Übung zu Betriebssystemtechnik

Nachrichtenaustausch und Copy-on-Write

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und Betriebssysteme

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UNIVERSITÄT
ERLANGEN-NÜRNBERG

TECHNISCHE FAKULTÄT

Einleitung

Ziel der Übung

Getrennte Adressräume überwinden

$\Rightarrow$ Nachrichtenaustausch

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- `send, receive`

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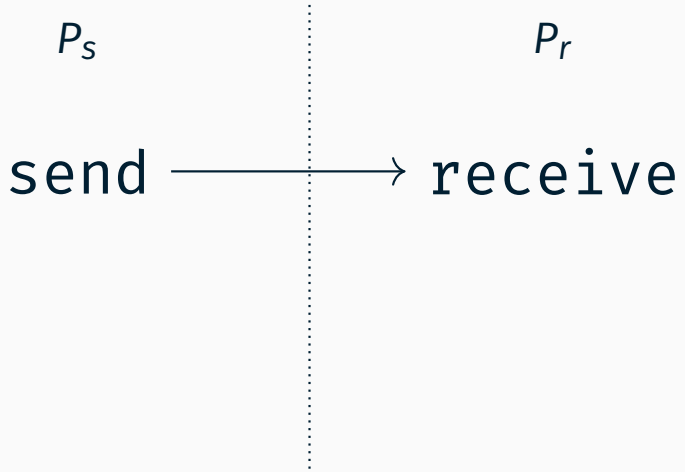
- `send, receive`



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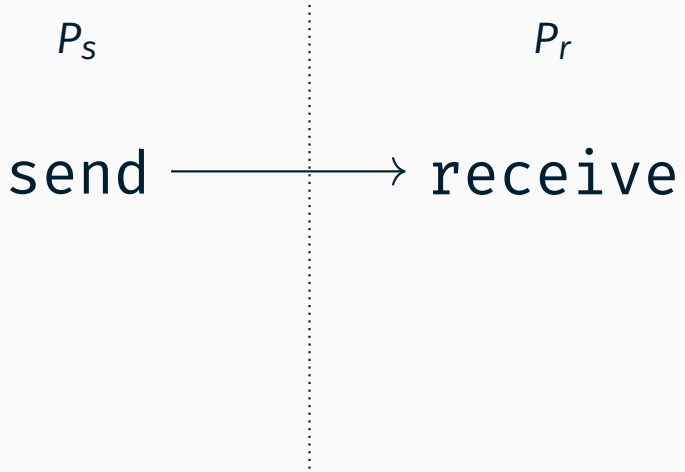

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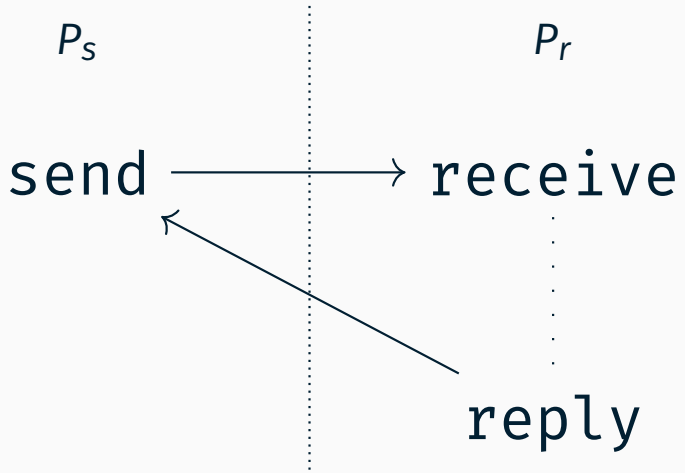

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Vorteil von `send, receive, reply`:

$\Rightarrow$ Keine Timer nötig, um DoS auf Server-Seite zu verhindern!

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synchron/asynchron vs. blockierend/nichtblockierend?

synchron	Prozess schläft, bis Senden fertig
asynchron	Prozess kehrt während Senden zurück
(nicht-)blockierend	Synchronisation der Operationen

Umsetzung

Zustandsdiagramme `send`, `receive`, `reply`

`send(to, data, len, replybuf, replylen)`

Existiert `to`?

Zustandsdiagramme `send`, `receive`, `reply`

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send(to, data, len, replybuf, replylen)
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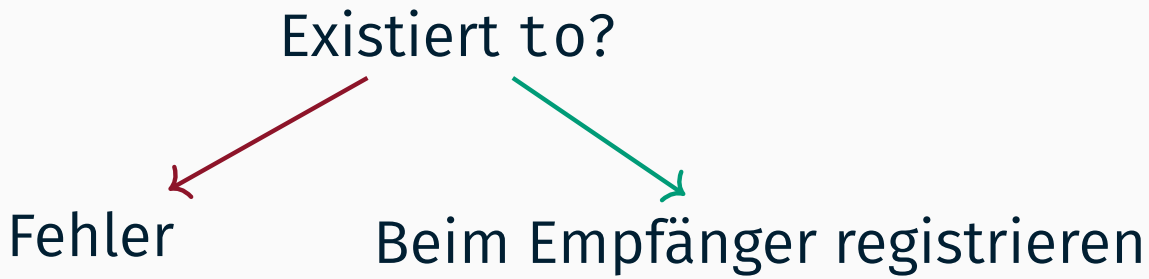

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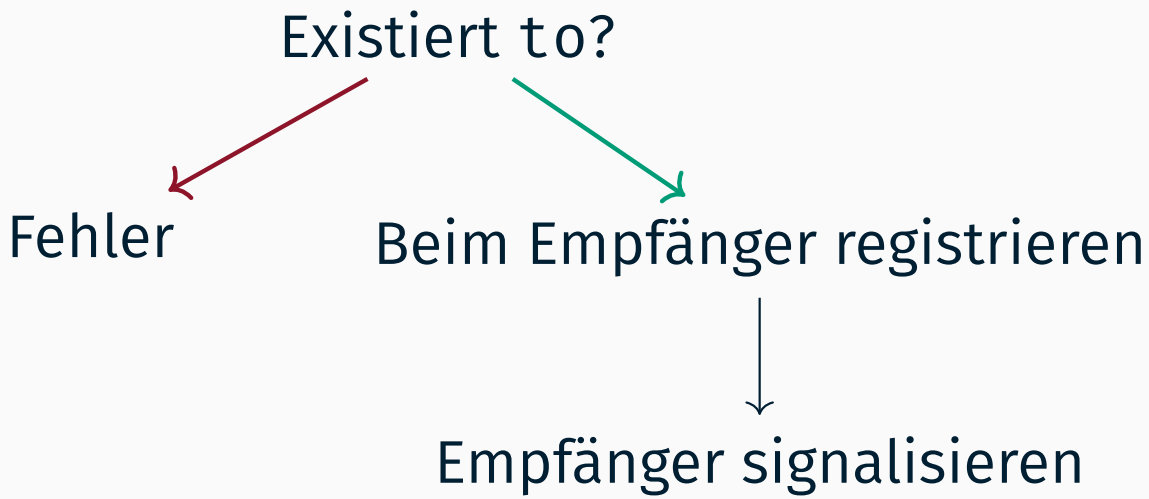

