Systems & Software Security

COMSM0050
2020/2021

University of BRISTOL

Race condition: Examples
Dirty COW

bristol.ac.uk

Example 3: dirty cow

- Dirty Copy on Write
- CVE-2016-5195 (fixed October 2016)
- Linux vulnerability that could be exploited to gain root access
- Concurrency issue relating to how memory is managed

Example 3: dirty cow

- Local privilege escalation
- Allows an attacker to write to a file that is read only
- Can be used to gain a foot in a machine
    - e.g. by modifying /bin/bash
    - e.g. libraries
    - e.g. system configurations
    - e.g. overwriting /etc/passwd
    - etc…

Memory Mapped Files

- a.k.a mmap
    - Link to the man page on the course website
- maps files or devices to virtual memory of a process
- If changes are made and the mmaping is SHARED (e.g. MAP_SHARED flag) change to memory is copied to file
    - Minus some synchronization
    - Can be forced with msync
- More details in the man page.

mmap code example

```
int fd;
size_t size;
const char* mmaped;
fd = open (“file.txt", O_RDONLY);
// get file size e.g. with stat
mapped = mmap (0, size, PROT_READ, MAP_PRIVATE, fd, 0);
mmaped[10]; // content of the file at address 10
```

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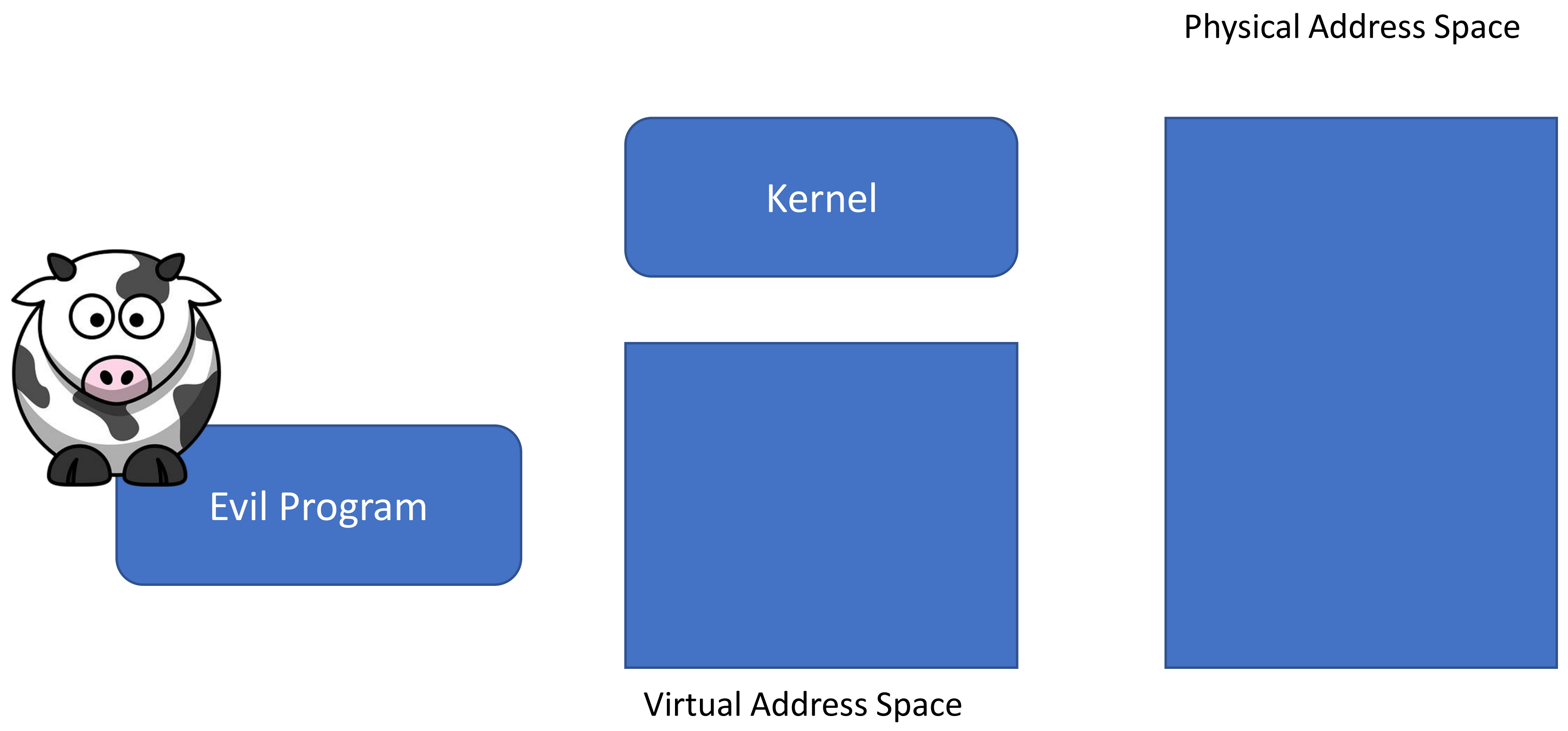
Exercise: try this at home!

