Betriebssysteme

7. Tutorium - Paging

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13. Dezember 2024

ITEC - Operating Systems Group

Page Fault Handling

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What is Demand-Paging and Pre-Paging?

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- Generates lots of page faults before working set is in memory

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+ Might reduce number of page faults
- Loads more than needed ⇒ Wasteful
- More I/O ⇒ Slower?
+ HDDs a lot faster when reading chunks

On-Demand Paging

Different kind of page faults

Not all pages are created equal. Do you have any idea what types of page faults typically exist?

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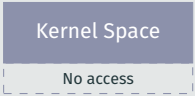

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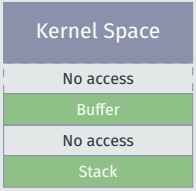

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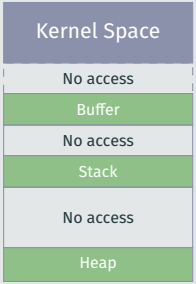

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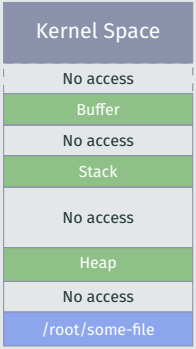

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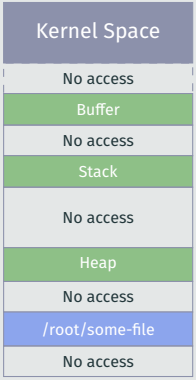

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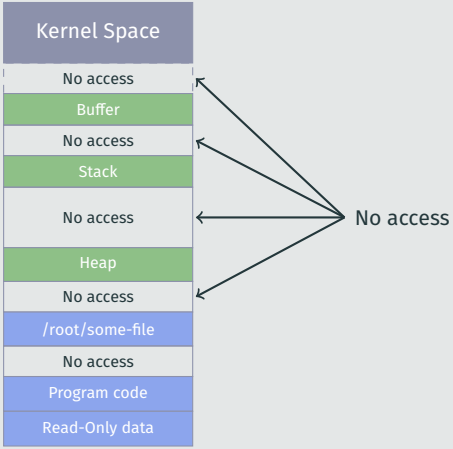

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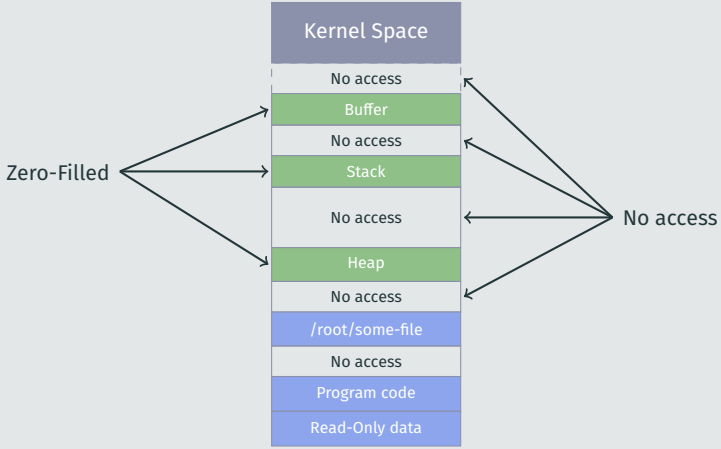

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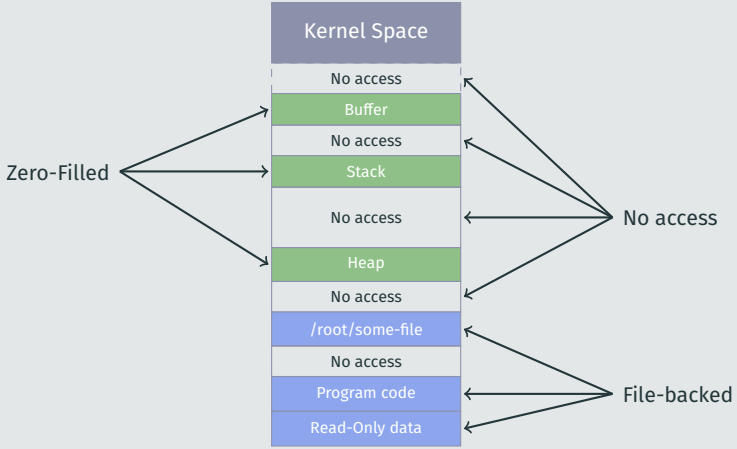

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Different kind of page faults

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Also supported on some systems: *Purgable memory*. Stolen from Apple and also implemented in SerenityOS in this video.