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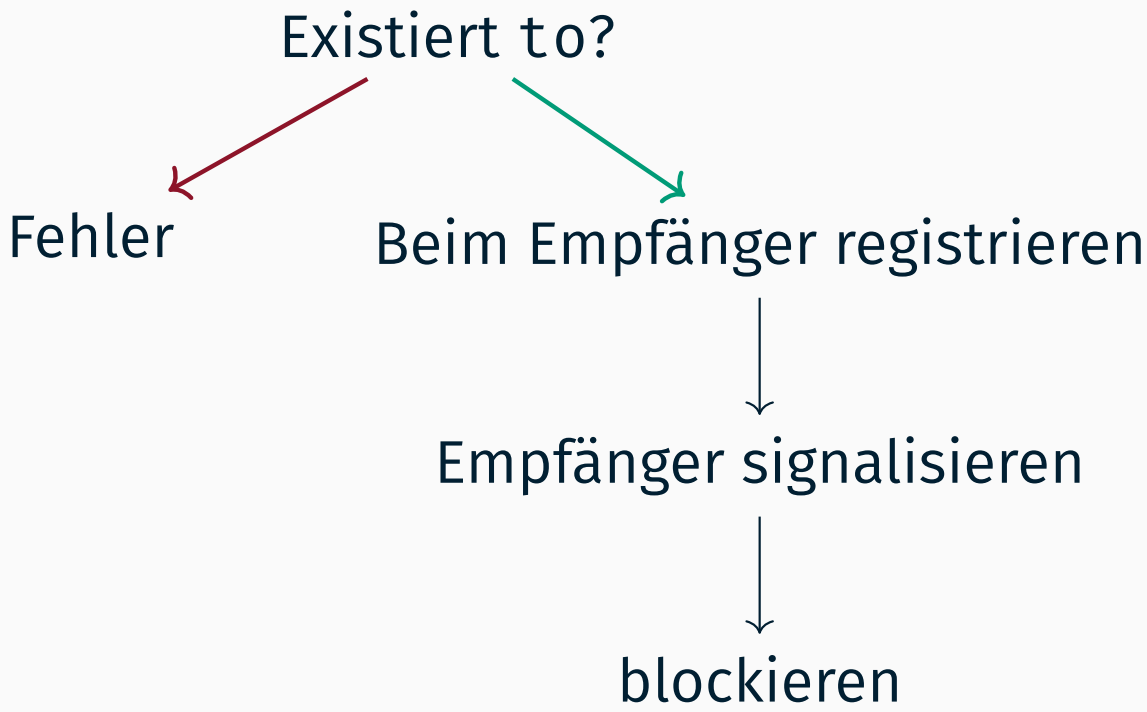

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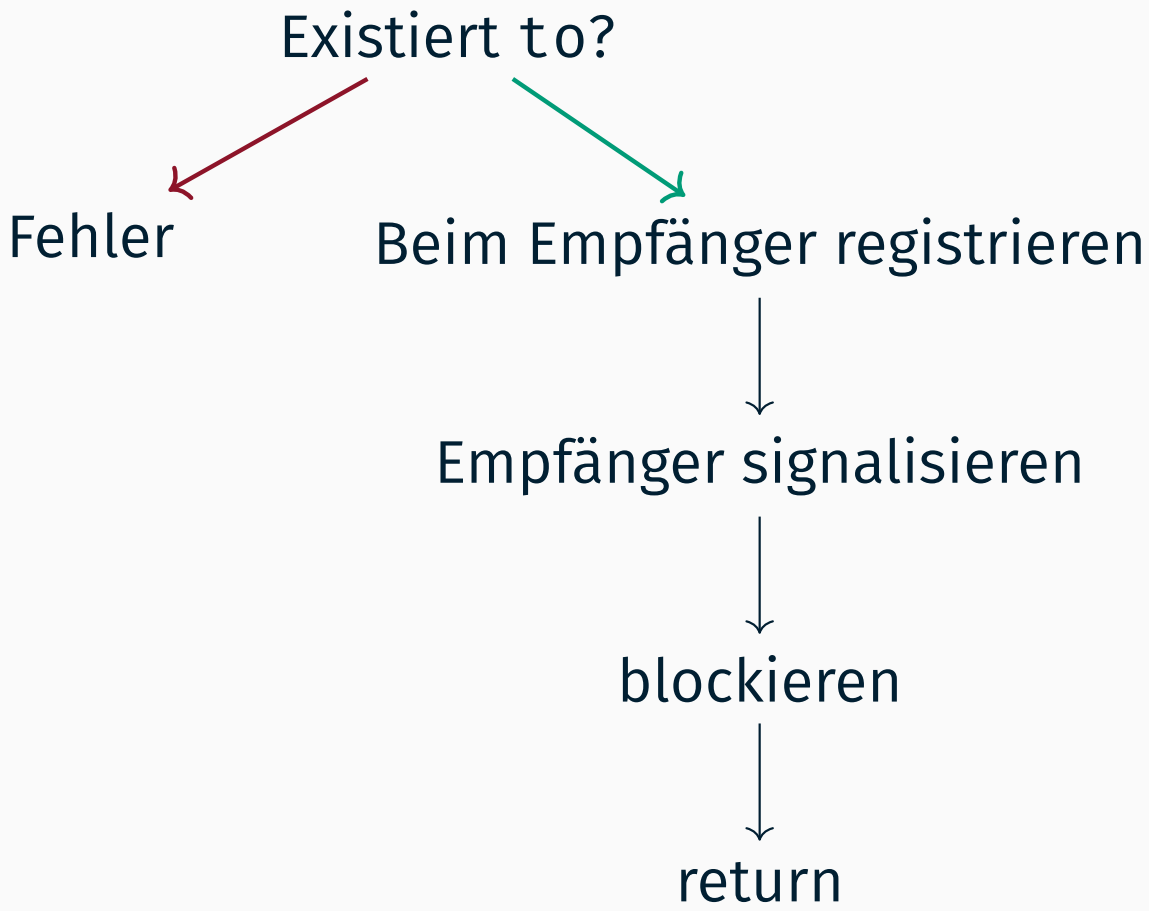