Memory Mapped Files

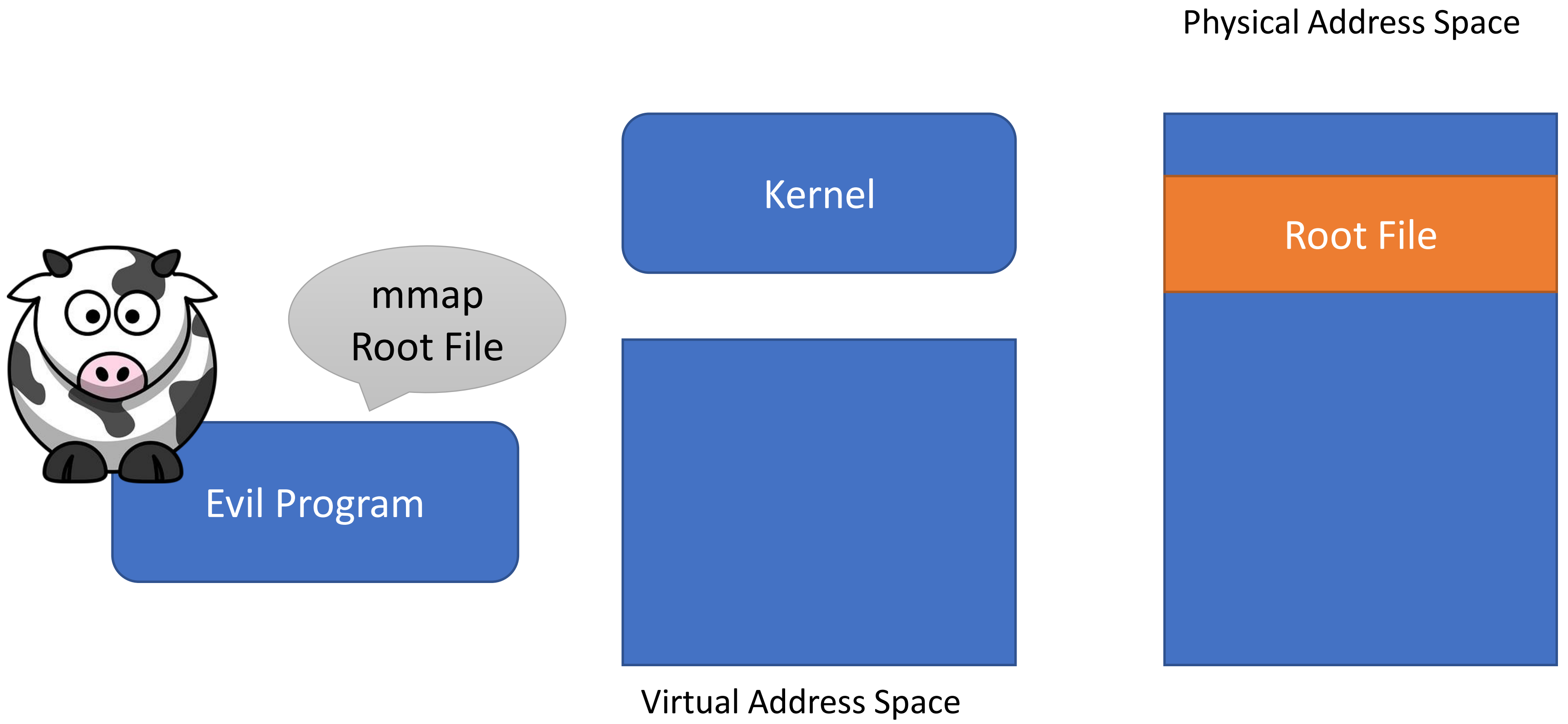
- File can be mmaped as **private**
- Change to privately mmaped file do not affect the underlying file
- Private mmaped file can be read/write regardless of access to the underlying file

- … but sometimes you could change the underlying file!
  - dirty COW!

