L1TF in KVM

About Me

- Alexander Graf
- KVM and QEMU developer for SUSE
  - Server class PowerPC KVM port
  - Nested SVM
- Founding member of SUSE ARM team
- U-Boot UEFI support

Speculation

Speculation

```
static long last_add;

long read_add(long *data, long add)
{
   last_add += add;
   return *data + add;
}
```

Speculation

```
0000000000000000 <read_add>:
   0:48 01 35 00 00 00 00   add    %rsi,last_add(%rip)
   7:48 89 f0               mov    %rsi,%rax
   a:48 03 07               add    (%rdi),%rax
   d:c3                     retq
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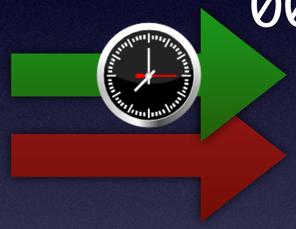

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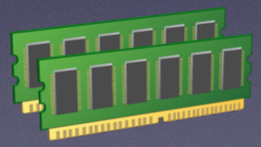
Caches



xx GB

~250 cycles

`last_add(%rip)`

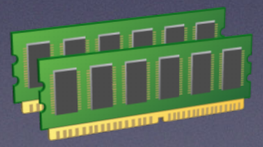
Latency numbers from https://www.7-cpu.com/cpu/Skylake.html

Caches

L3

8 MB

42 cycles



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`last_add(%rip)`

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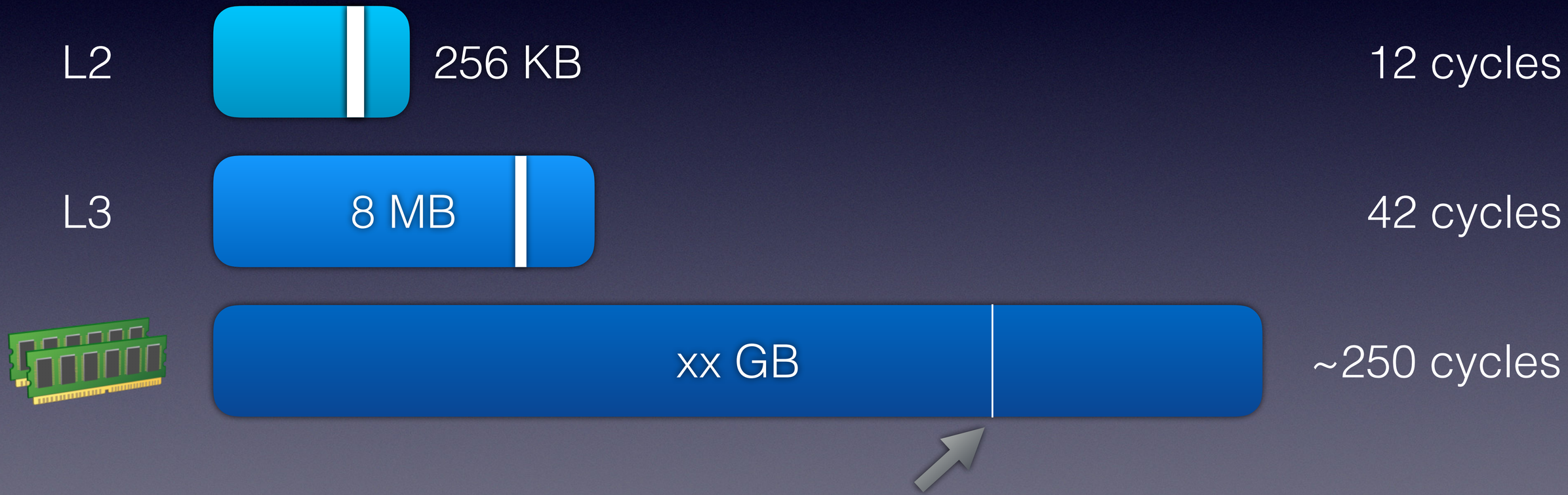
Caches



