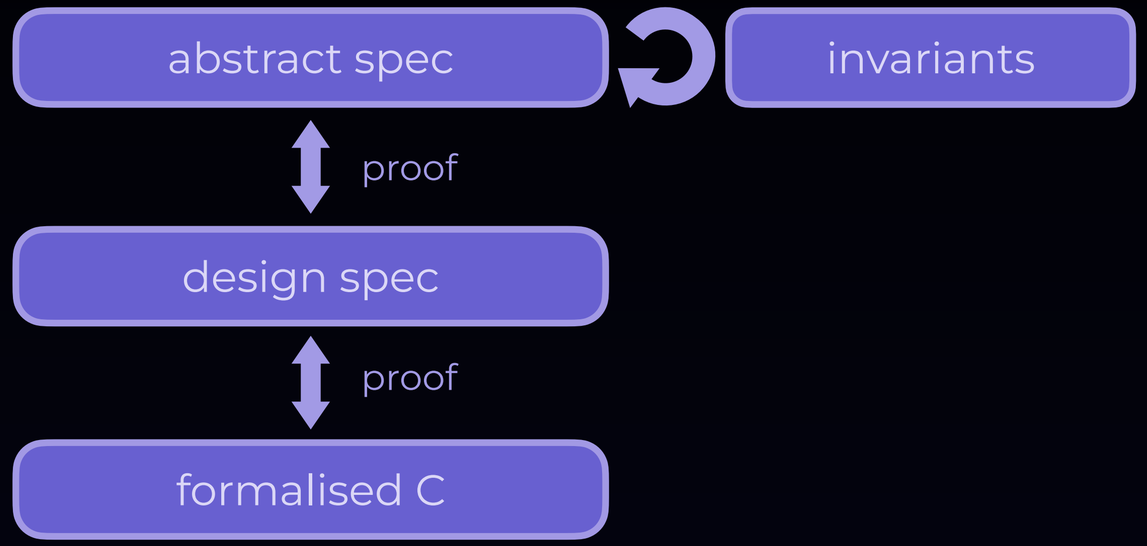

# seL4's Security Proofs

Ryan Barry | seL4 summit 2026, Vancouver, Canada

# What is “correctness”?

# Verification stack



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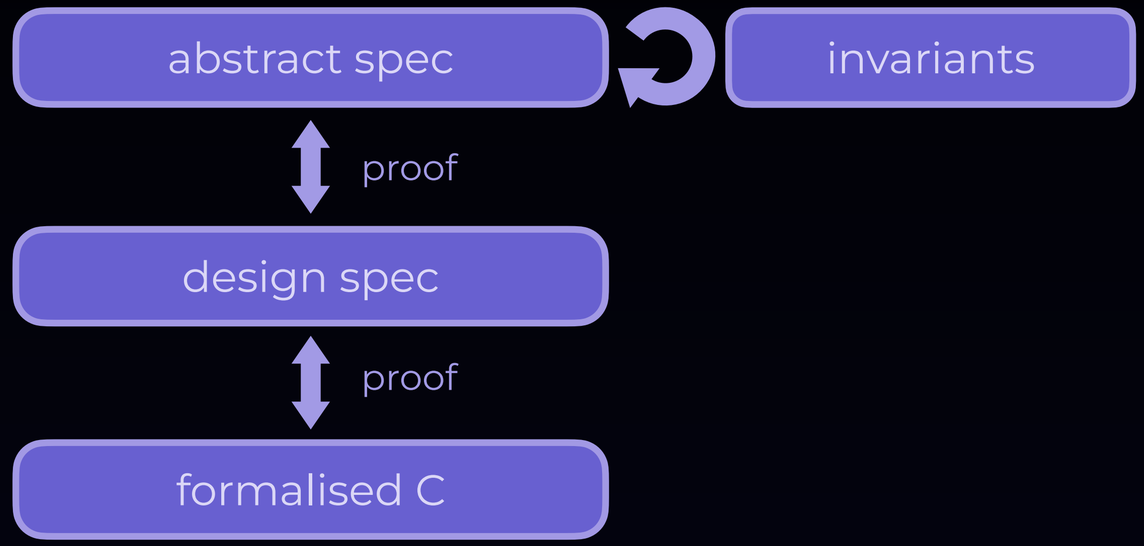


behaviour here...

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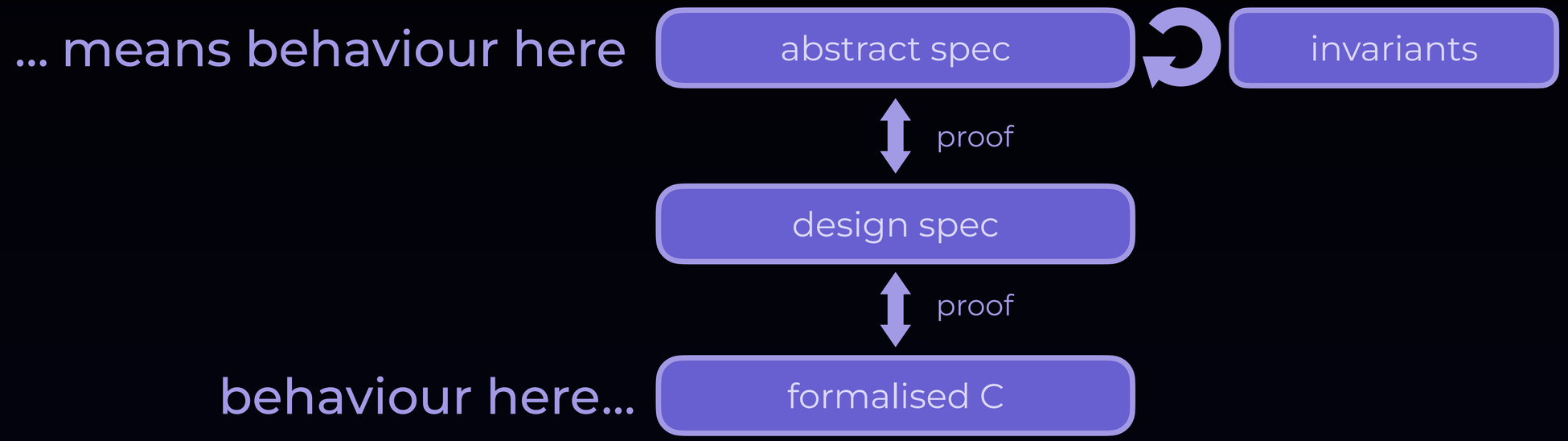

# Assumptions

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- Among others, seL4's assumptions include:

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We assume the hardware works as expected

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**Hardware Assumptions**

We assume the hardware works as expected

**Specification Assumptions**

We assume the specification says what we want it to

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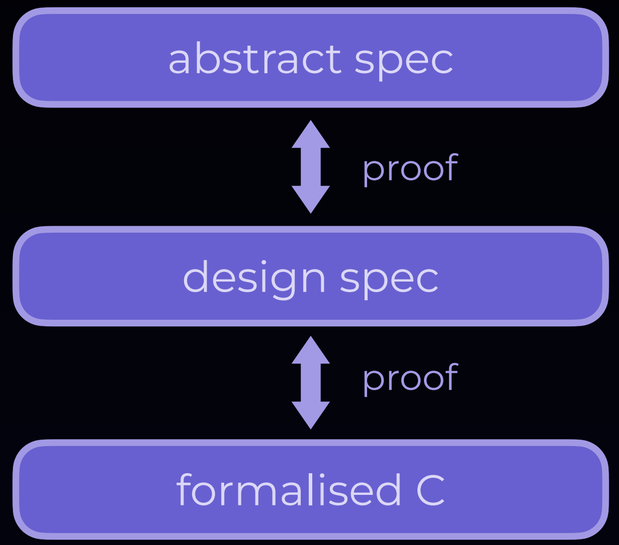

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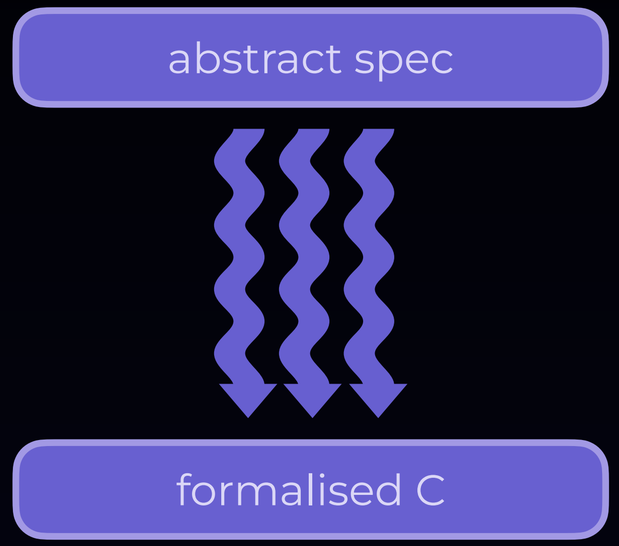

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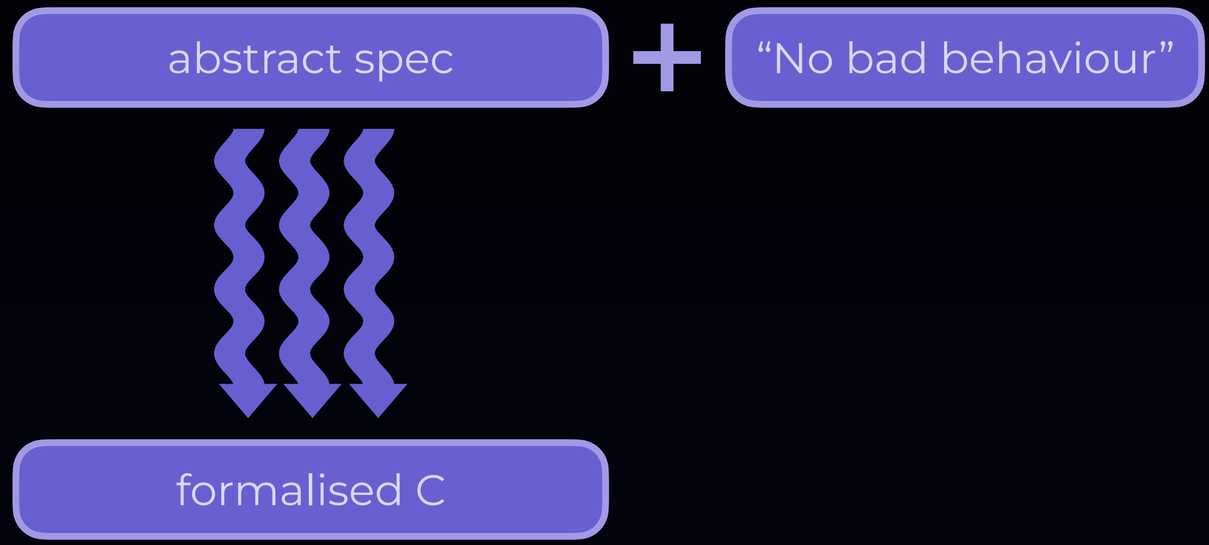

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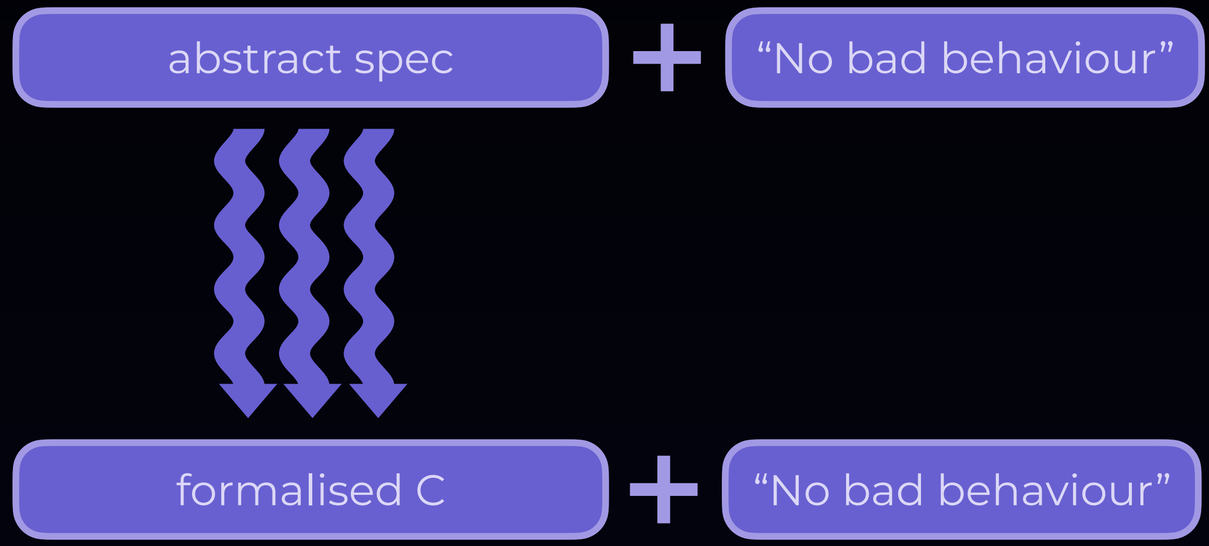

# Security Properties

# CIA Triad

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- Confidentiality
  - Can’t learn information without authorisation

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- Integrity
  - Can’t modify data without authorisation
- Authority Confinement
  - Can’t escalate authority

# Confidentiality

Breaking confidentiality
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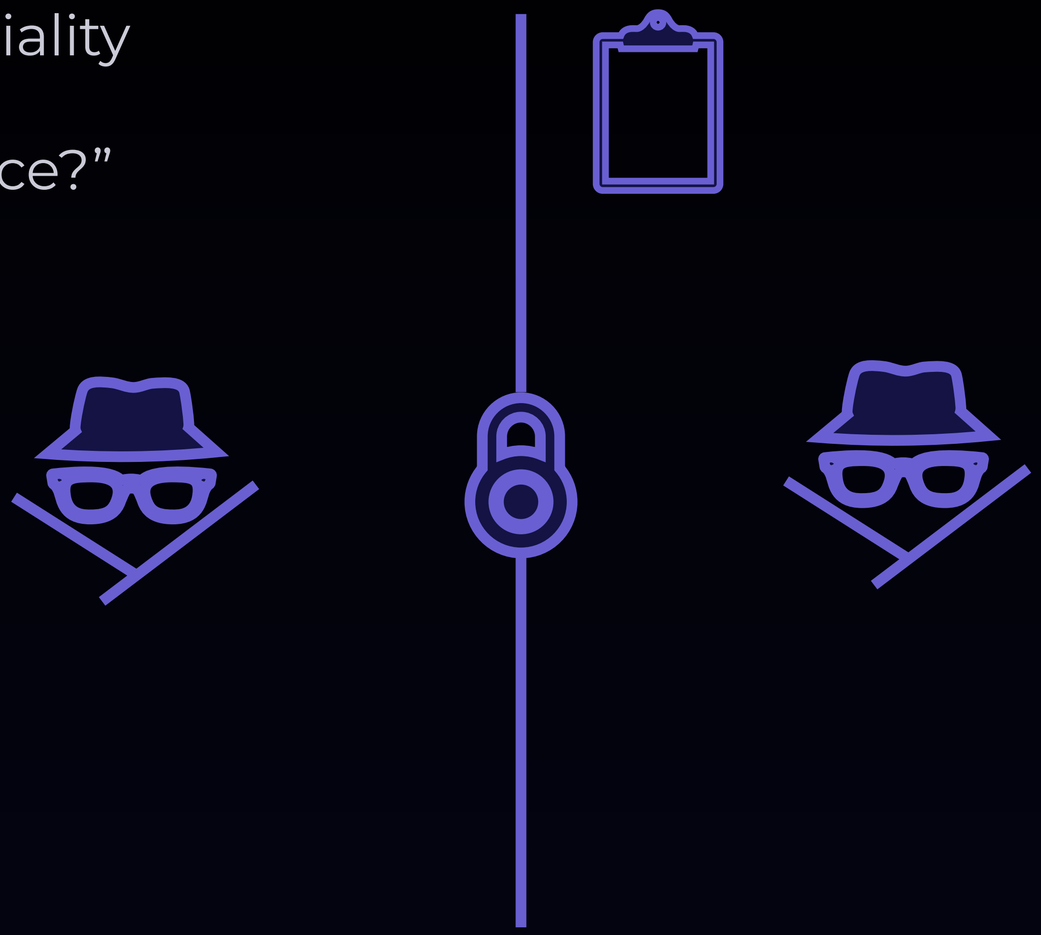
“Who can I influence?”