Dirty COW illustrated



Dirty COW illustrated



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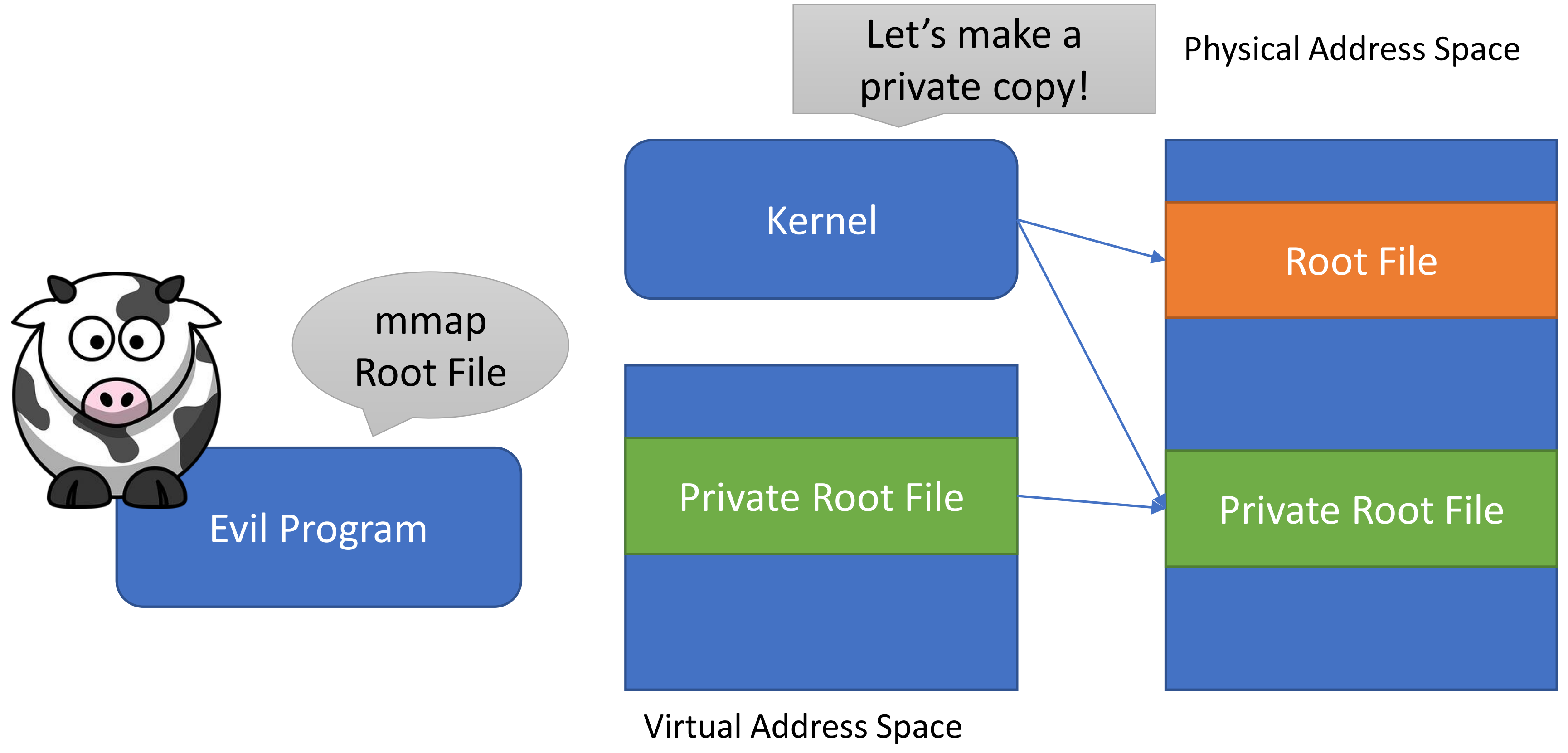
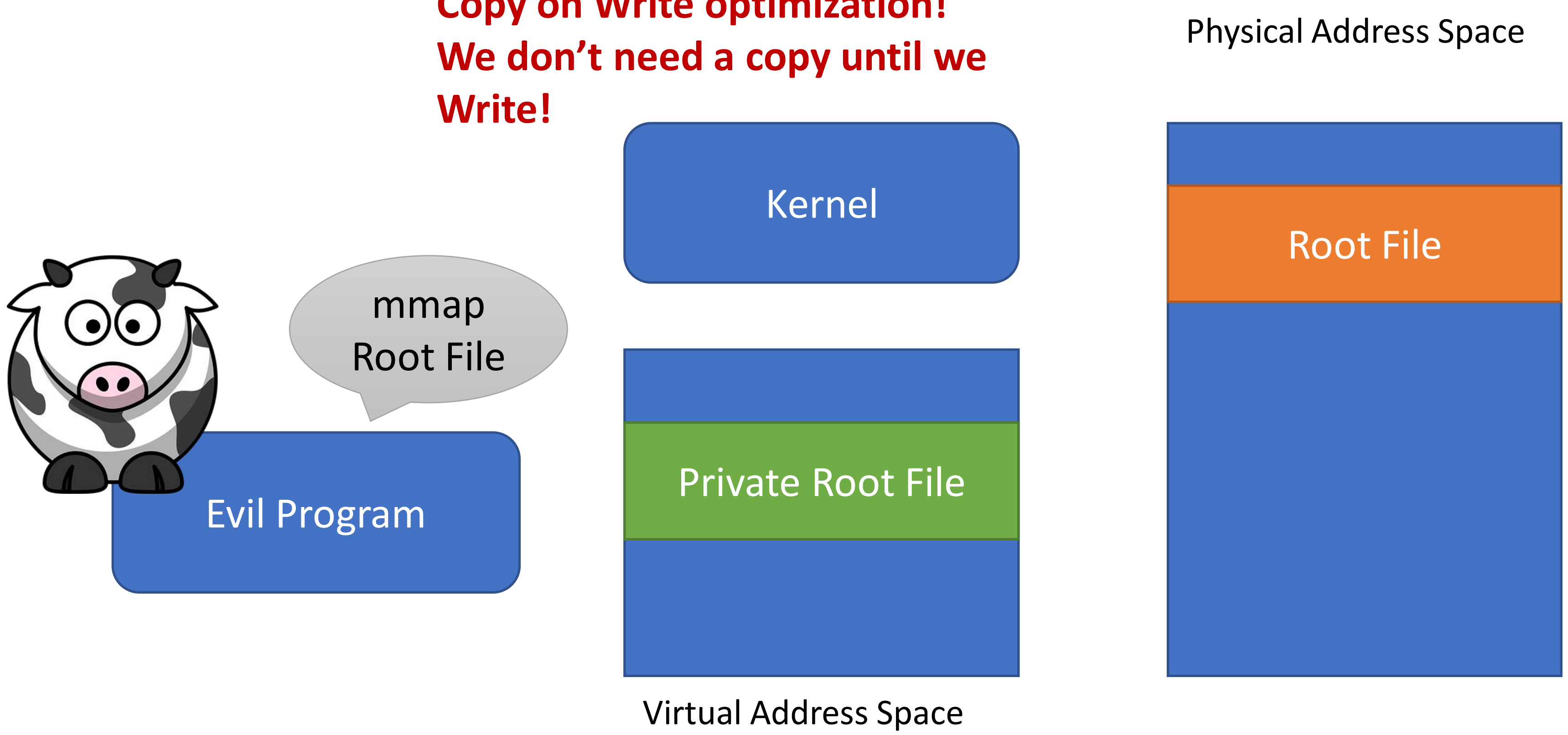


Dirty COW illustrated

Copy on Write optimization! We don't need a copy until we Write!



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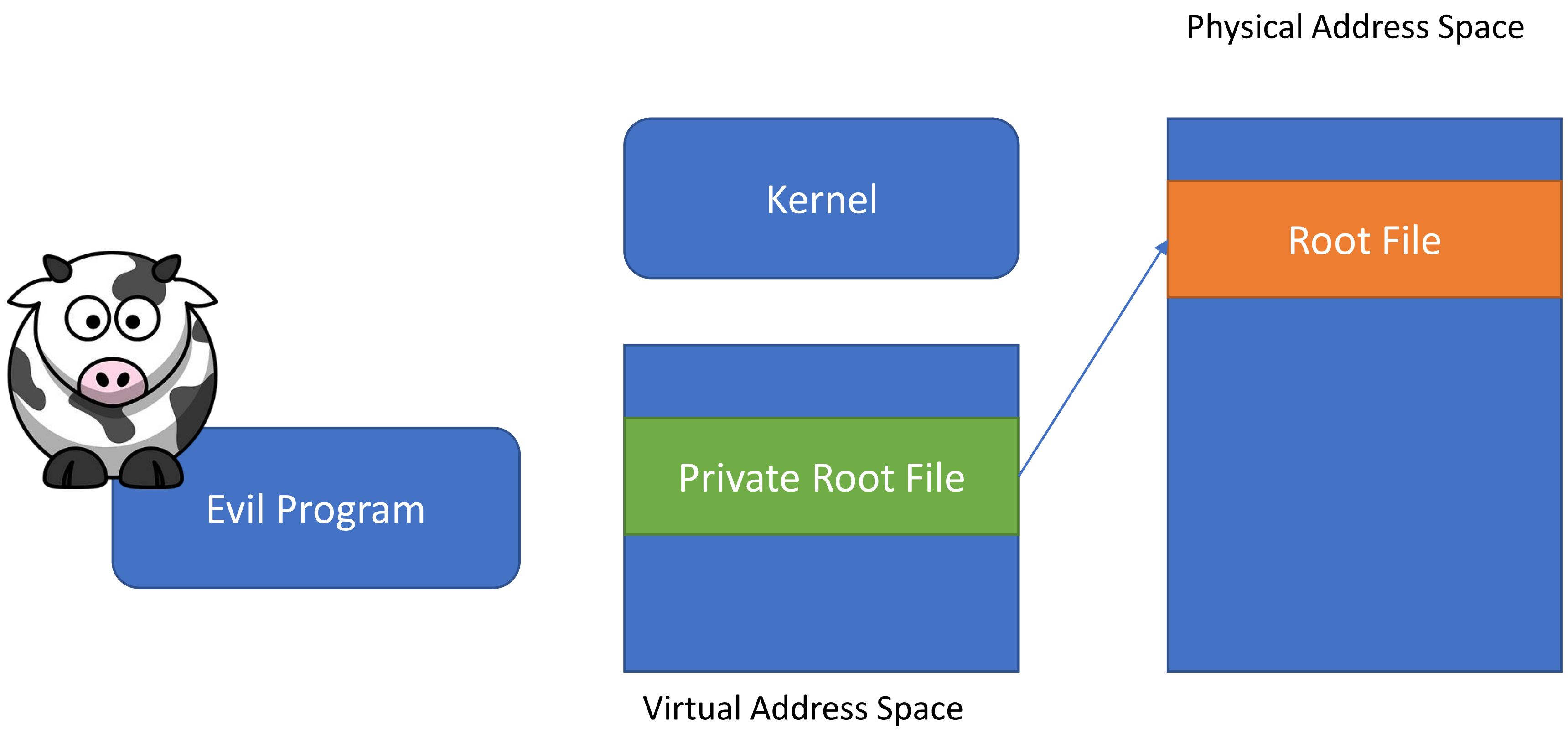