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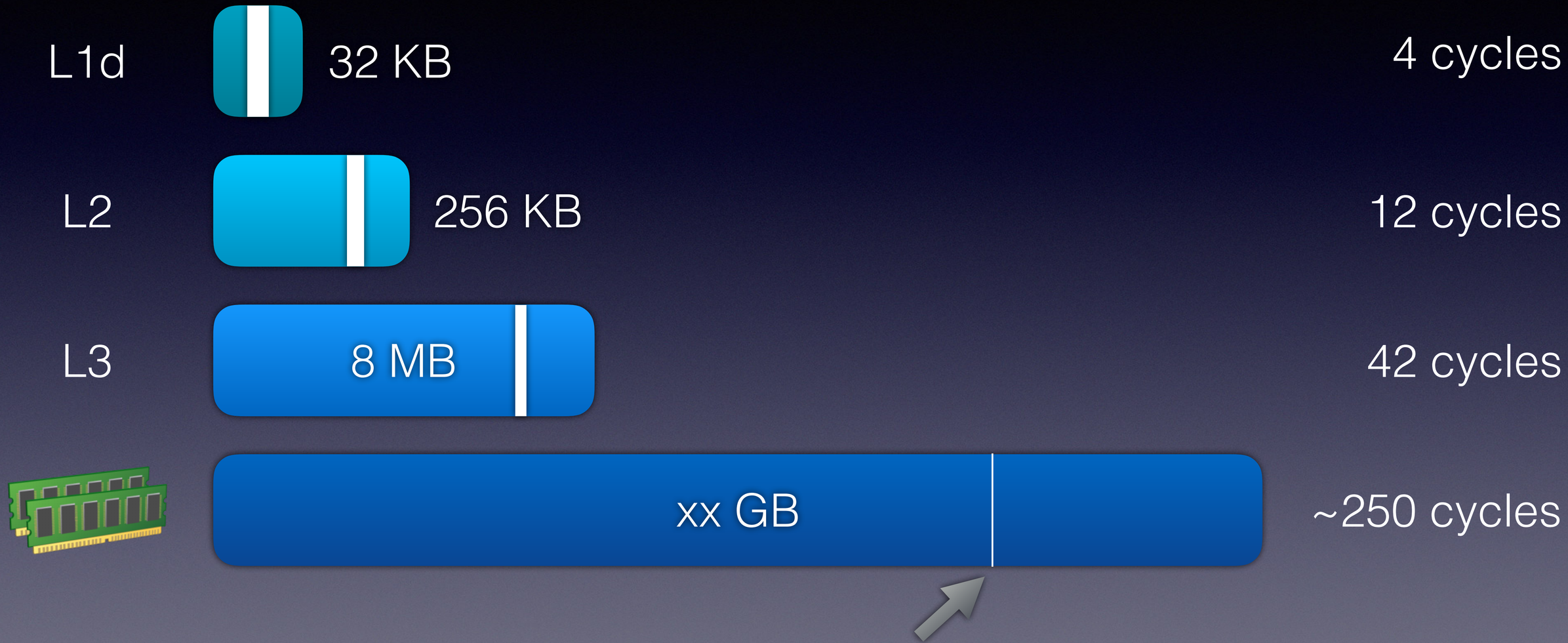

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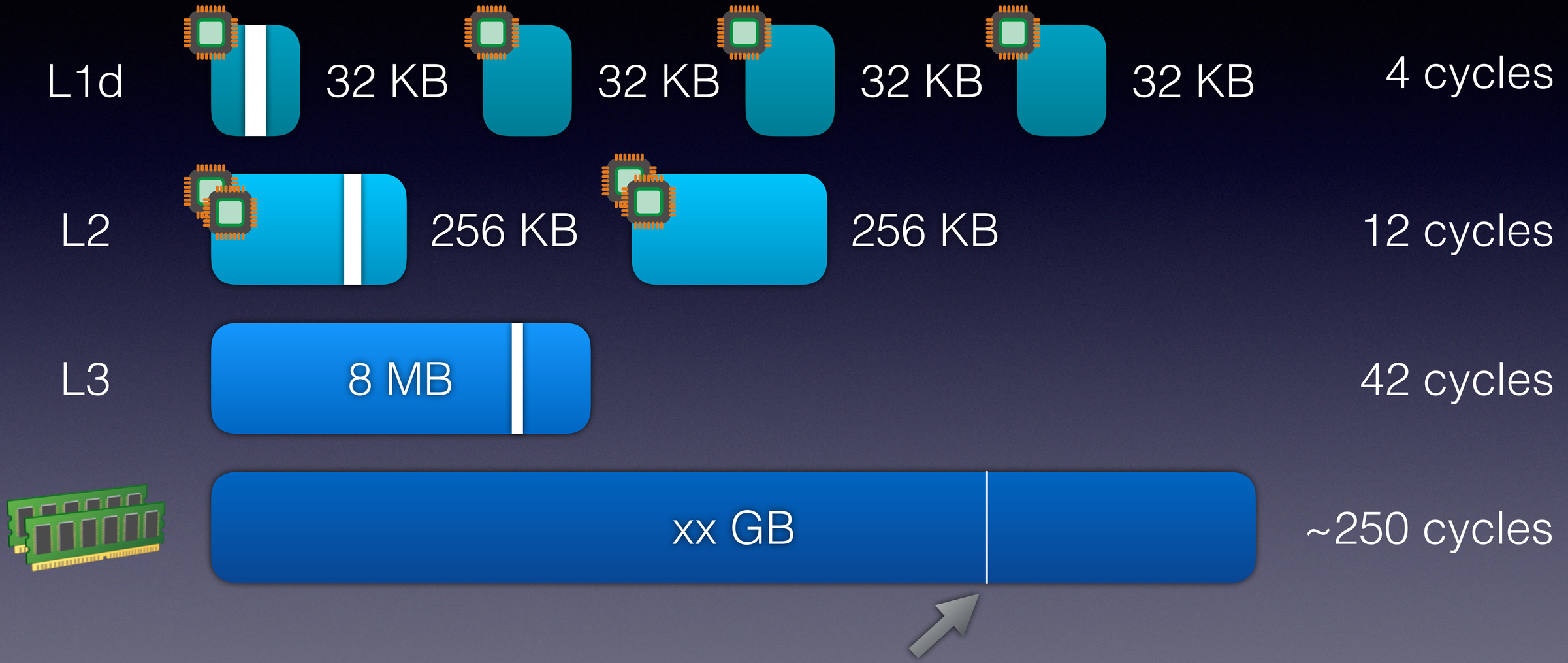

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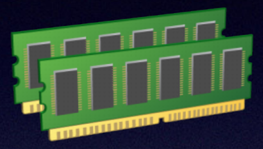
Paging



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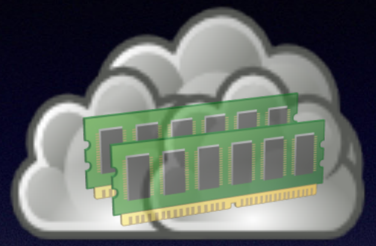

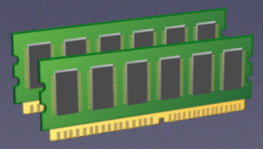

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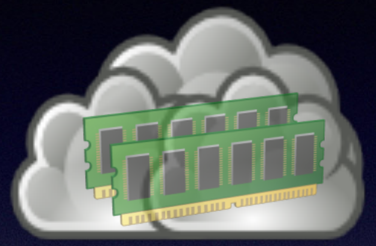

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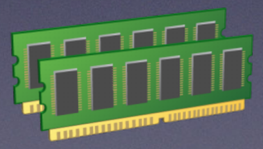

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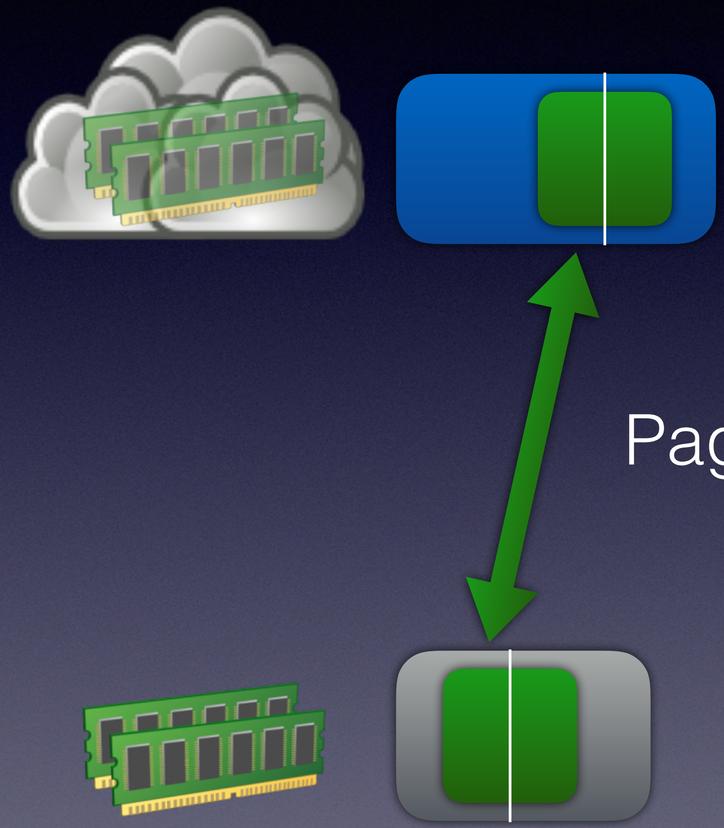
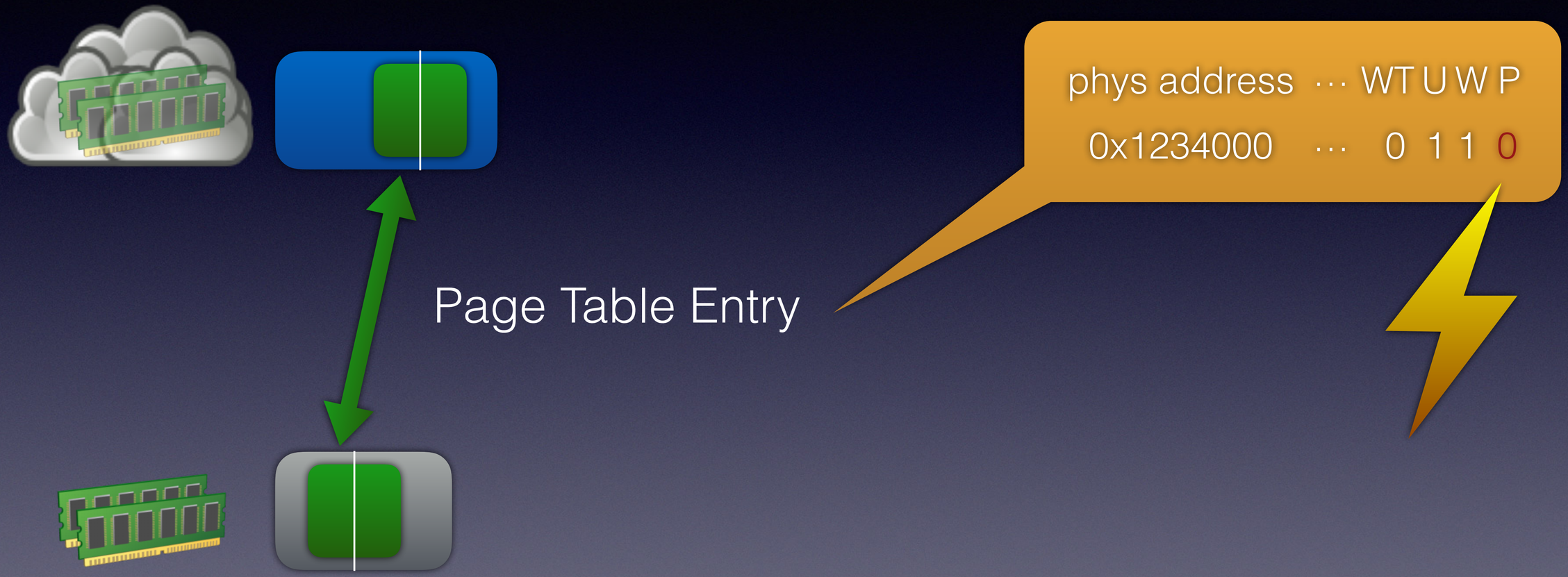


Page Table Entry

phys address	⋯	WT	U	W	P
0x1234000	⋯	0	1	1	1

Paging



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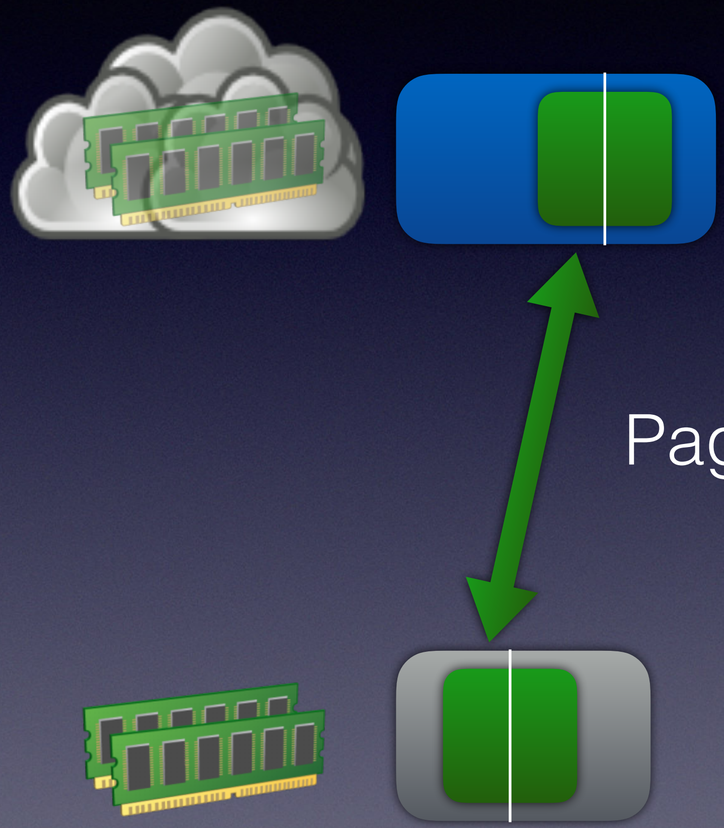

Page Table Entry

L1d

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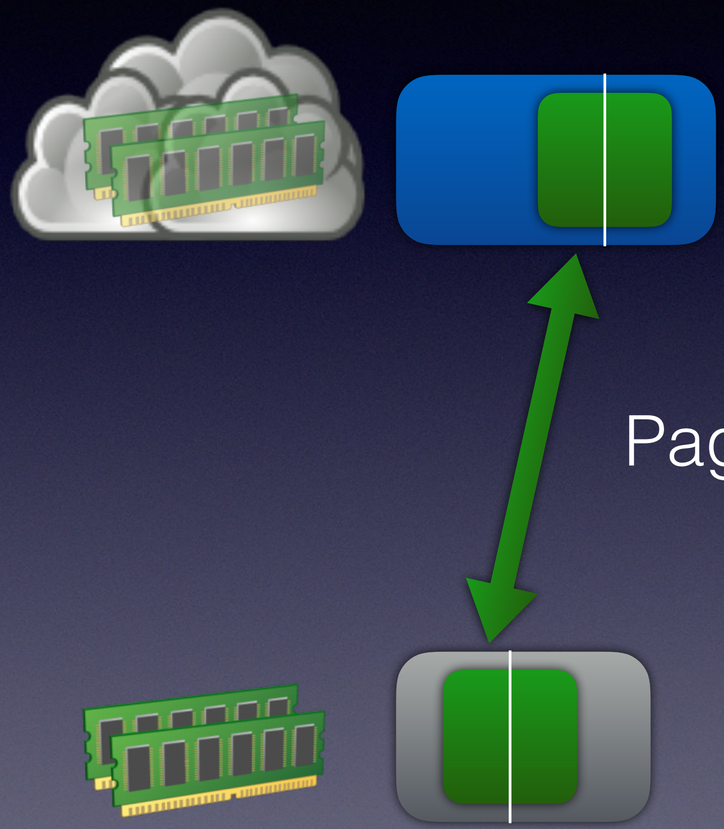

Page Table Entry

Paging

Page Table Entry

Extended