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- Access flags: Can the user perform the operation on this page?
- Where to find the most recent version (different for zero filled, file backed, etc.)

CoW

How could you implement Copy-on-Write memory?

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- Mark memory as read-only on fork
- Add an additional `CoW` flag: When a page fault is raised check it, copy the page and clear the `CoW` and `ro` flag

Page replacement

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$\Rightarrow$ Needs to write dirty pages back to disk

$\Rightarrow$ Sloow

Page Replacement - Global and Local Algorithms

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Local page replacement algorithms:

- Only look through the frames *of that process*

Global page replacement algorithms:

- Look through *all* frames, even that of other processes

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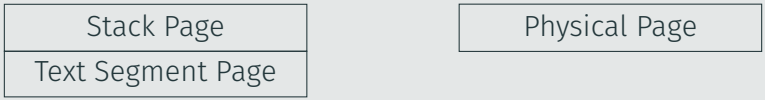

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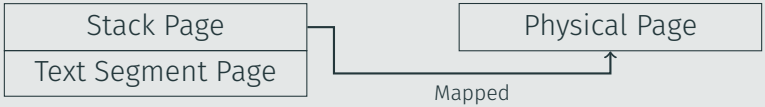

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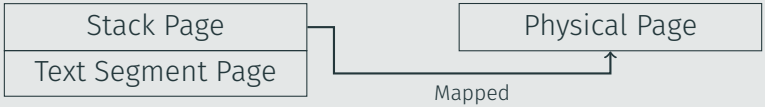

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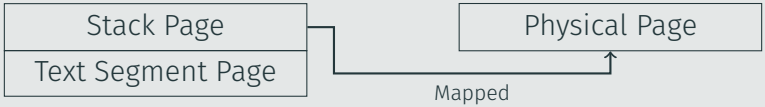

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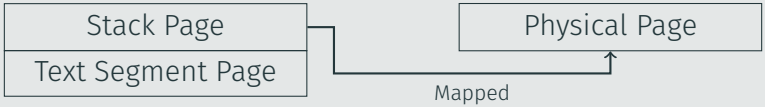

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- Not enough frames to fit the working set

$\Rightarrow$ Pages will be stored to disk and reloaded very often

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- **Clock:** Uff, let's talk about that on its own page

Page Replacement Policies – Clock

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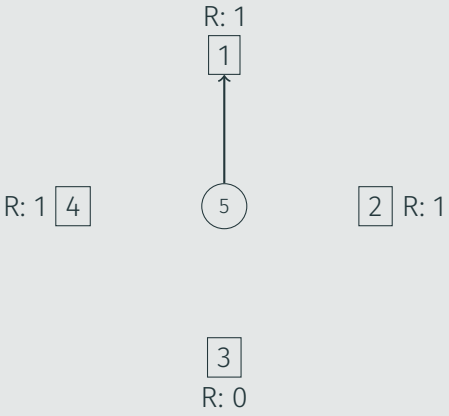

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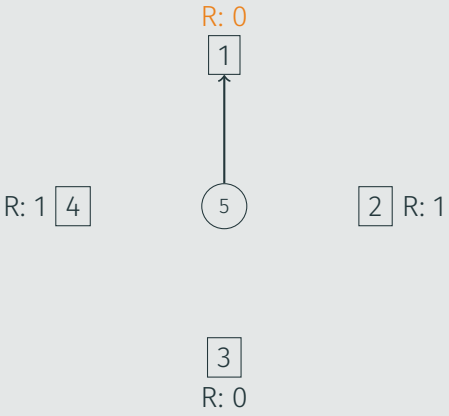

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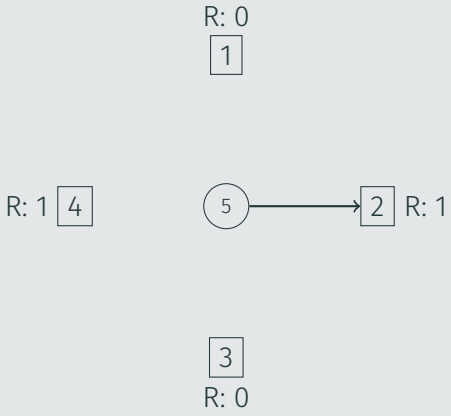