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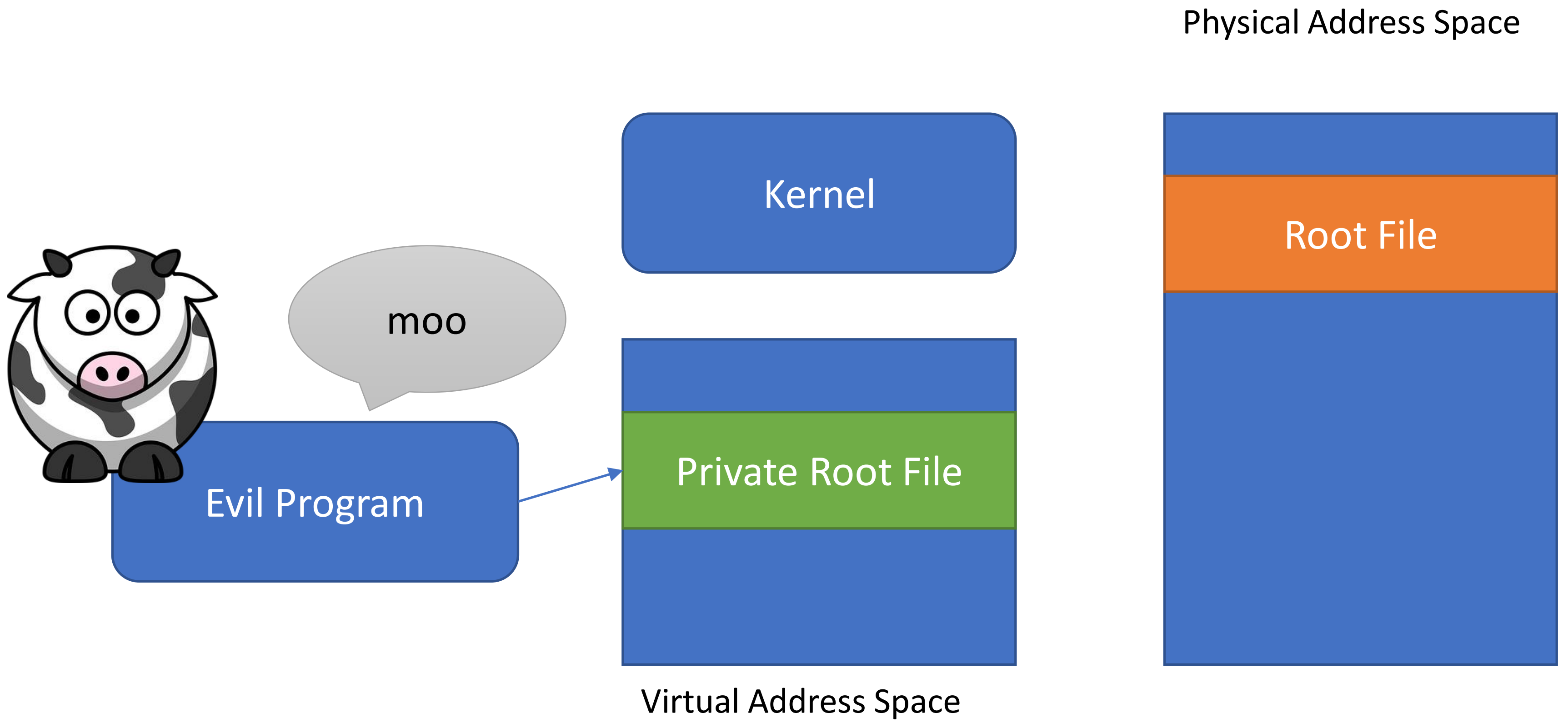