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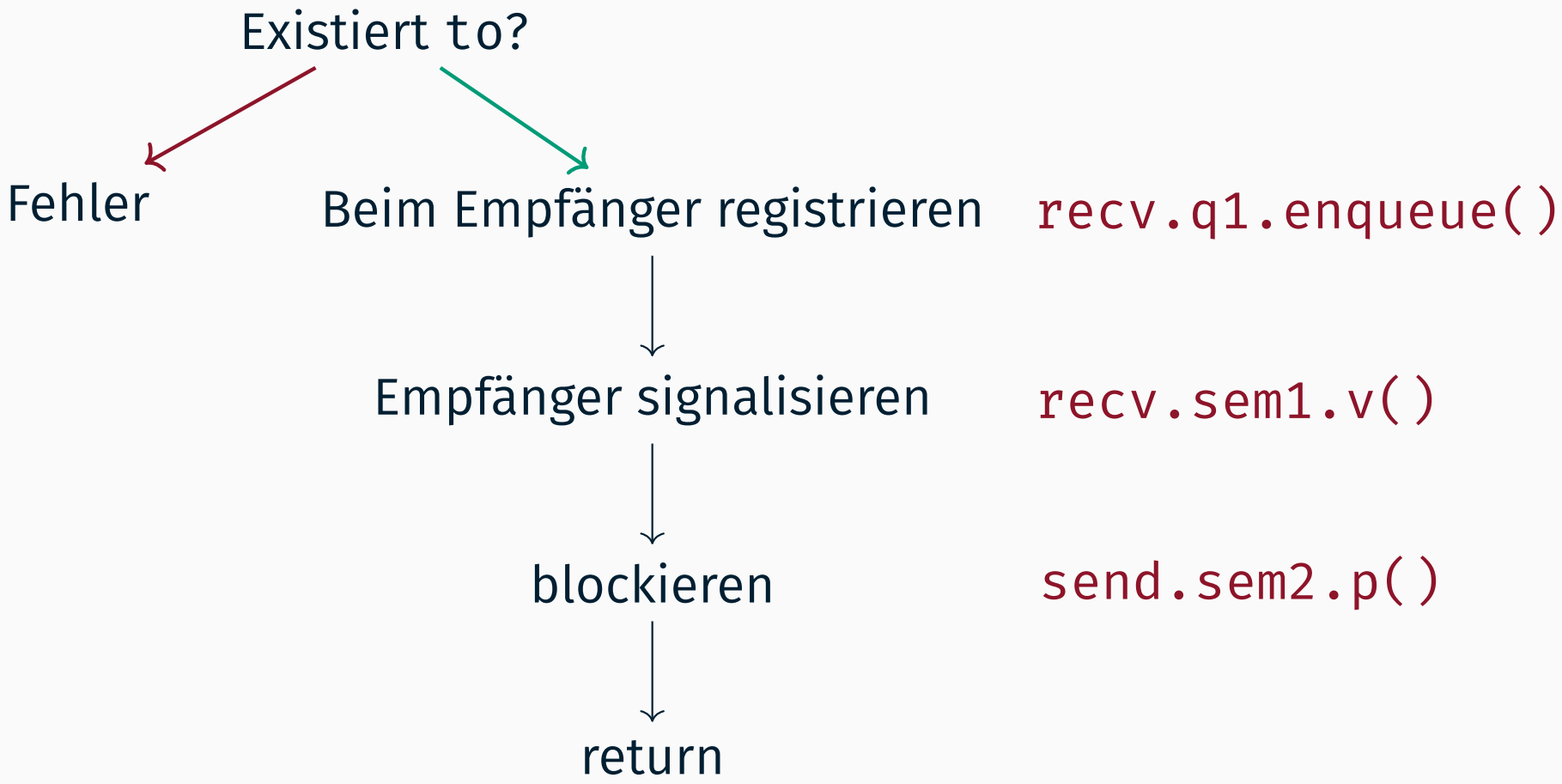

Zustandsdiagramme `send, receive, reply`

`recv(data, len)`

Auf Signal eines Senders warten

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Infos des Senders entgegennehmen

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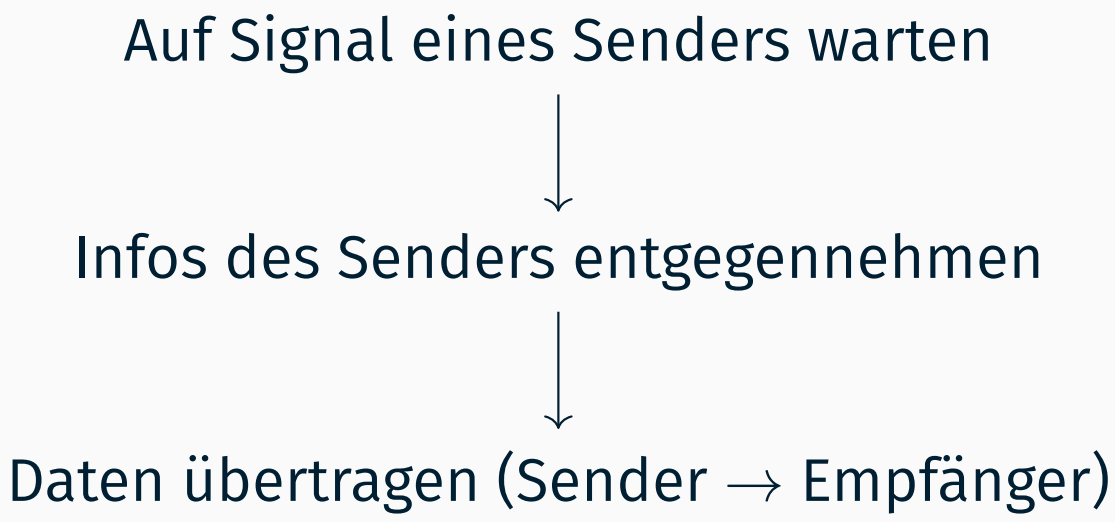

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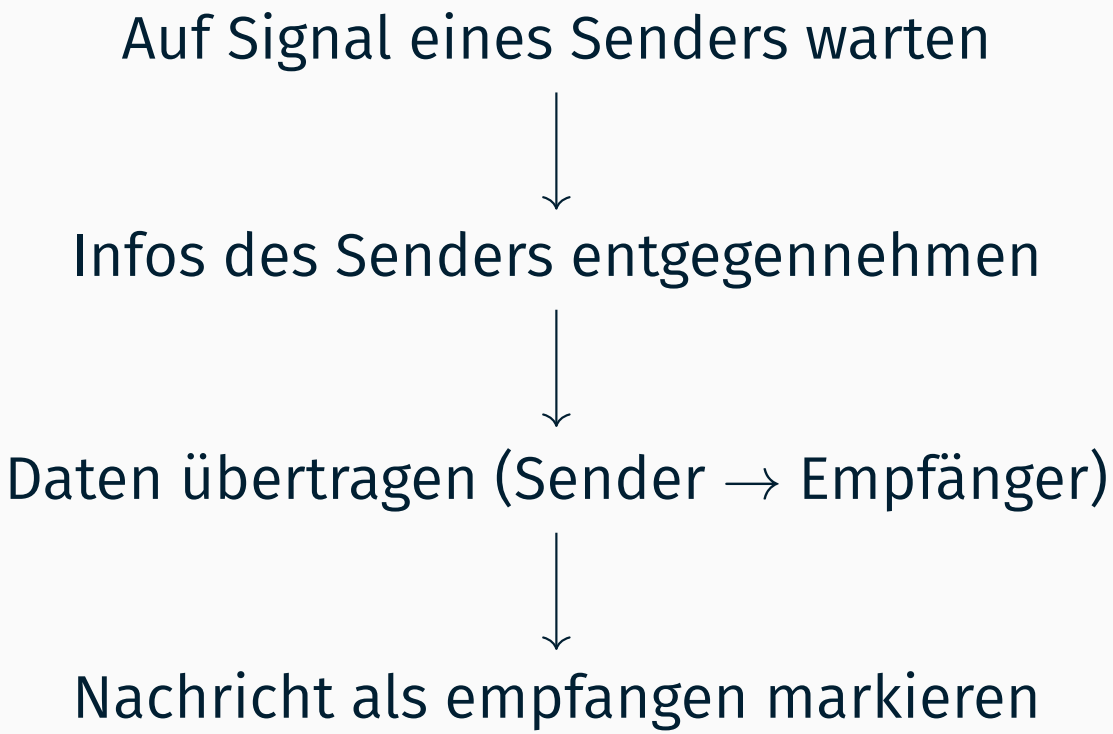

