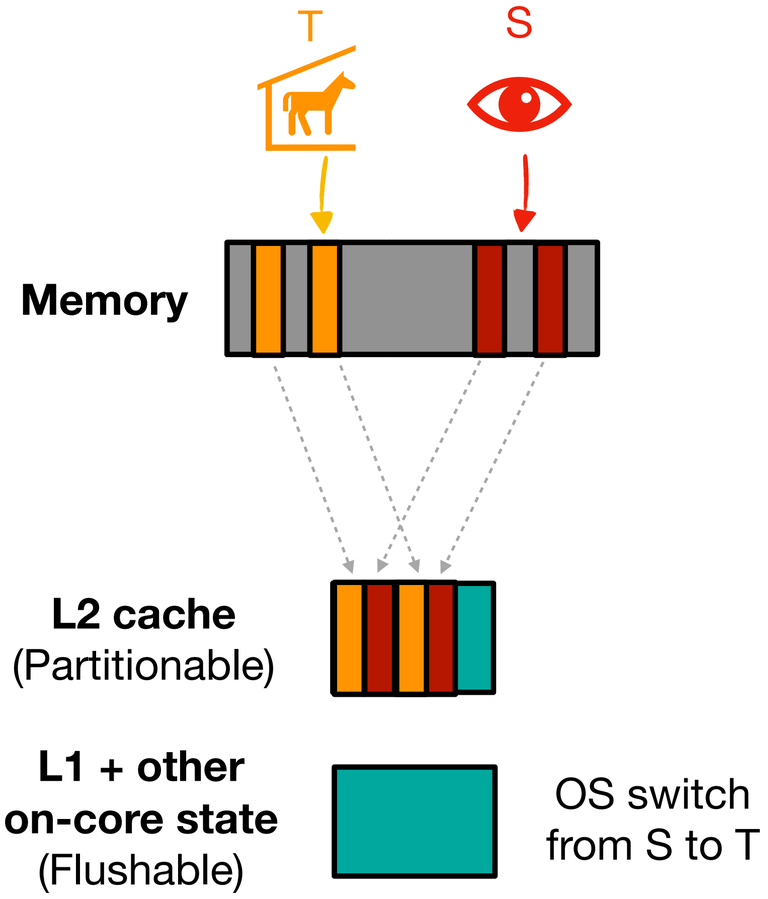

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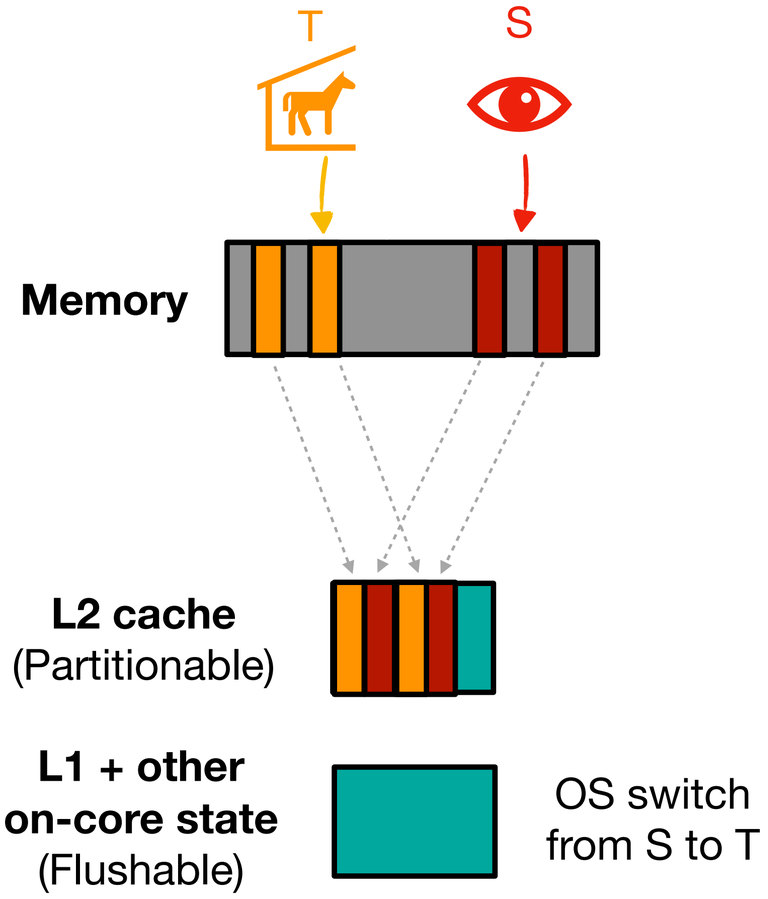

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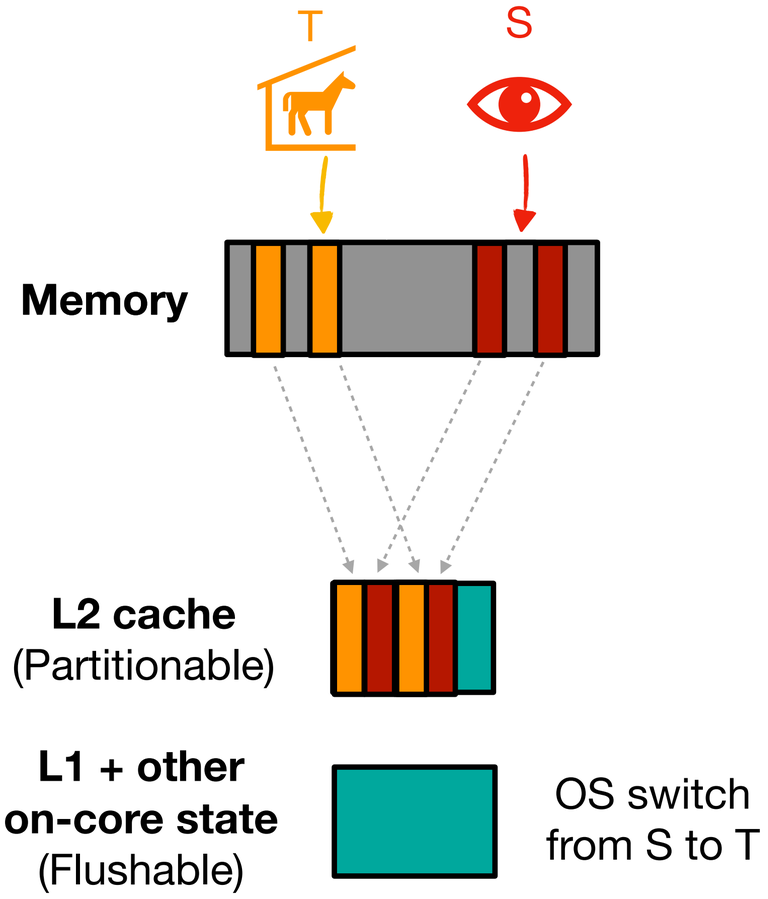