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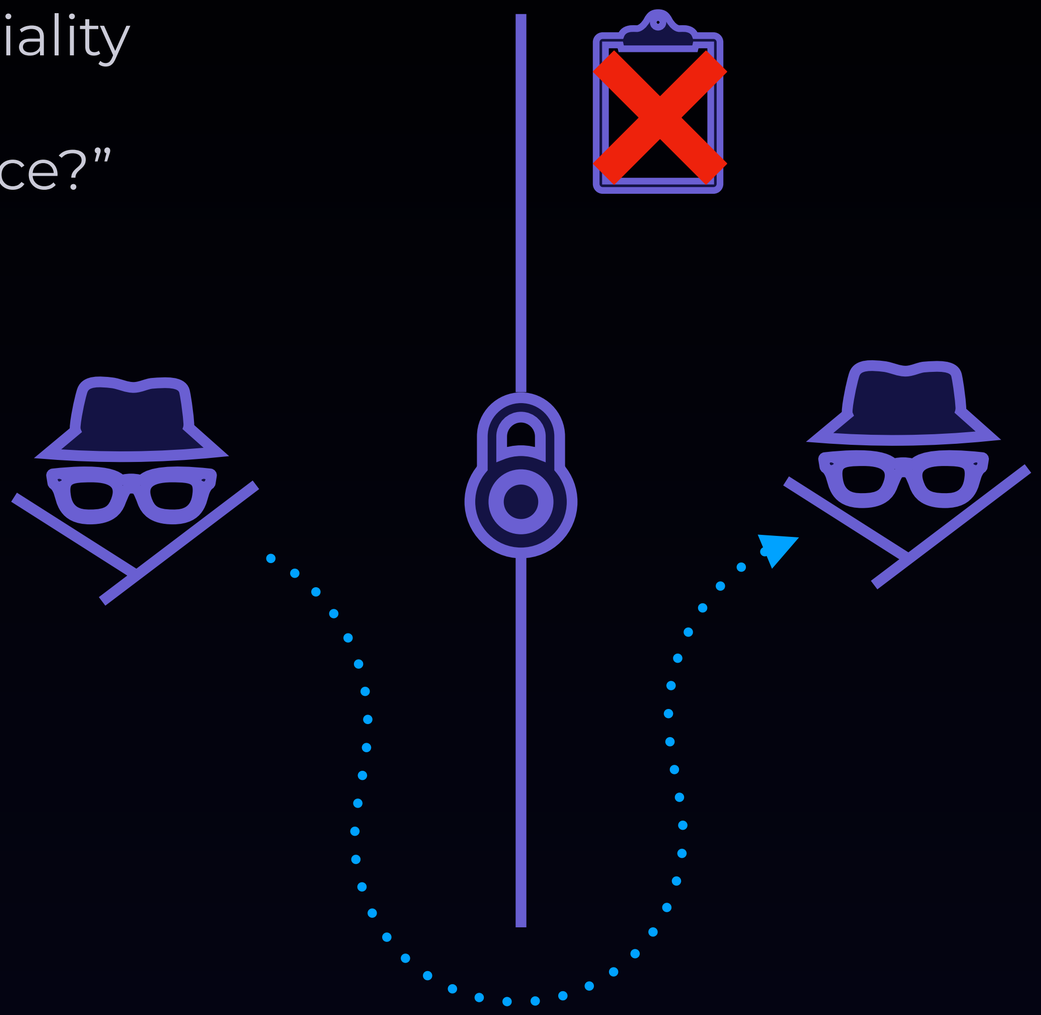

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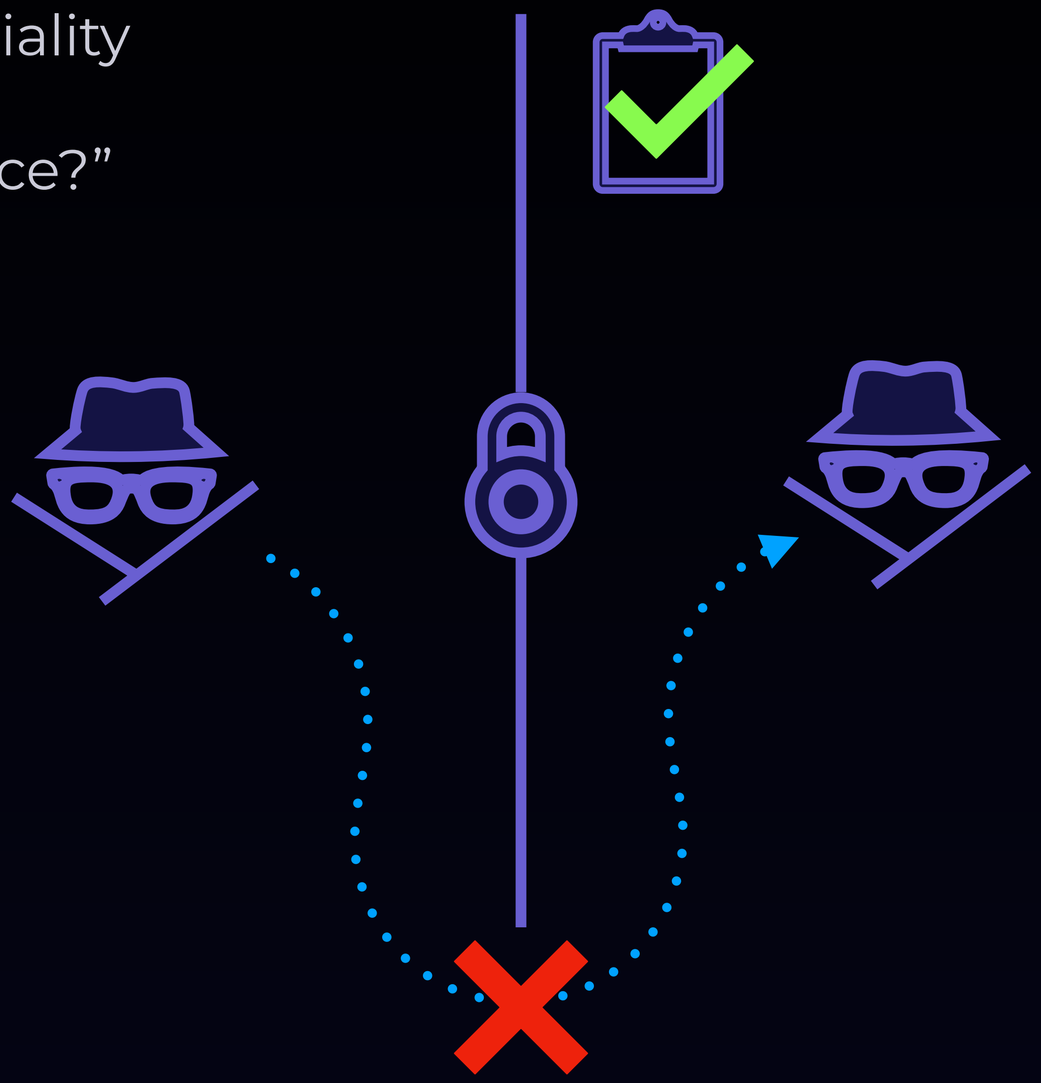

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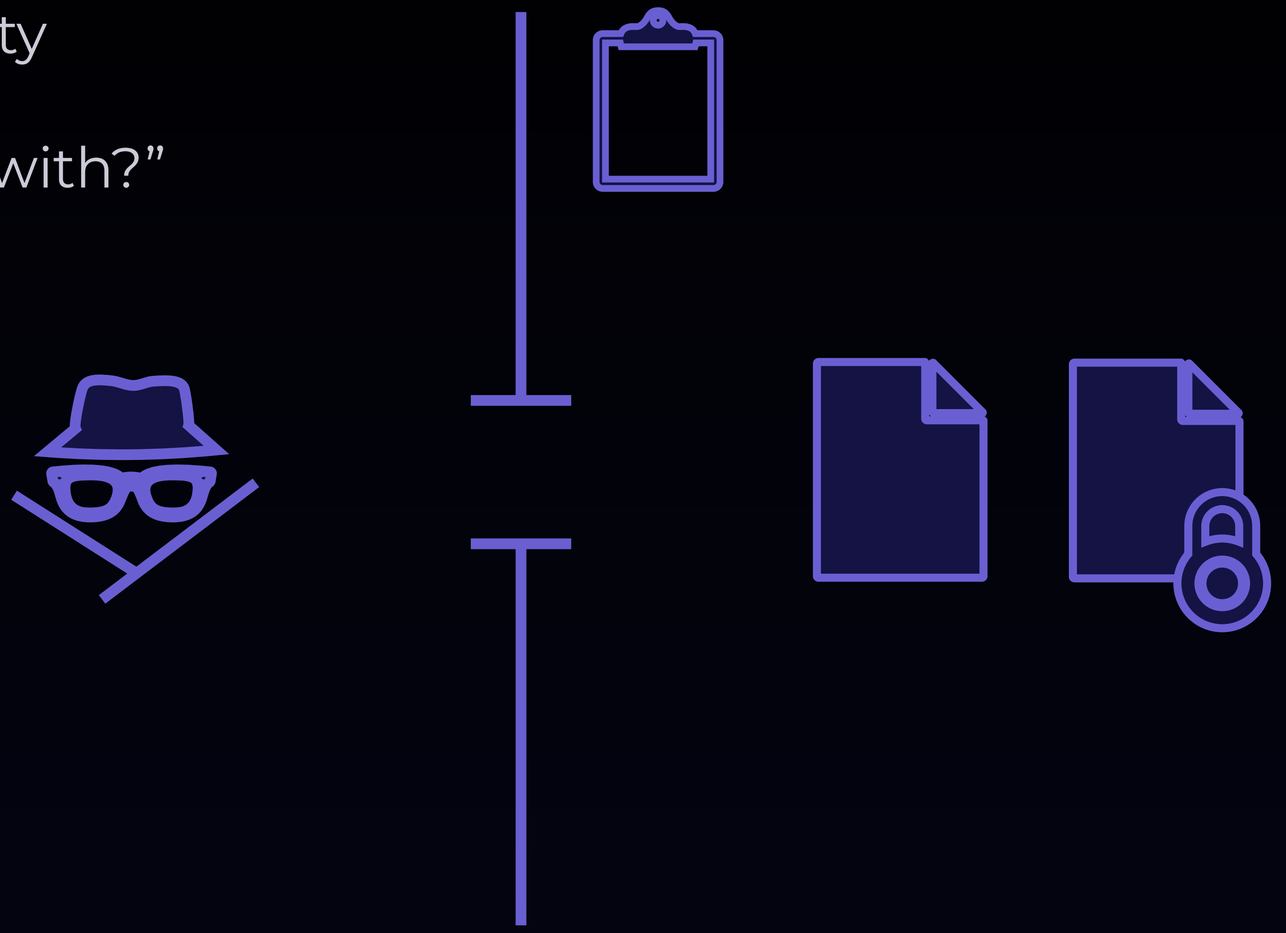

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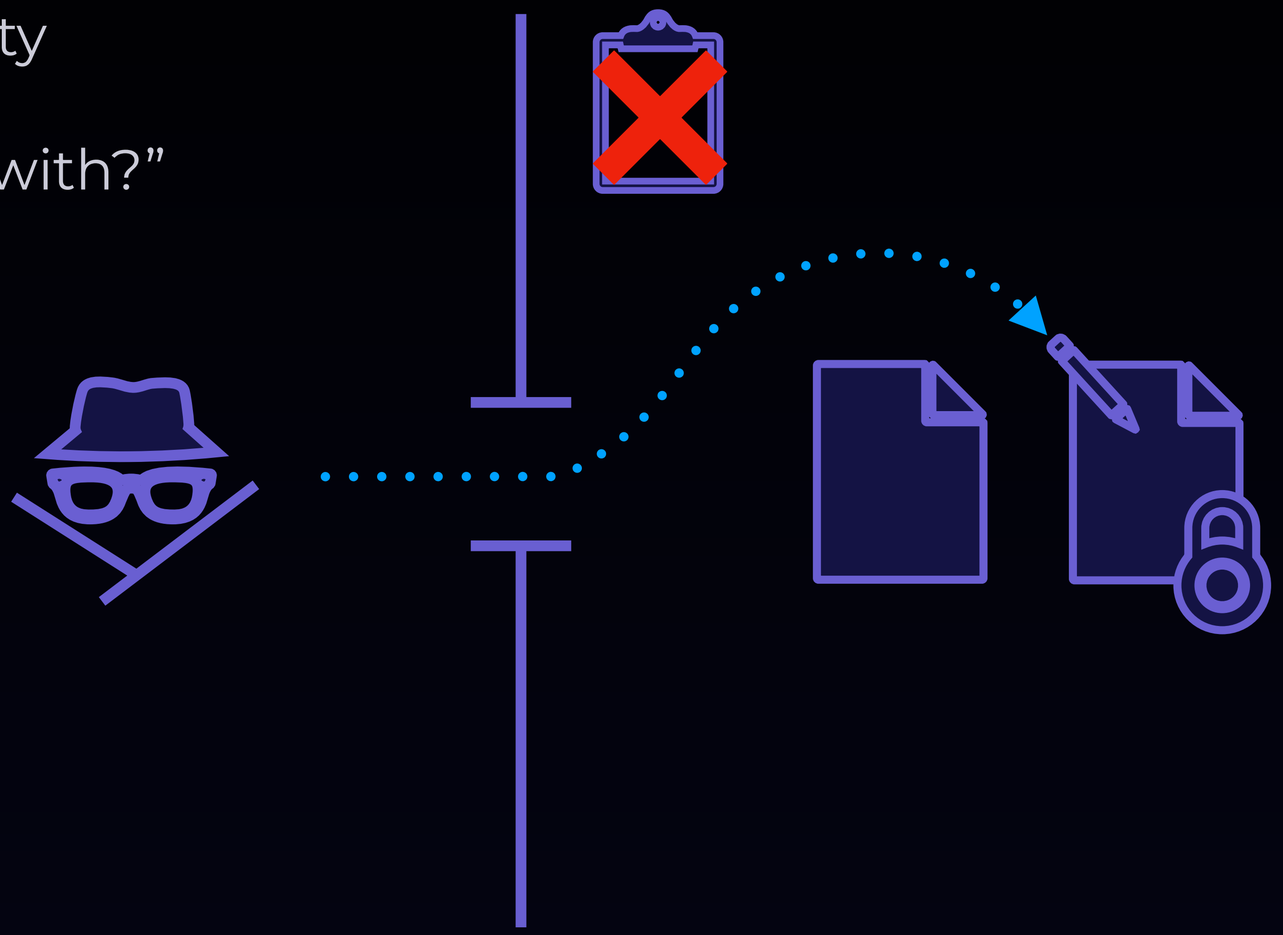

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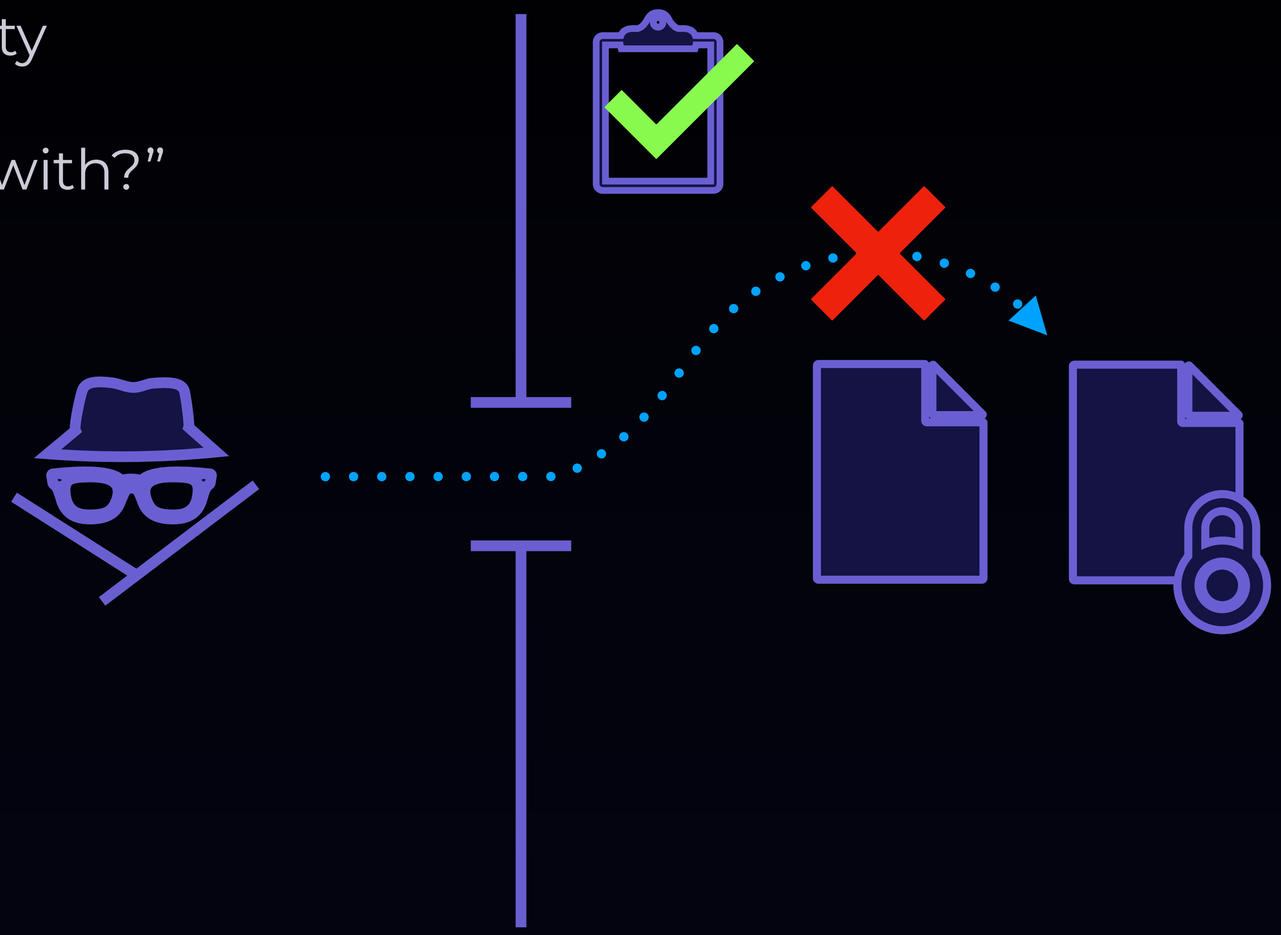

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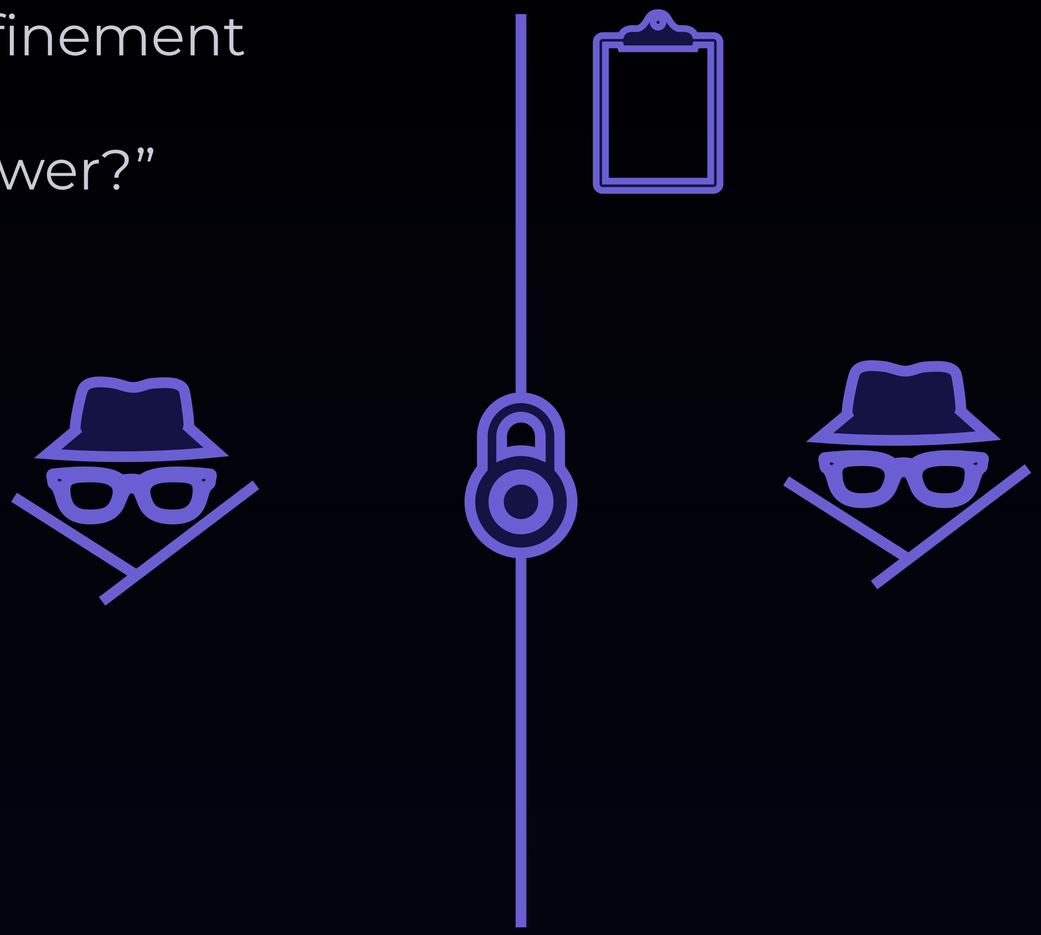