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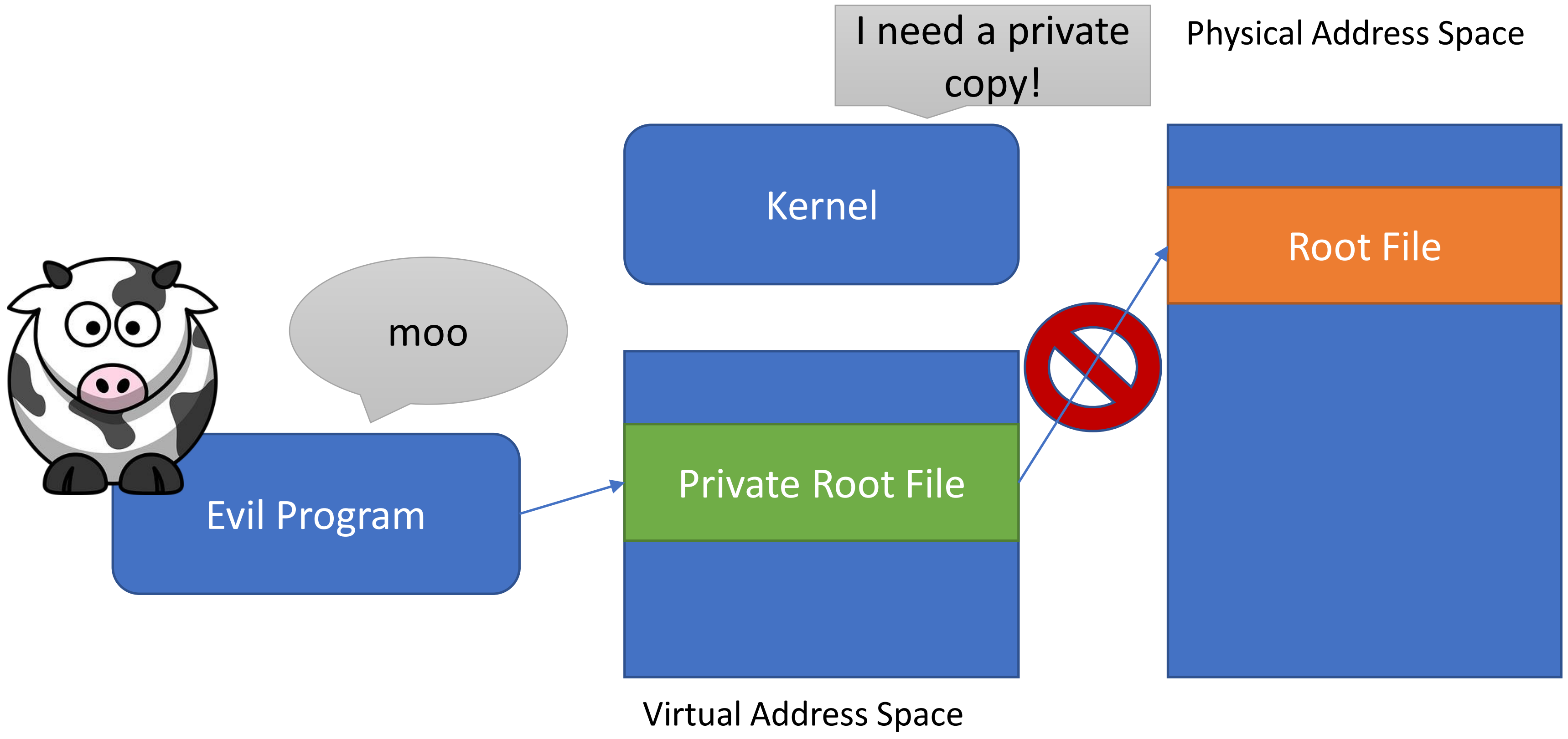

