Topics in Operating Systems

Kernel Virtual Address

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Kernel Virtual Memory

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  - Require MM context loading/unloading on user-kernel context switch
  - In kernel context, user data is accessed (a lot!) why?
  - Even worse, user data of many processes accessed
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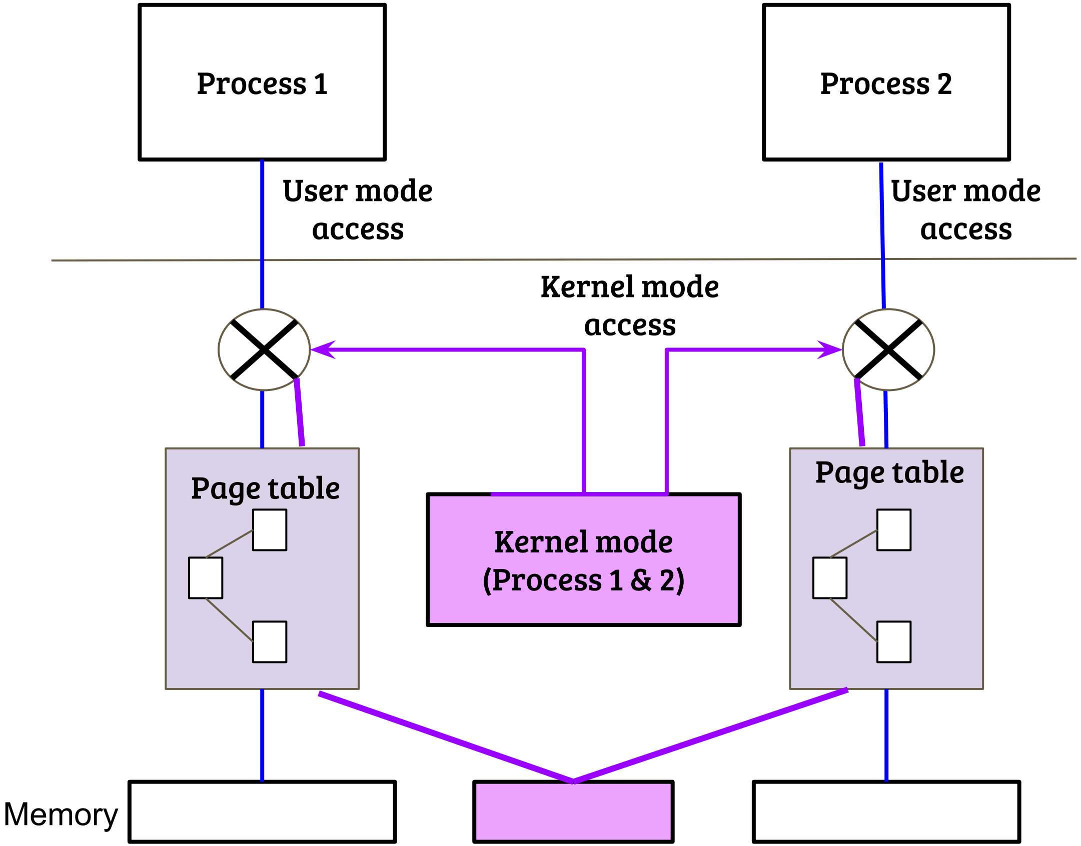
  - Kernel VM change propagation? Compromised Isolation!

Issue of Kernel VM propagation



- Kernel virtual address mapping should be present in both process page tables.
- Ex: If kernel allocates memory while serving syscall from process-1, process-2 in kernel mode should see it !
- How to design?