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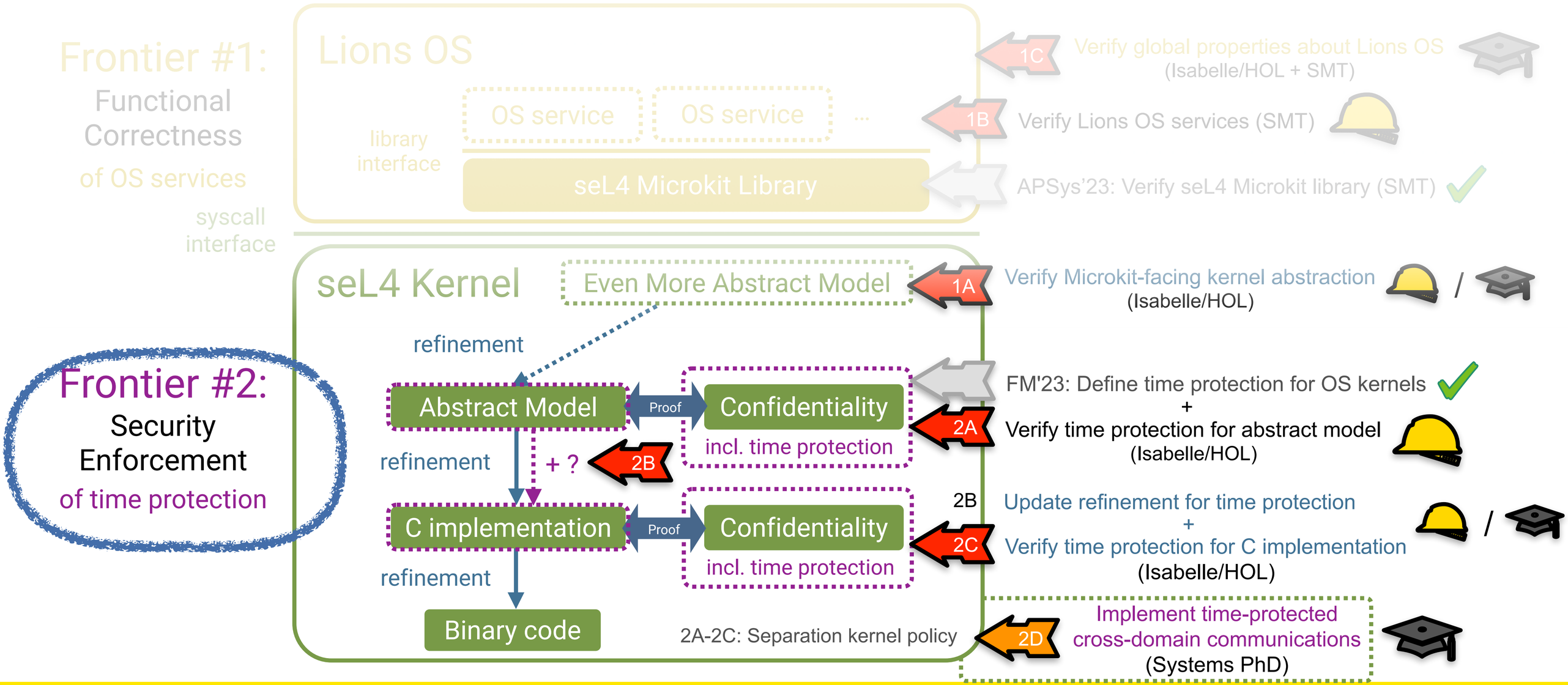
Two new frontiers for seL4 refinement



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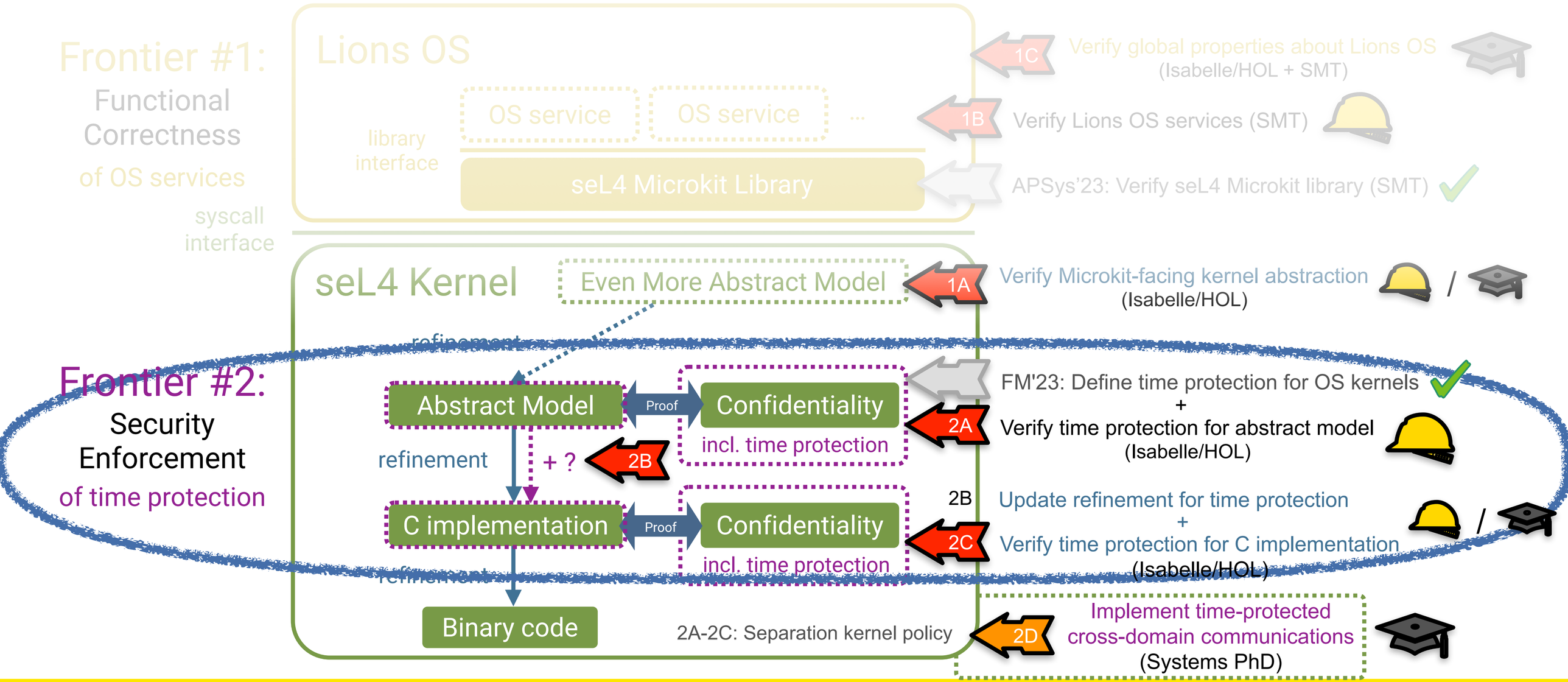