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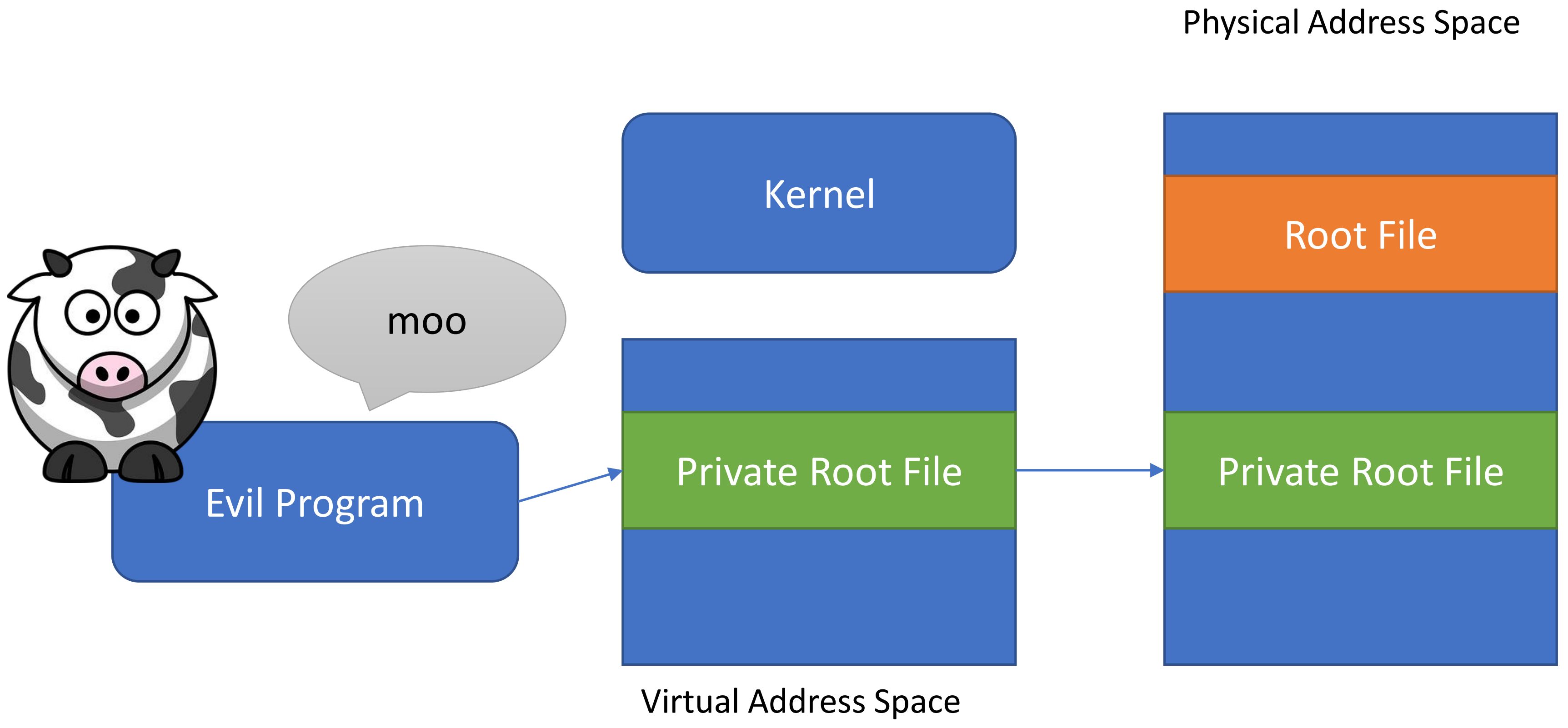
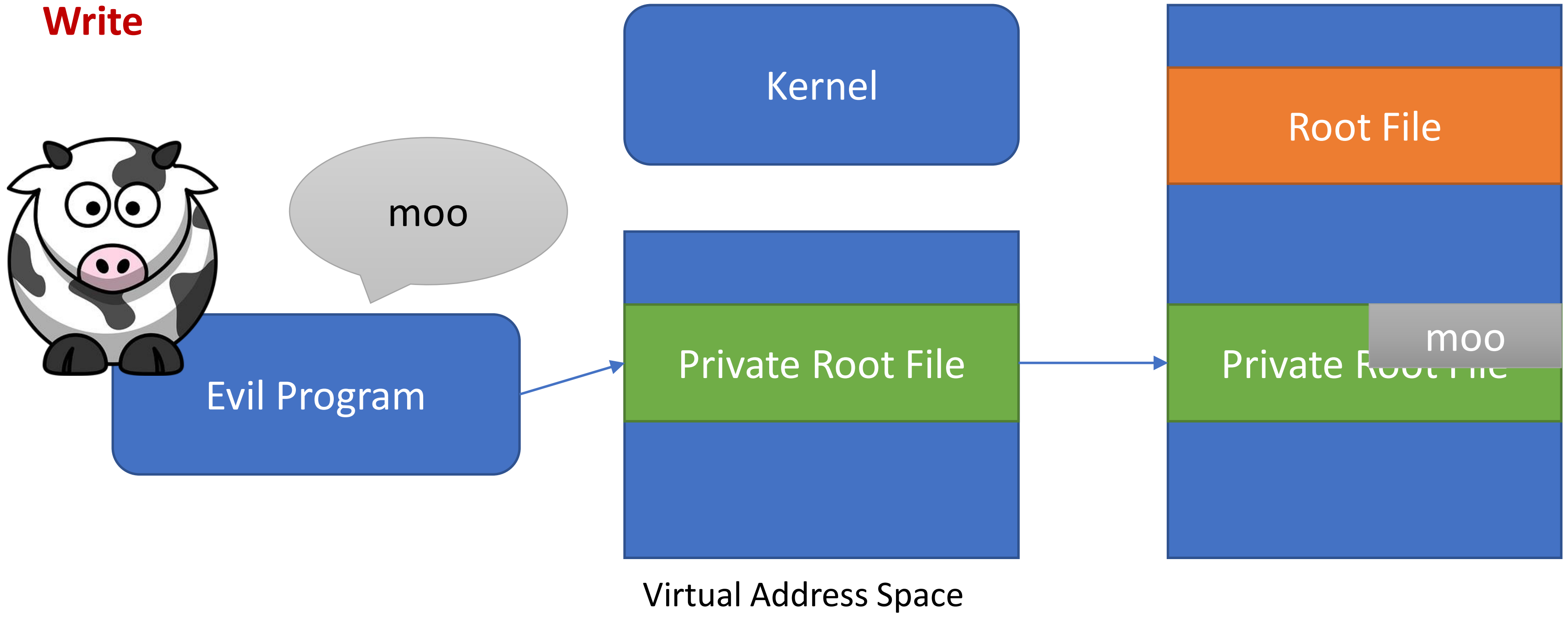


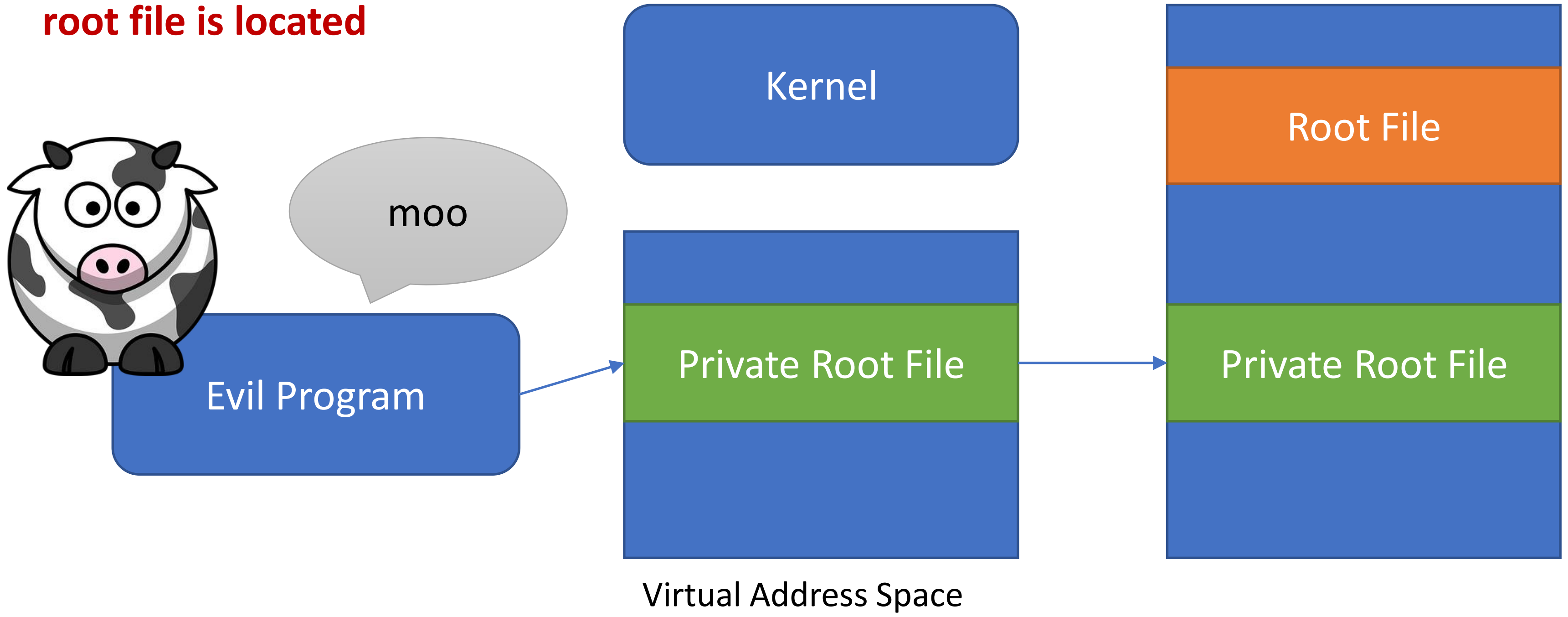
Dirty COW illustrated

TWO STEPS:
Locate the address
Write



Dirty COW illustrated

Let's break things!
Our evil program is writing, and the private root file is located