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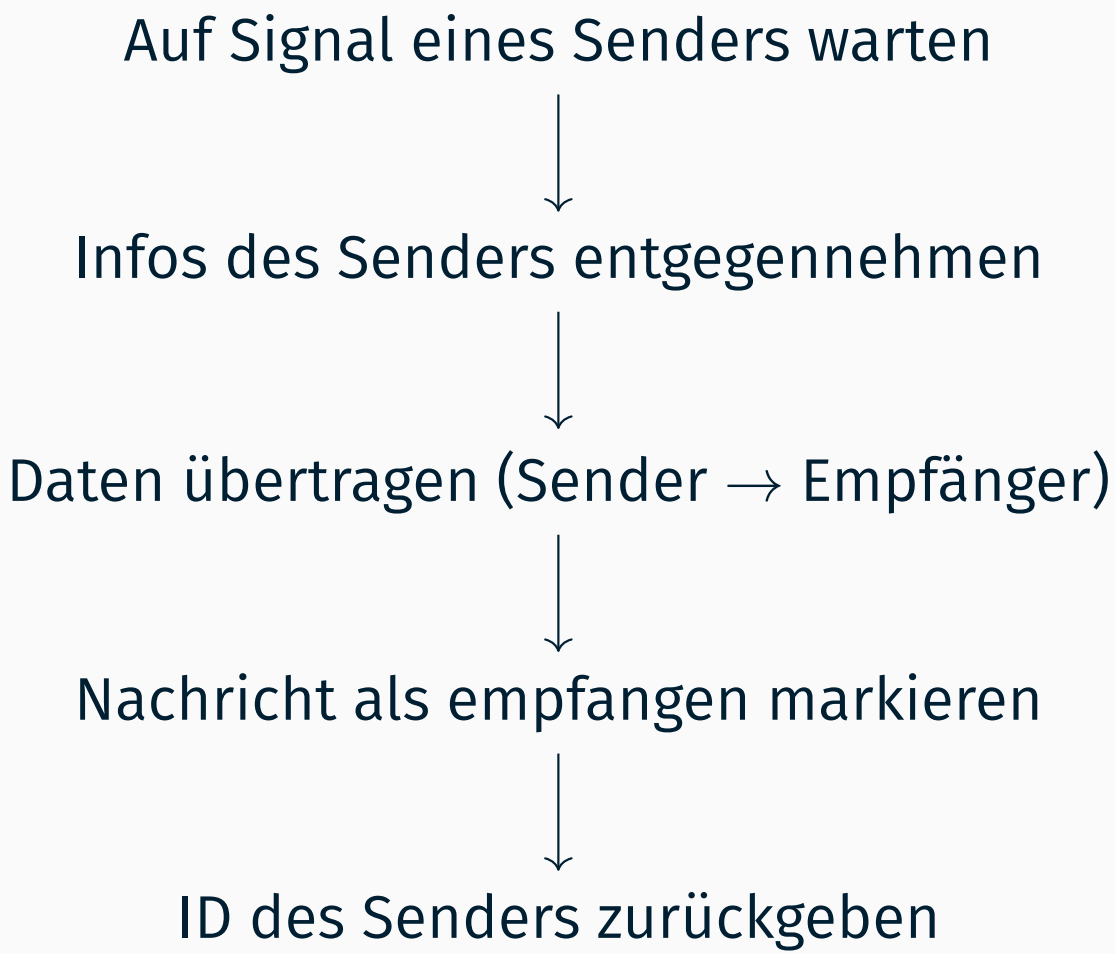

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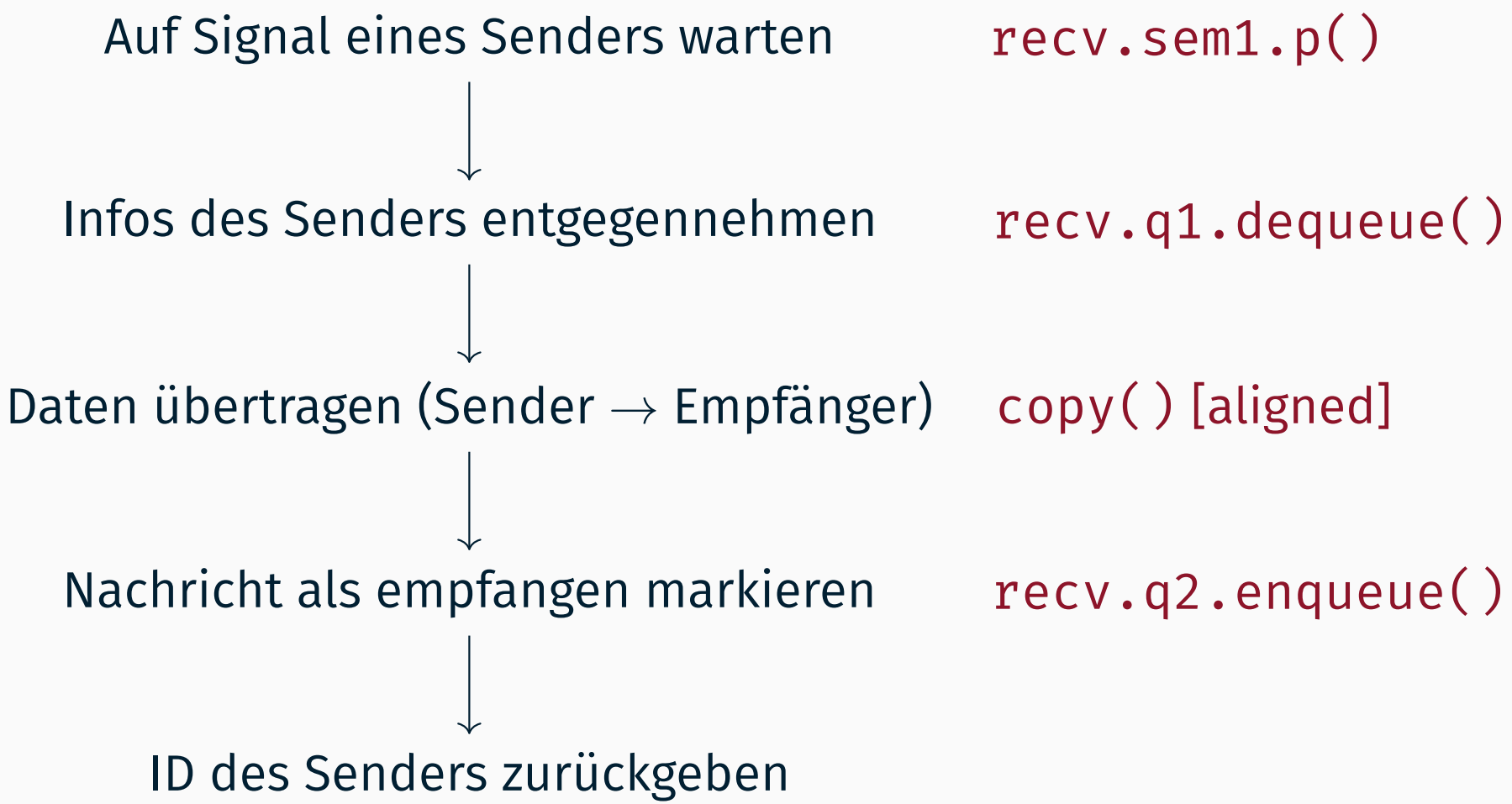

Zustandsdiagramme `send`, `receive`, `reply`

`reply(to, data, len)`

- Gab es ein `send` von `to`?