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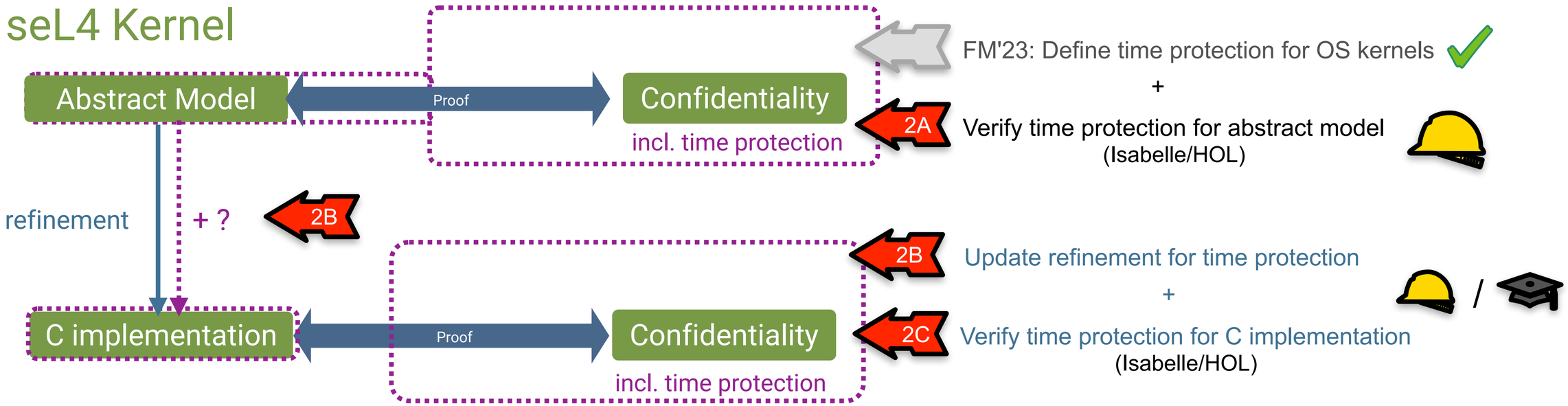

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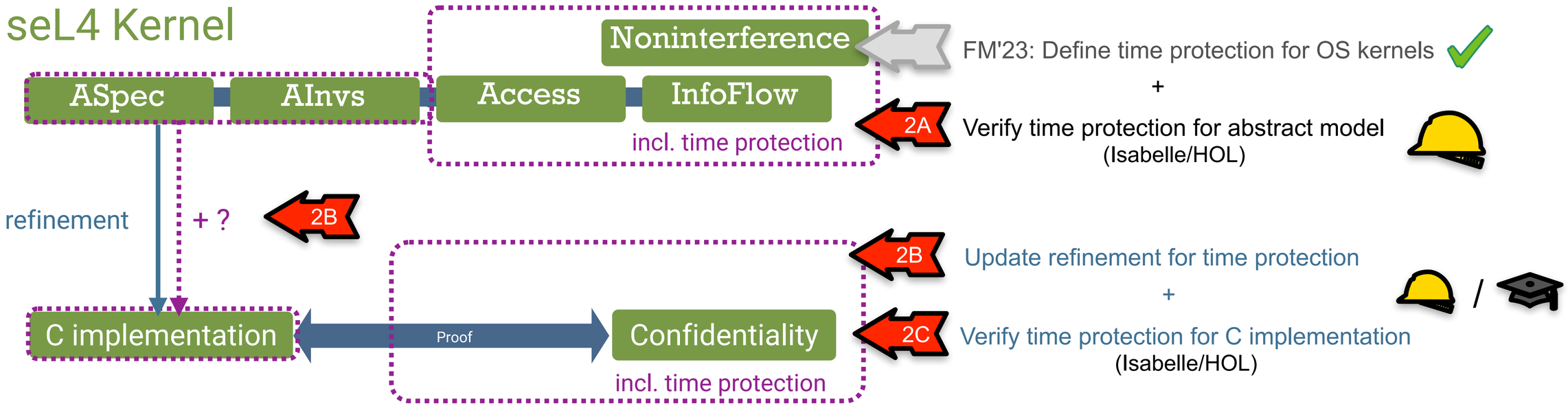

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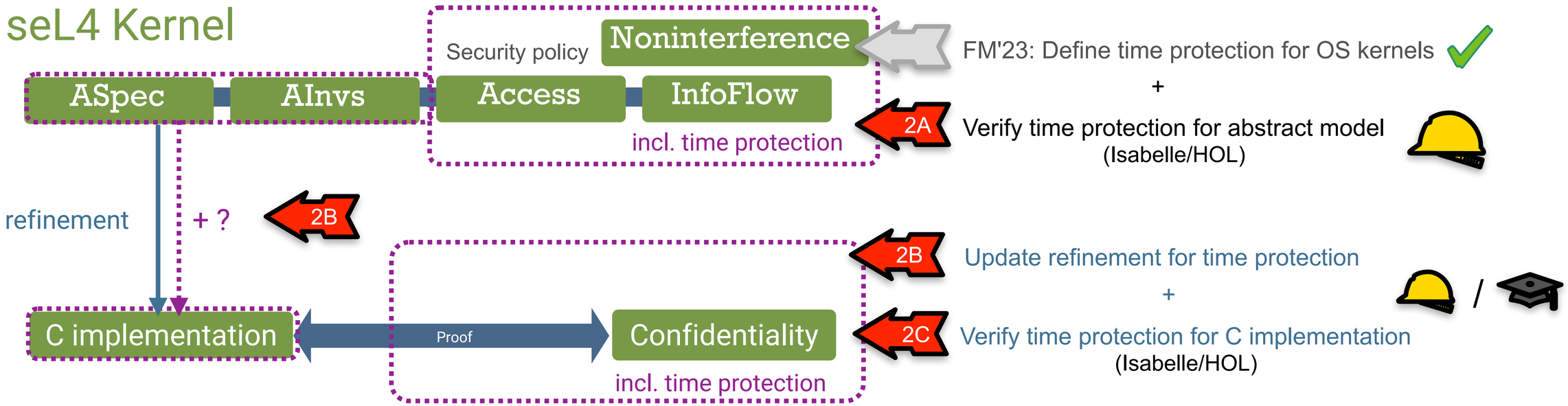