Constraints: Processes and memory are dynamically created and destroyed

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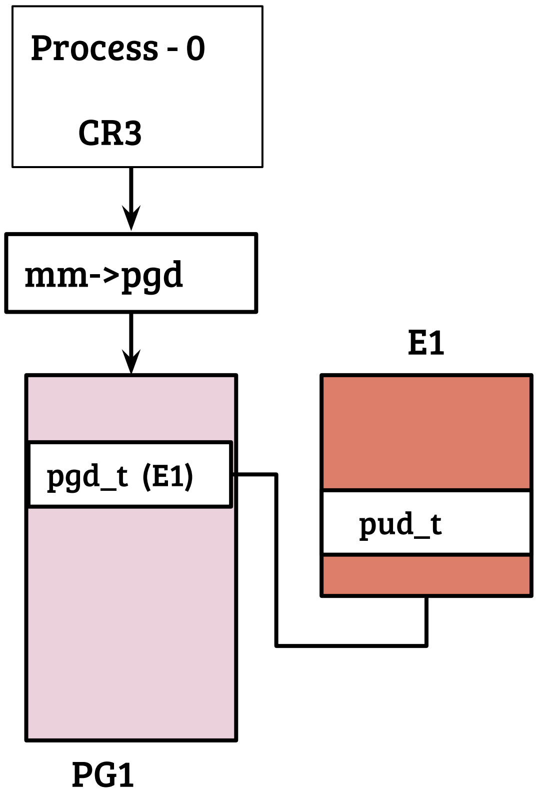
Solution: Every process owns its own **pgd** entries but inherits the kernel **pgd** entries from the parent :-)

Solution overview



- One (or more) entries in PGD-level (level-4) reserved for kernel mapping
- How many?
- Depends on VA-range covered by one entry and the kernel VA size

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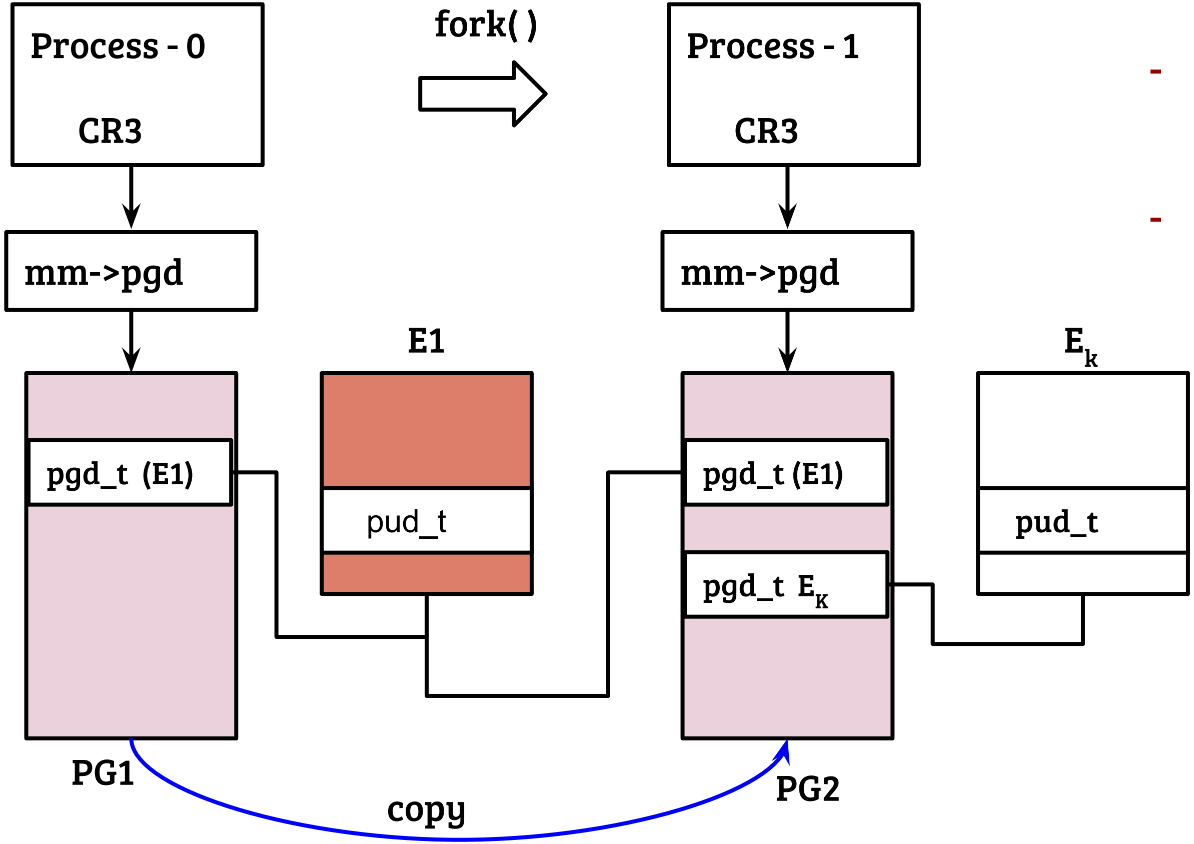
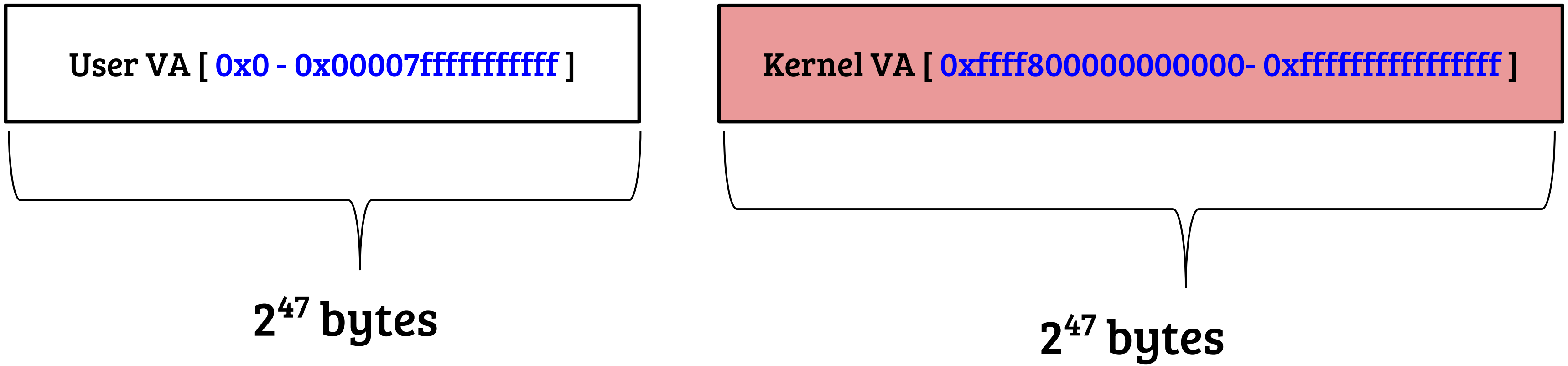