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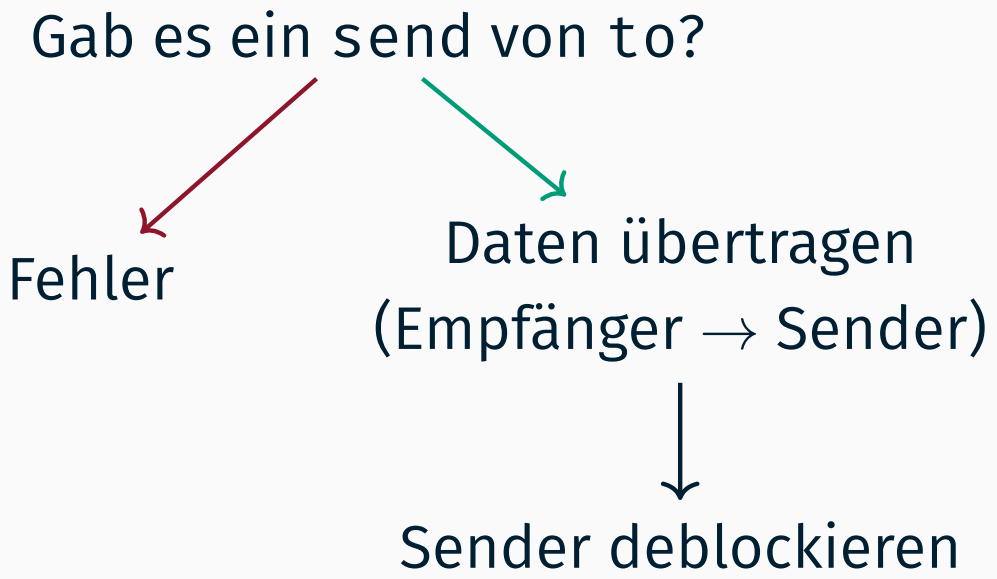

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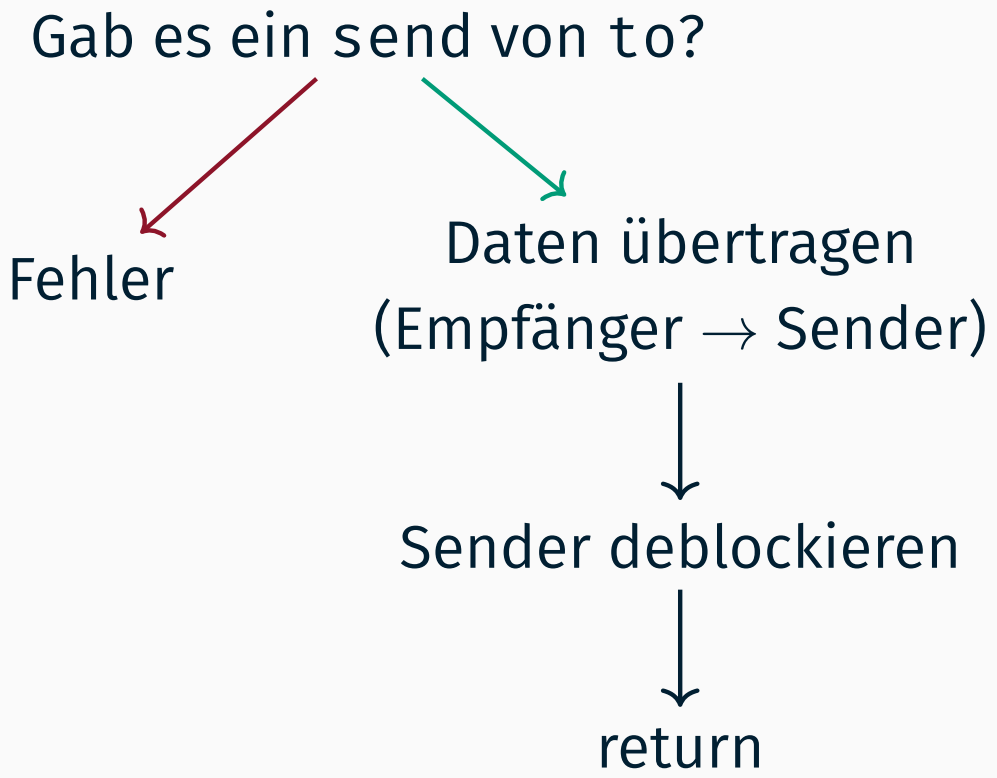

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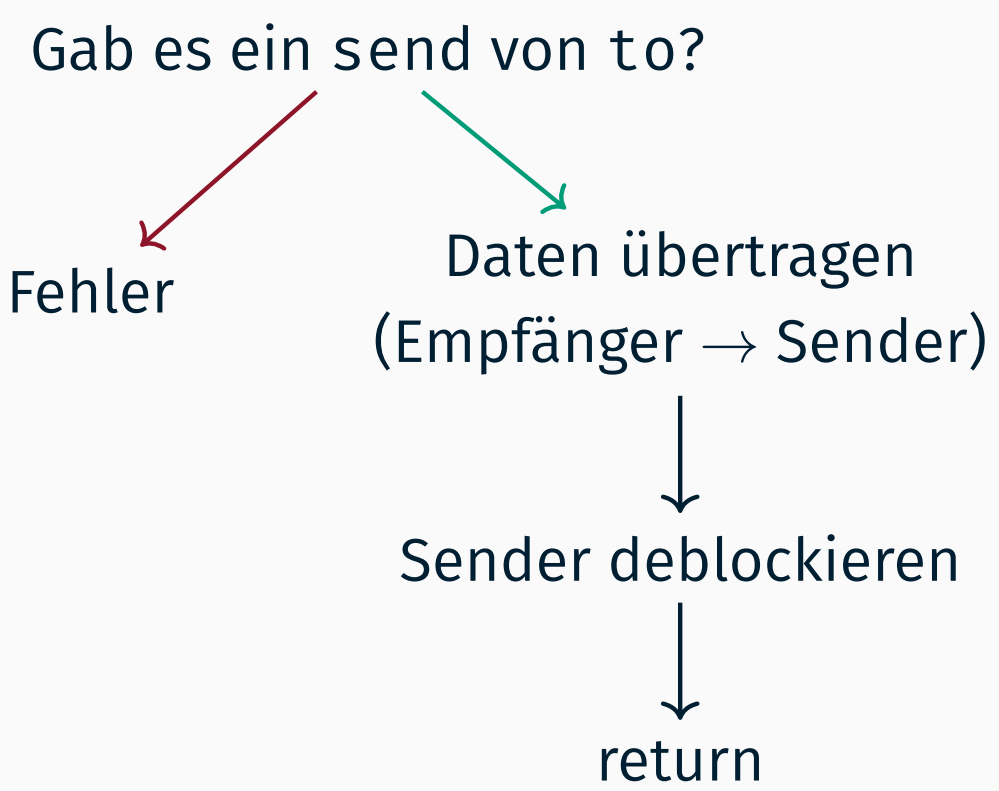

Nachricht mit ID in Queue 2?