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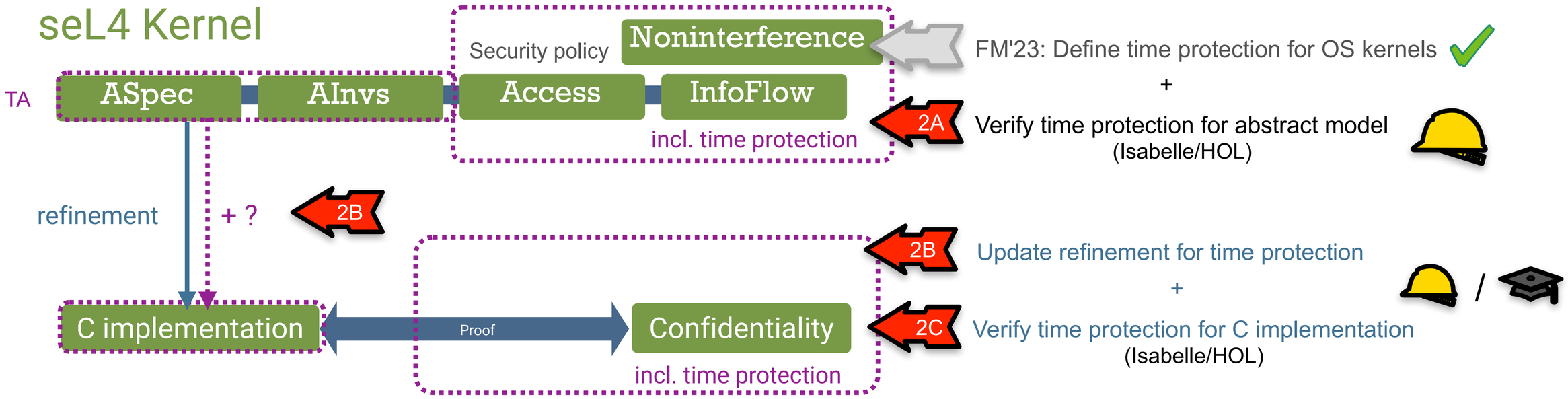

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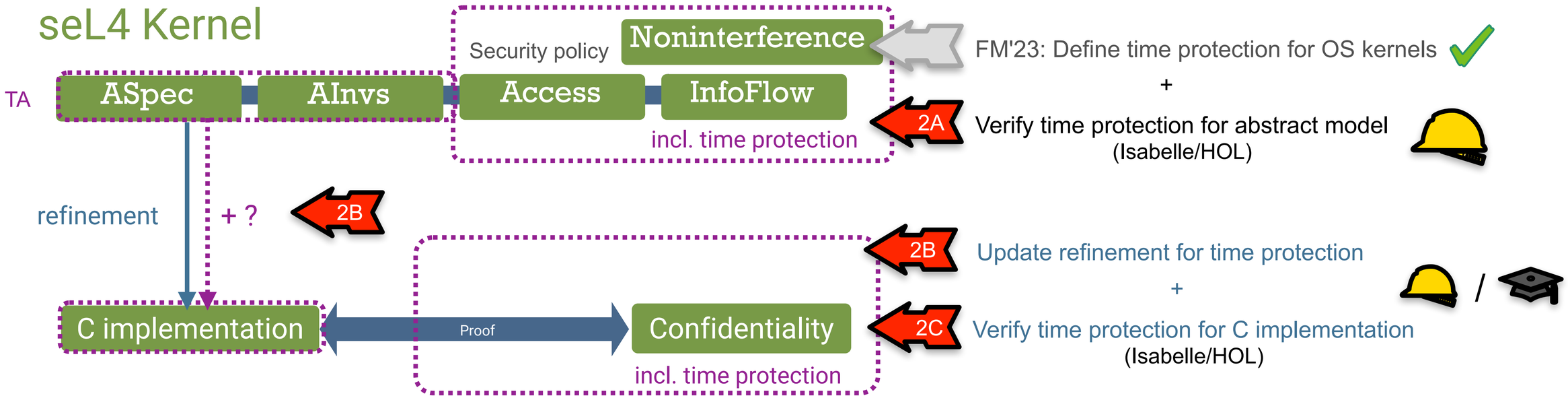

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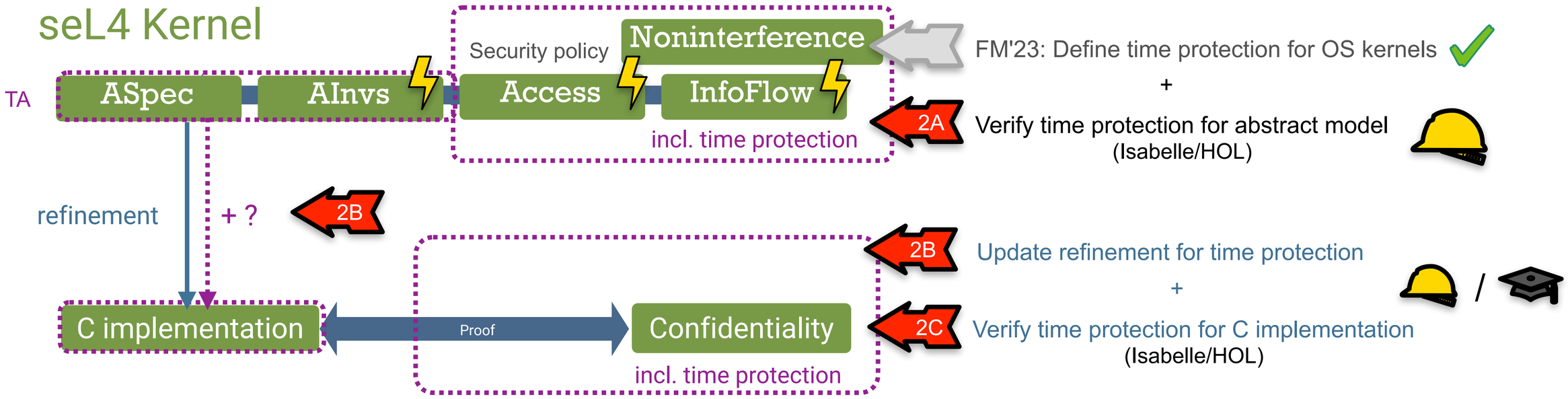