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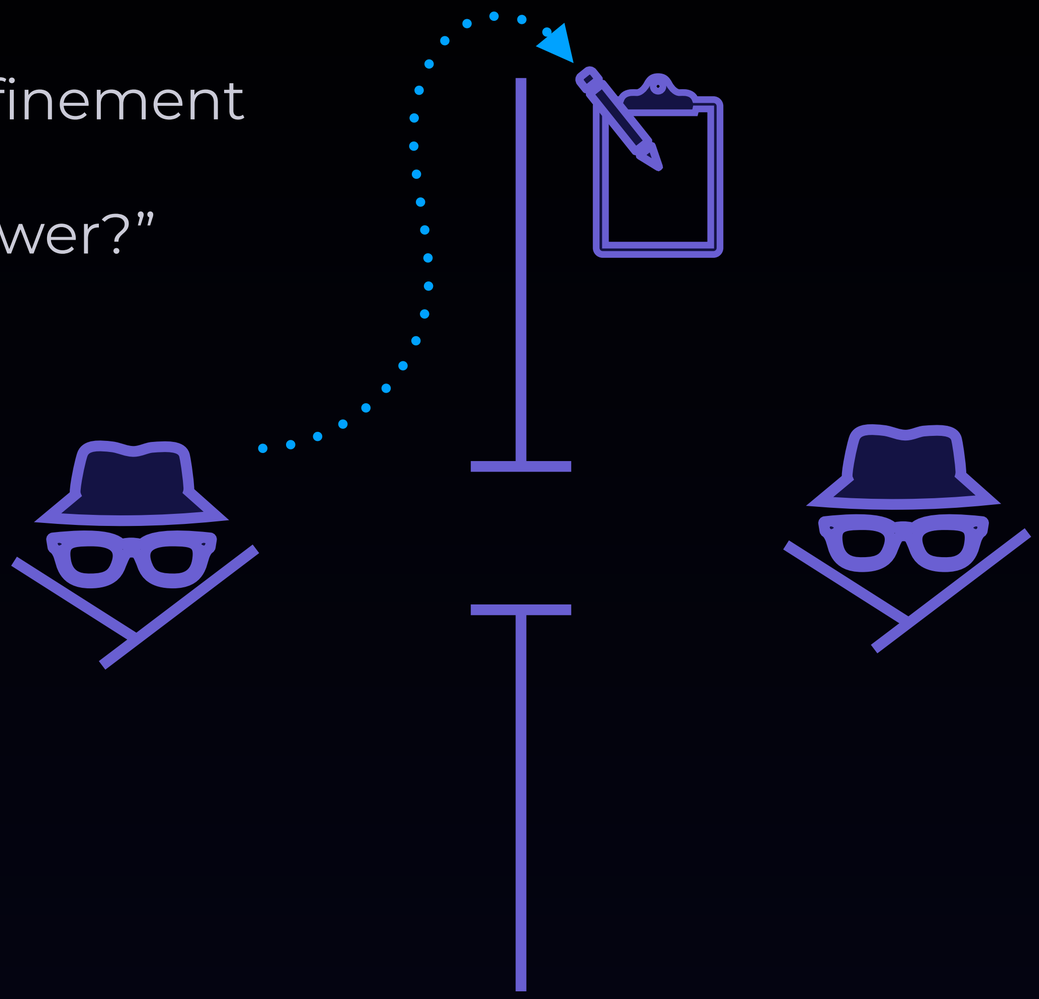

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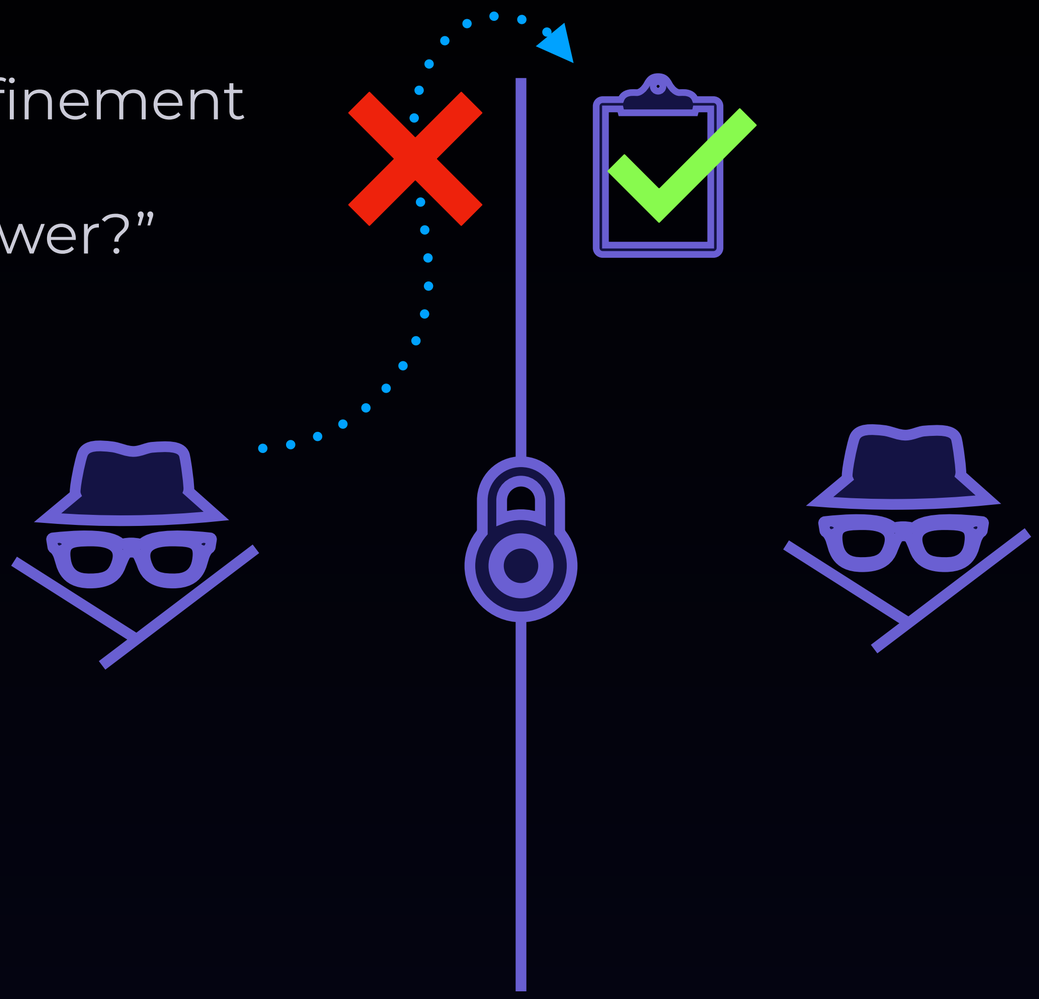

# PAS

Policy, Abstraction, Subject

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- Agent Authority Graph
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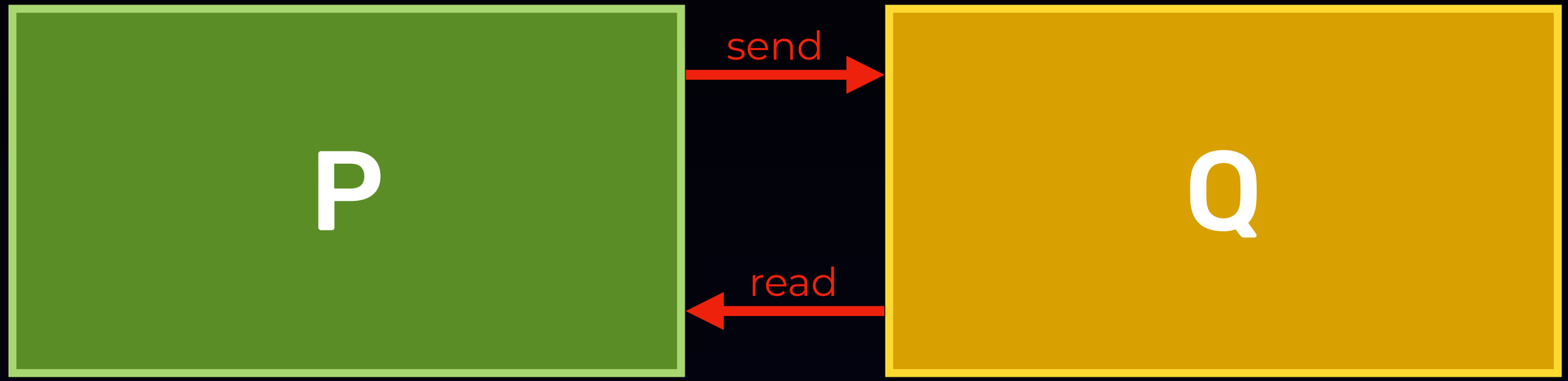

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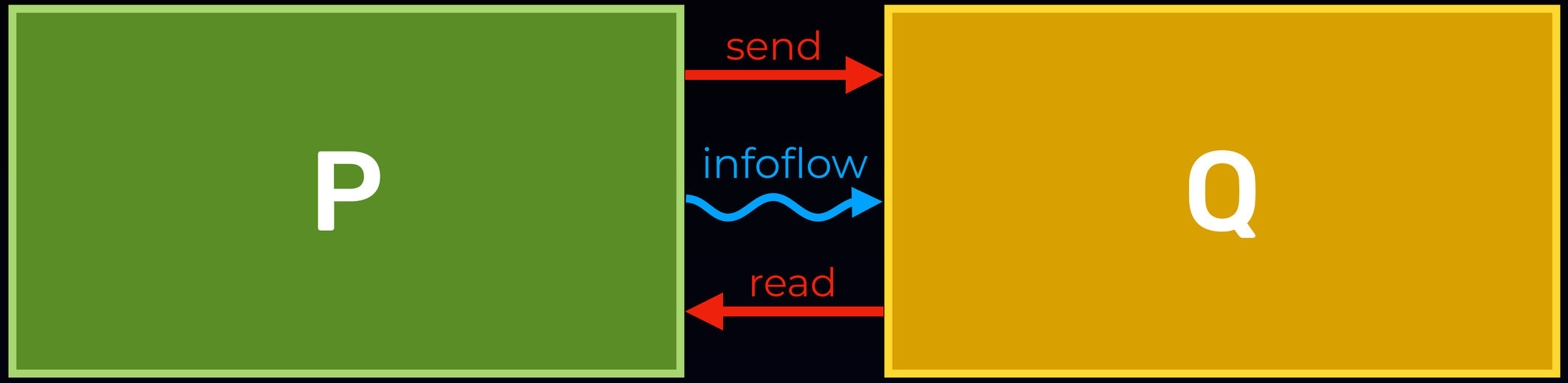

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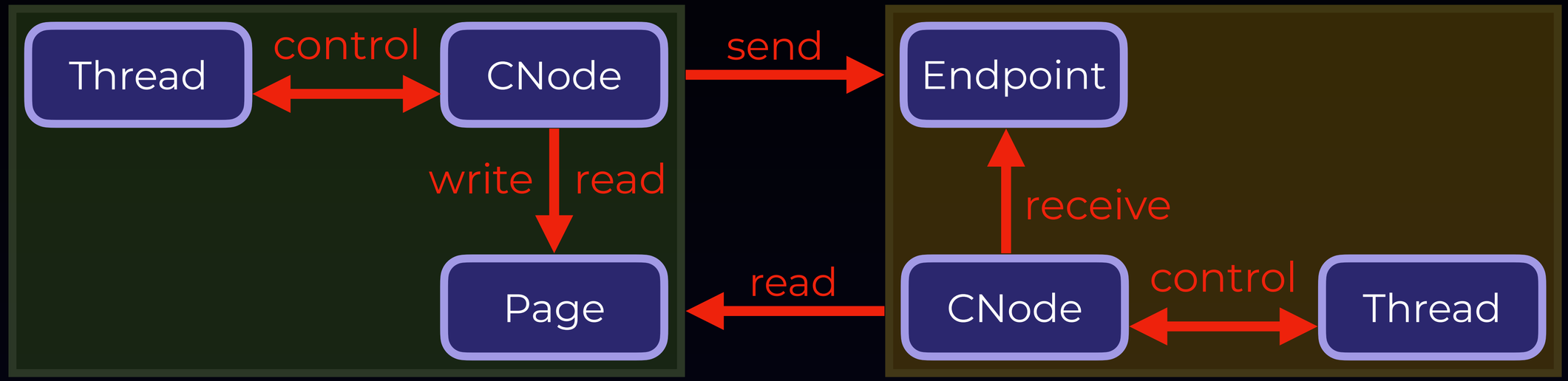
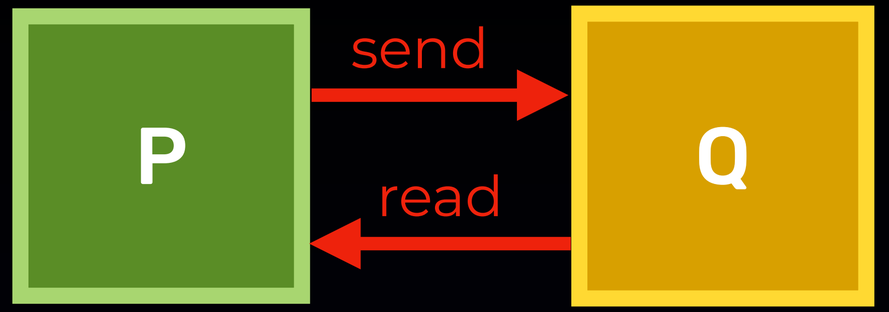
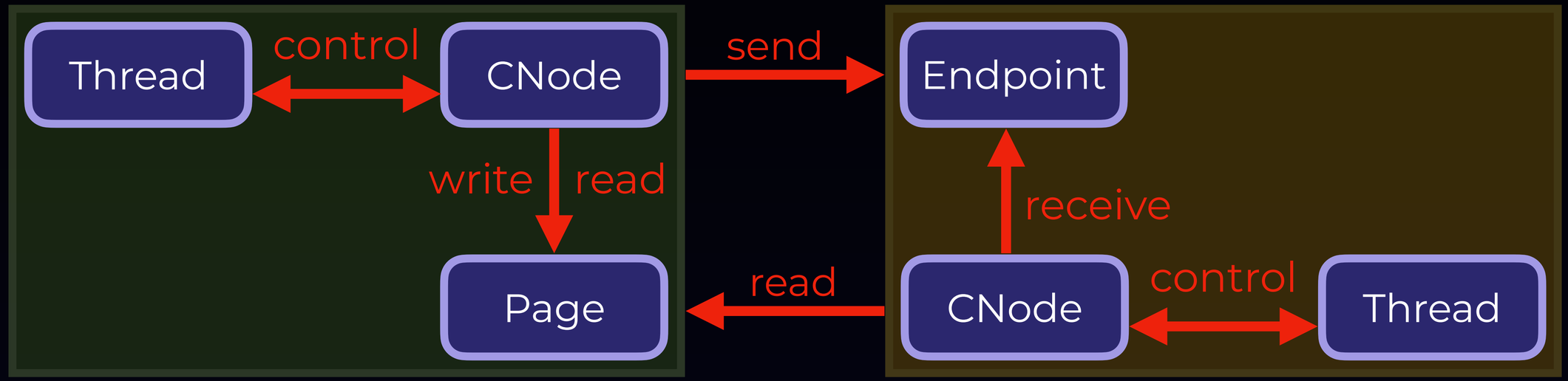


# Abstraction

- Mapping memory to agents
  - Green maps to P
  - Yellow maps to Q



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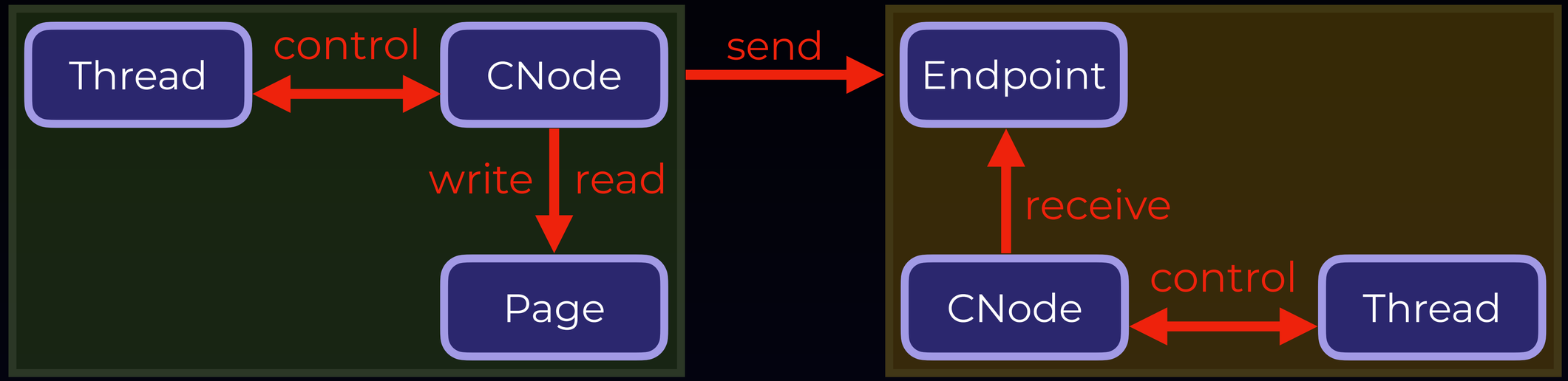