`copy()`

`send.sem2.v()`

Kopieren zwischen Adressräumen

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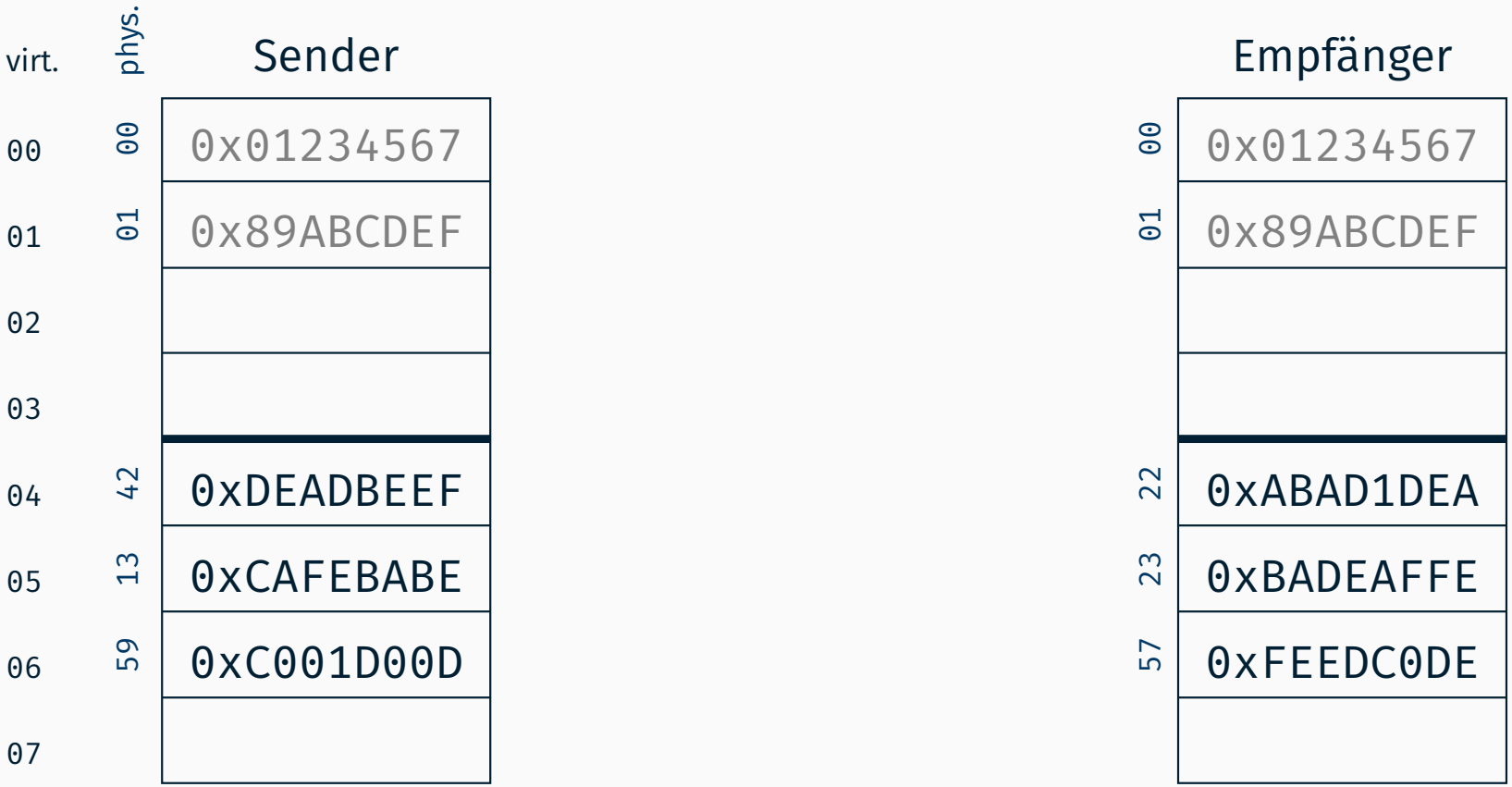

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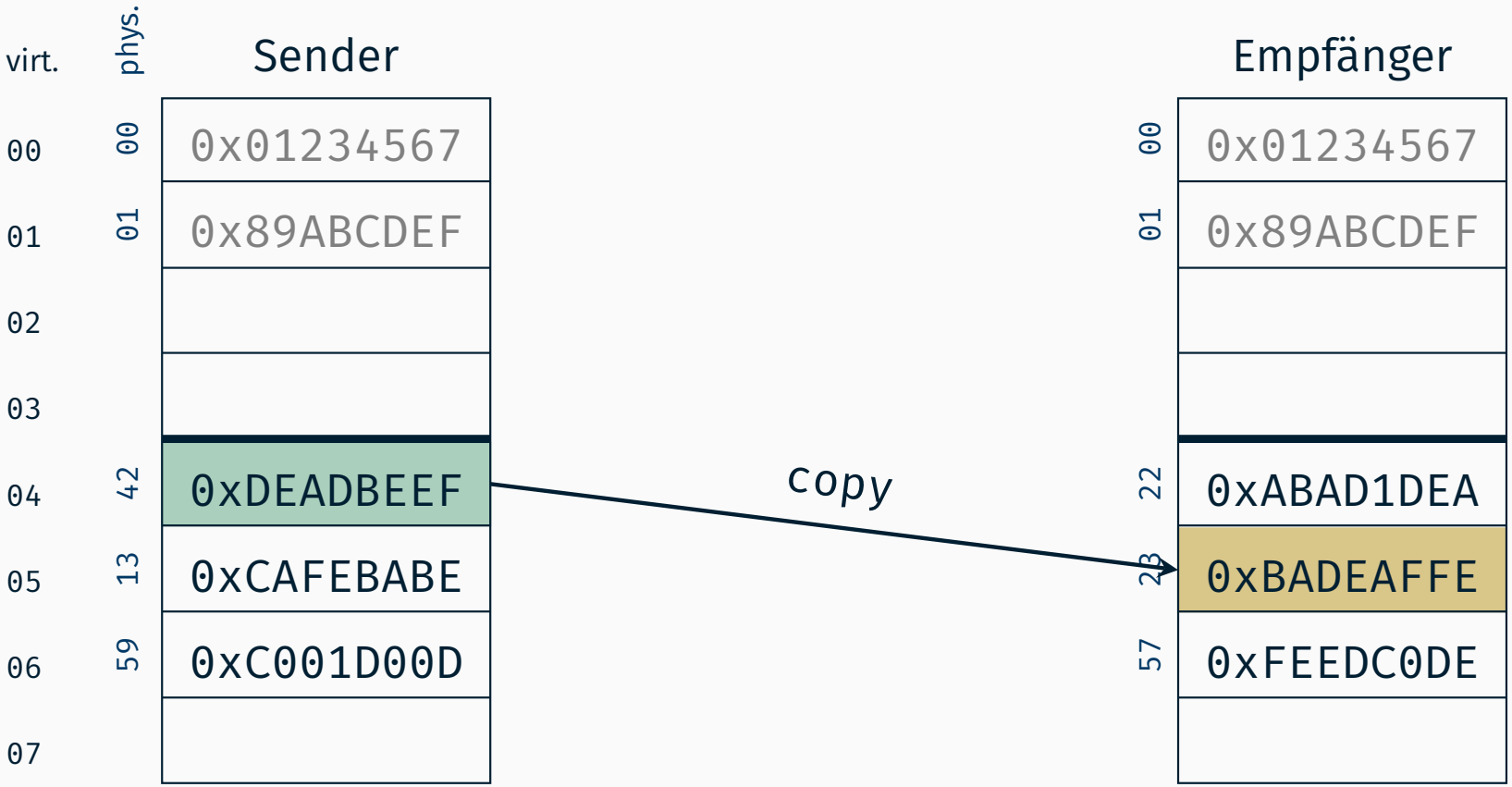