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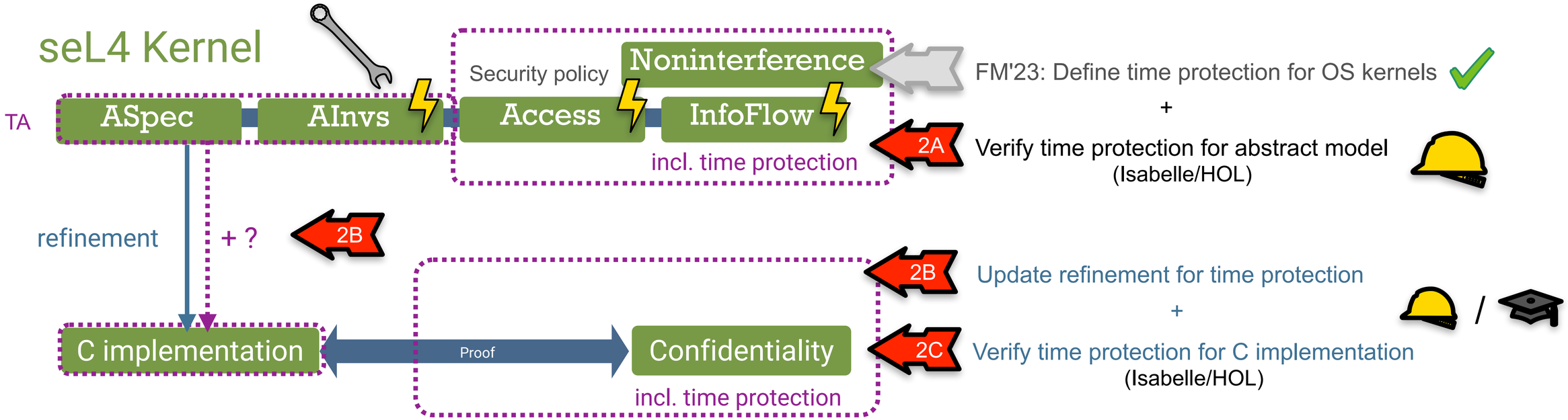

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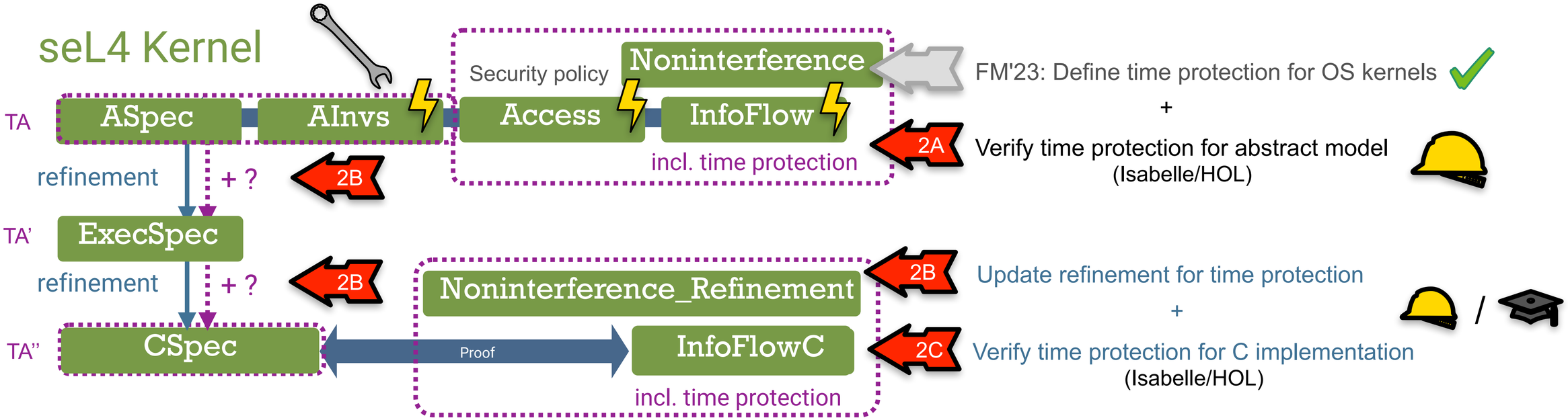

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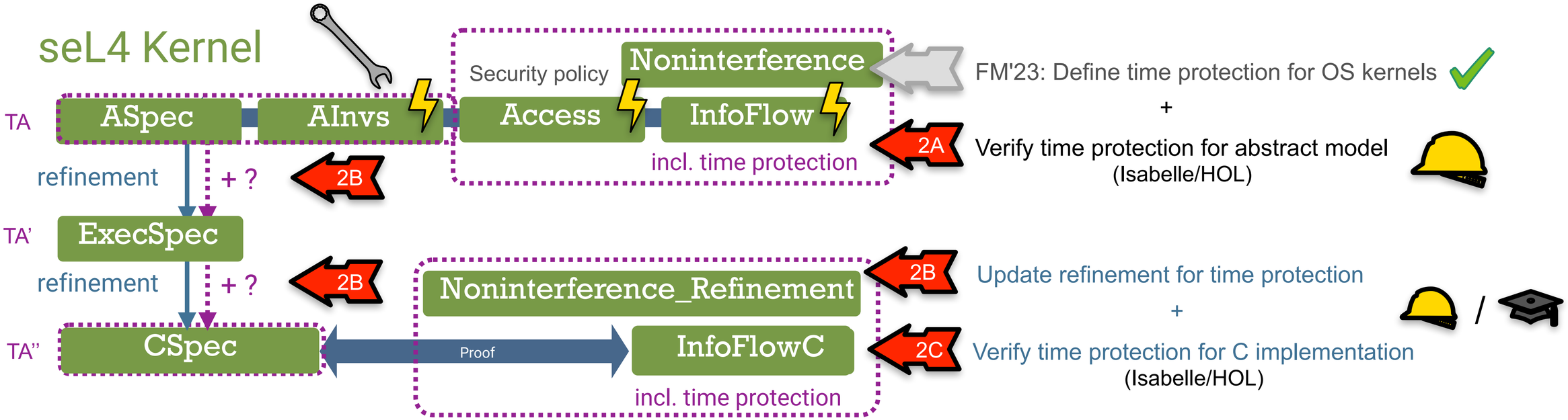