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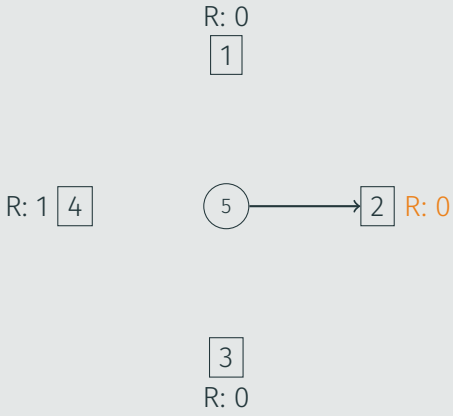

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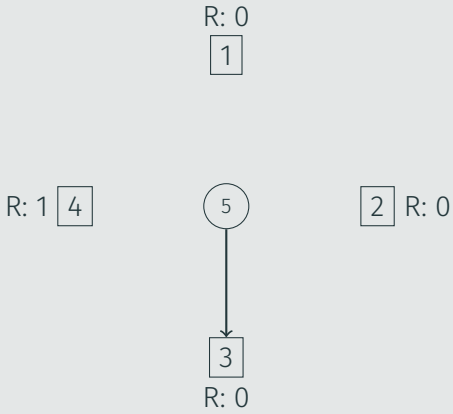

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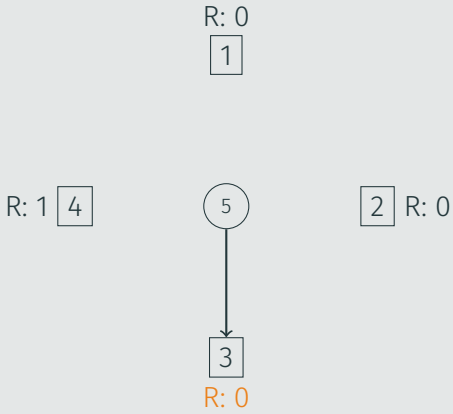

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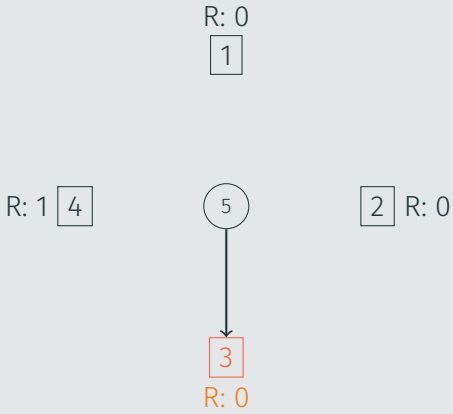

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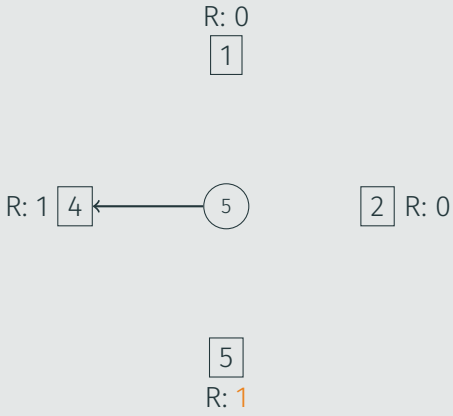

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- Referenced (and modified) bits are set by the CPU when accessing or writing to the page
- Referenced bits are periodically cleared by the kernel using timer interrupts

Page Replacement Policies

Do it

- Clock: Ordered by Load time ASC, Head is on Frame 3
- Reference order: 4, 0, 0, 0, 2, 4, 2, 1, 0, 3, 2

Frame	Virtual page	Load time	Access time	Referenced	Modified
0	2	60	161	0	1
1	1	130	160	0	0
2	0	26	162	1	0
3	3	20	163	1	1

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- Code: Mostly, loops are mostly linear and it follows certain patterns
- Heap: Well, the heap has more random access patterns. So not that well, probably

Ende

XKCD 313 - Insomnia

F R A G E N?

Bis nächste Woche :)