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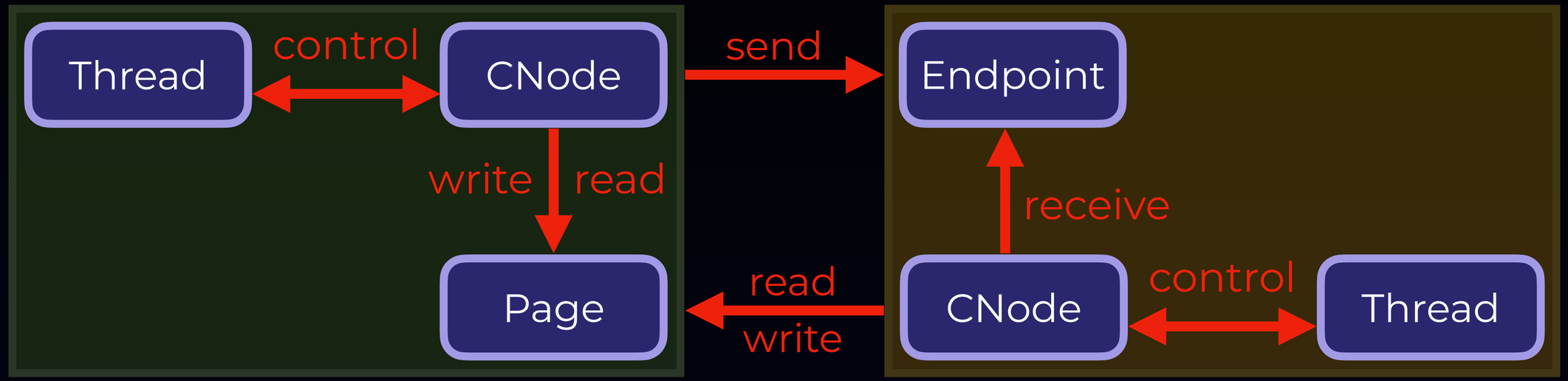
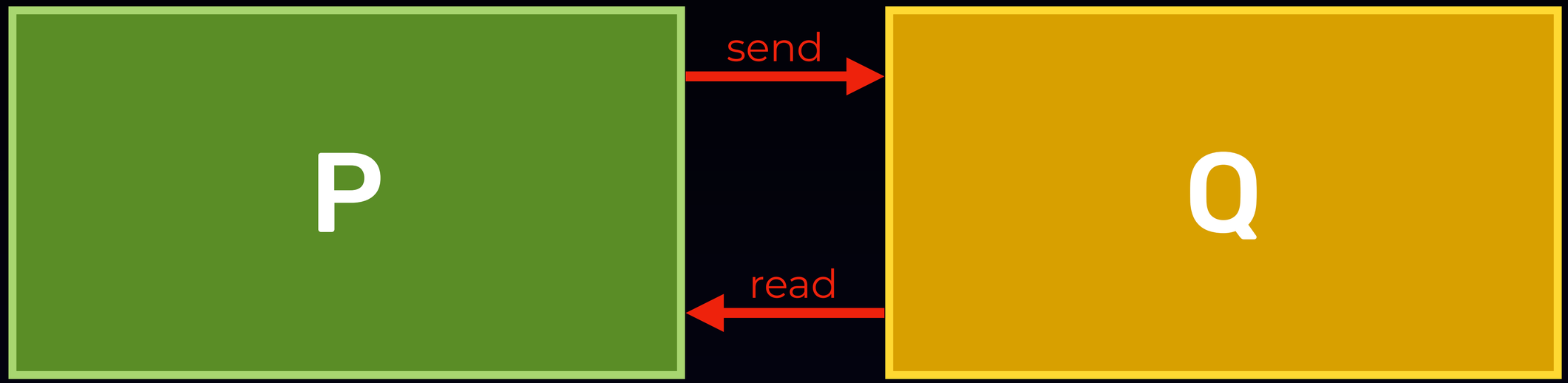


# Subject



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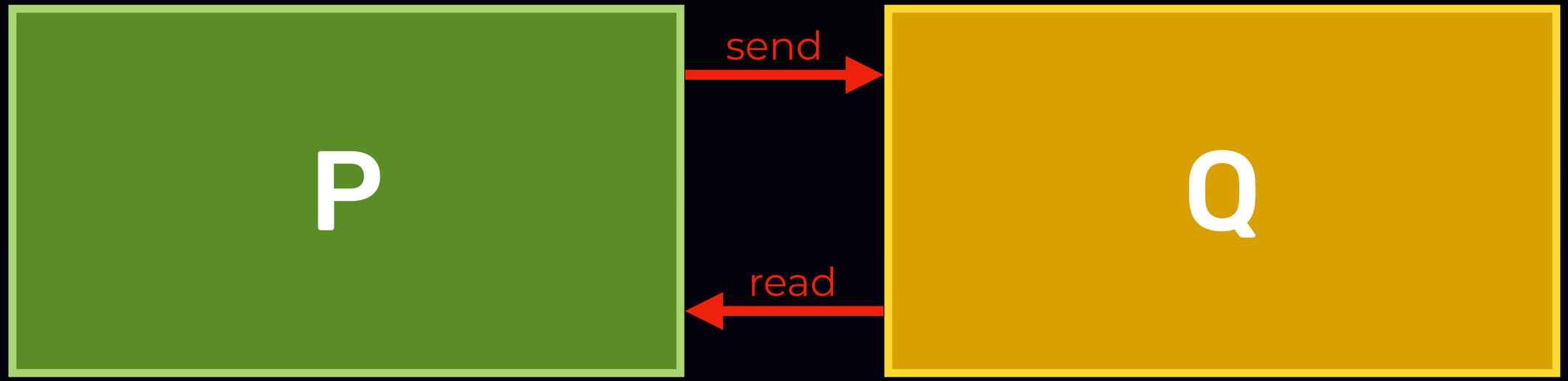
- Agent in focus



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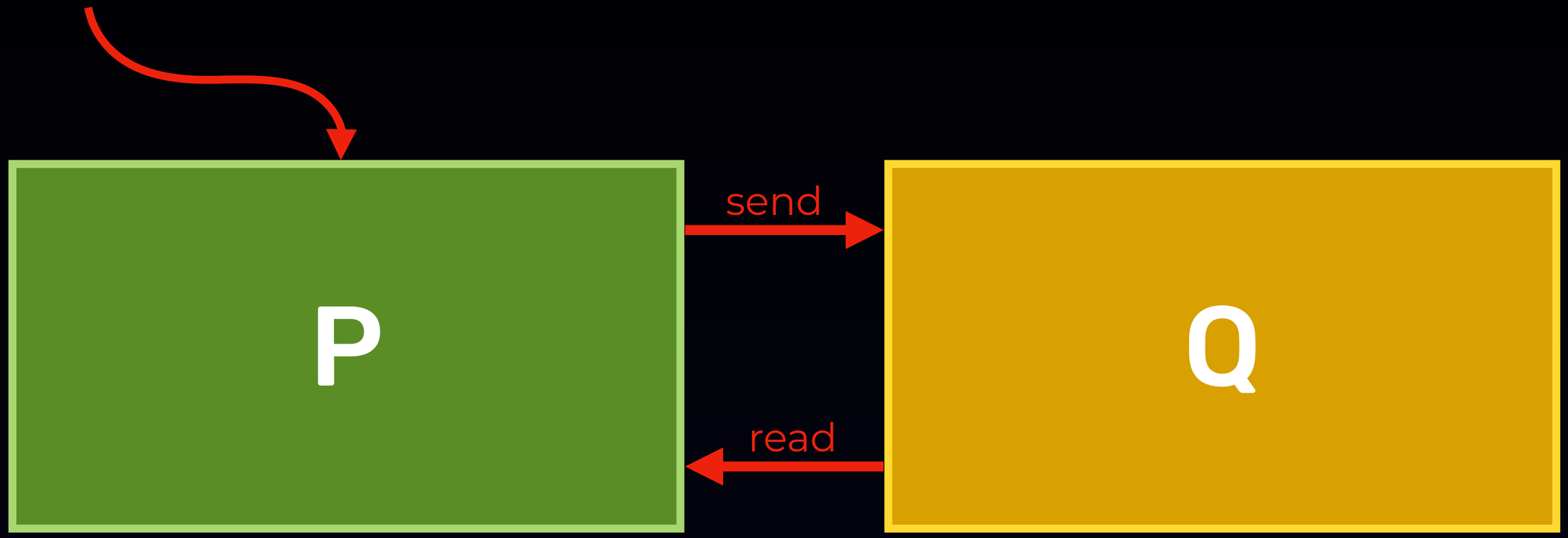
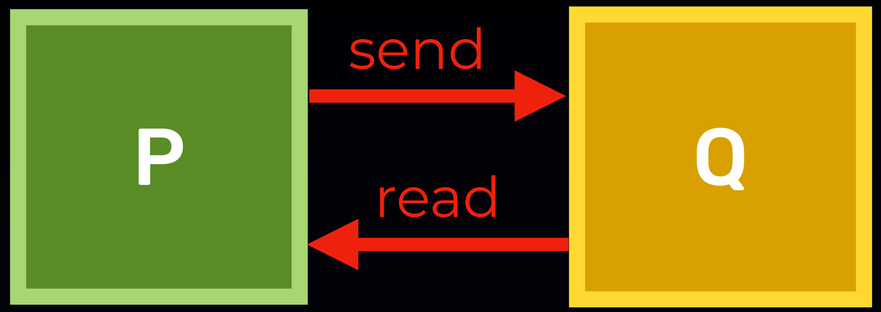
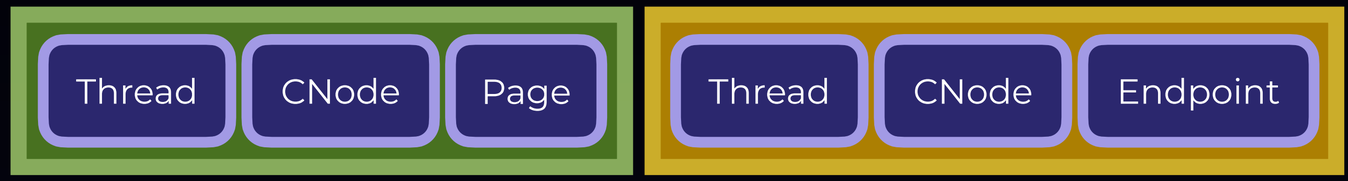


# Summary

**P**olicy




**A**bstraction




**S**ubject

# Proofs

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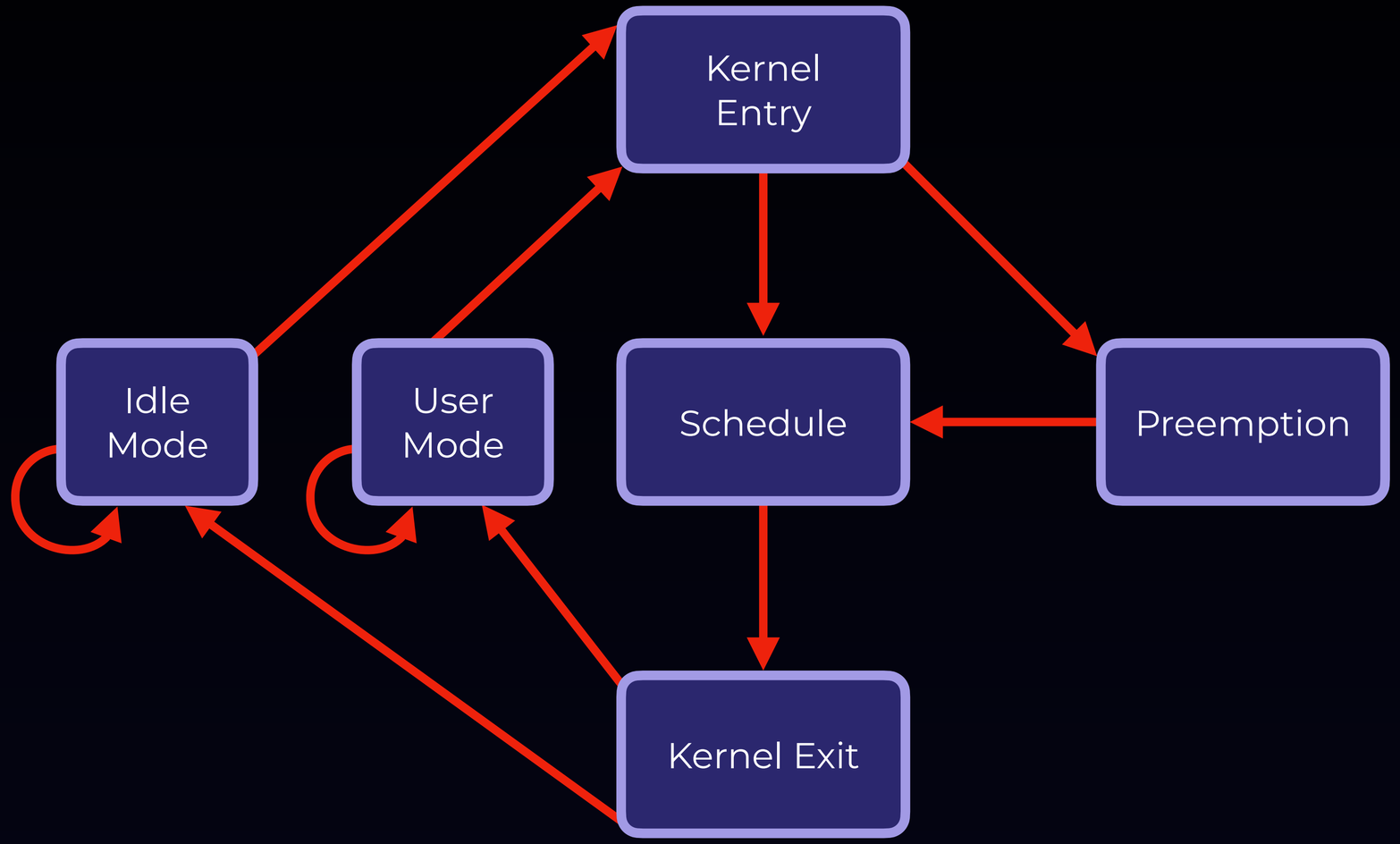
(Warning: Technical)

# Transition System



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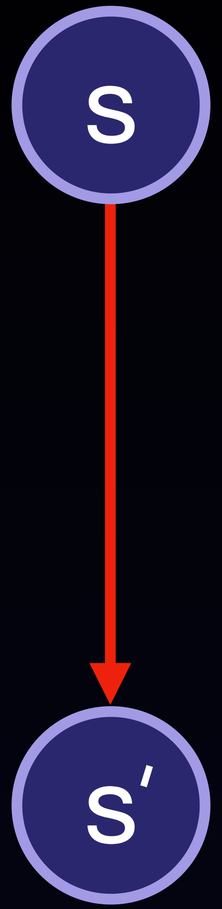

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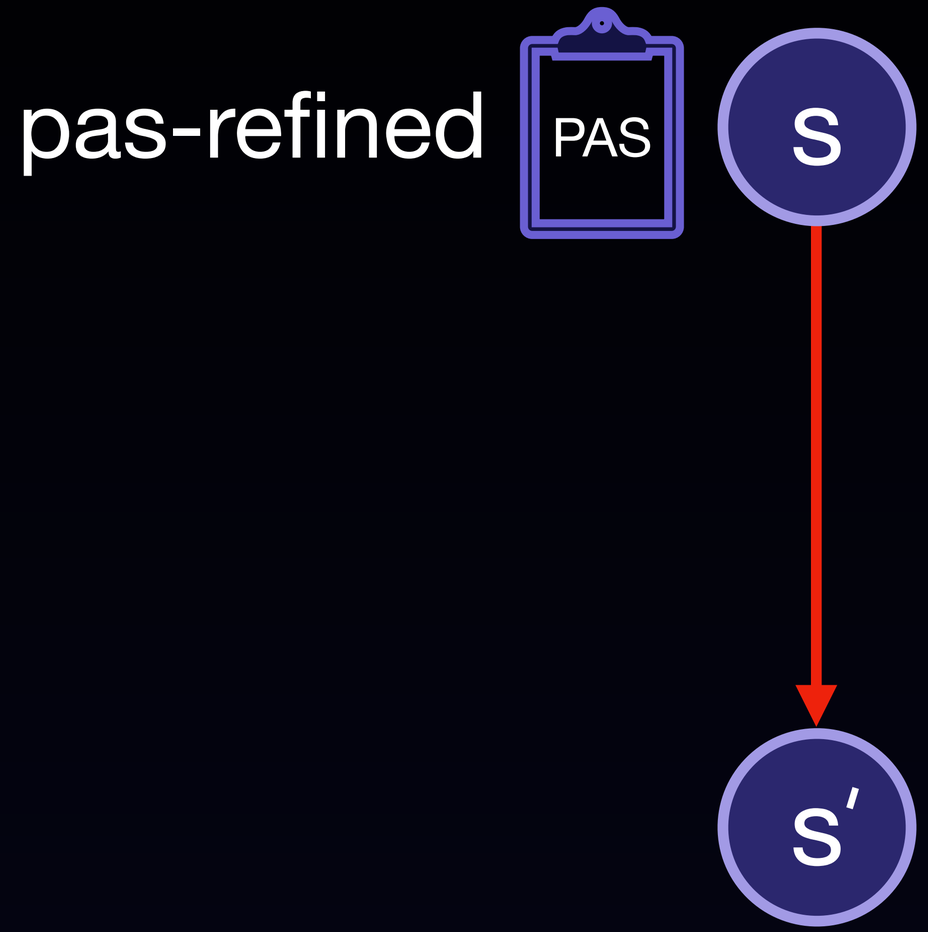