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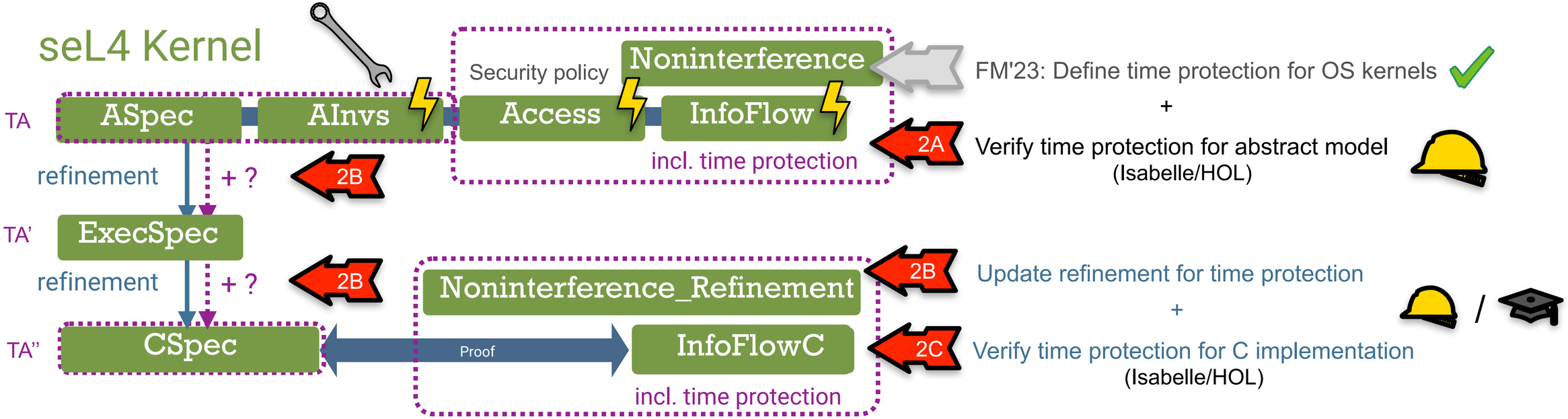

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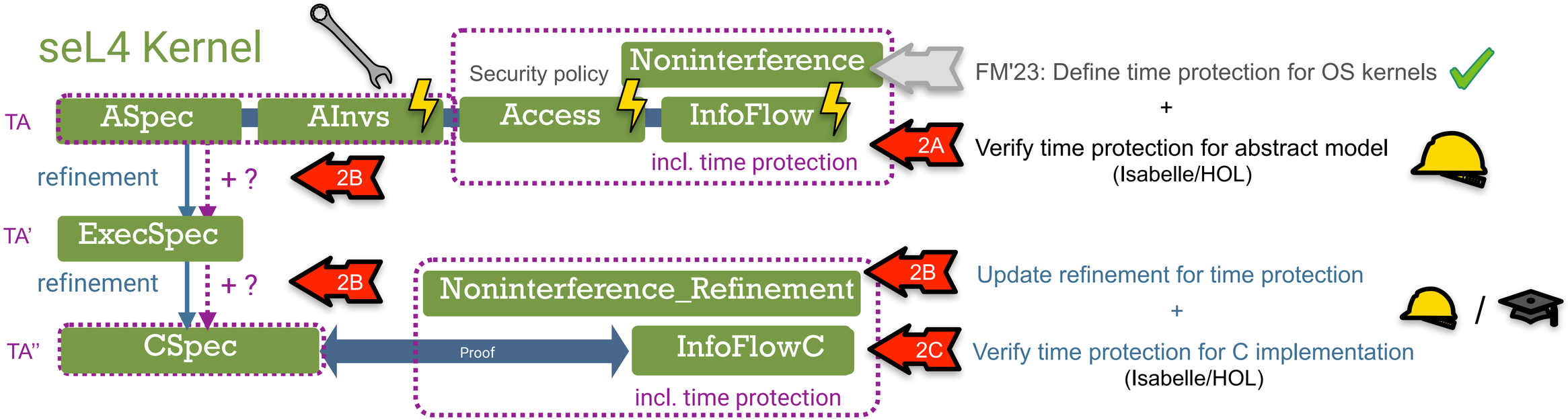