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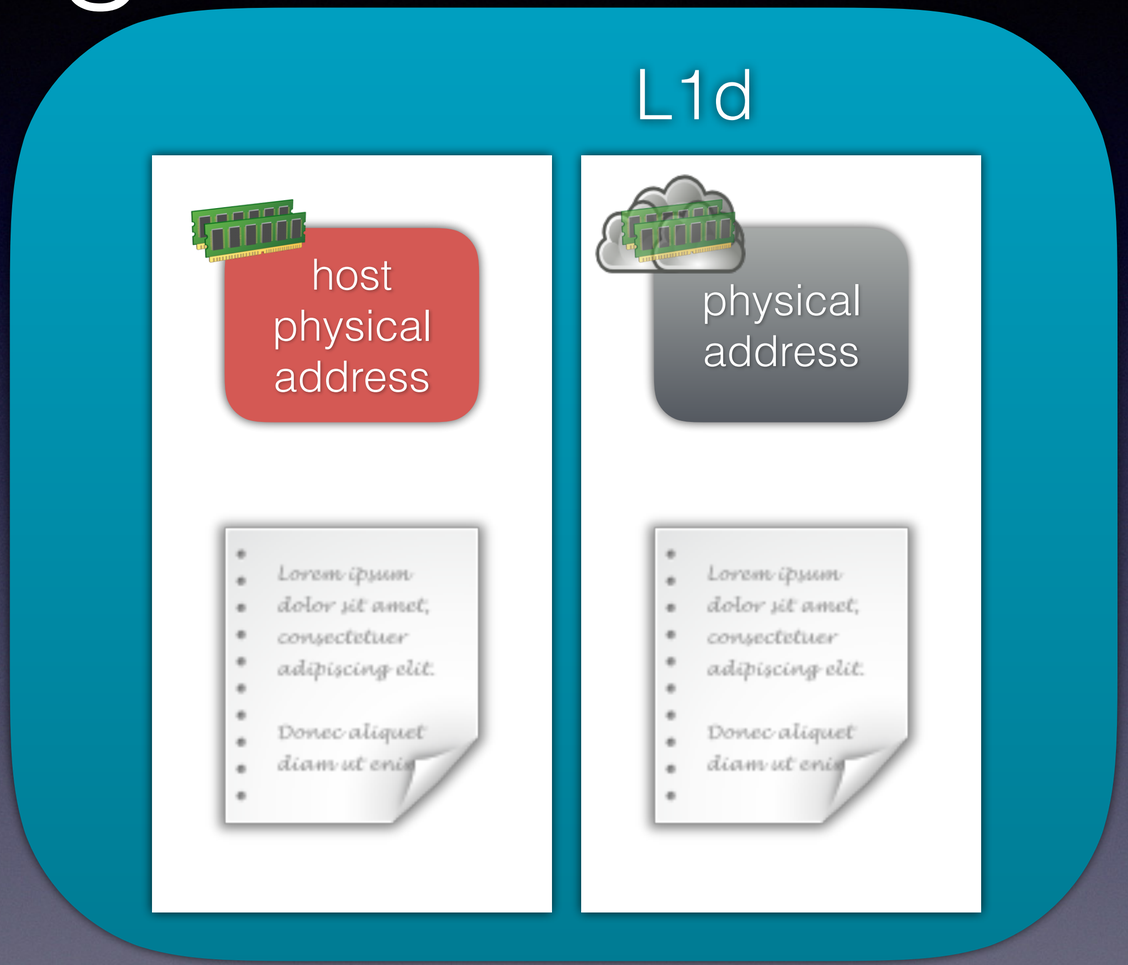
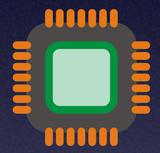
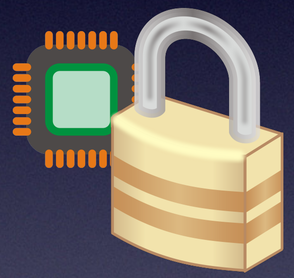
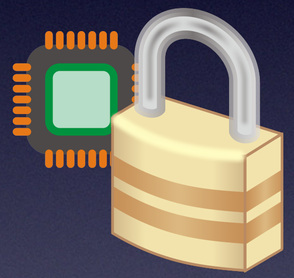


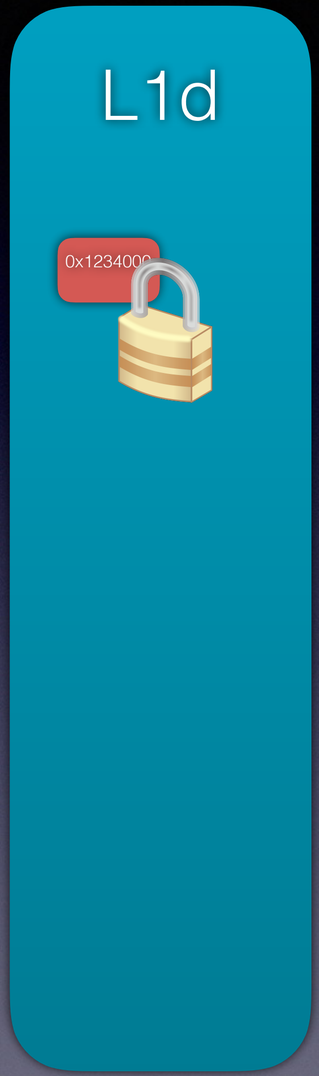


L1d



L1d

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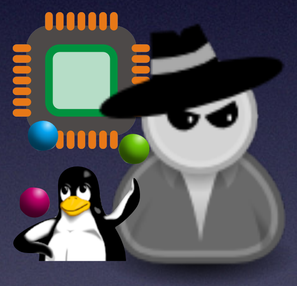

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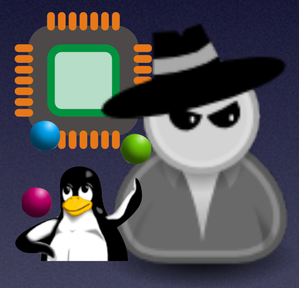
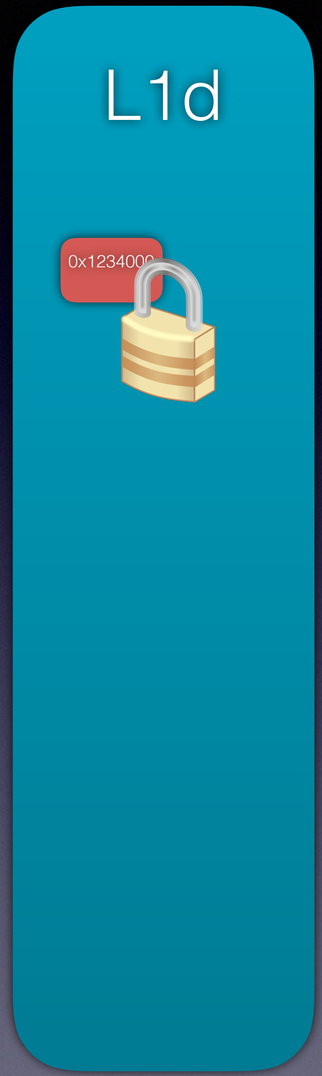
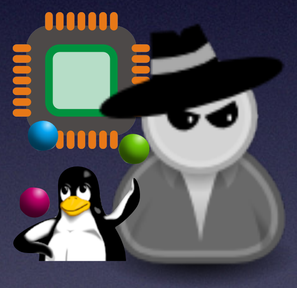


```
foo = *(char *)0x1000;
bar = oracle[foo * 4096];
```





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movsbq 0x1000,%rax
shl    $0xc,%rax
movsbq oracle(%rax),%rax
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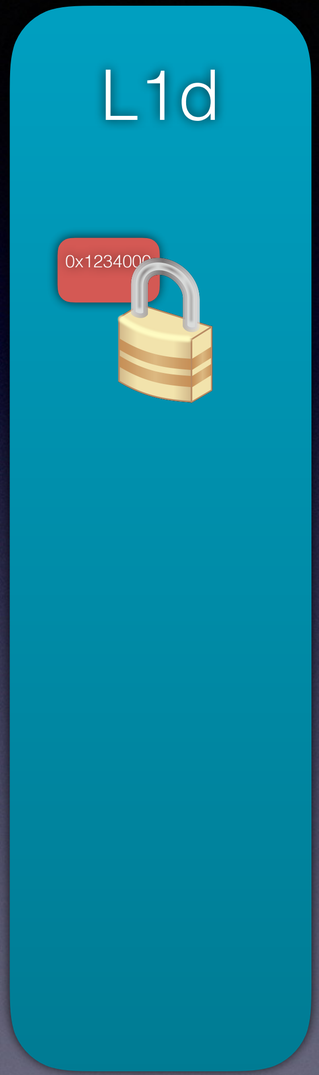

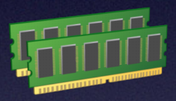

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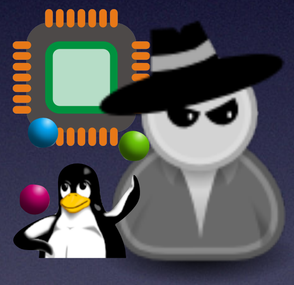

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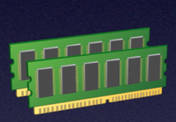
L1d