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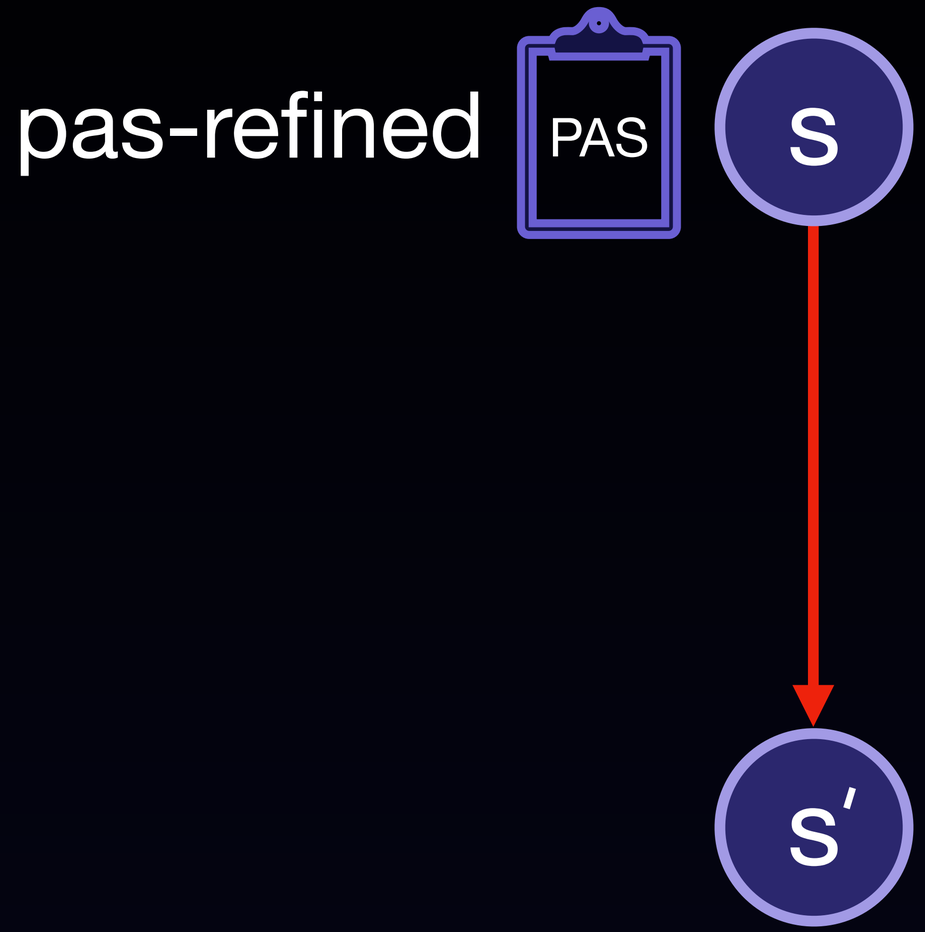
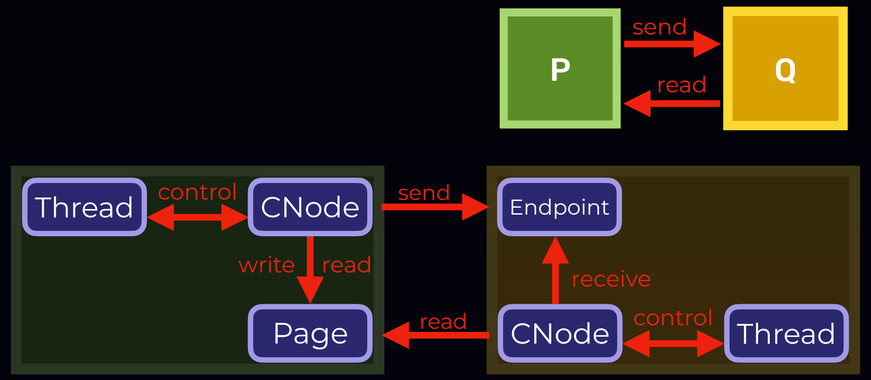



Recall



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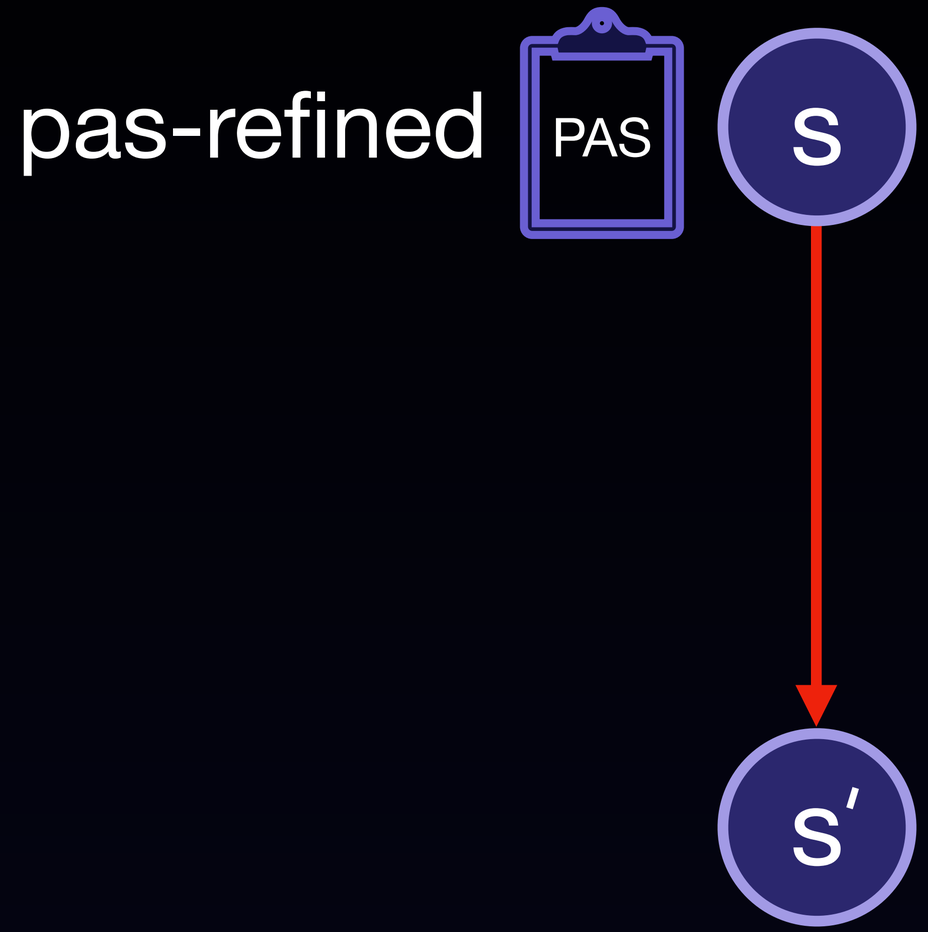

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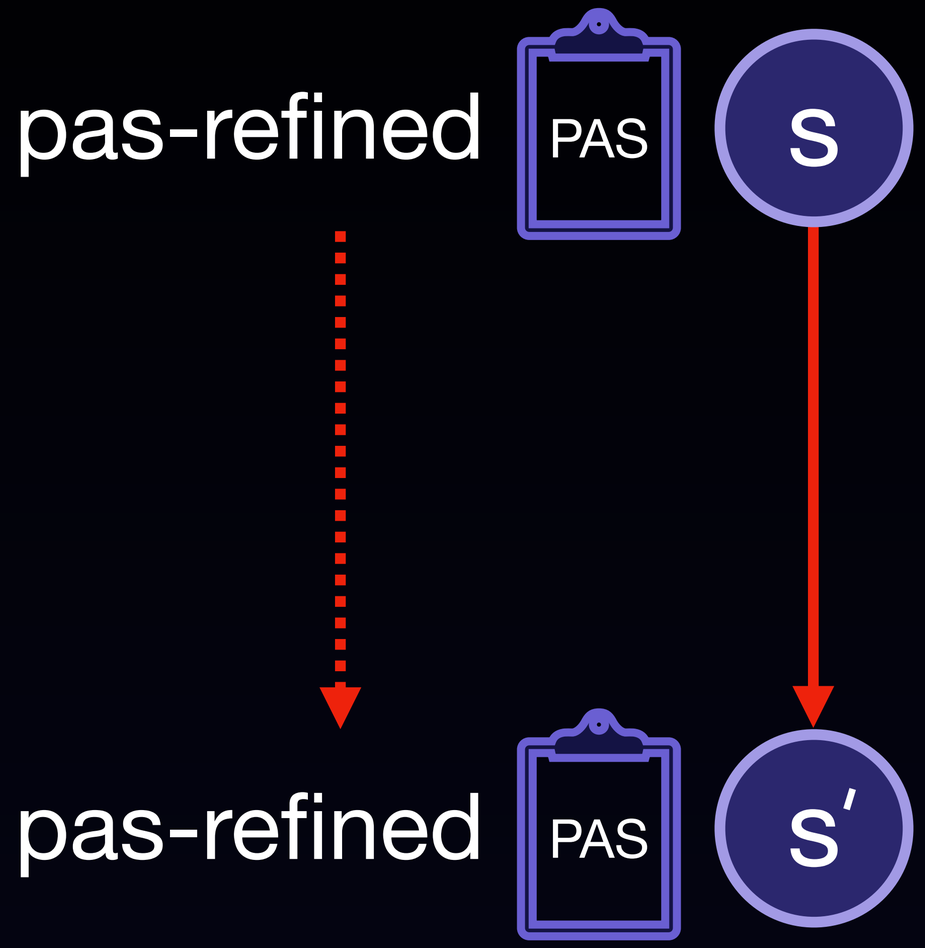
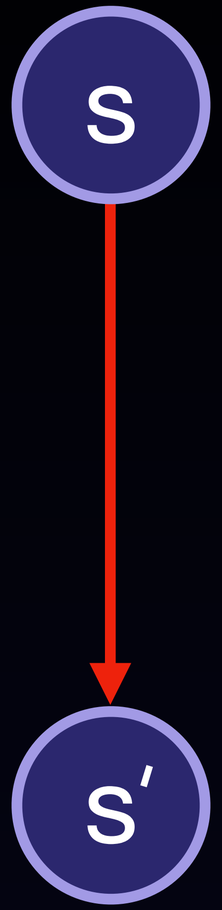


# Integrity



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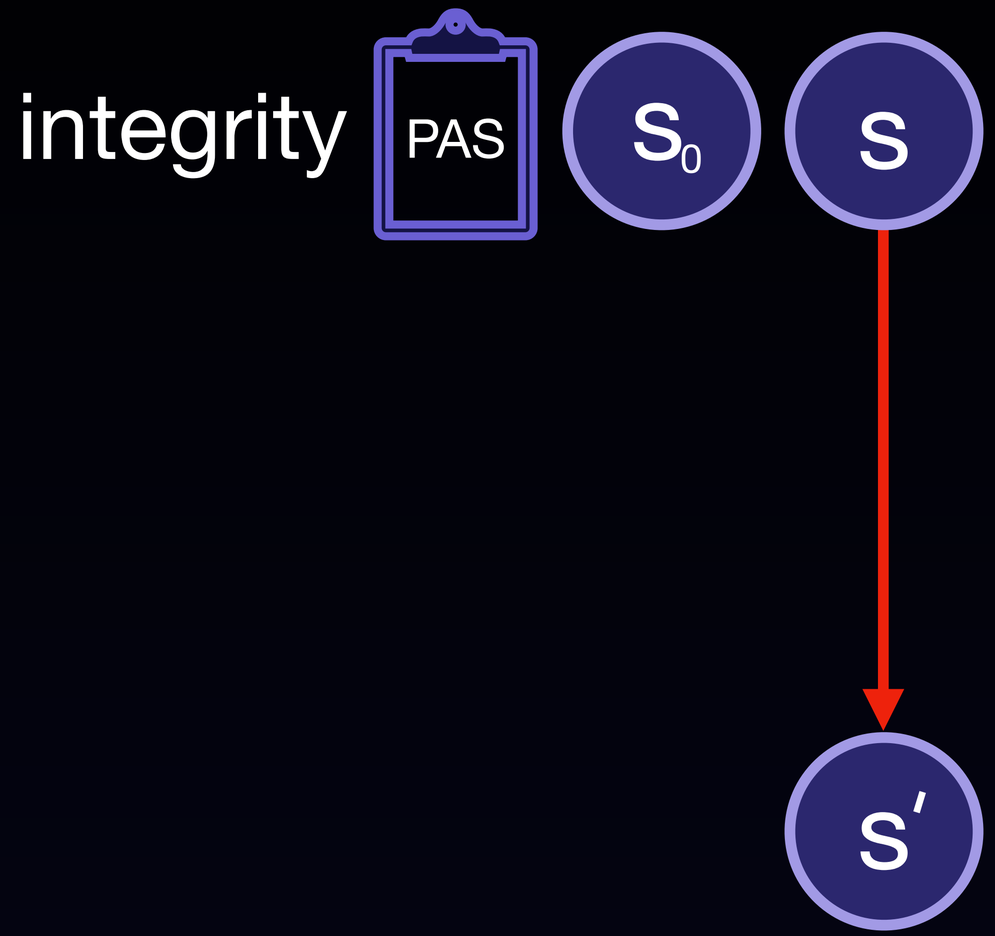

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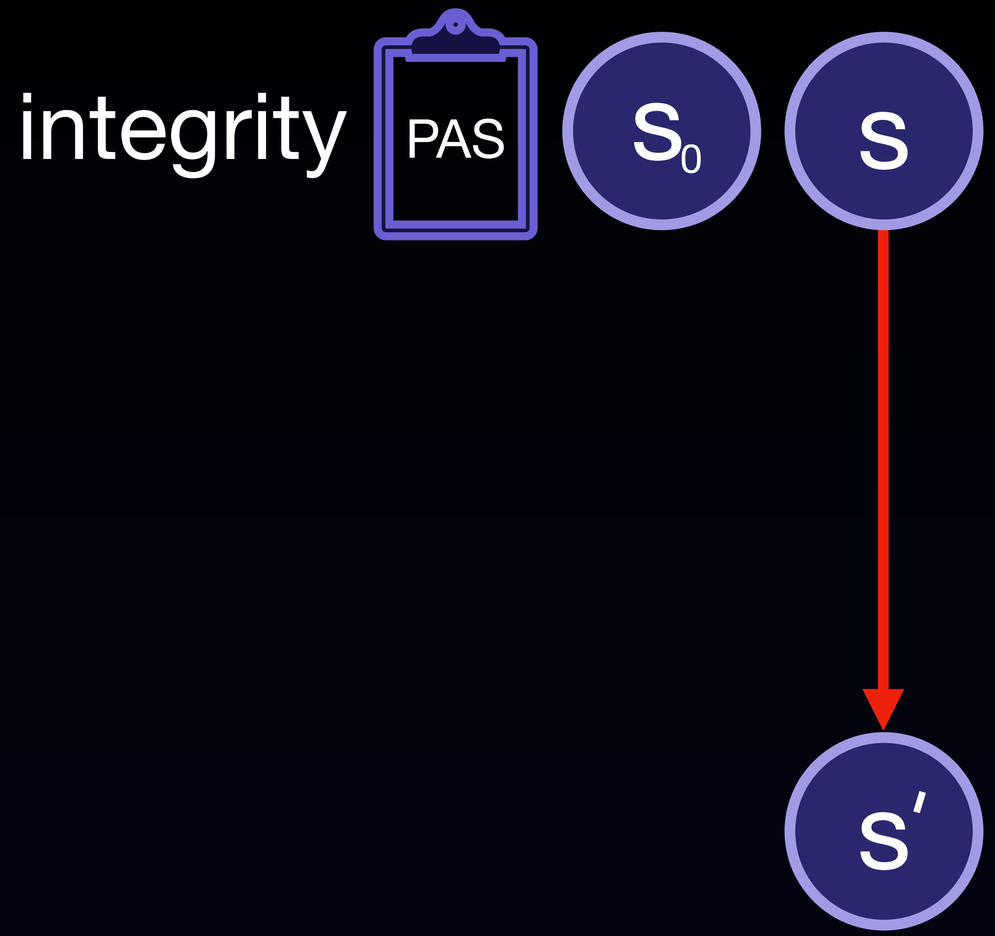


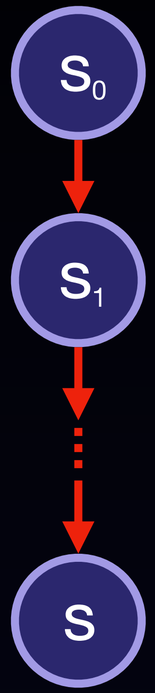

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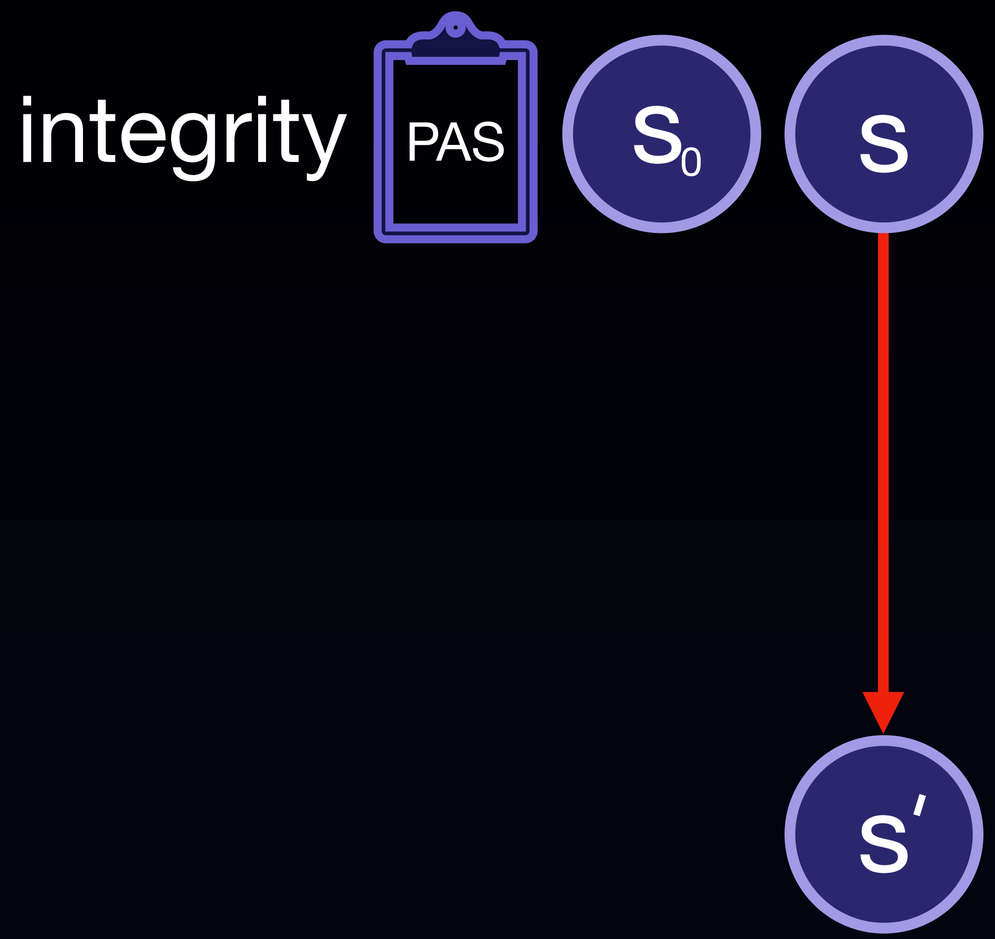