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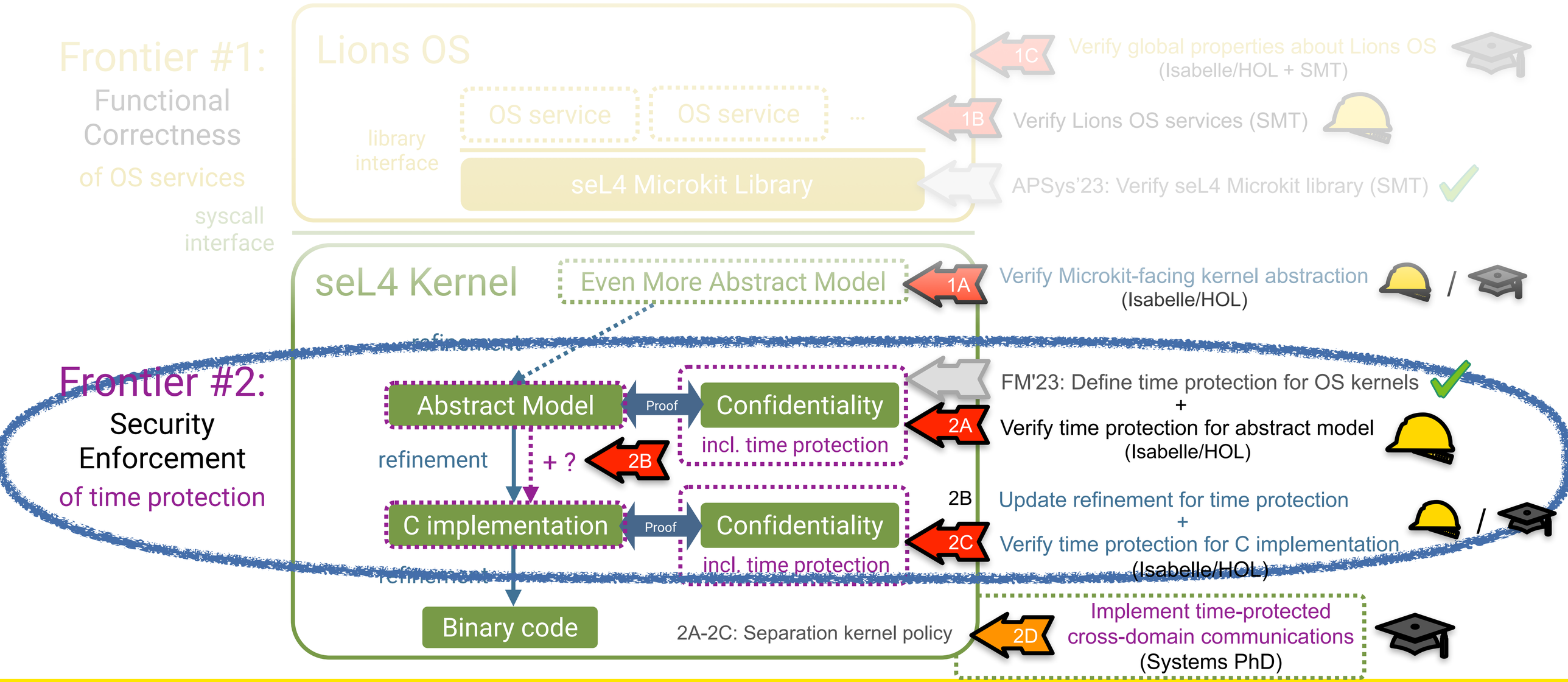

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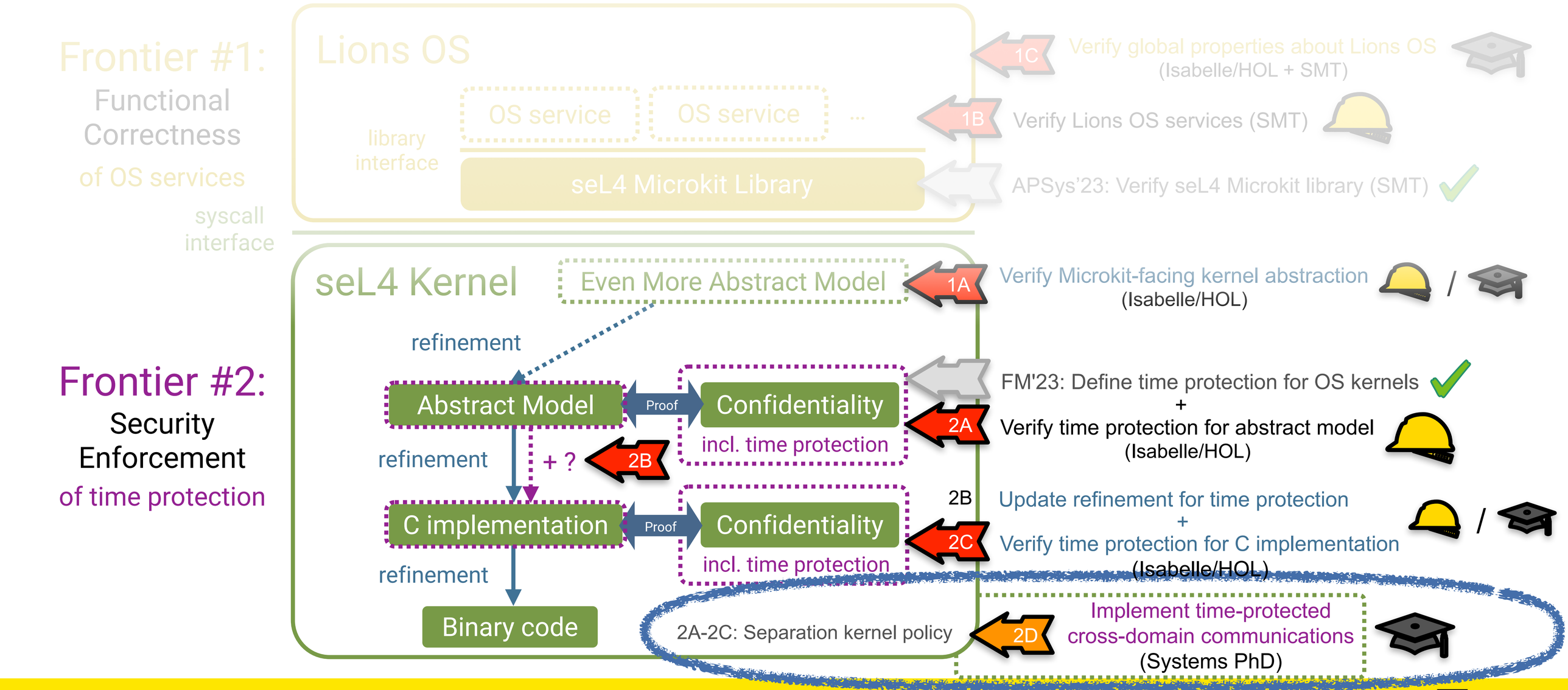