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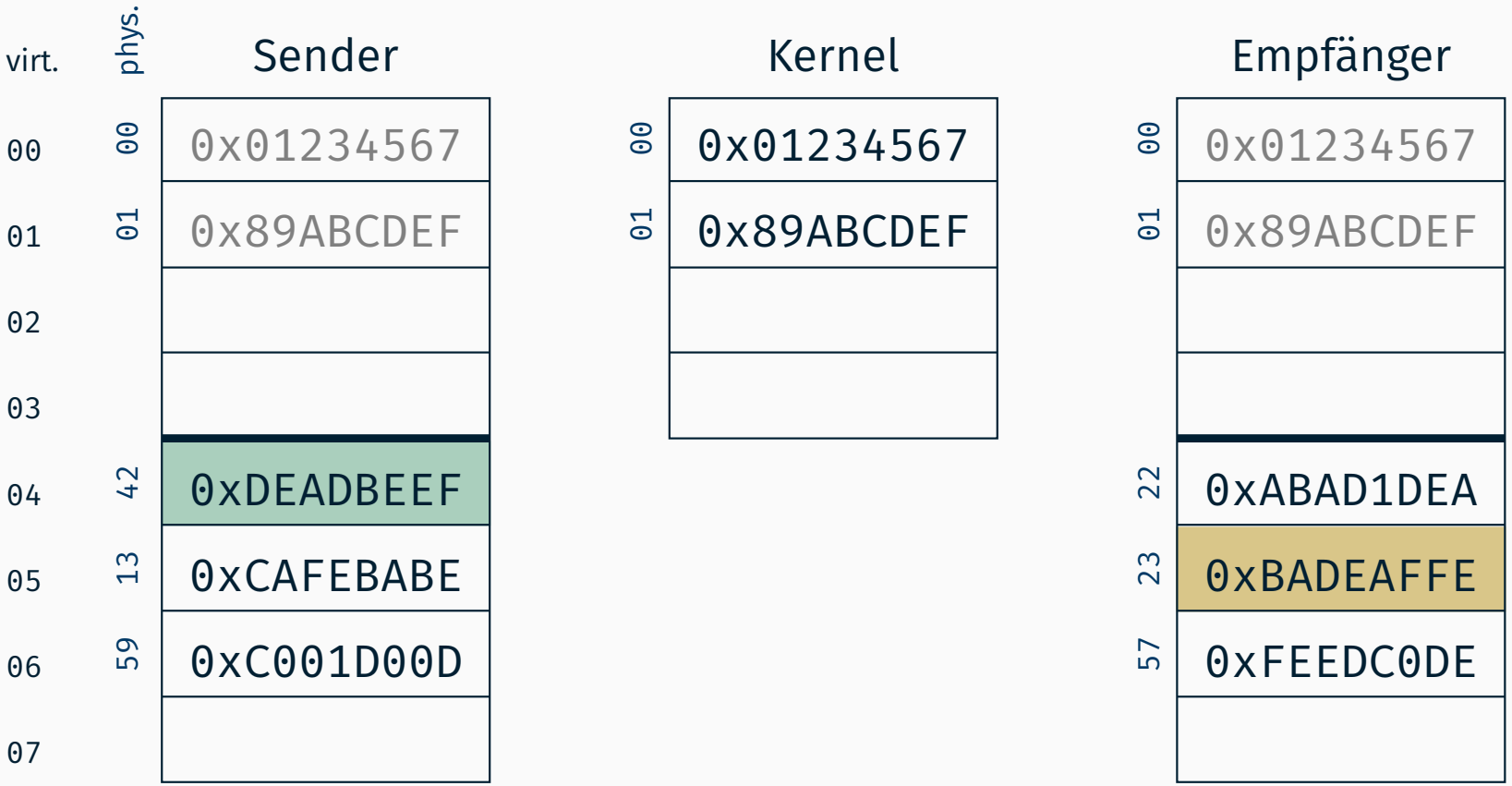

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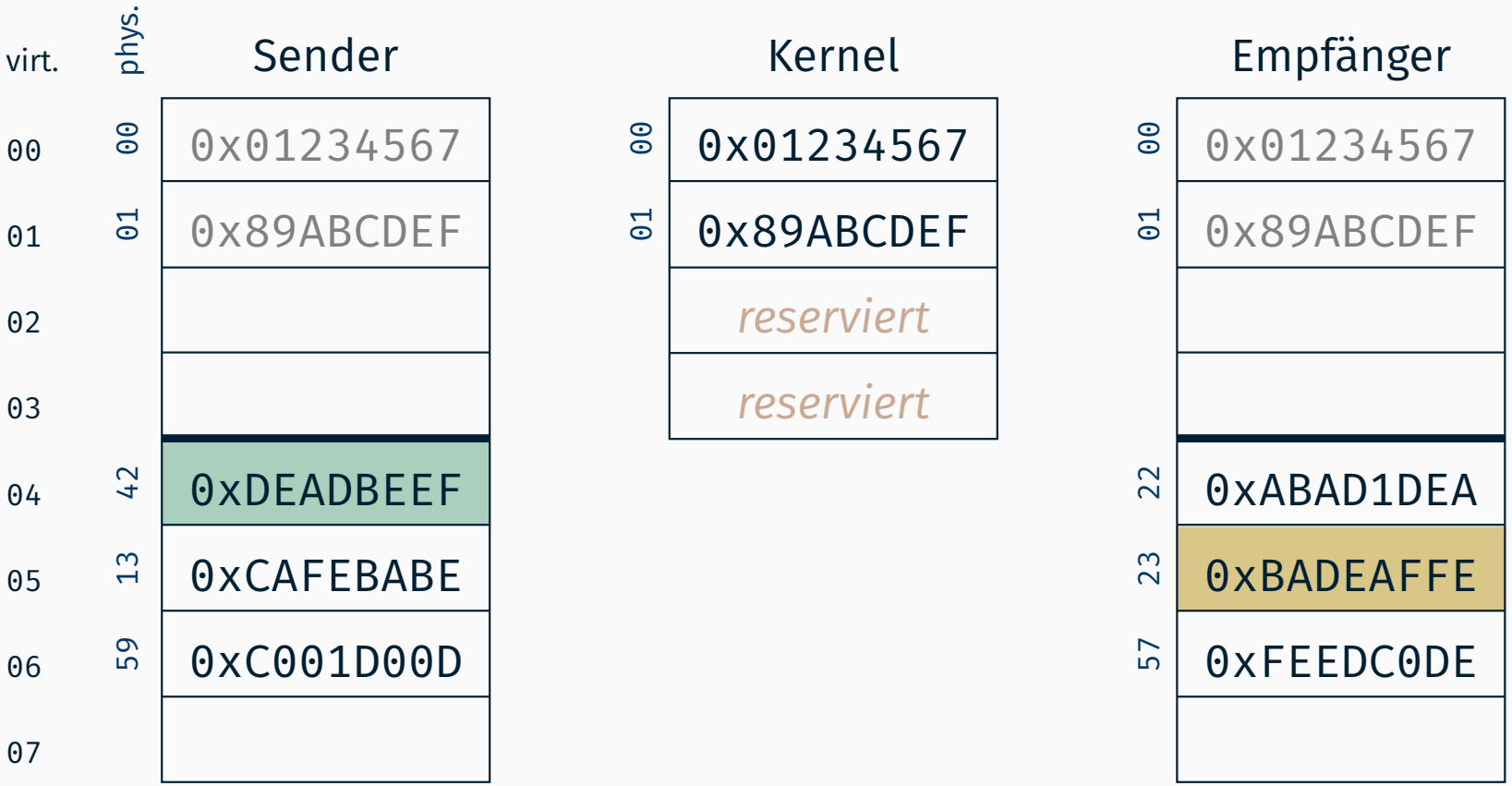