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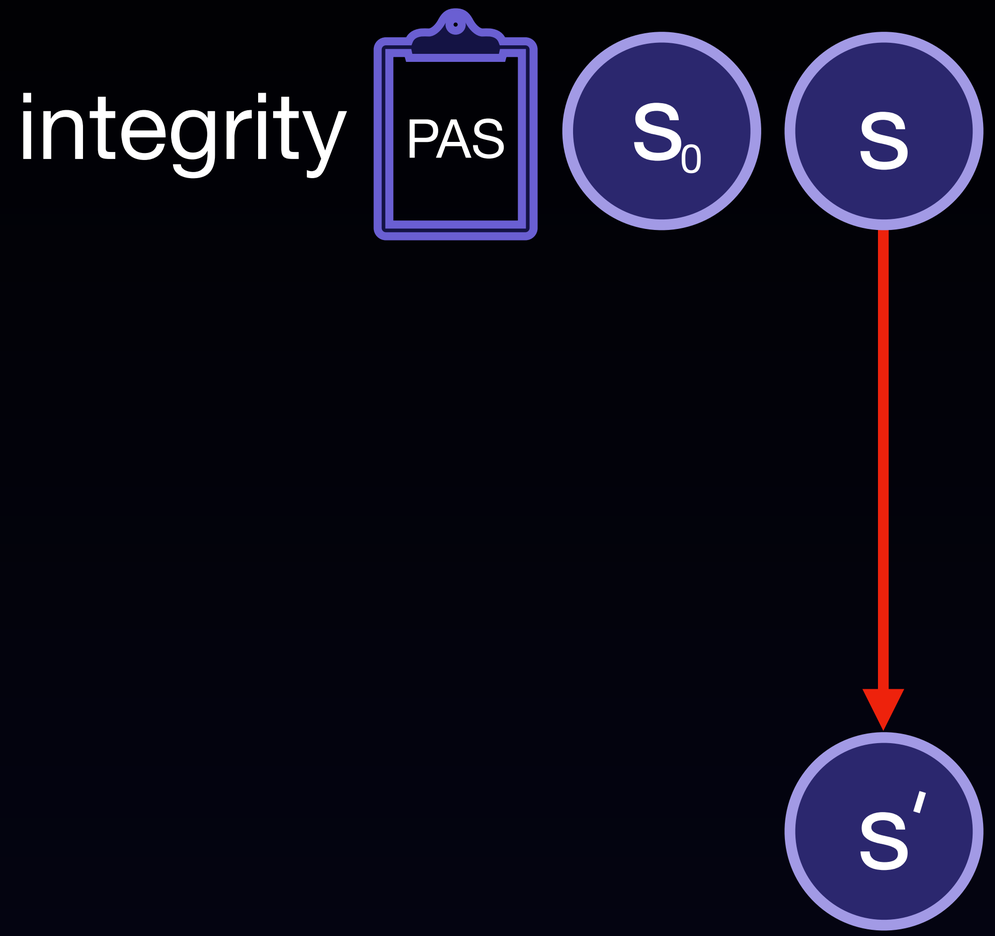

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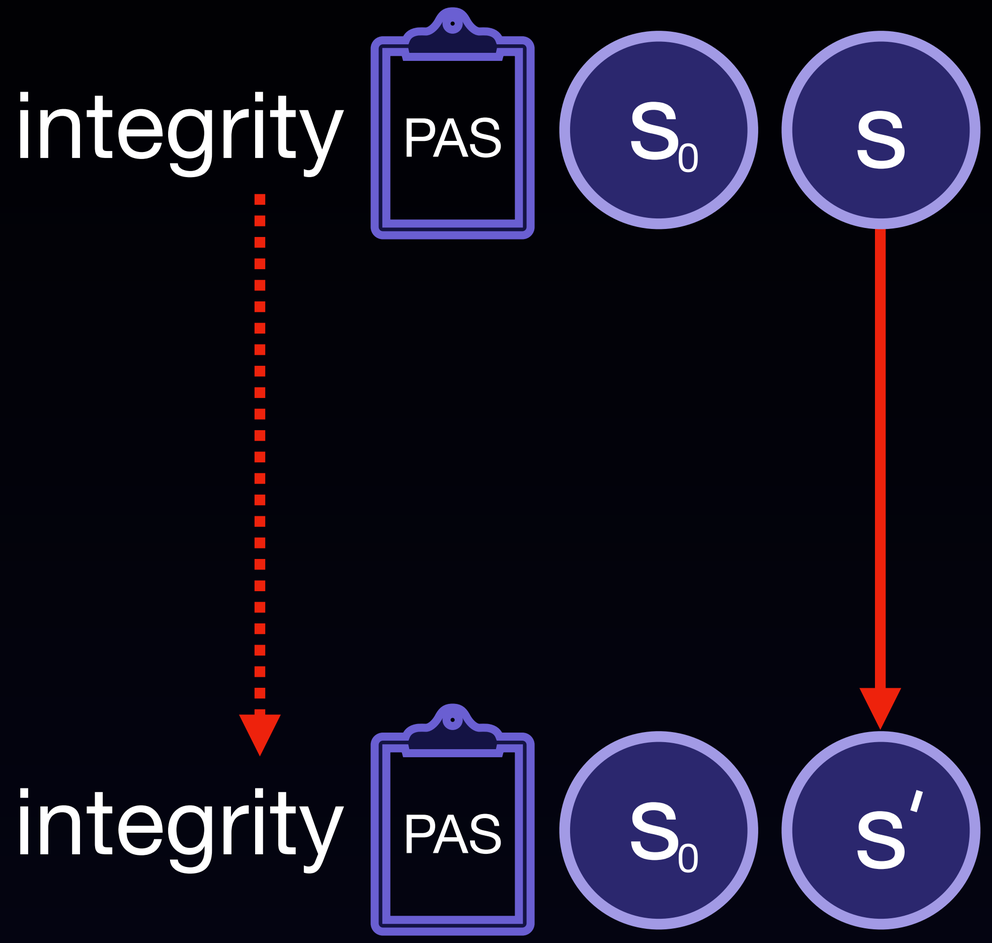

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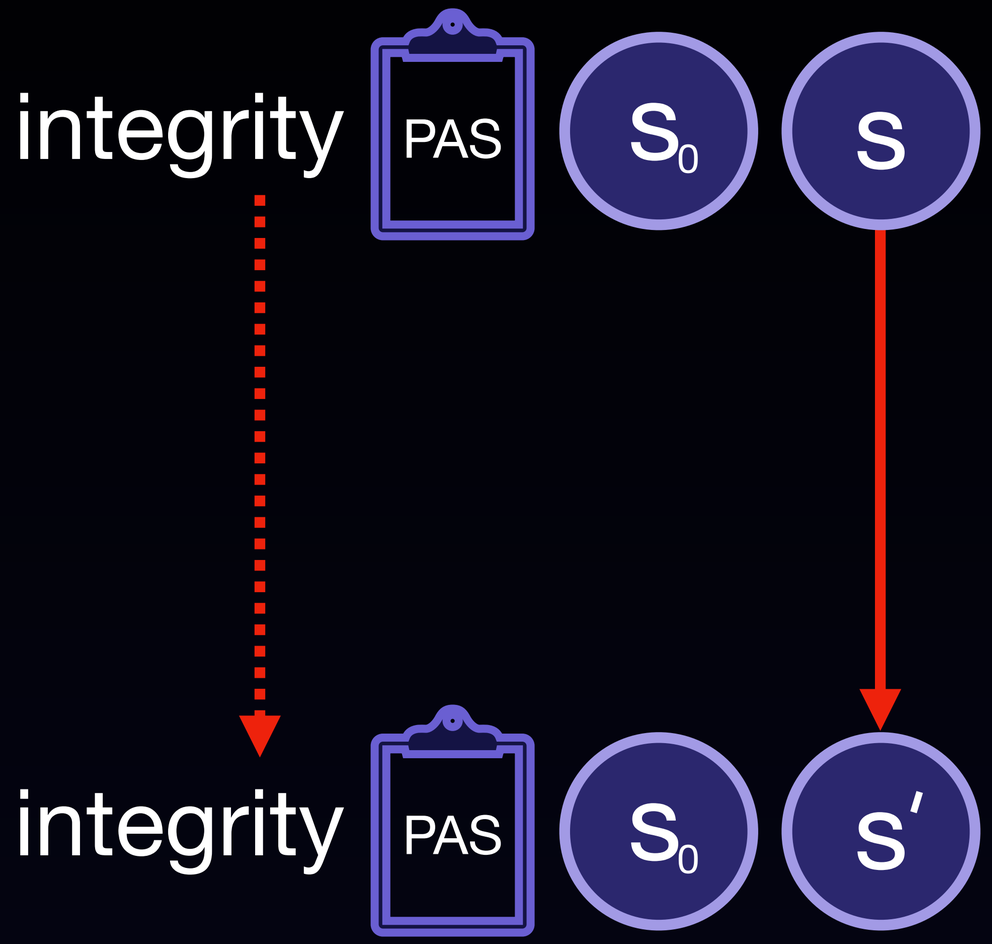


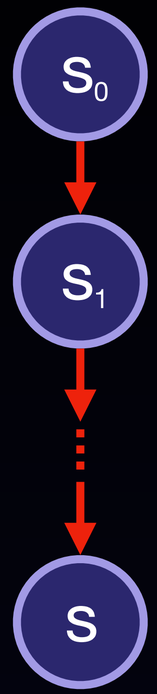

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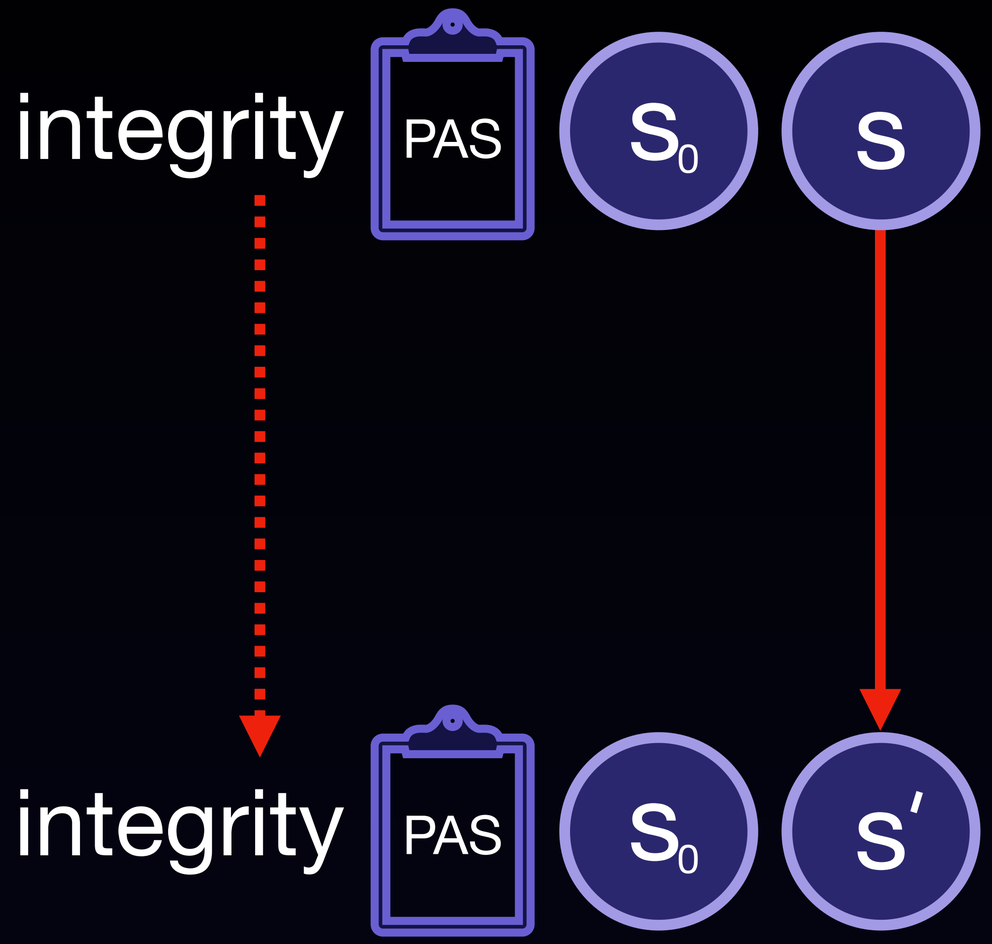


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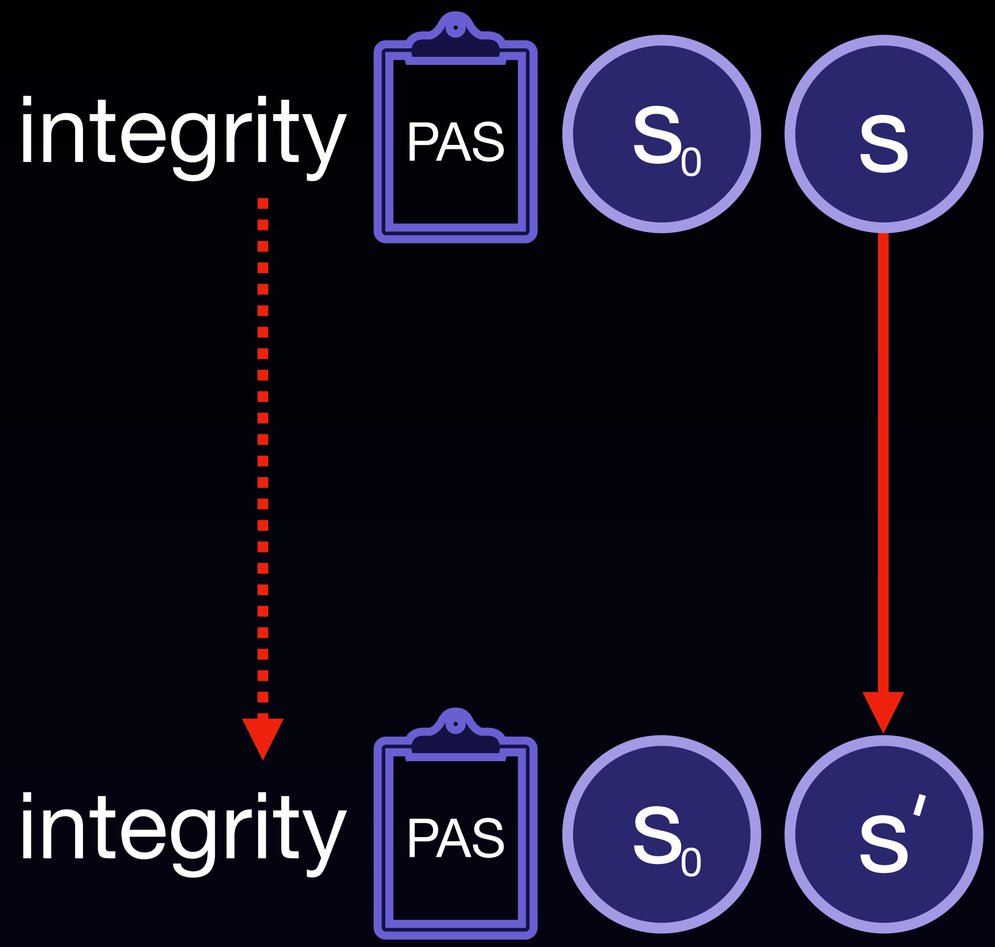


integrity PAS $s_0$ s′

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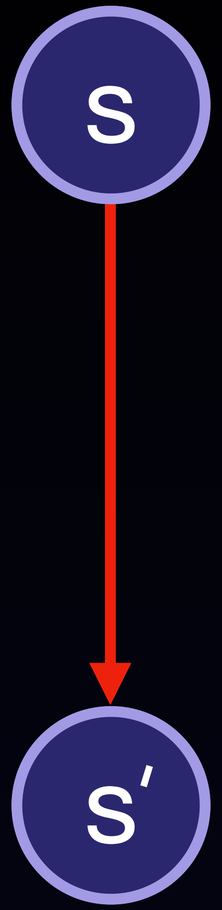

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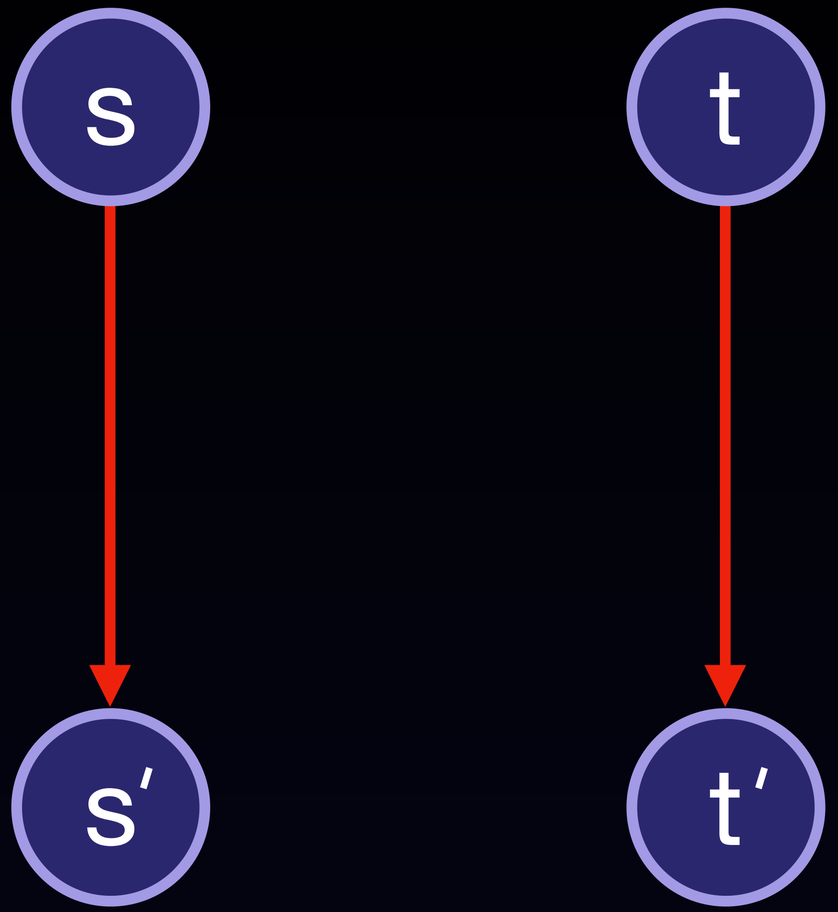