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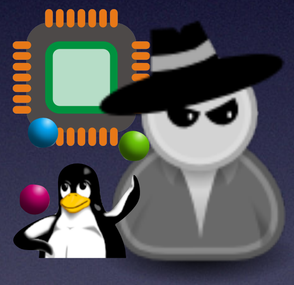

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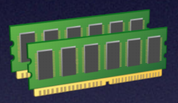

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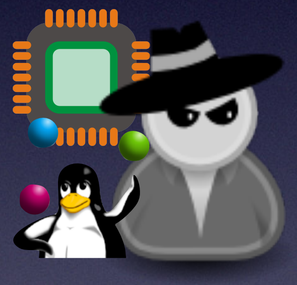

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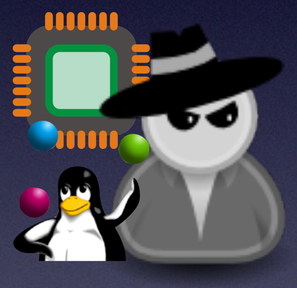

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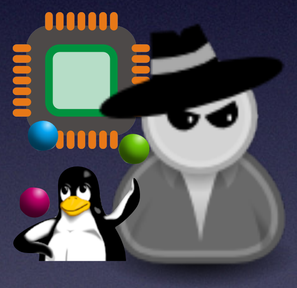

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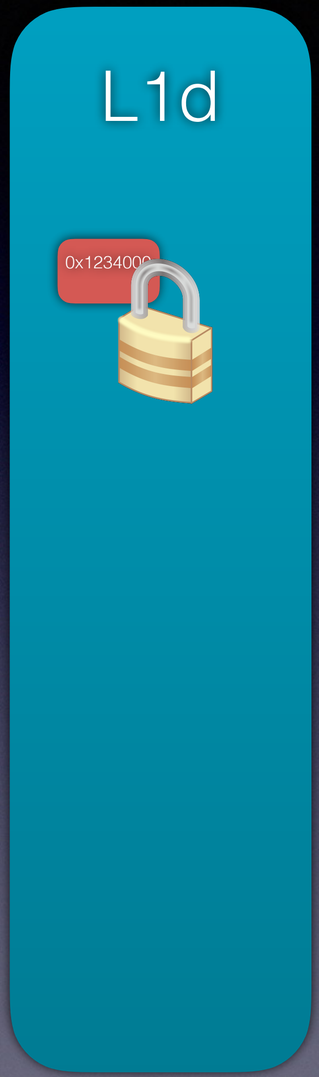

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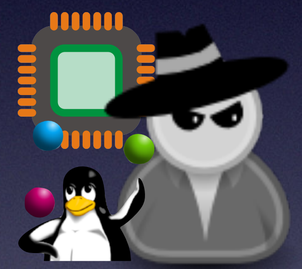

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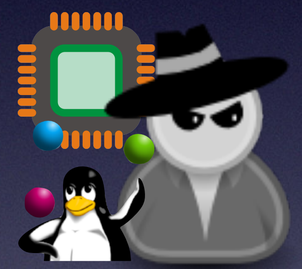

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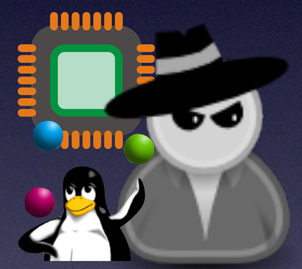

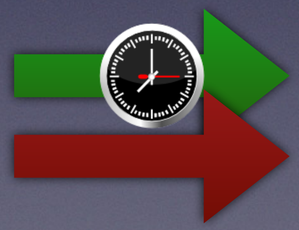

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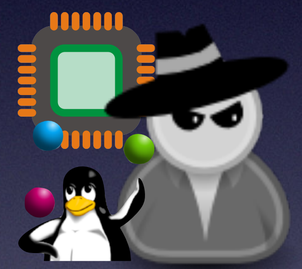

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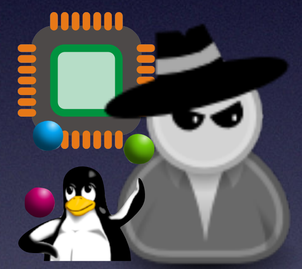