- All updates to E1 are visible across all the processes
- So we are at peace! Not really.

Virtual memory layout (x86_64)



User VA [0x0 - 0x00007fffffffffff]

Kernel VA [0xffff800000000000- 0xffffffffffffffff]

2^{47} bytes

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- User virtual addresses use the LSB 47 bits
- Kernel virtual address does not start from 0x8000000000, but from 0xffff800000000000
- Why? What about page table translation (it is only 48 bits VA) ?

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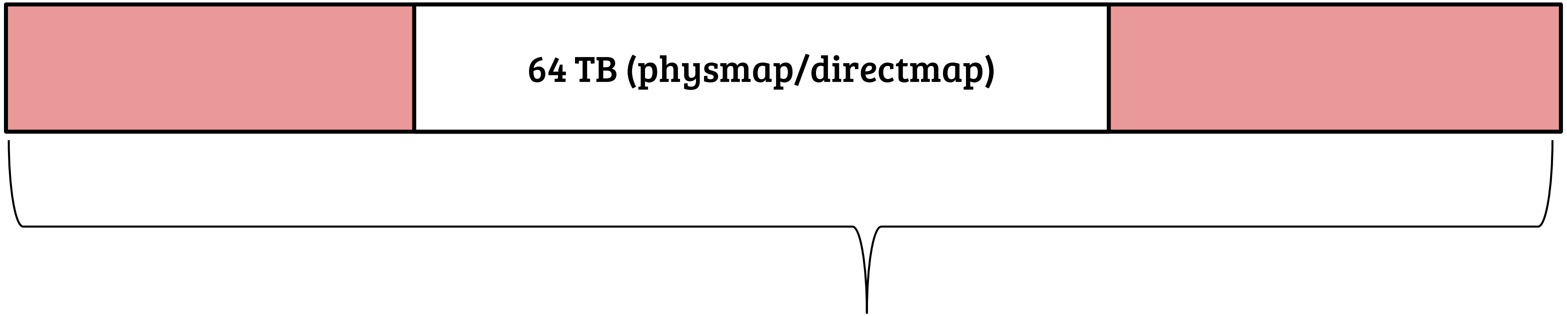

Kernel VA [0xffff800000000000- 0xffffffffffffffff]

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- Direct map virtual address maps the whole physical memory
- Every PFN has a direct mapped kernel virtual address
- How kernel updates the page tables in PF handler? (answered!)