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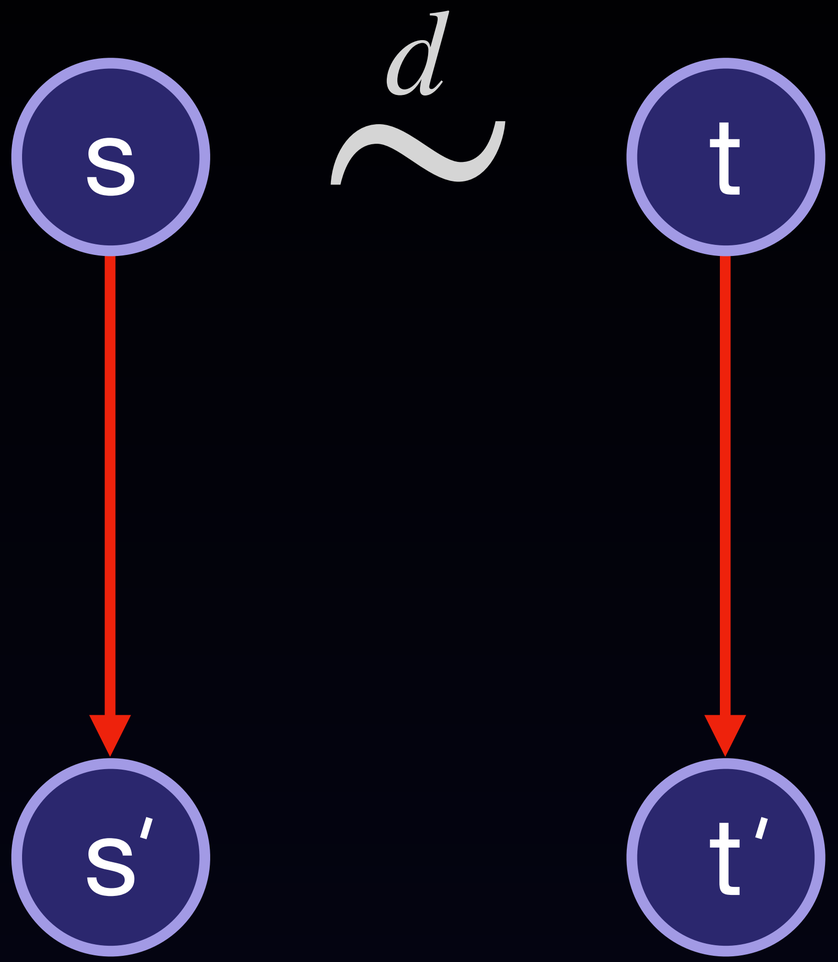

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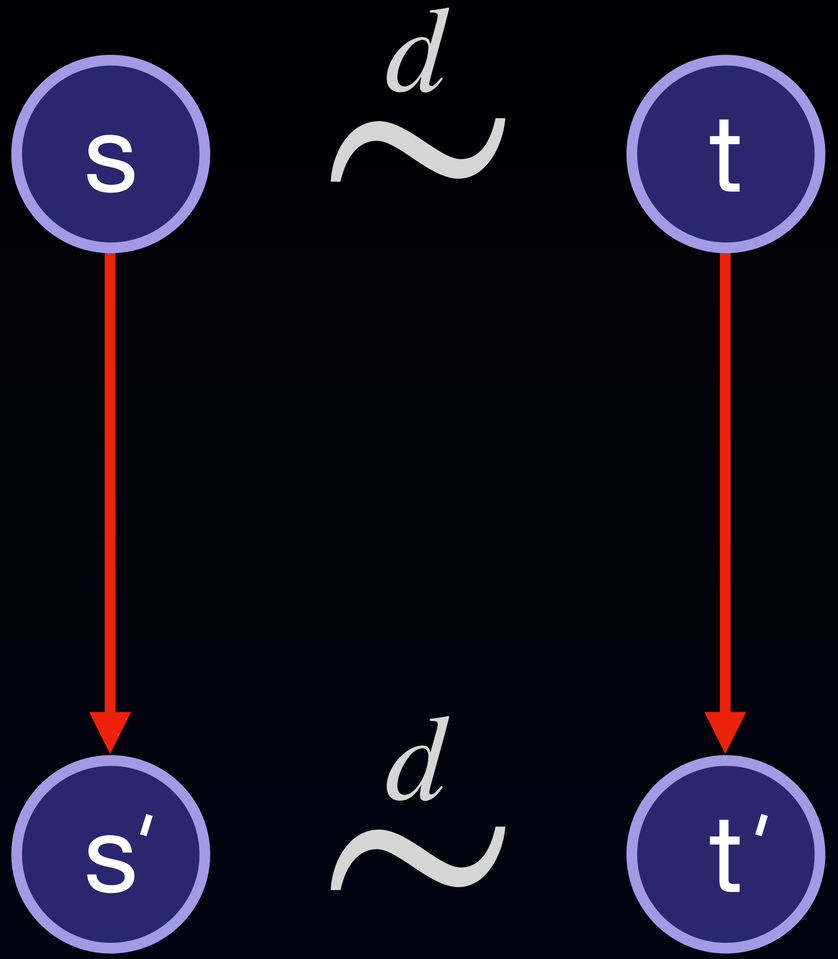

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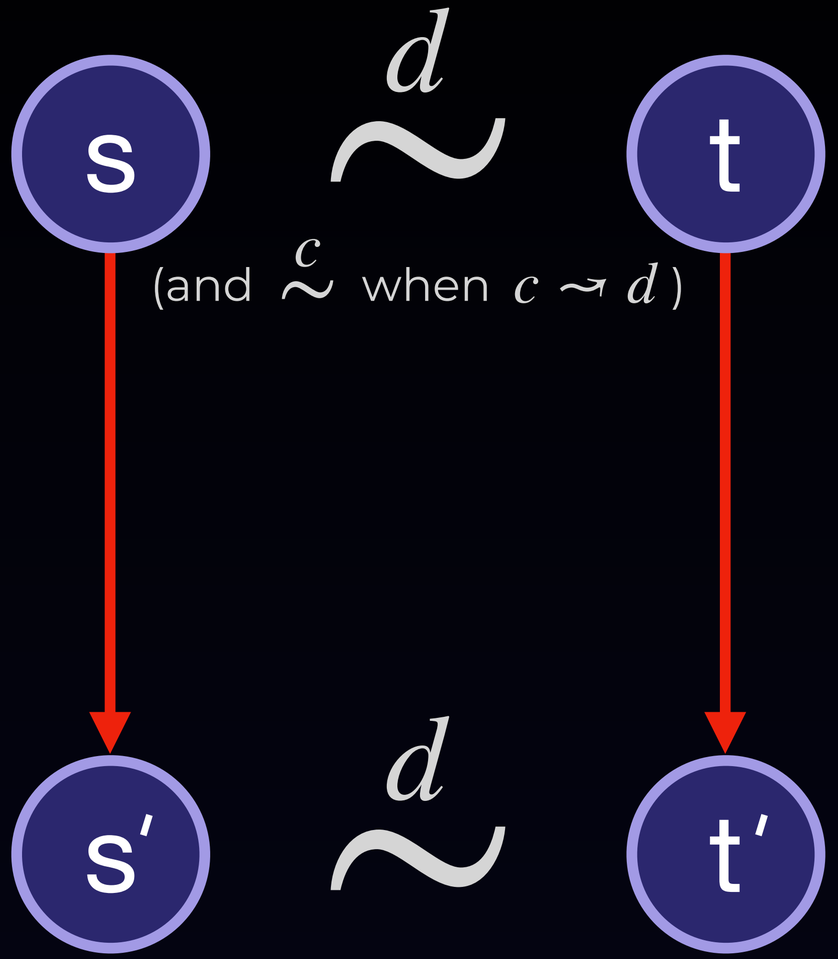

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**Hardware Assumptions**

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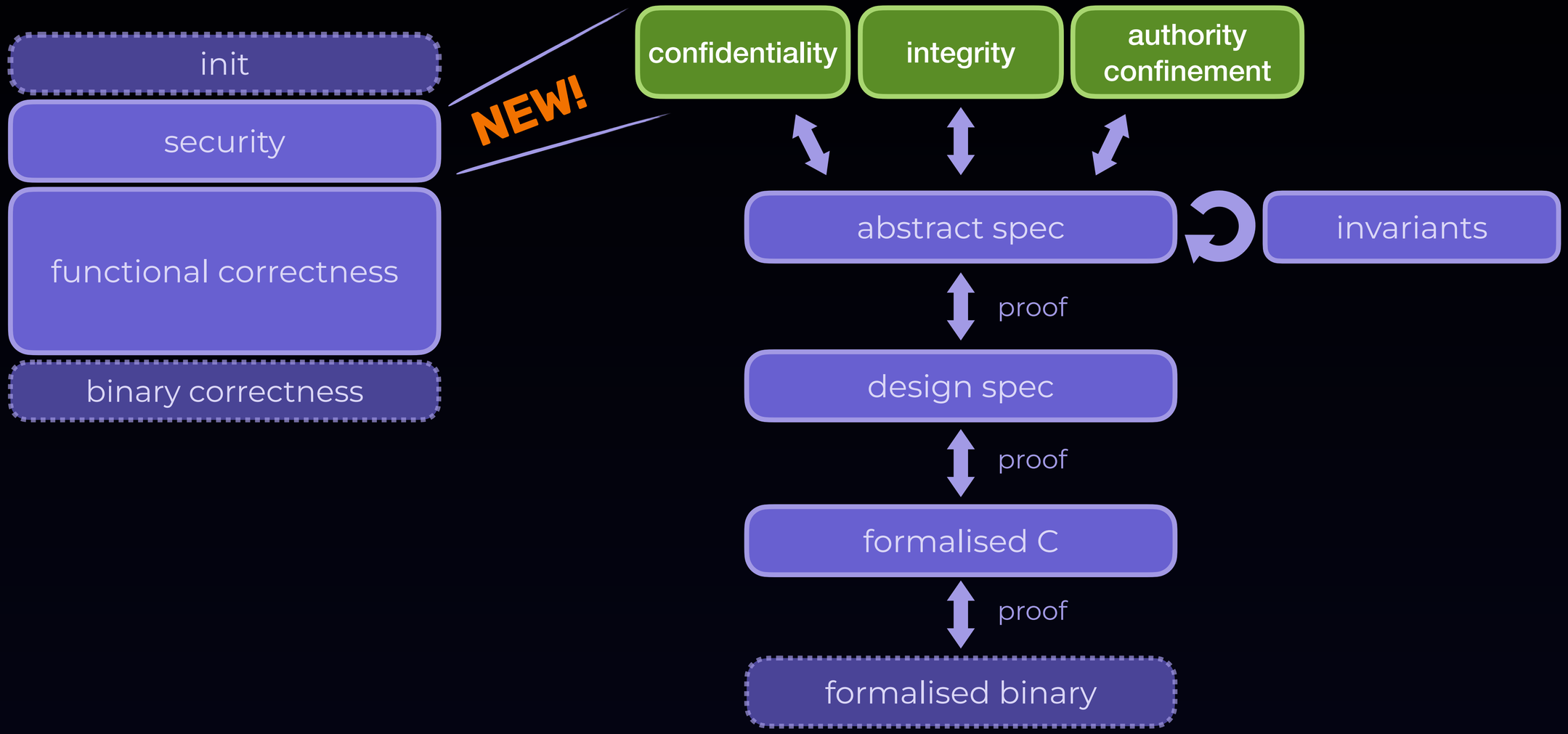
**Side-channel Assumptions**

We assume our model captures all relevant information channels

# AArch64 Security

Thanks to support from NCSC

# AArch64 Verification Stack

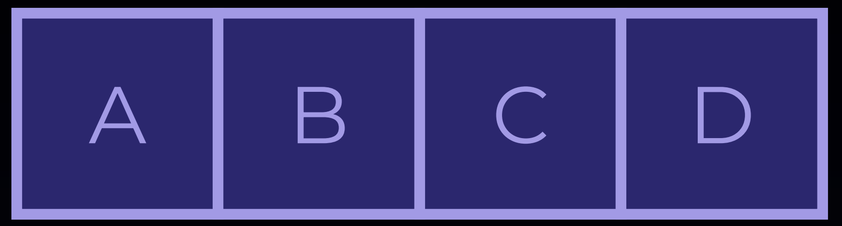


# AArch64 Additions

**New to the security proofs:**

- Virtual CPUs (VCPU)
- Floating-point units (FPUs)

# Example



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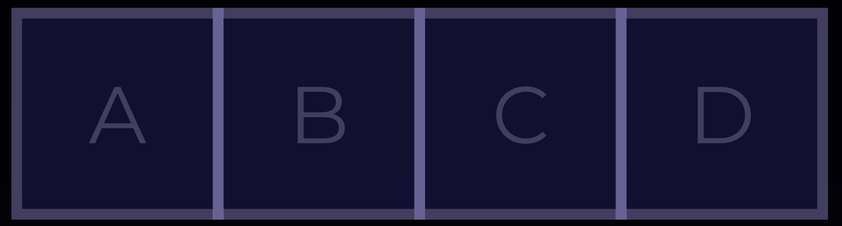
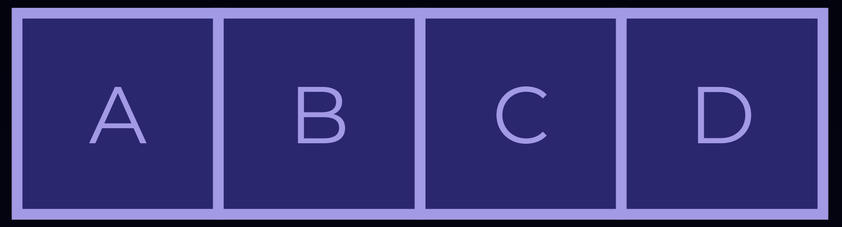
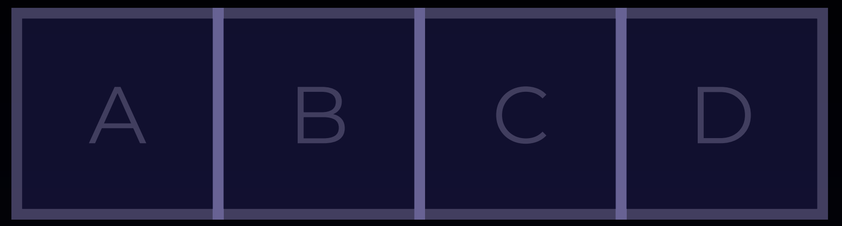



Heap




Registers

# Example

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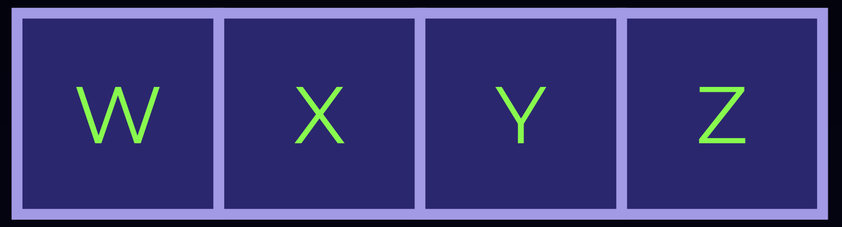



Registers

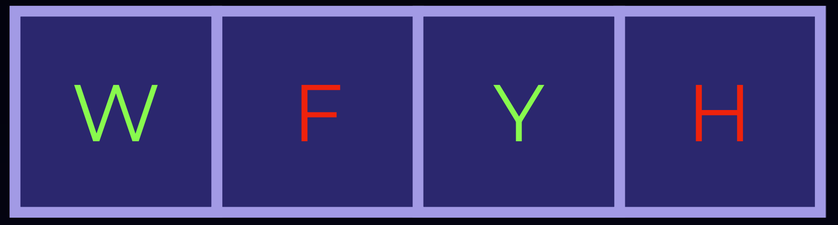
# Example


Heap


Registers

# Example

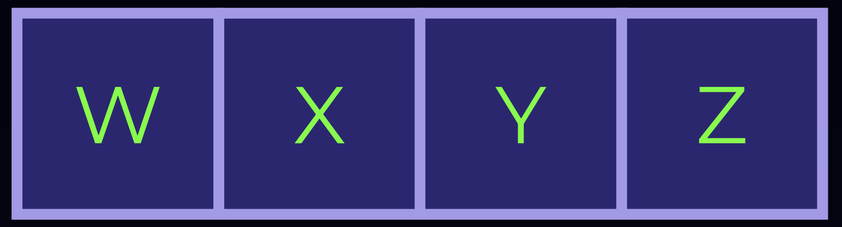

Heap




Registers

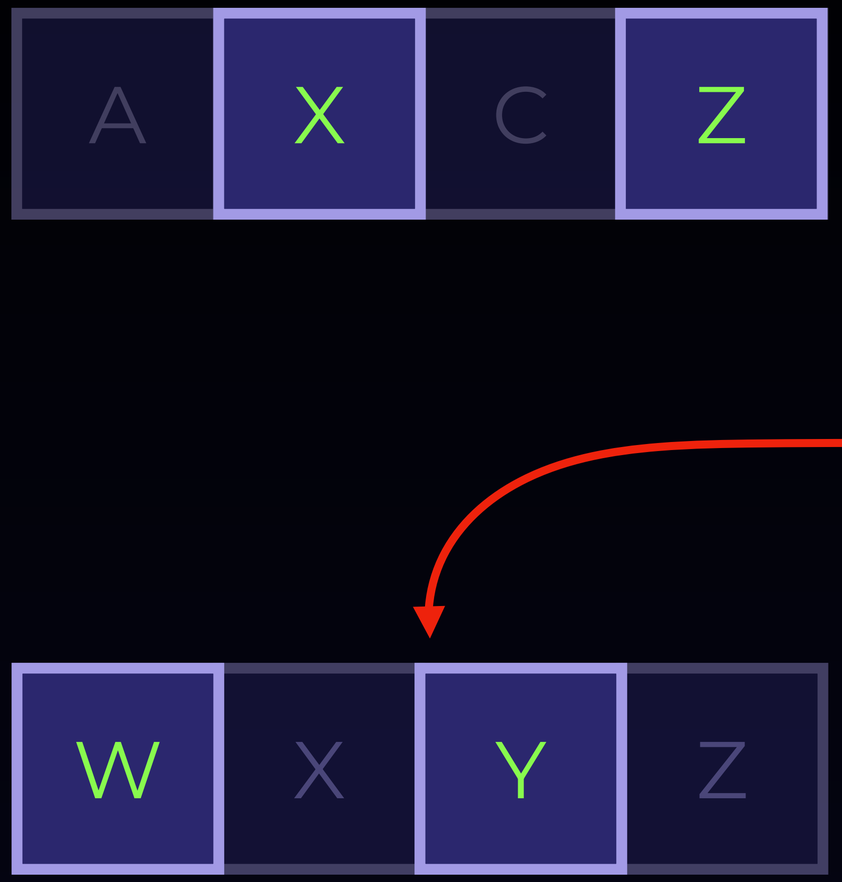
# Example


Heap




Registers

# Example



# Example

Constrain how this changes


Heap

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Constrain how this changes


Registers

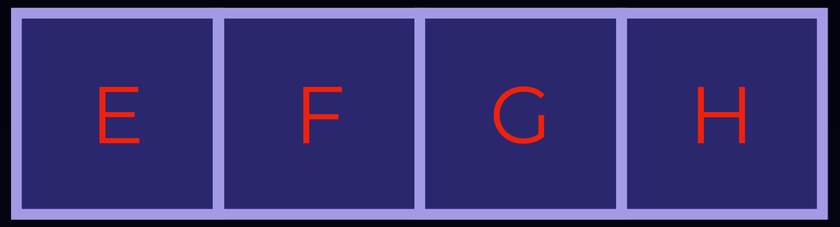
# Example

Constrain how this changes


Heap

+

Constrain how this changes




Registers

# Example

Constrain how this changes


Heap

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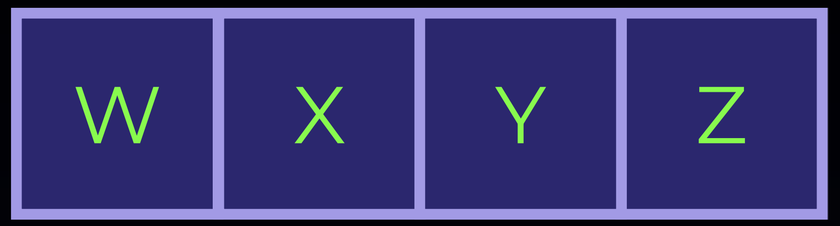
Constrain how this changes