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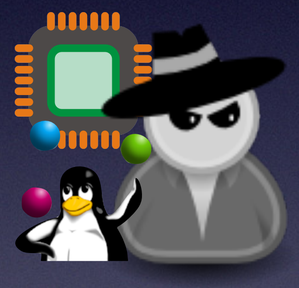

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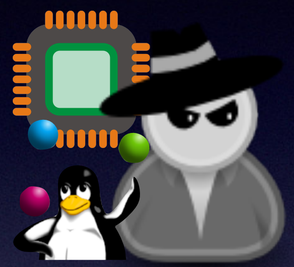
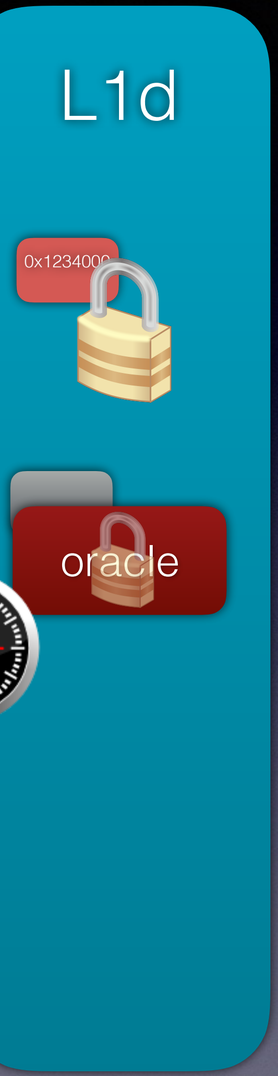
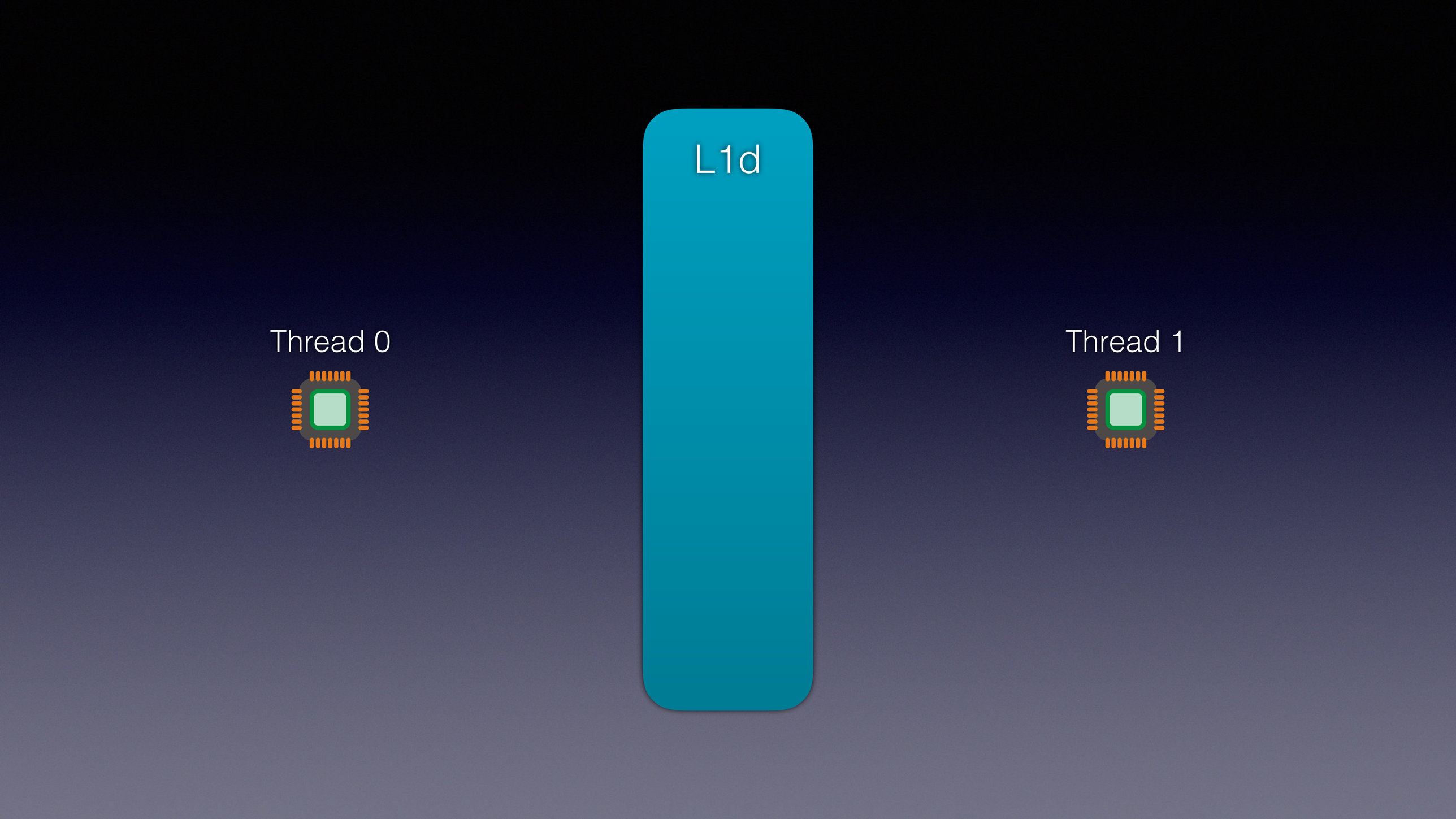
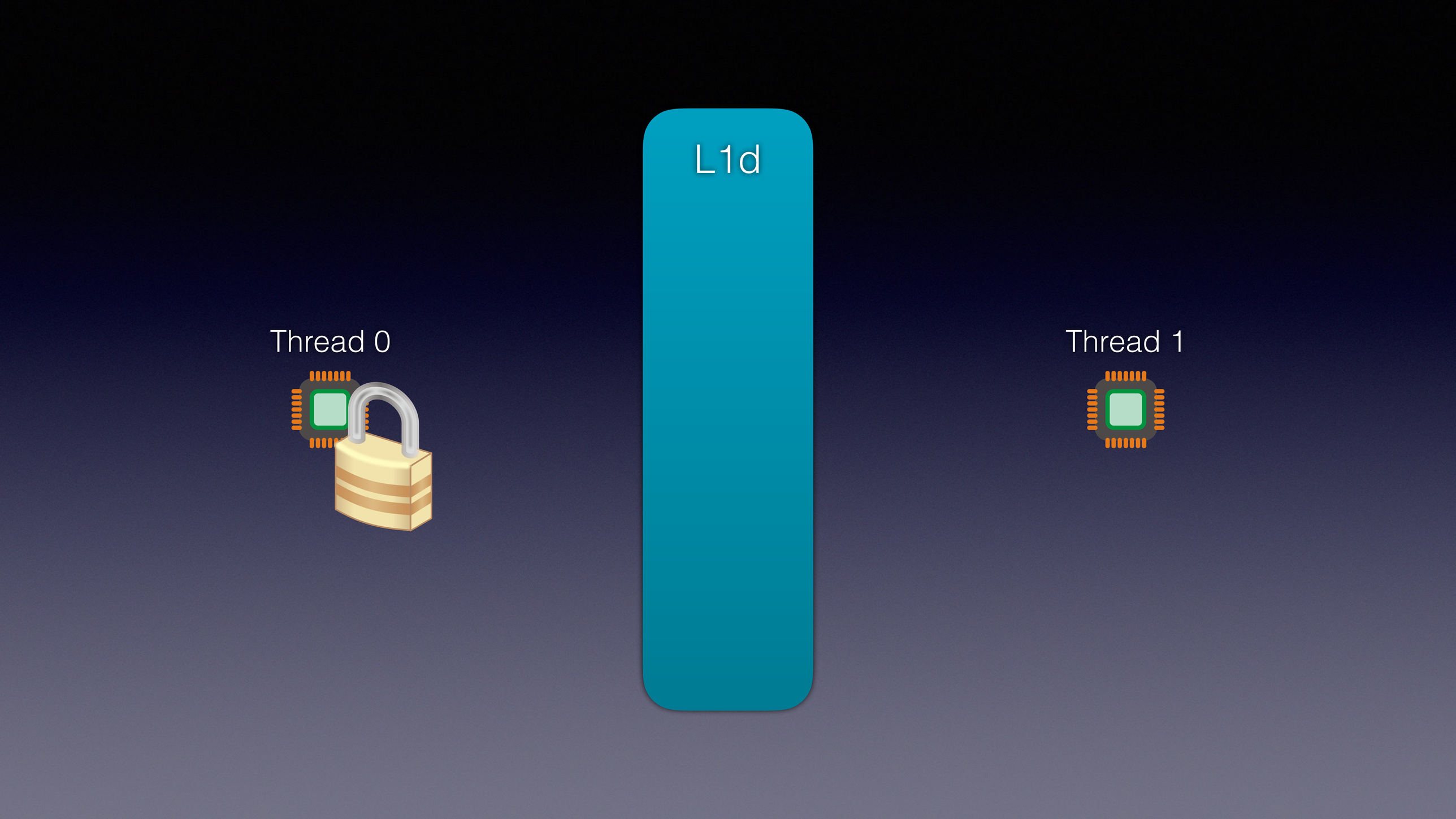
L1d




oracle


L1d
0x1234000
oracle


L1d
Thread 0
Thread 1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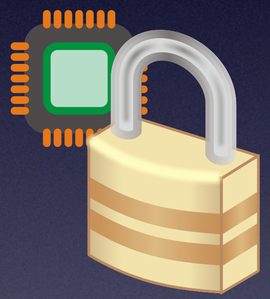

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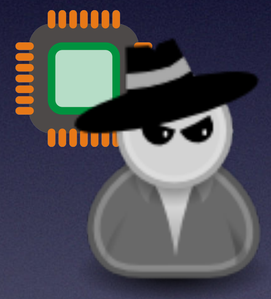

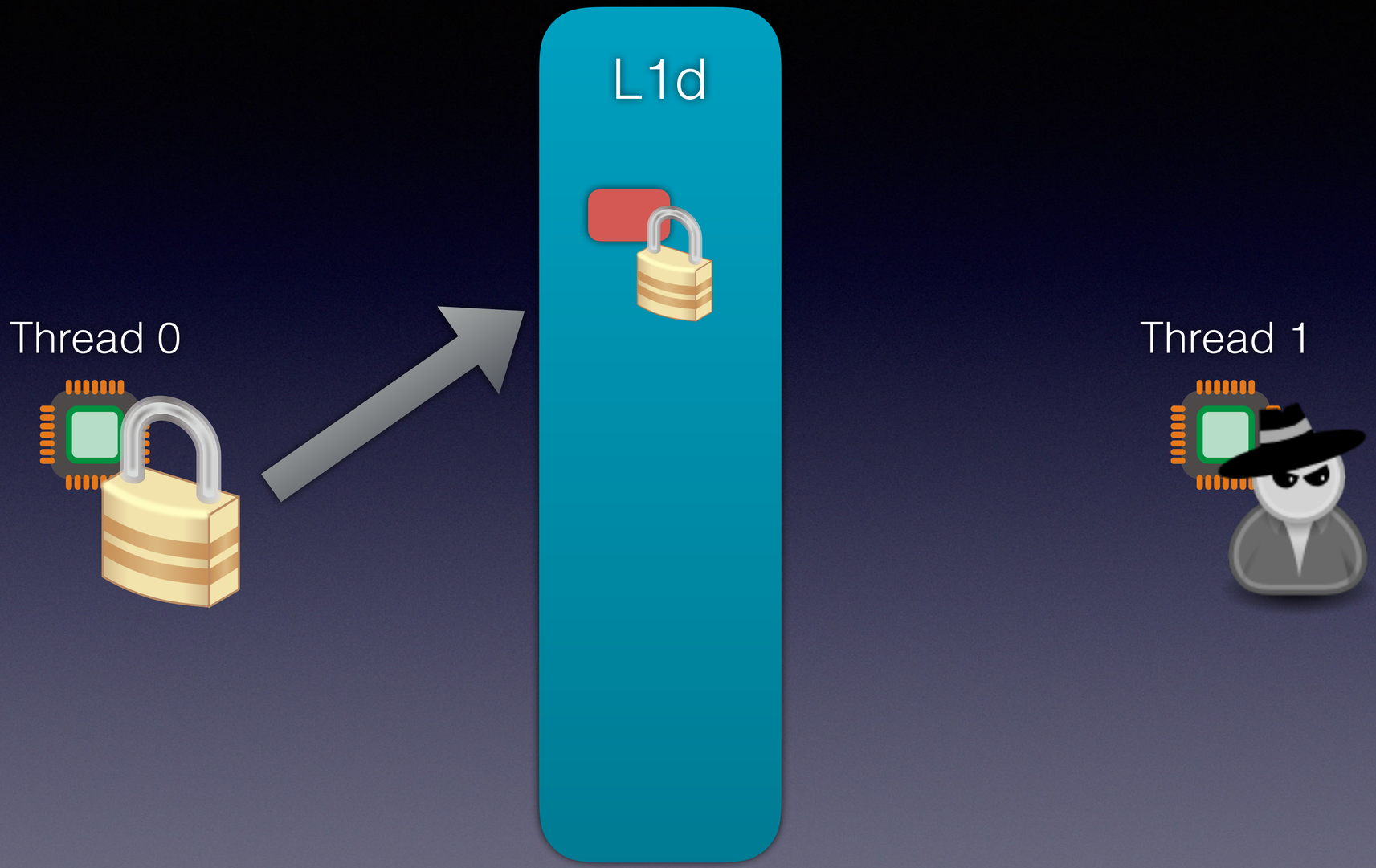
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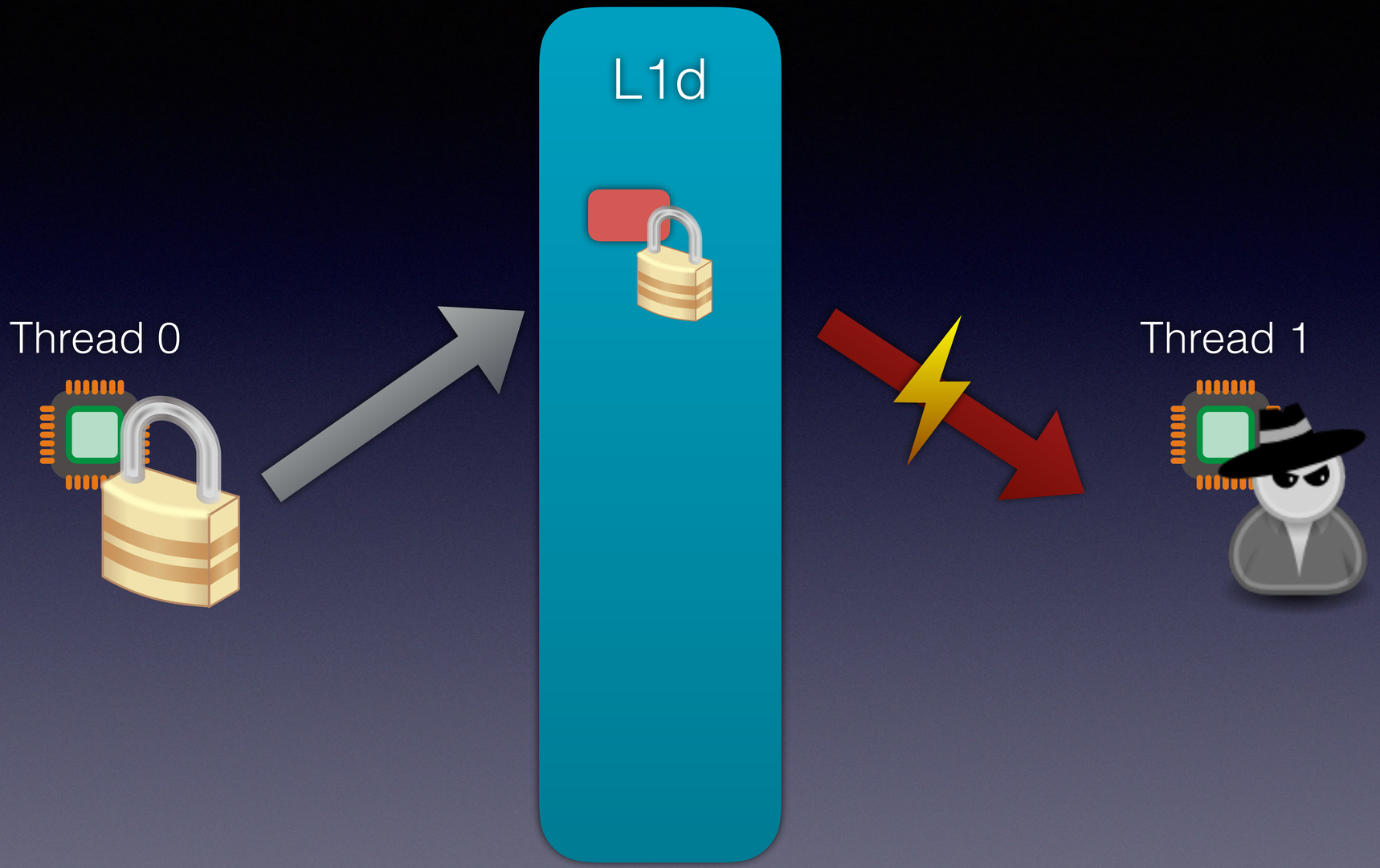
L1d
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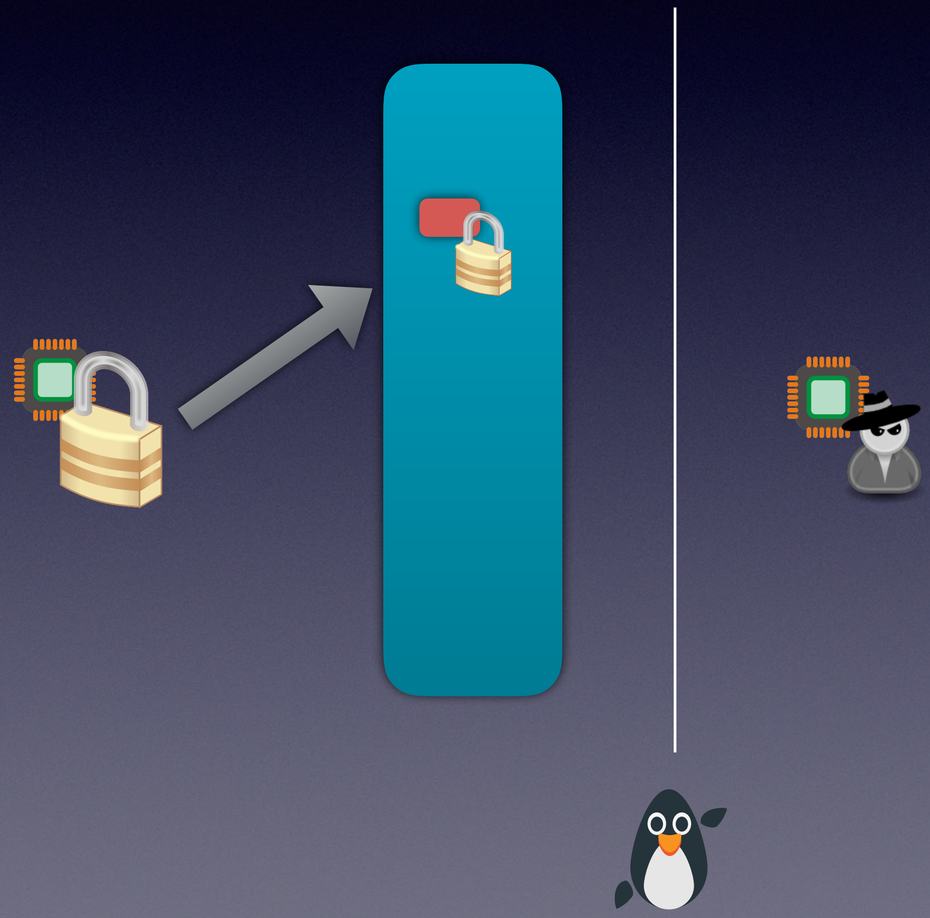
Mitigation



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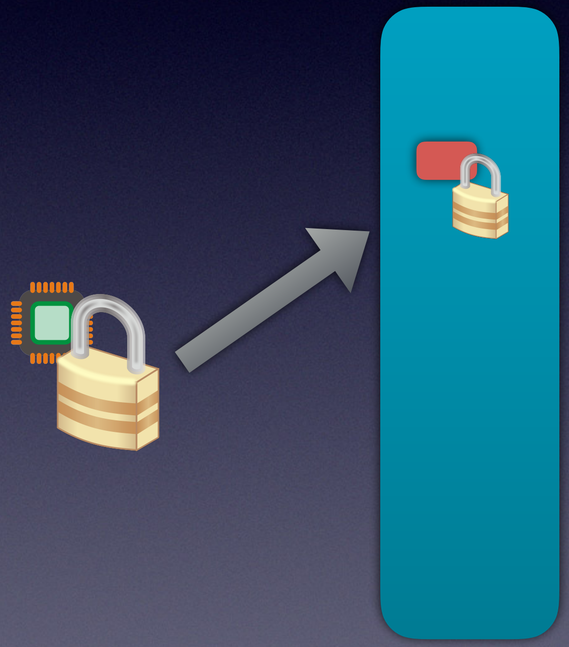

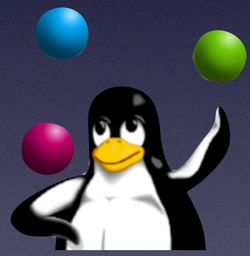

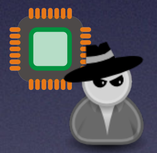

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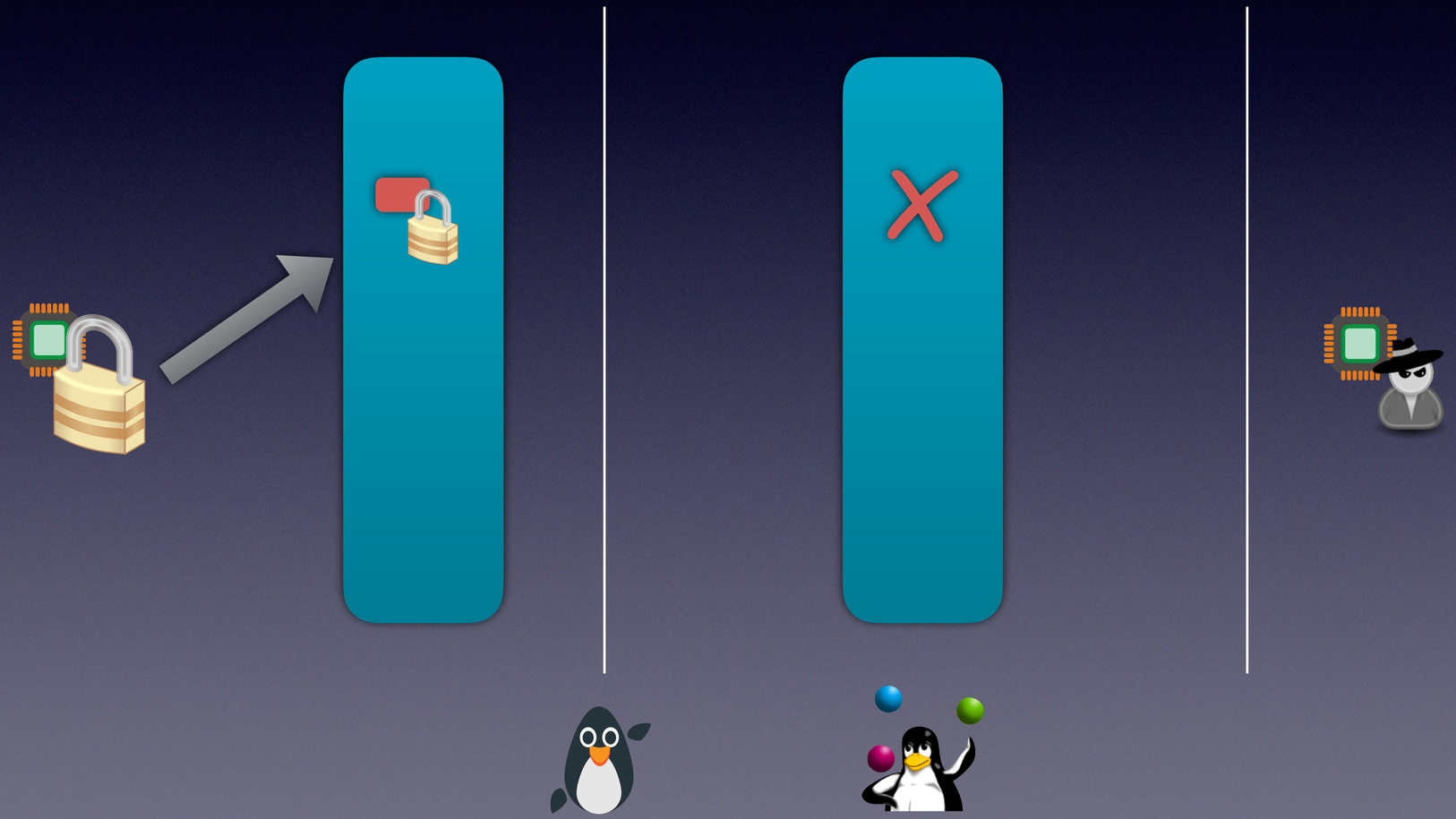

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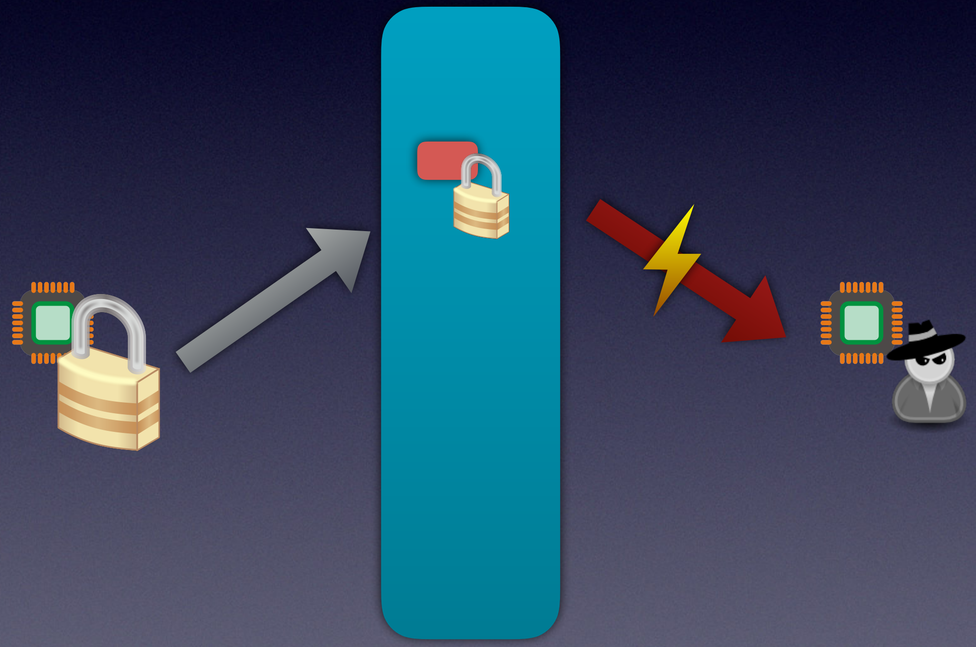