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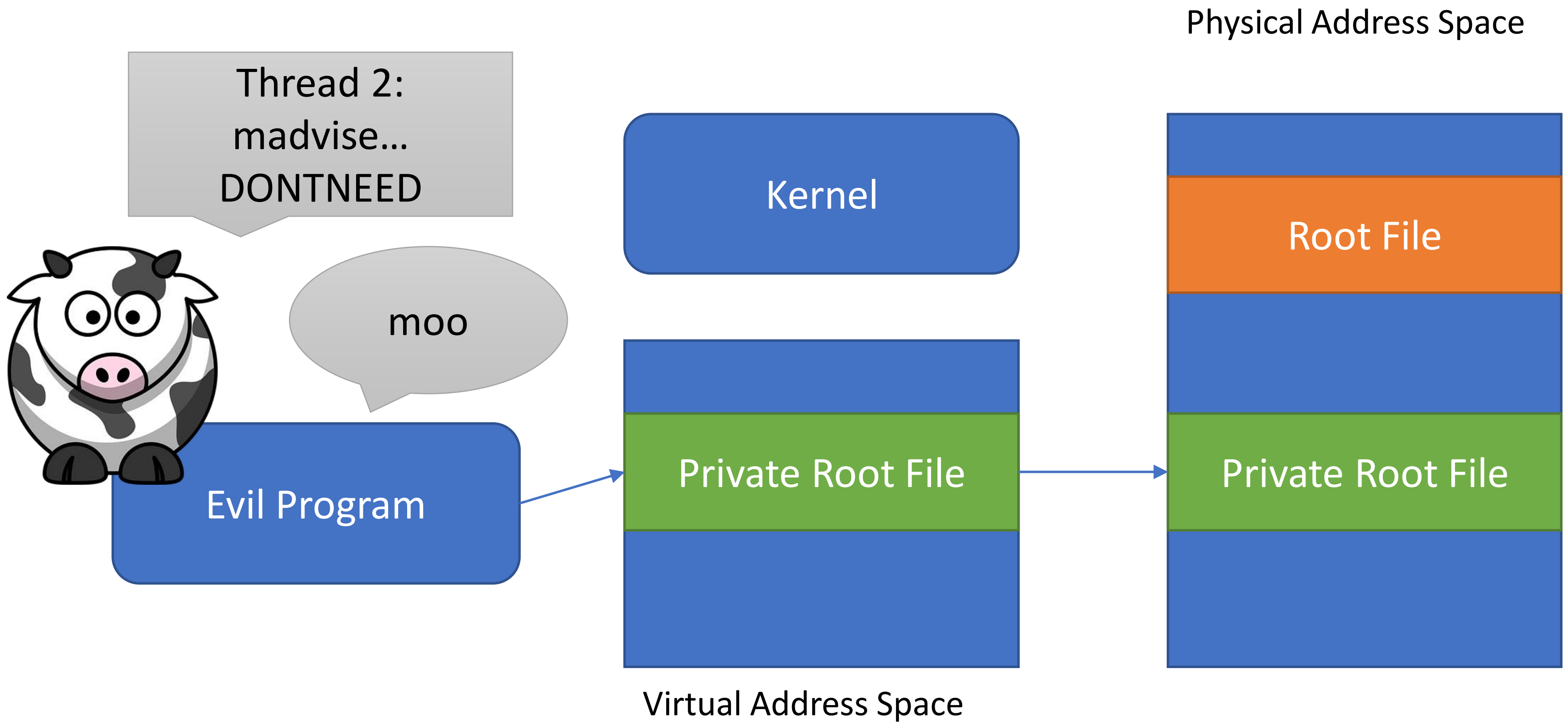