Registers

# Example

Constrain how this changes




Heap

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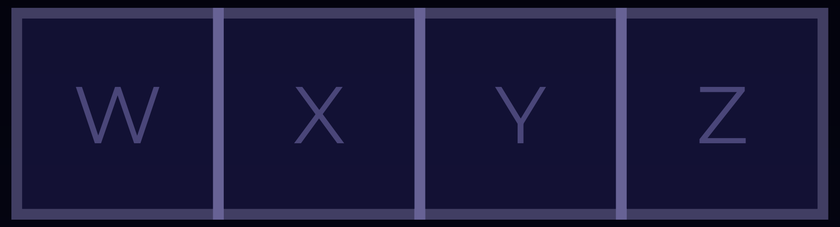
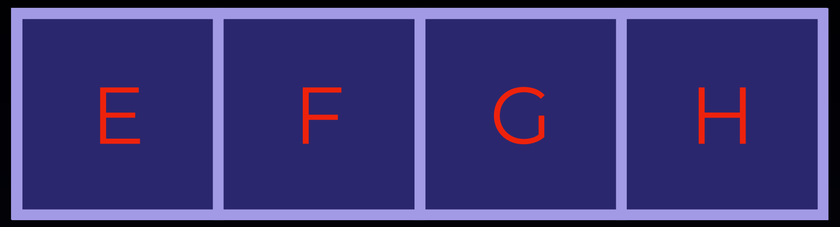
Constrain how this changes




Registers

# Example

Constrain how this changes




Heap

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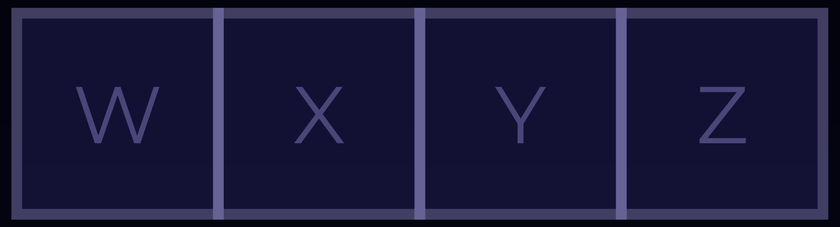
Constrain how this changes



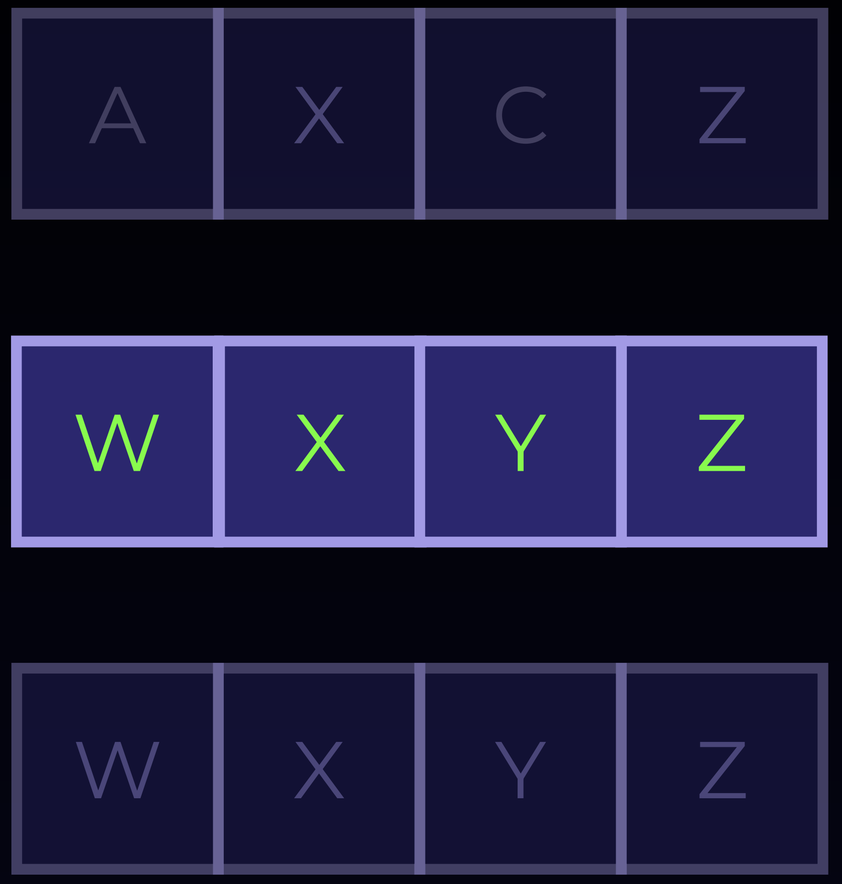

Registers

# Example

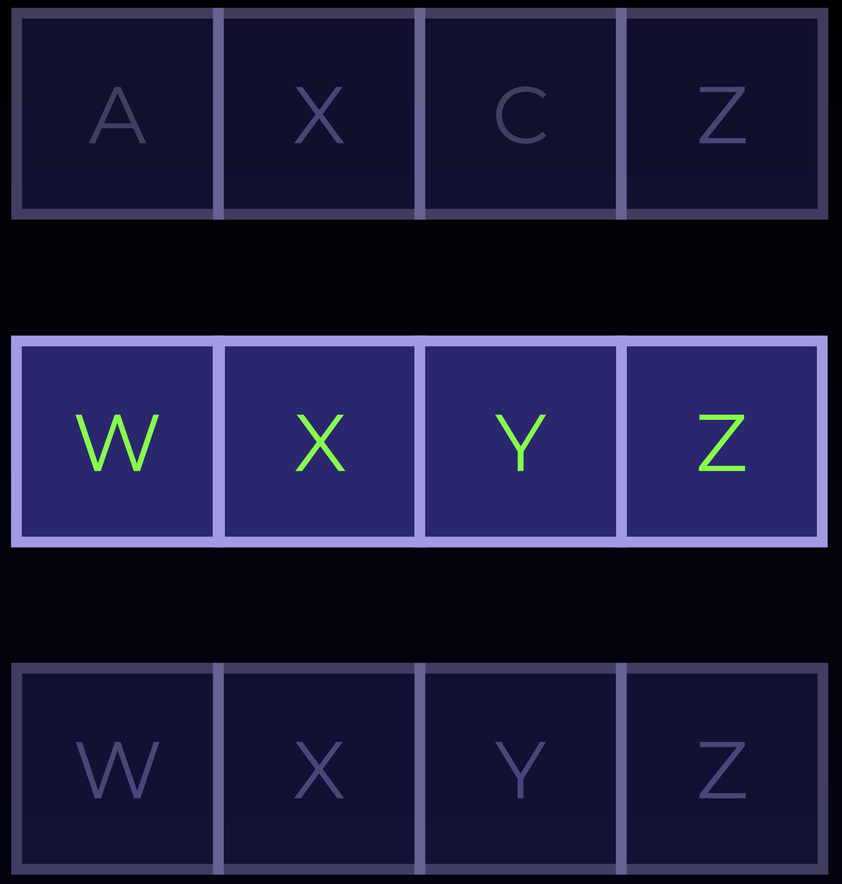

Heap


Registers

# Example

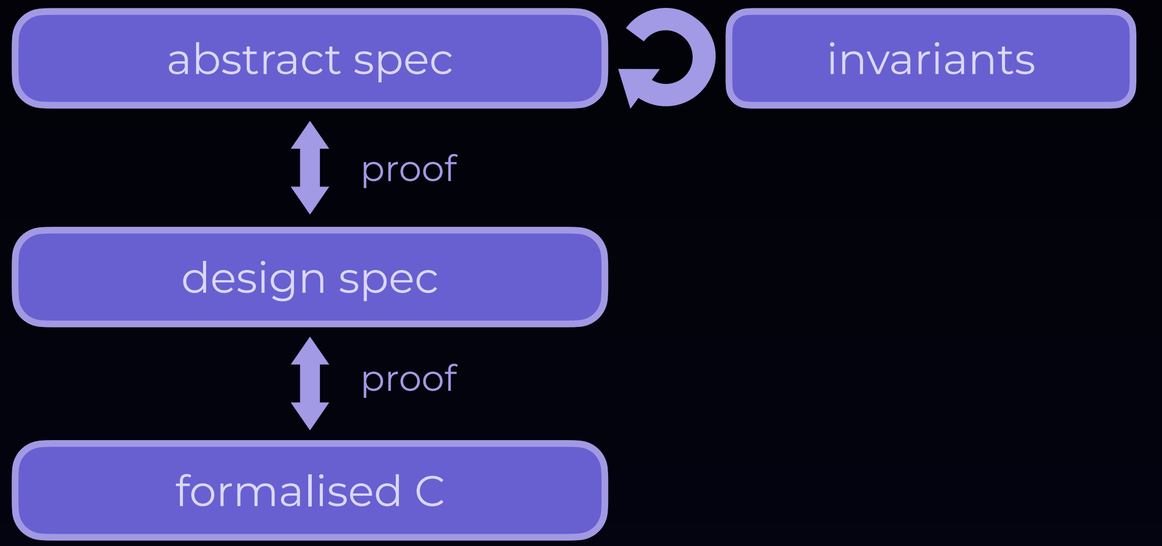


# Example

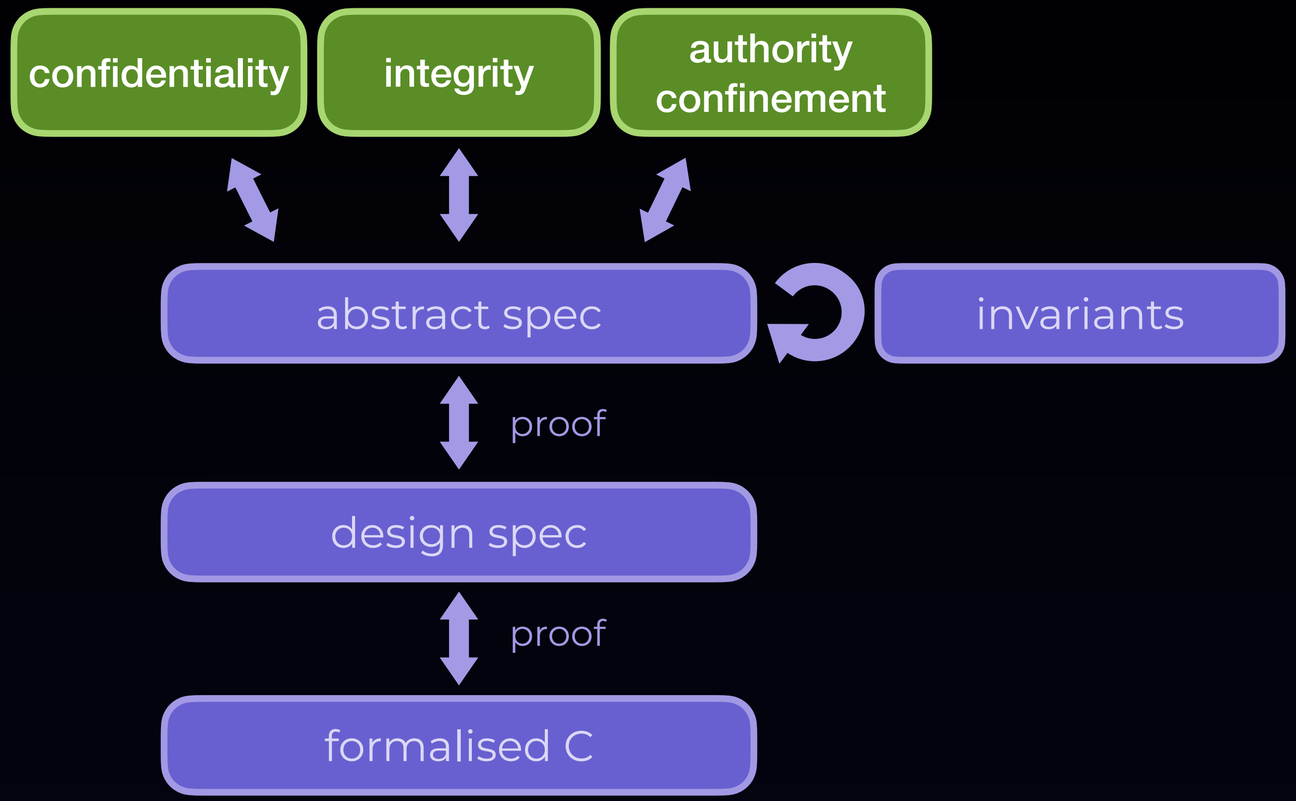


# Summary

# Summary

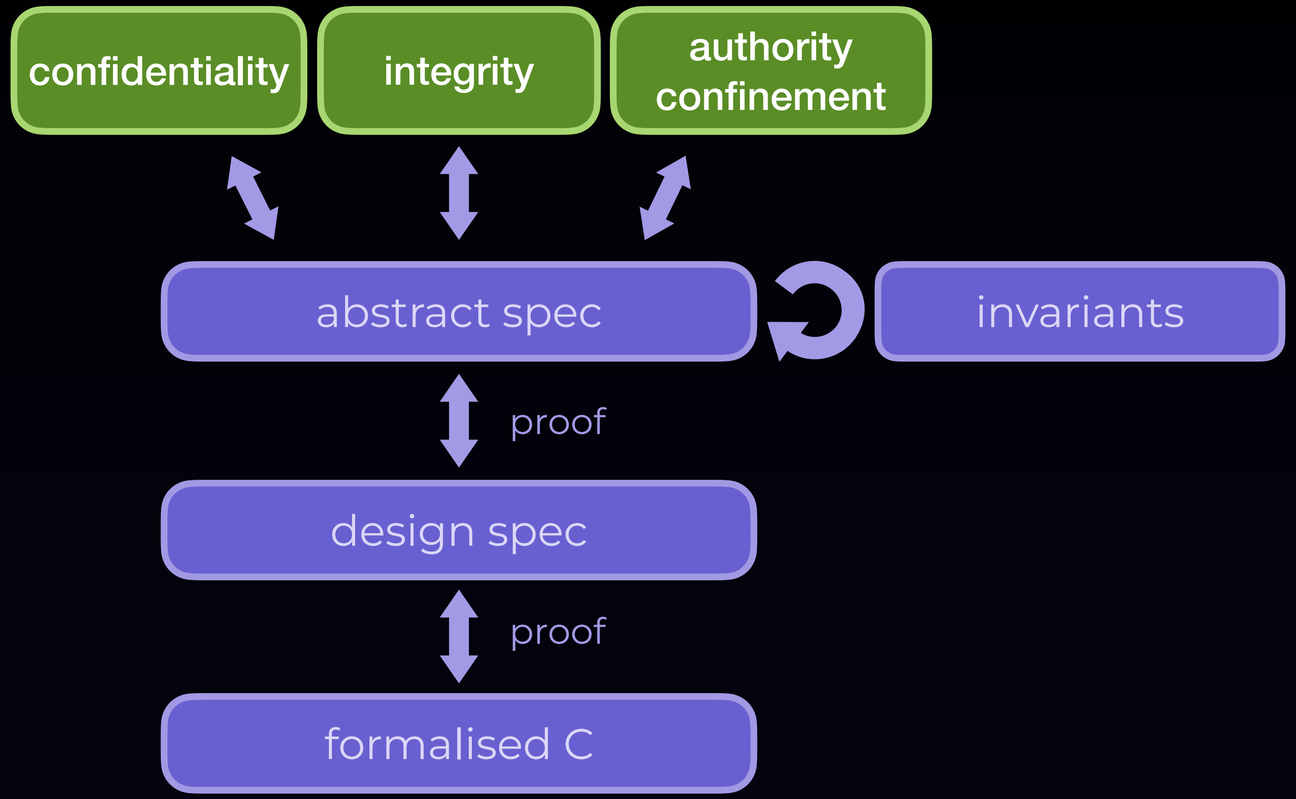

abstract spec
invariants
proof
design spec
proof
formalised C

# Summary


confidentiality
integrity
authority confinement
abstract spec
invariants
proof
design spec
proof
formalised C

# Summary

**Now on AArch64**



# What else to expect

**Also happening in seL4 verification**

- **MCS** proofs completed for RISC-V
- **RISC-V Platforms** all supported
- **Arch-split Refine** completed
- **Multikernel** proofs in progress

# Thank You