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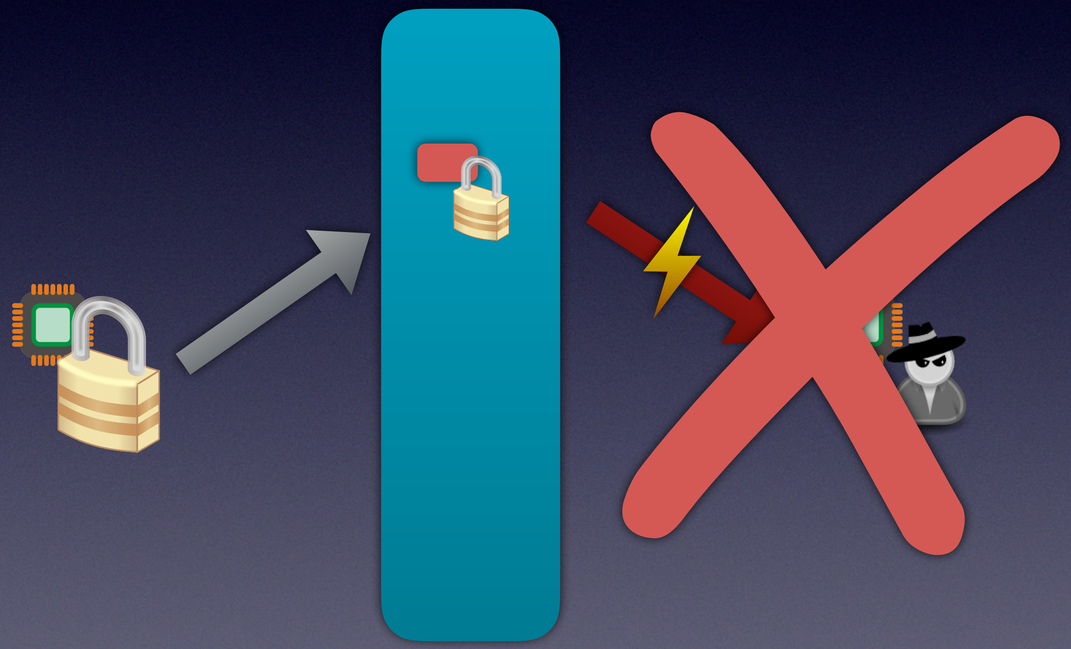
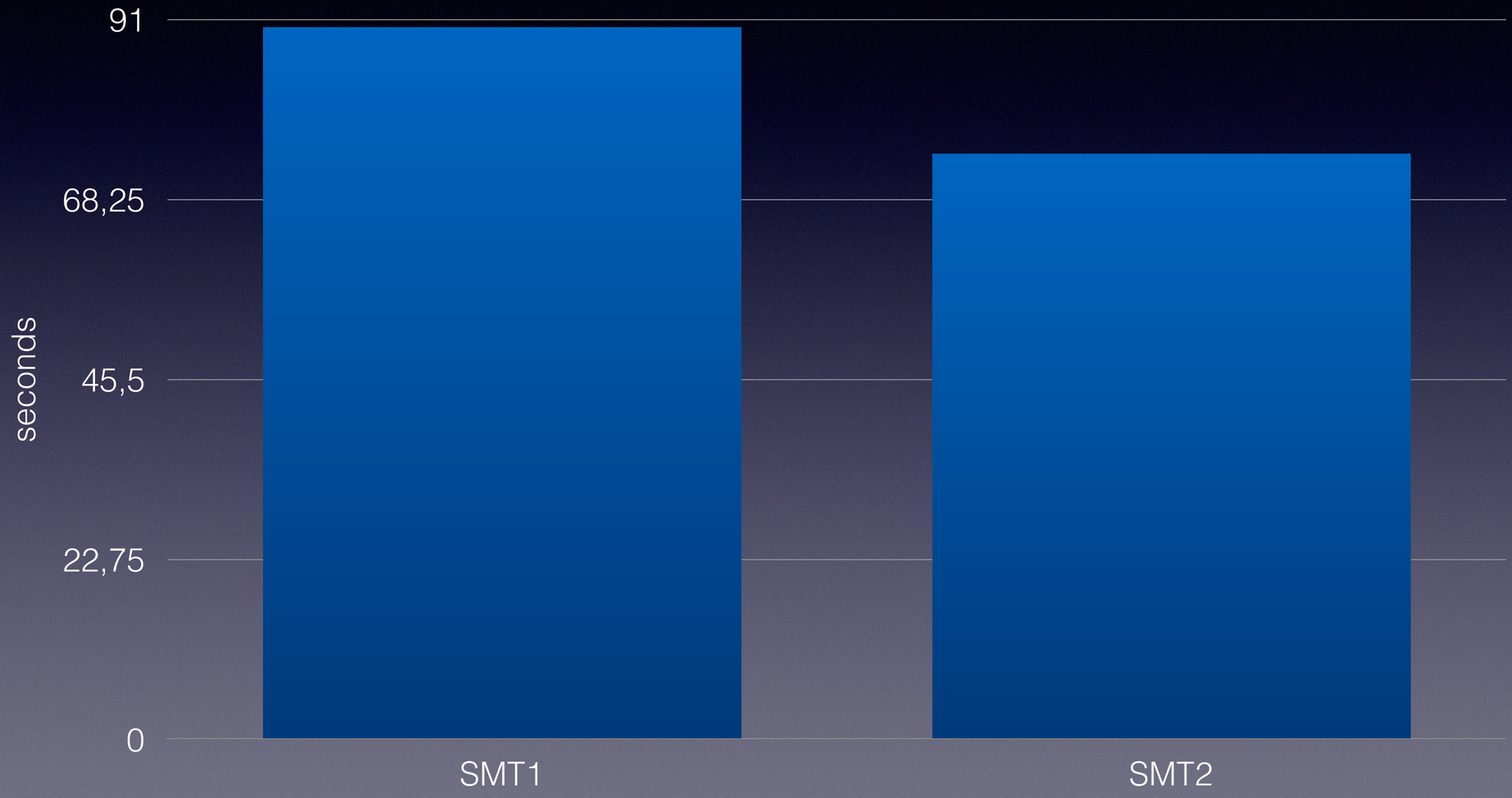


Kernel build

Kernel build



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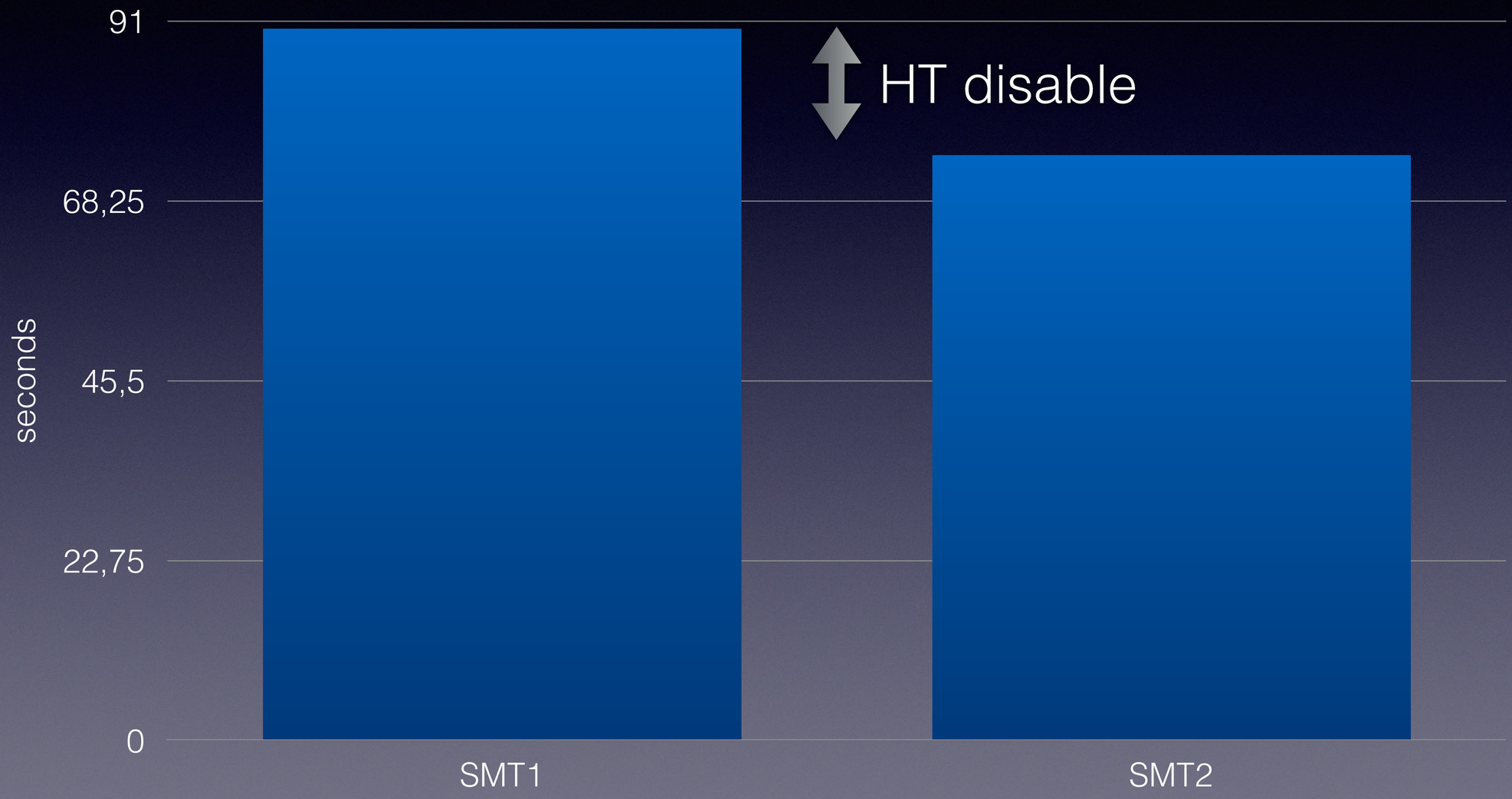

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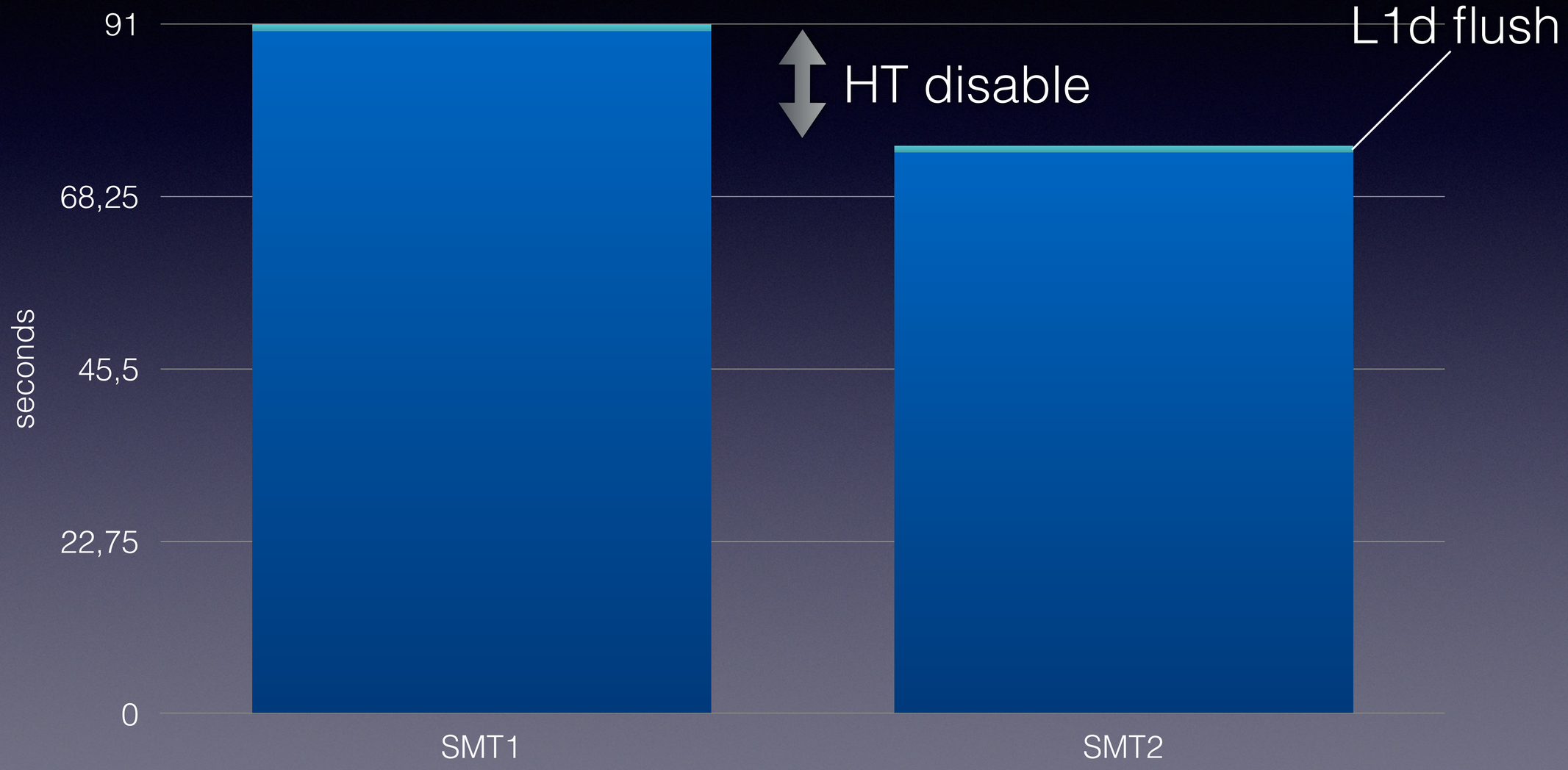

Alternative Mitigation

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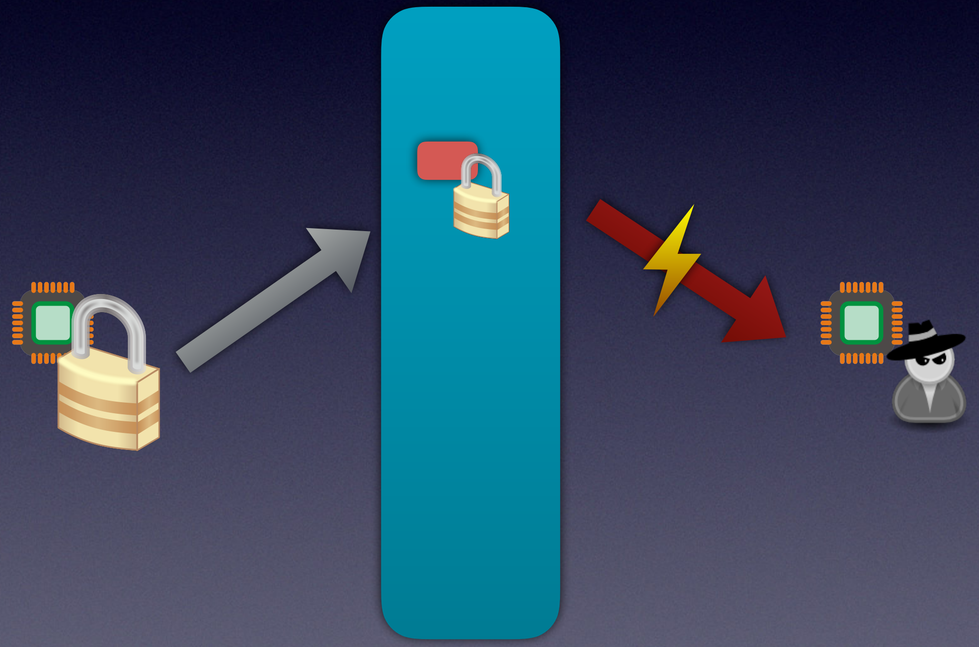

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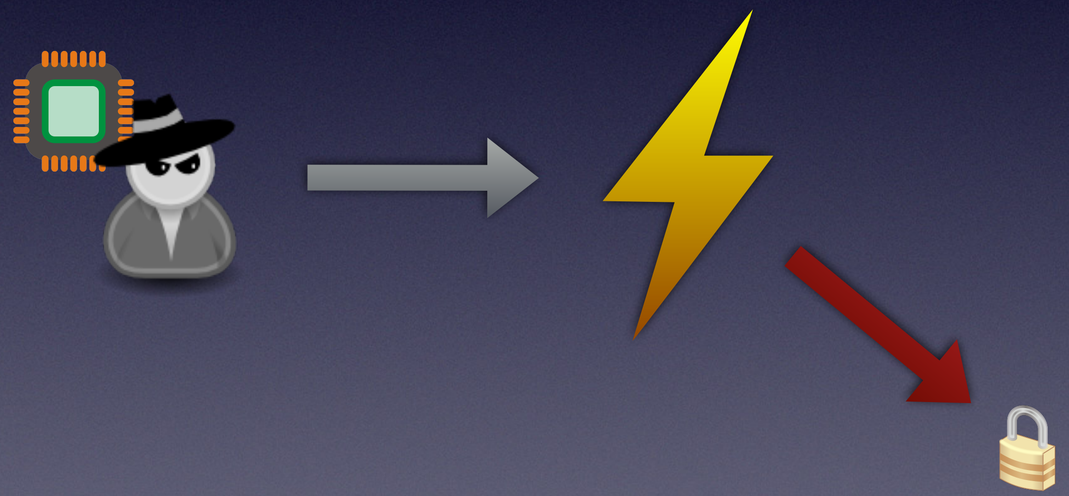

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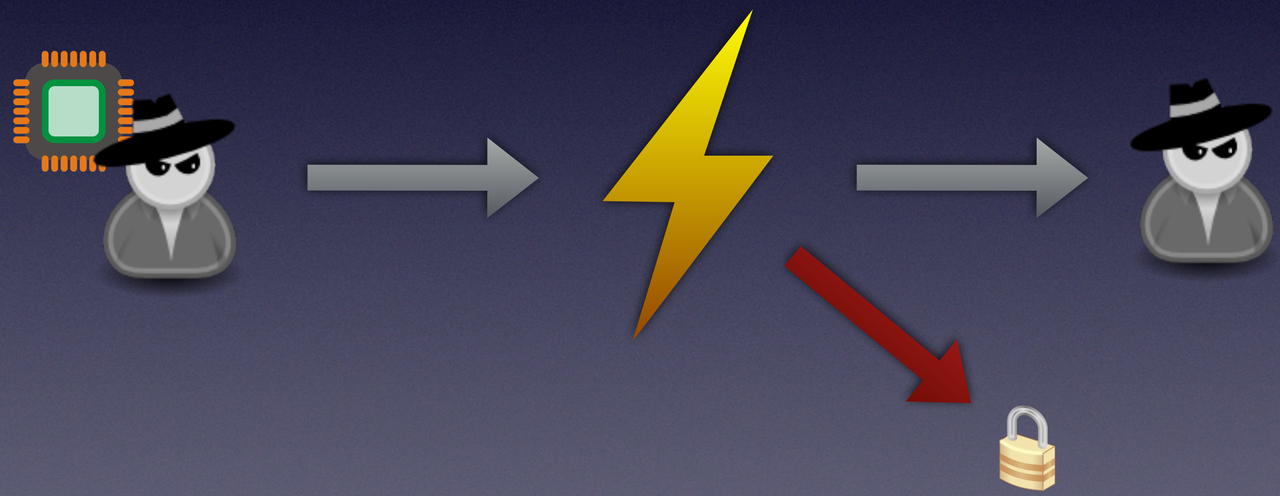

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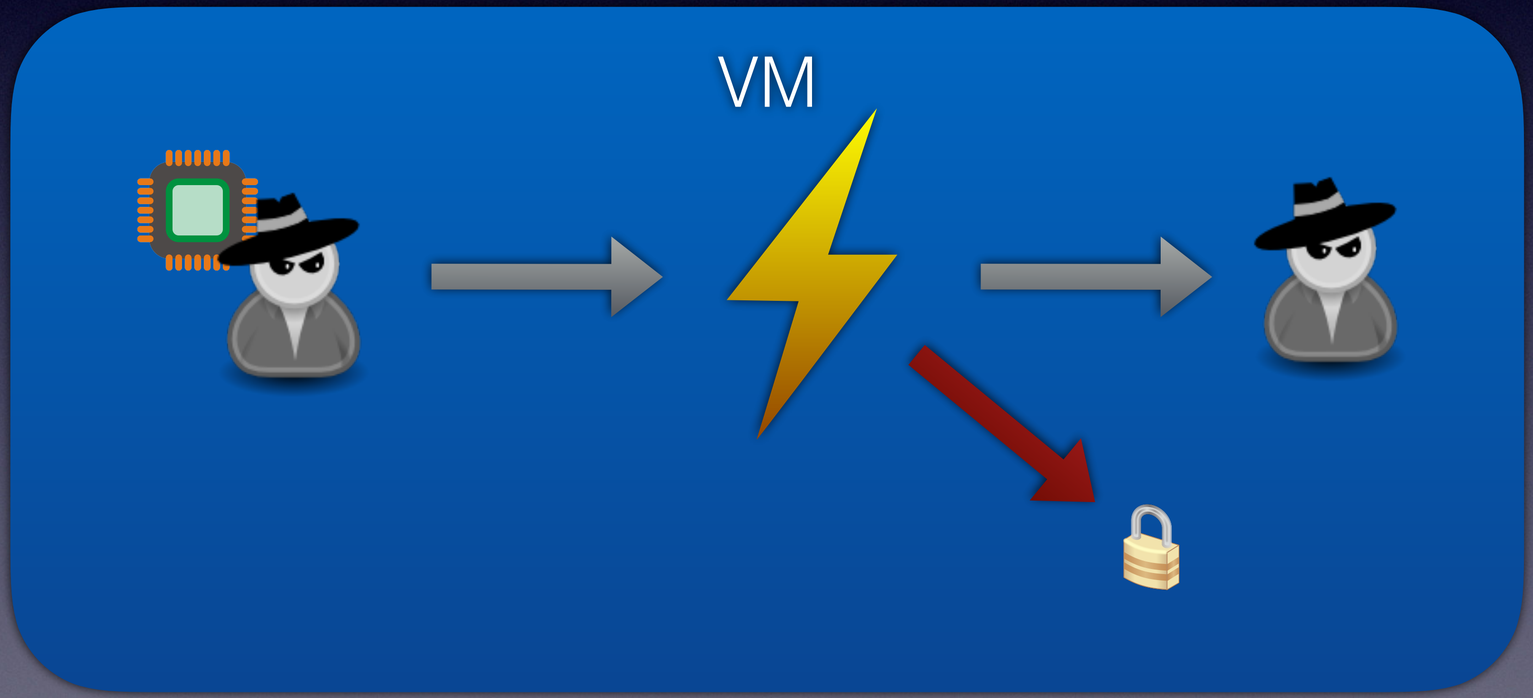

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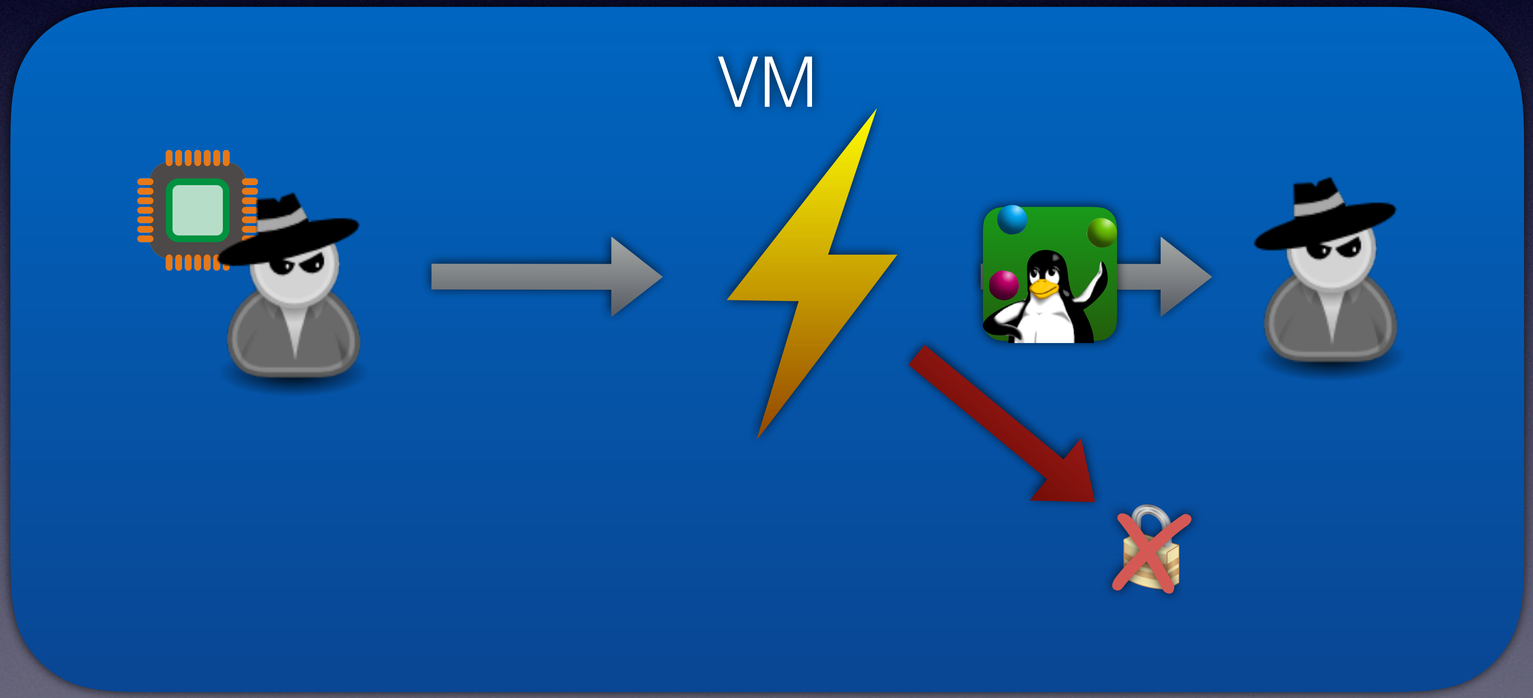

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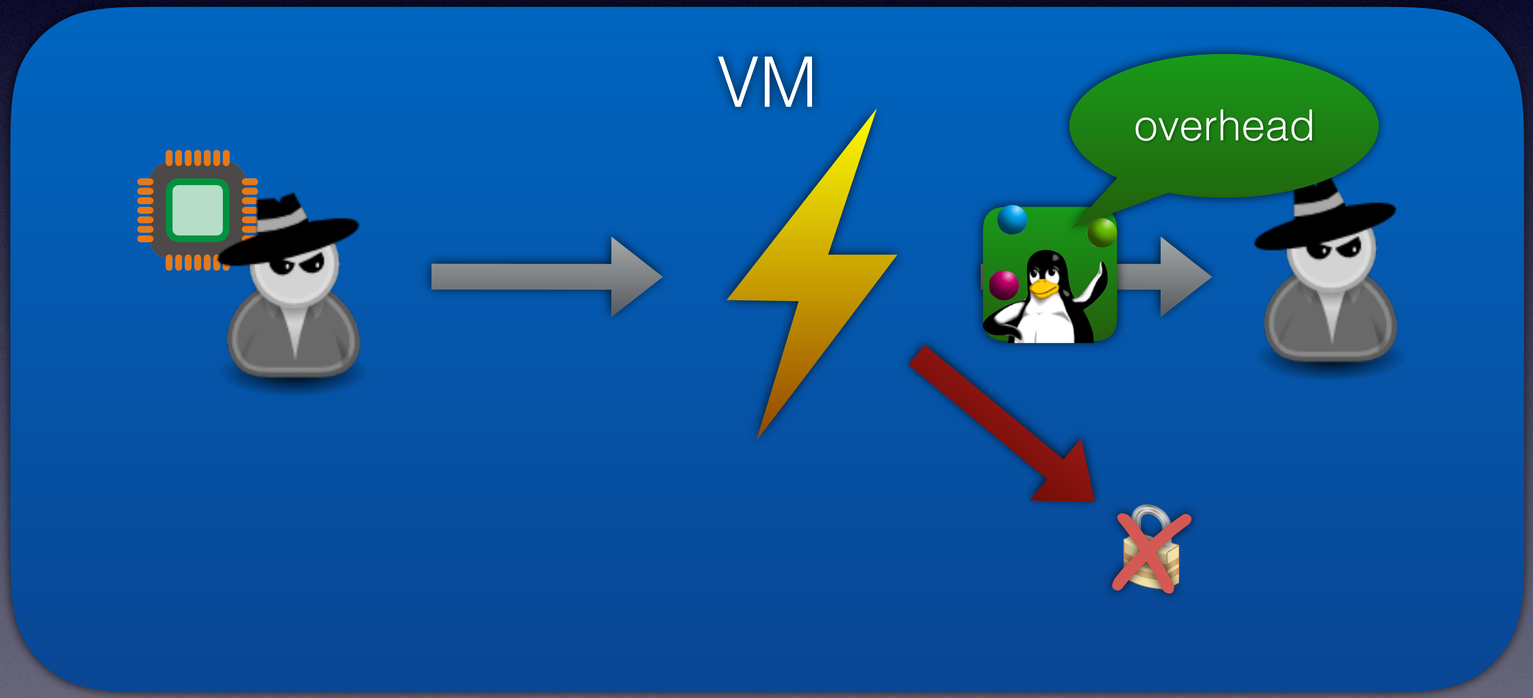

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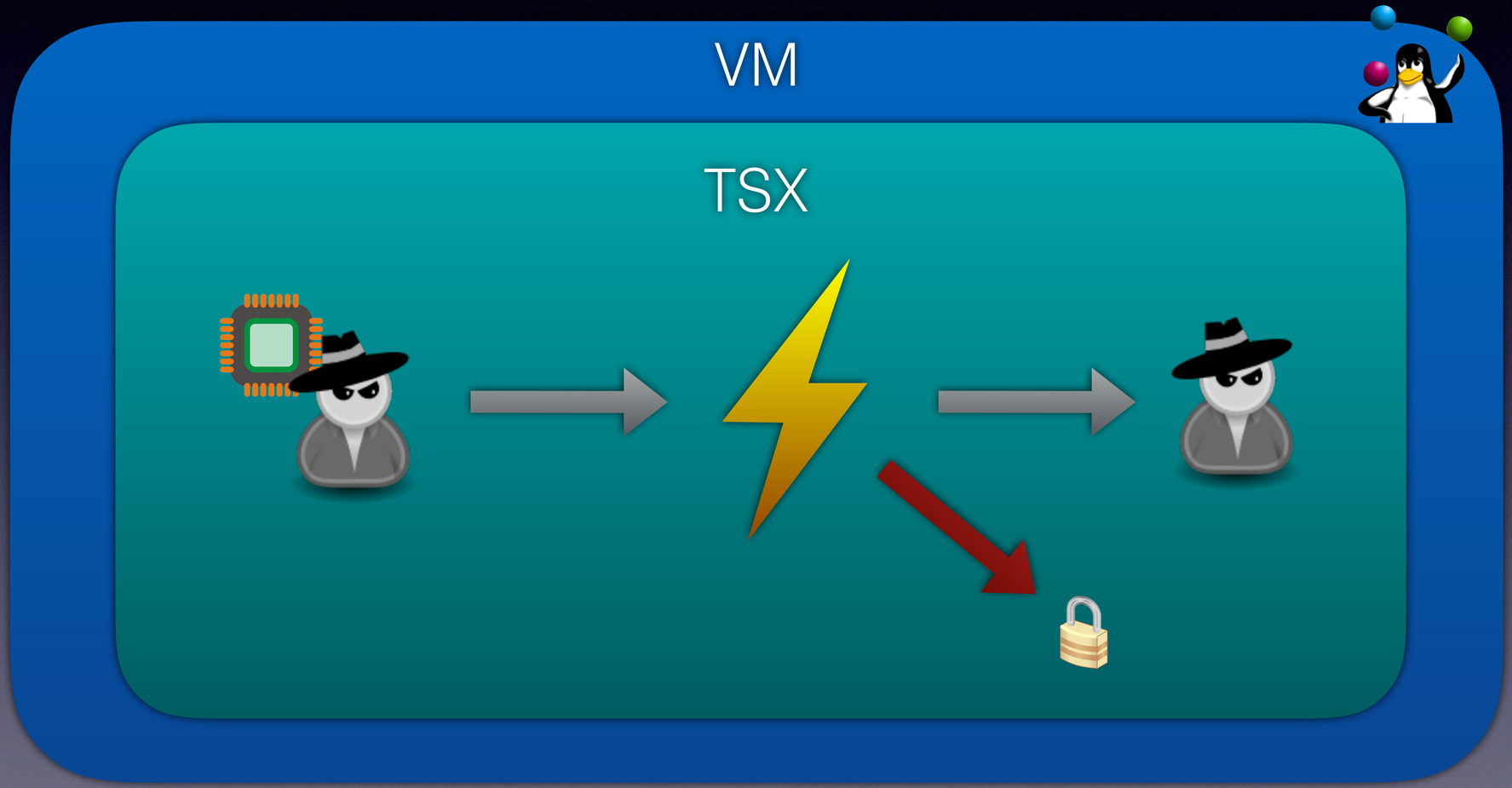