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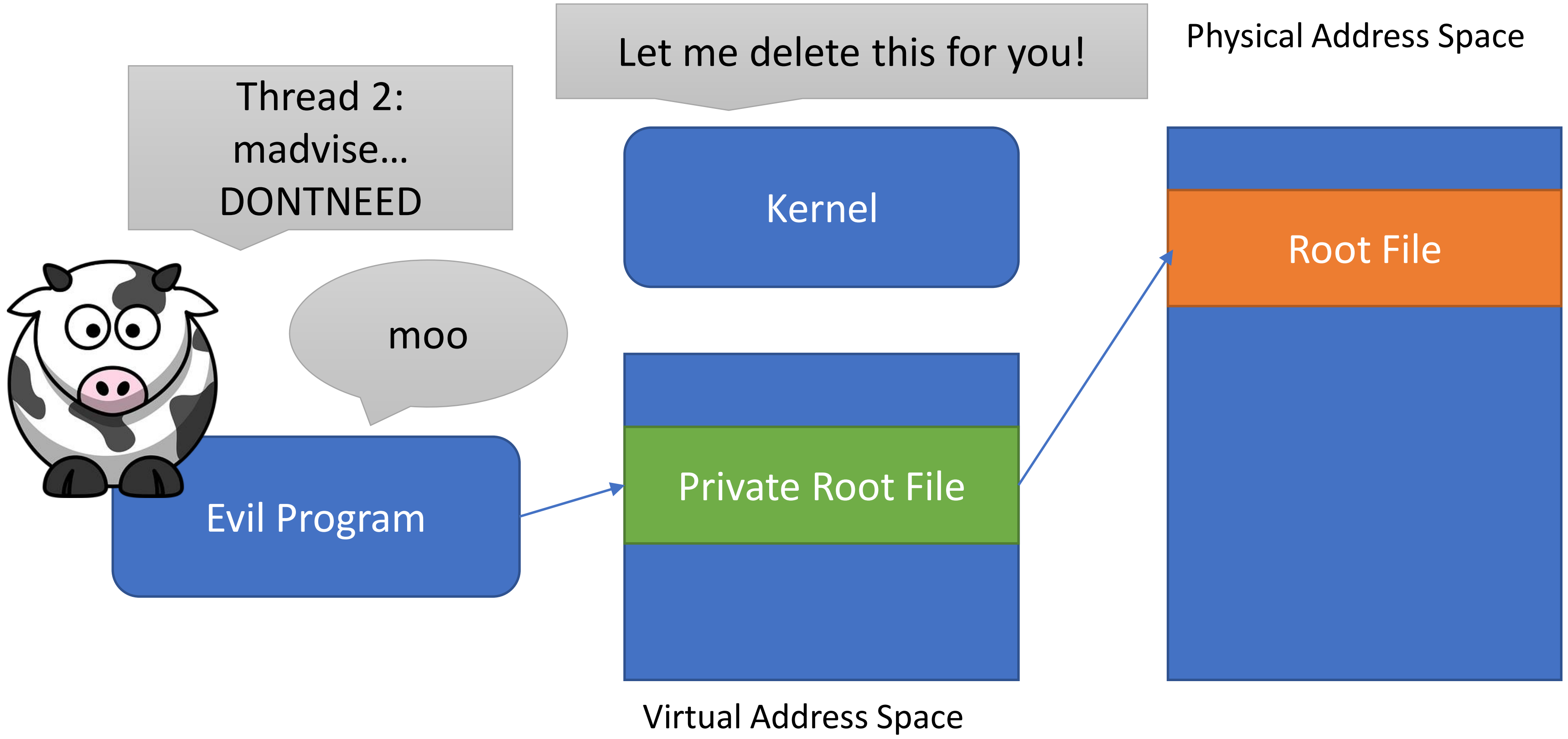

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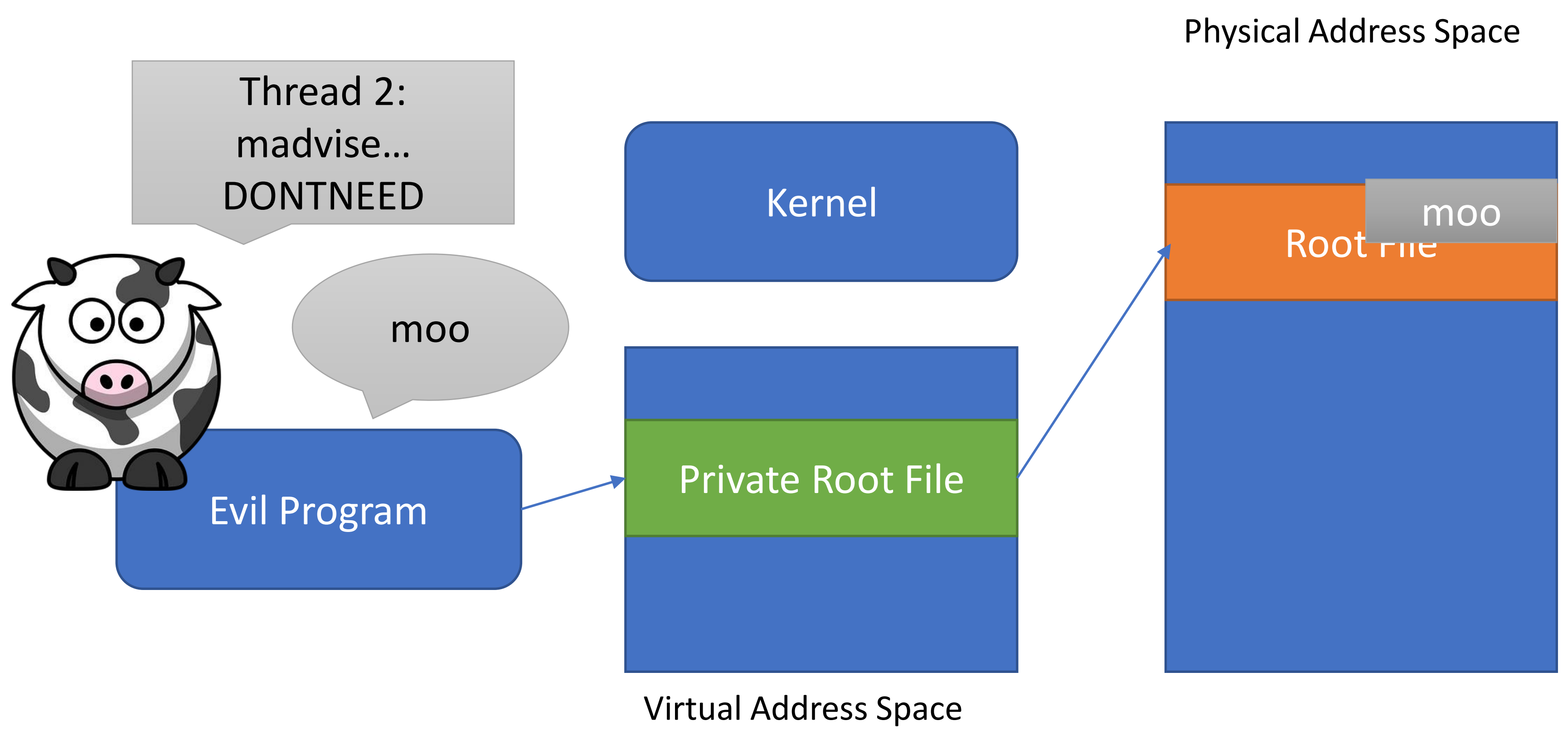

Problem explained

- Locate and Write are not atomic!
  - First locate
  - Then Write!
- Concurrent thread can change where the virtual address point to!
- Write to the original physical address
- Even when you don’t have the privilege!

Problem explained

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Linux kernel: > 27 millions line of code

There is probably plenty of bugs…