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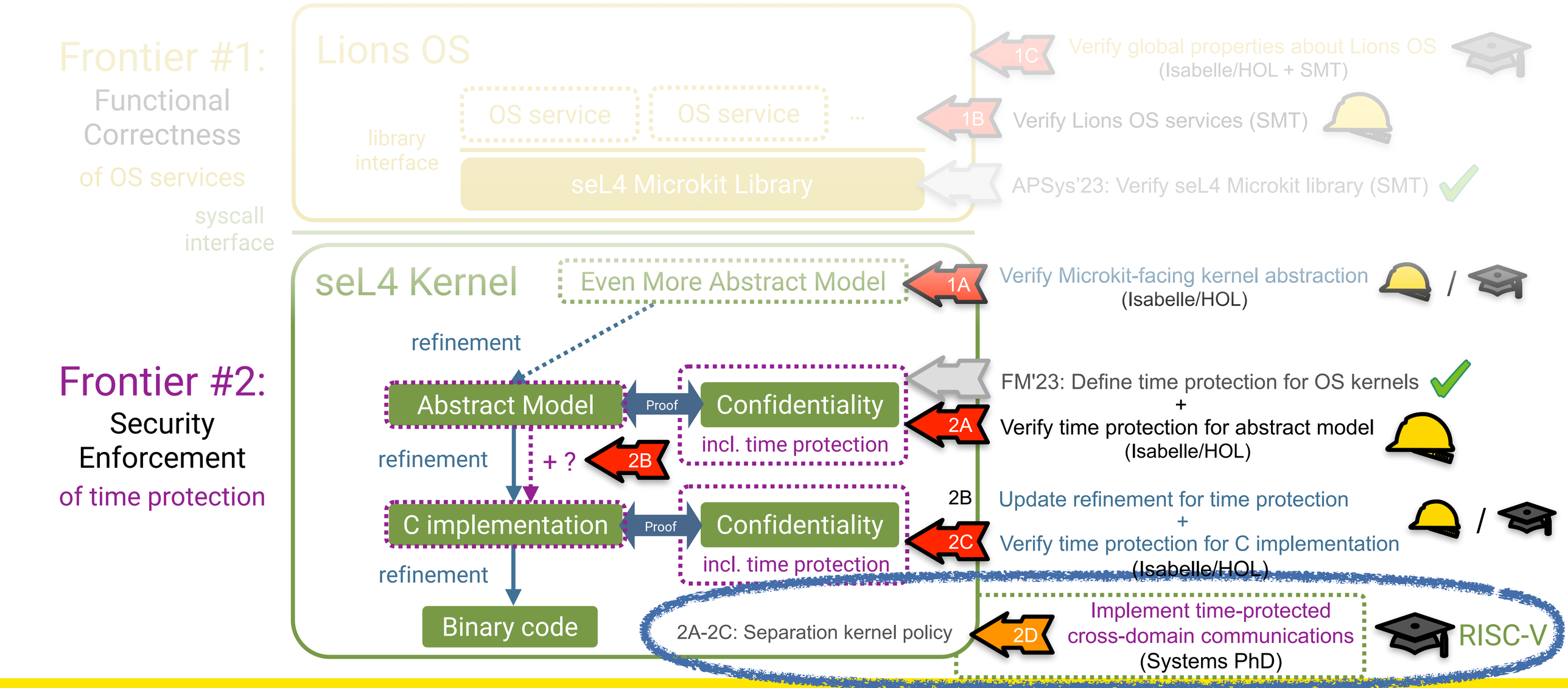

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Frontier #1:
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Frontier #2:
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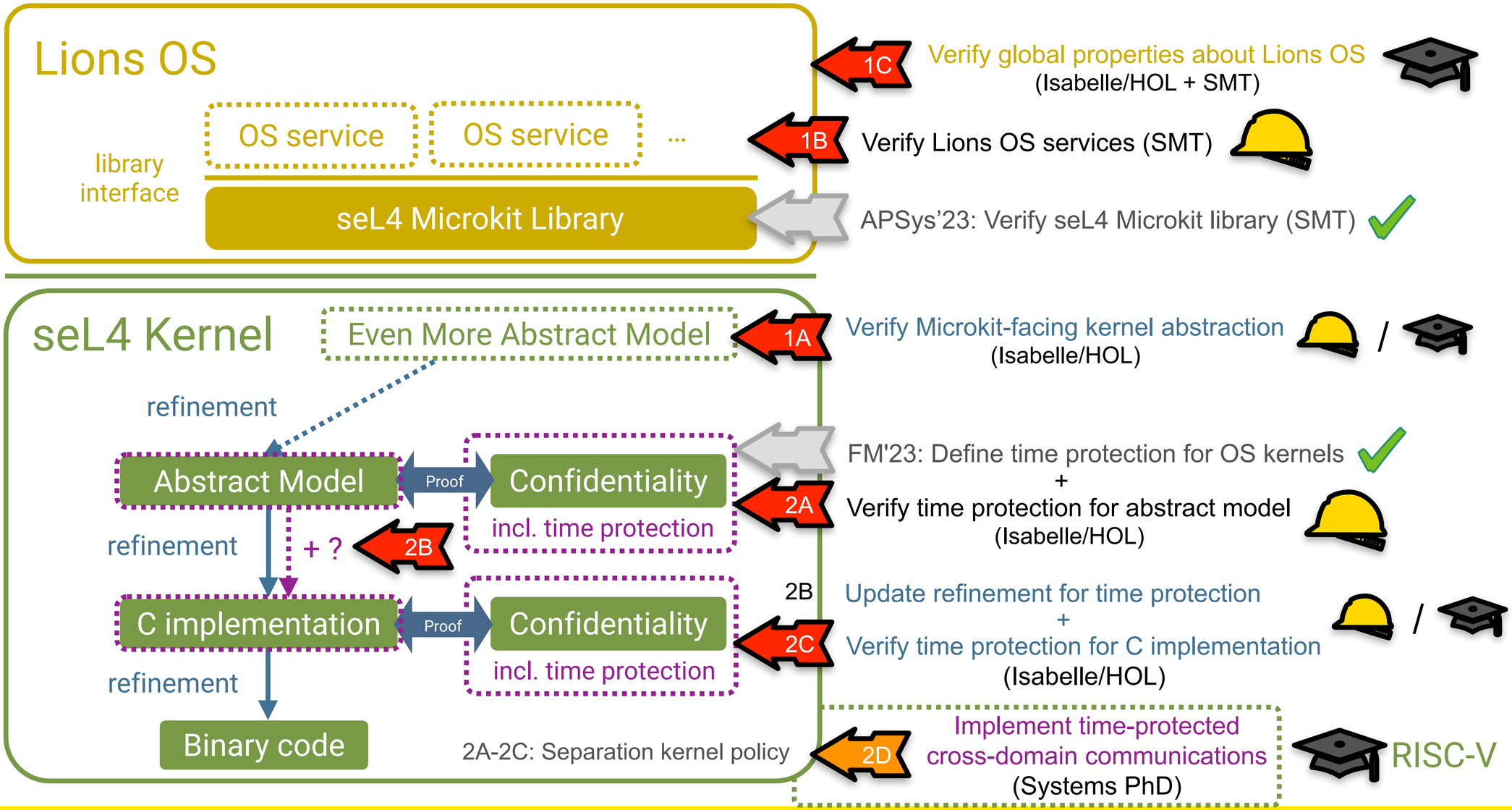

Trustworthy Systems @ CSE, UNSW Sydney

Thank you! Questions?

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