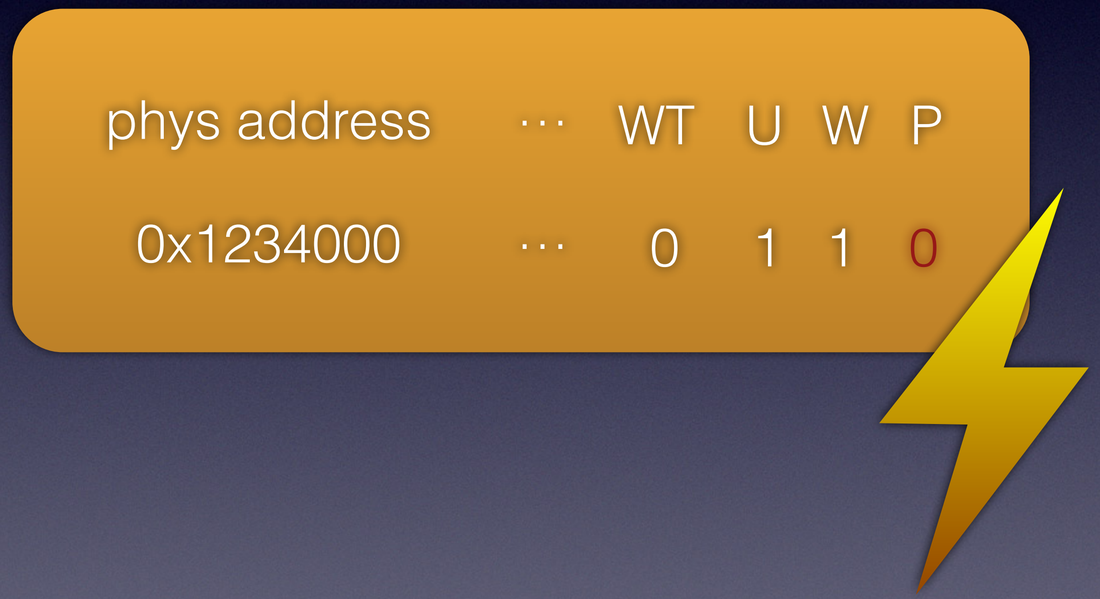
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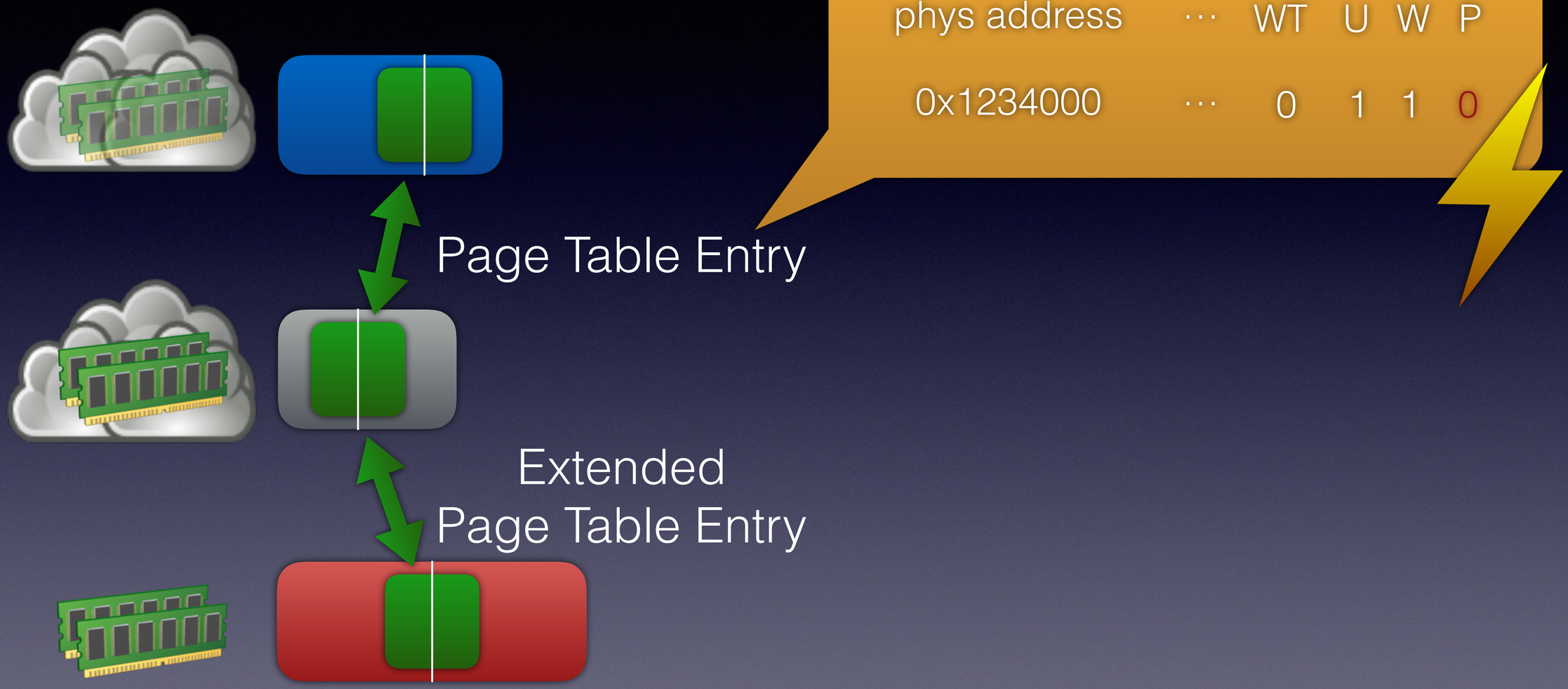
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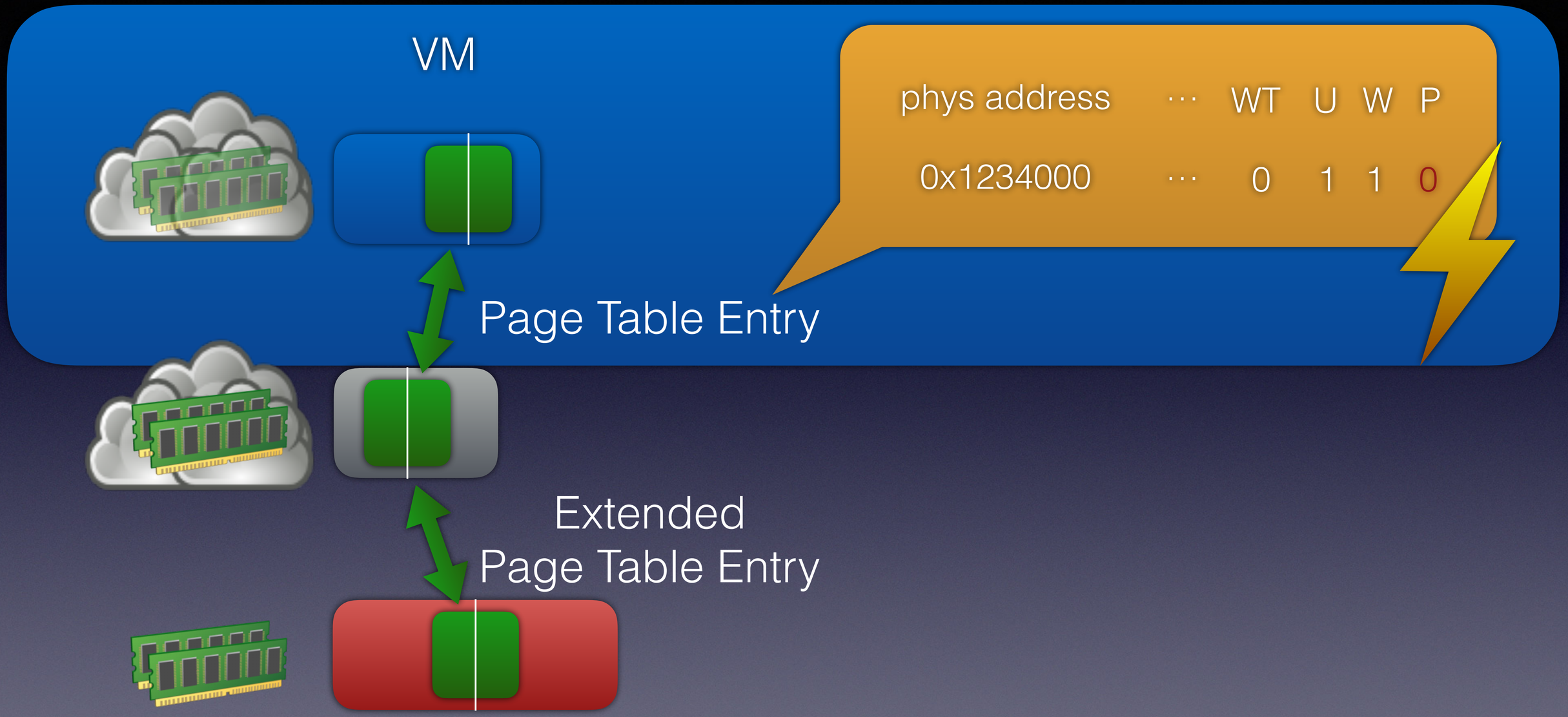
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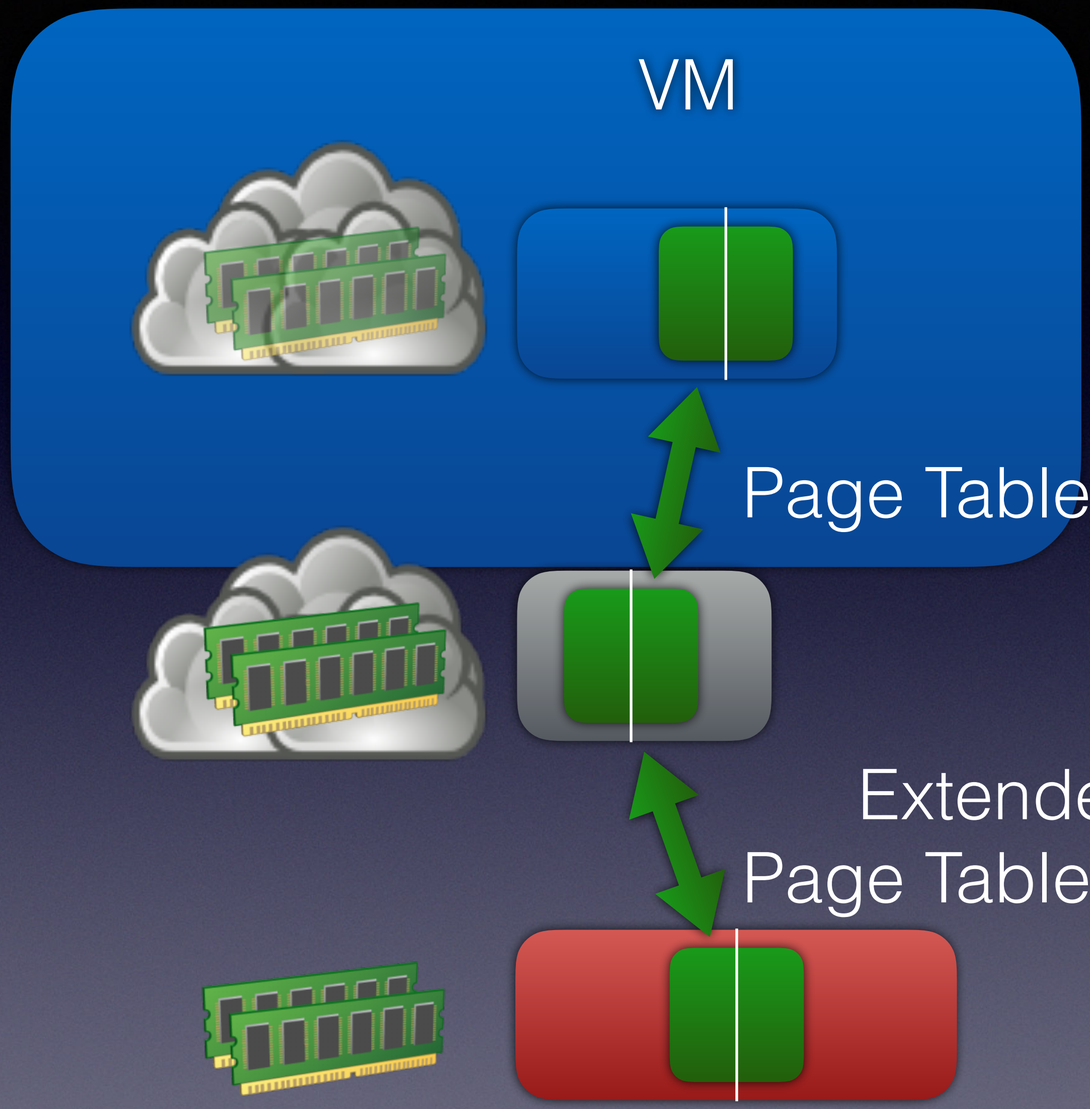
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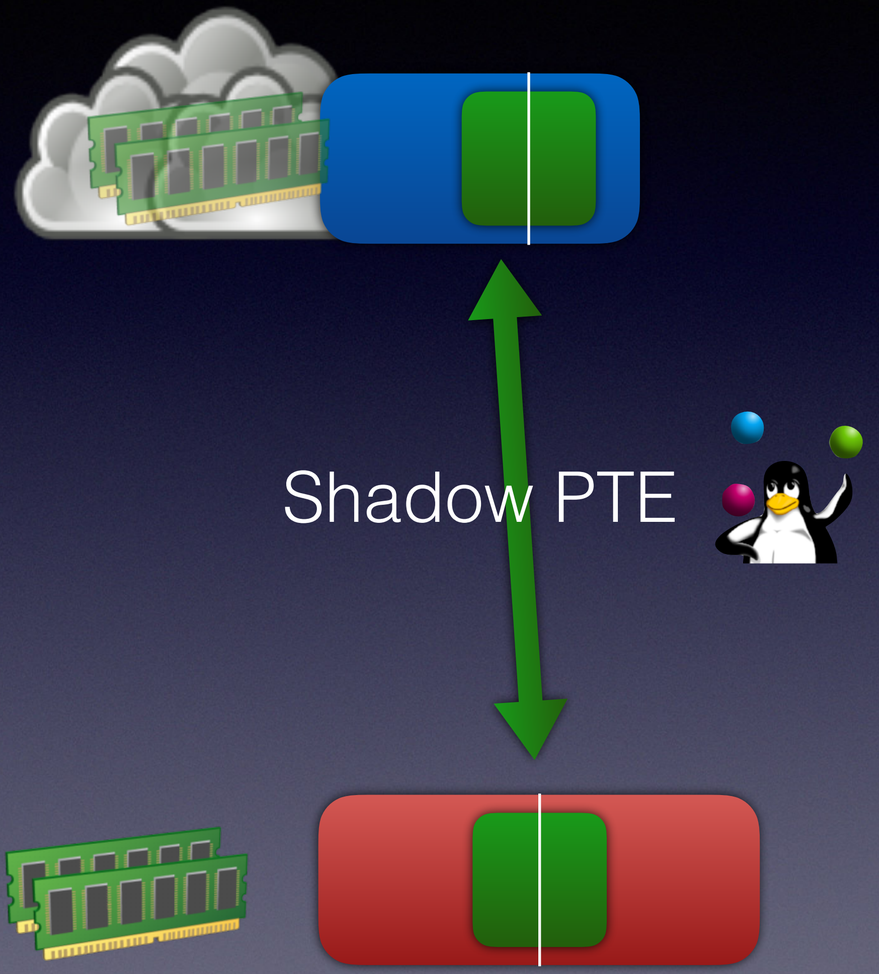
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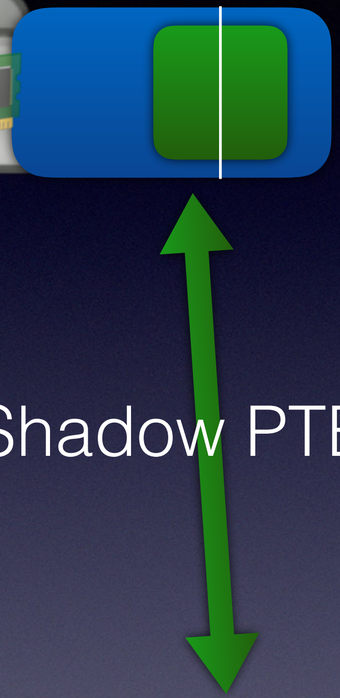
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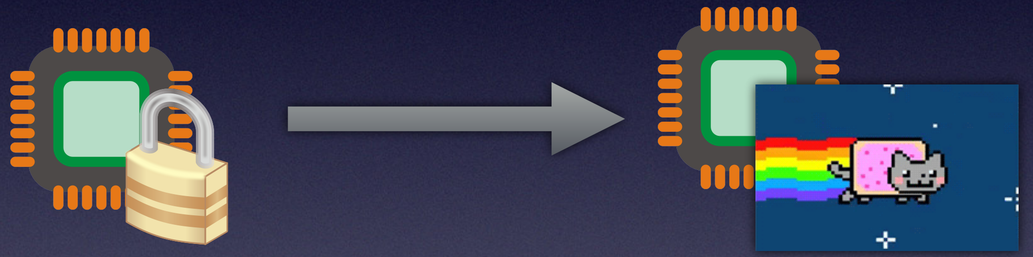

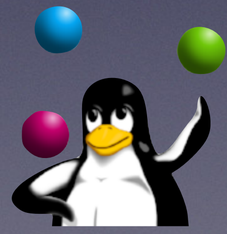

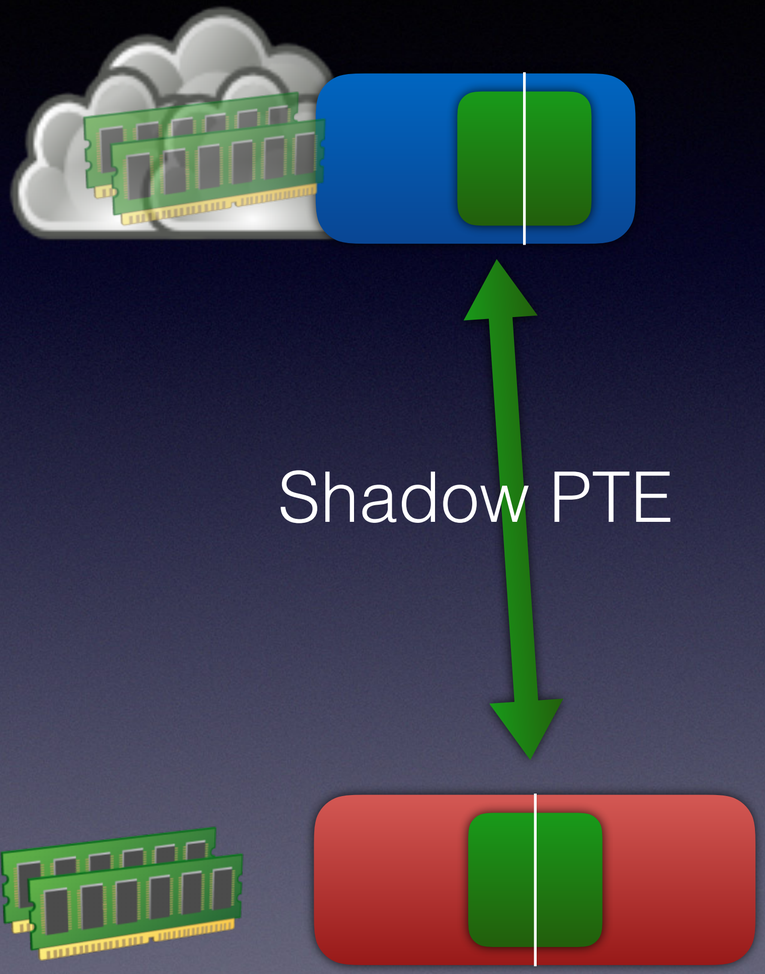
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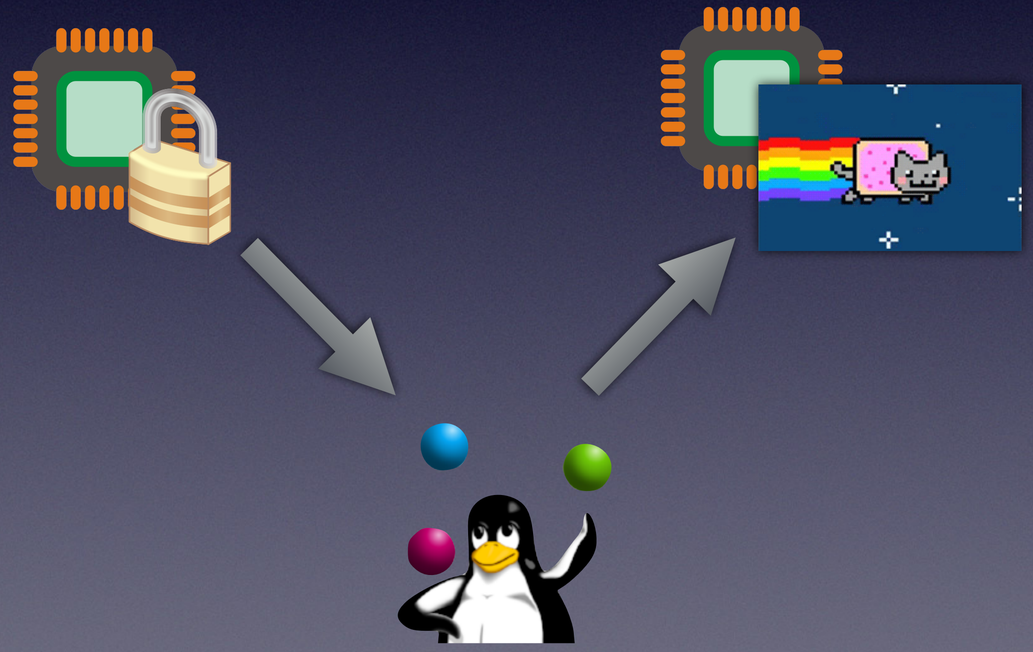

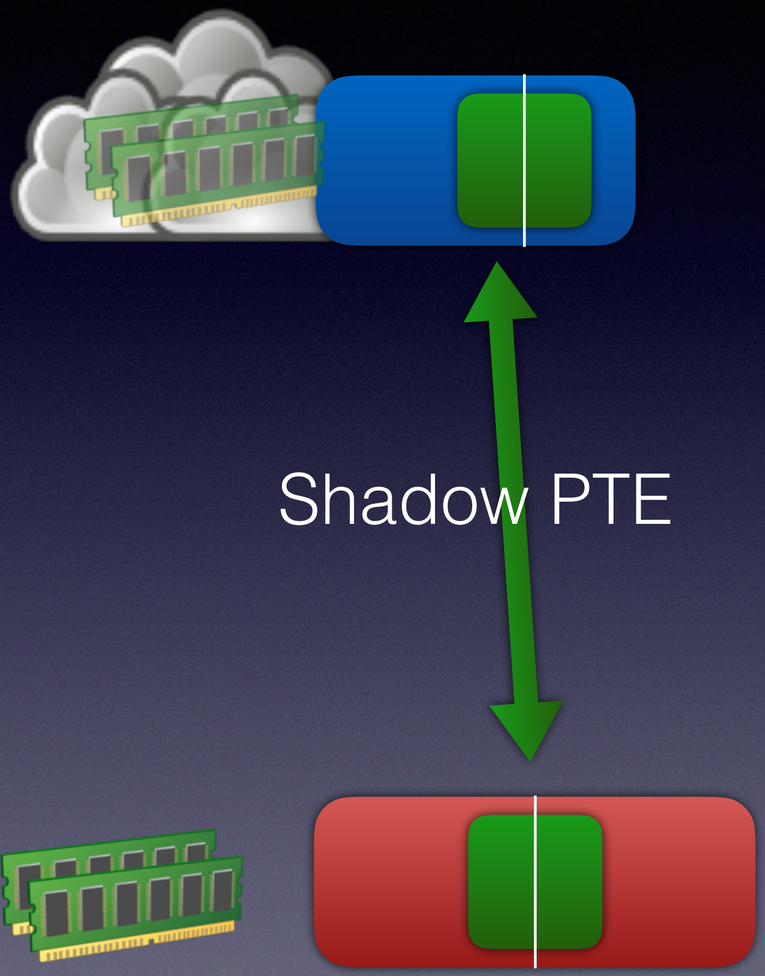
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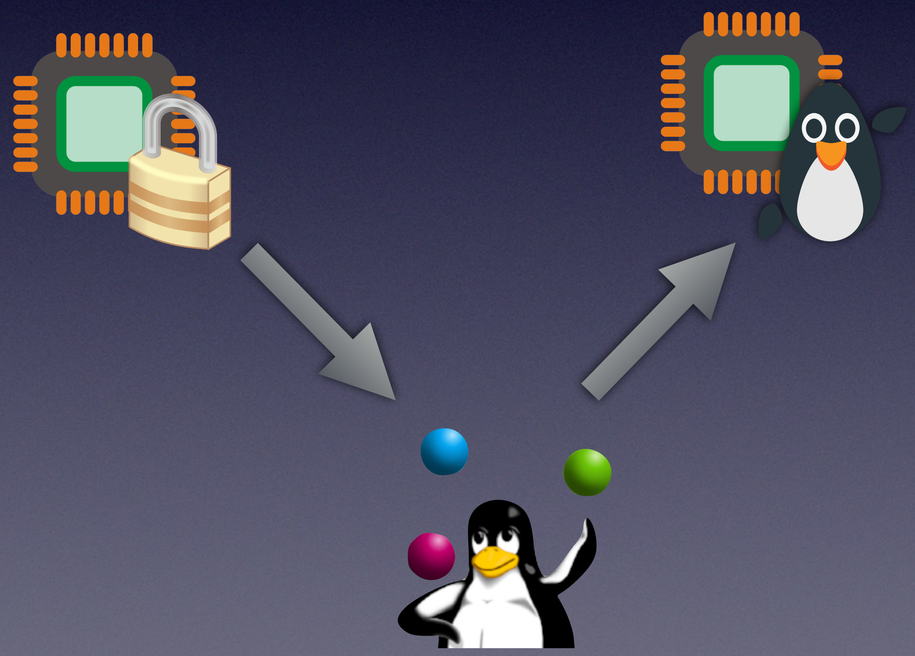

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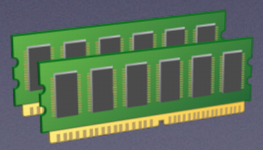

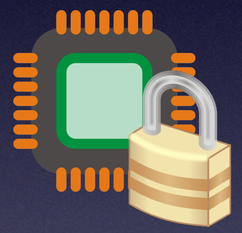

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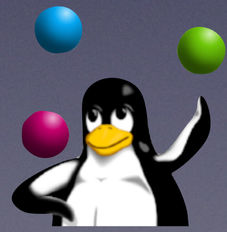

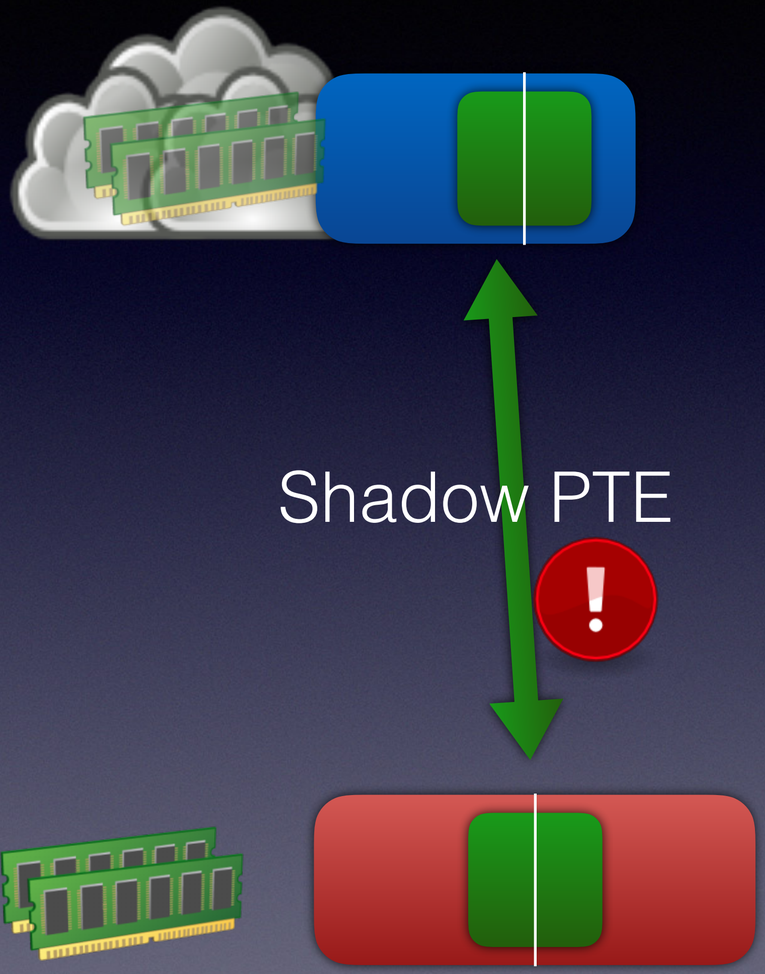
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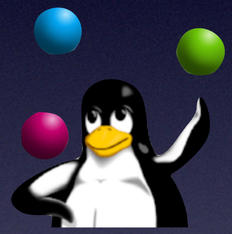

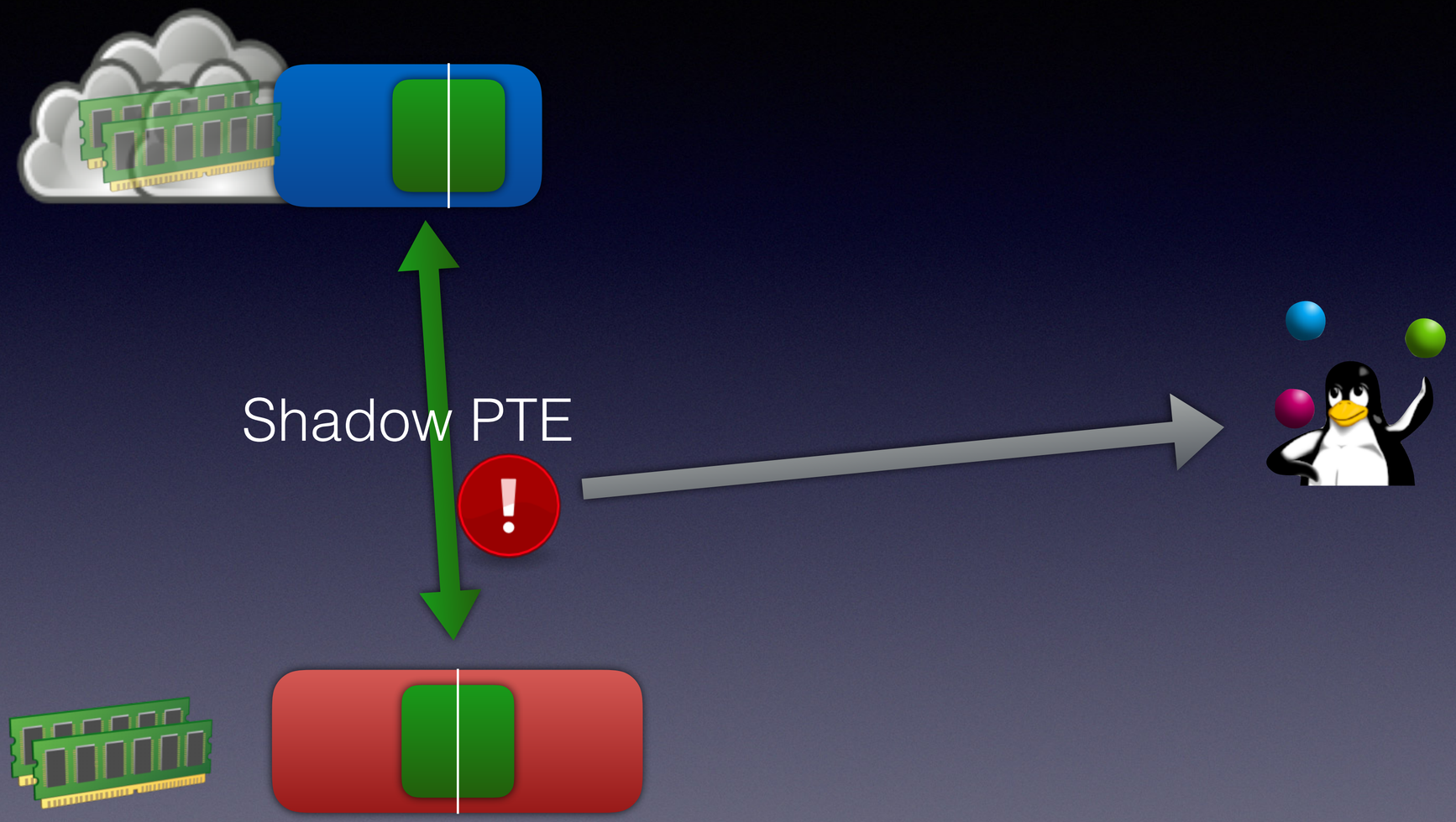
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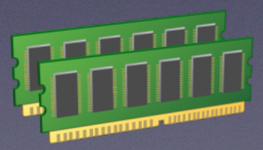

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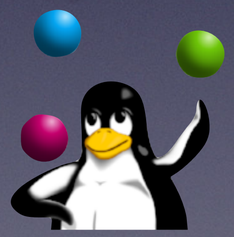


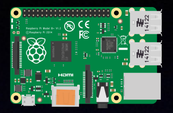
Alternative Mitigation

- Core Scheduling
- Hide host secrets

Demo

Thank You

External Sources



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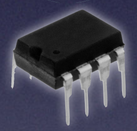

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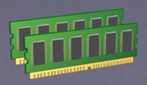

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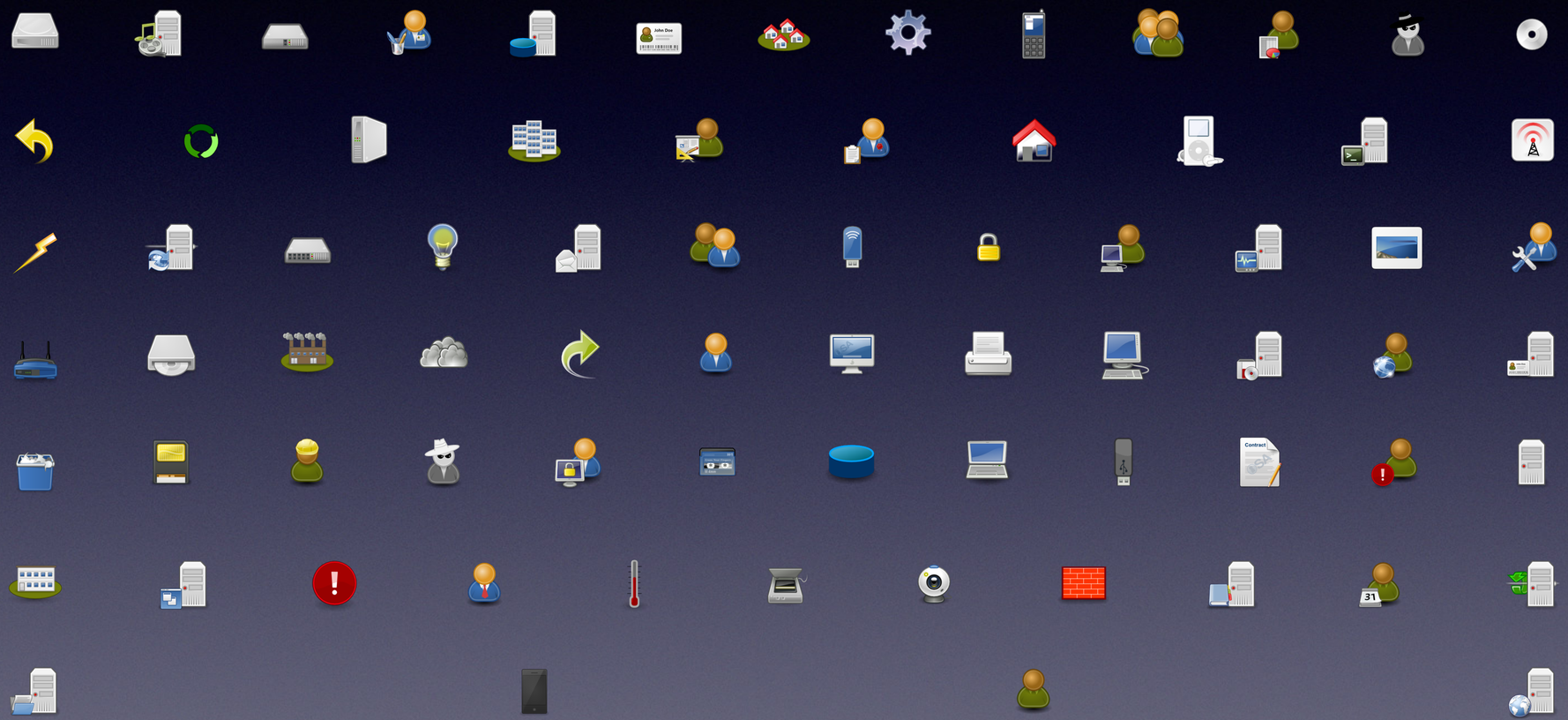

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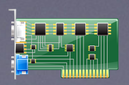

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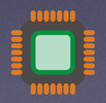

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