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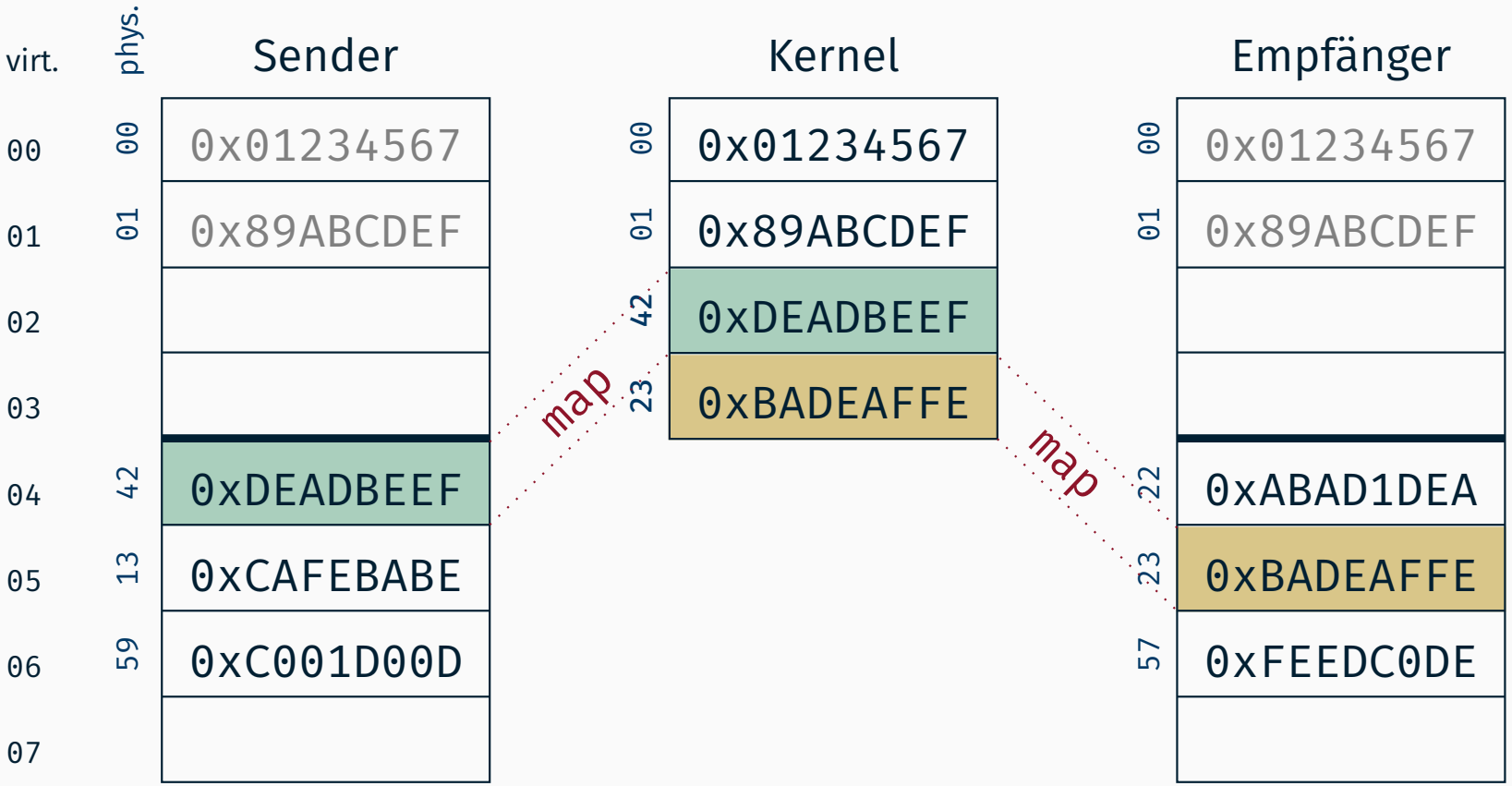

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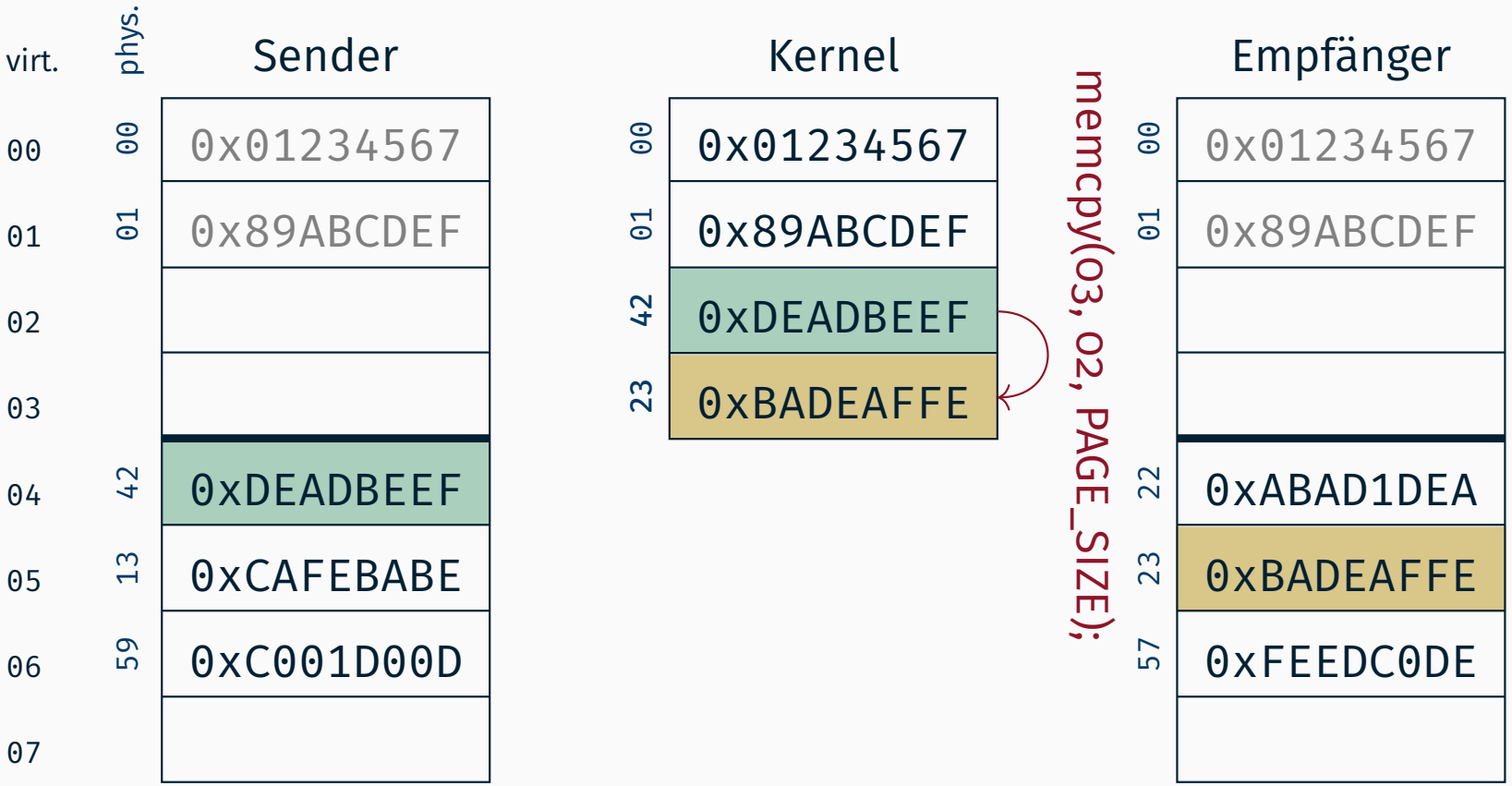

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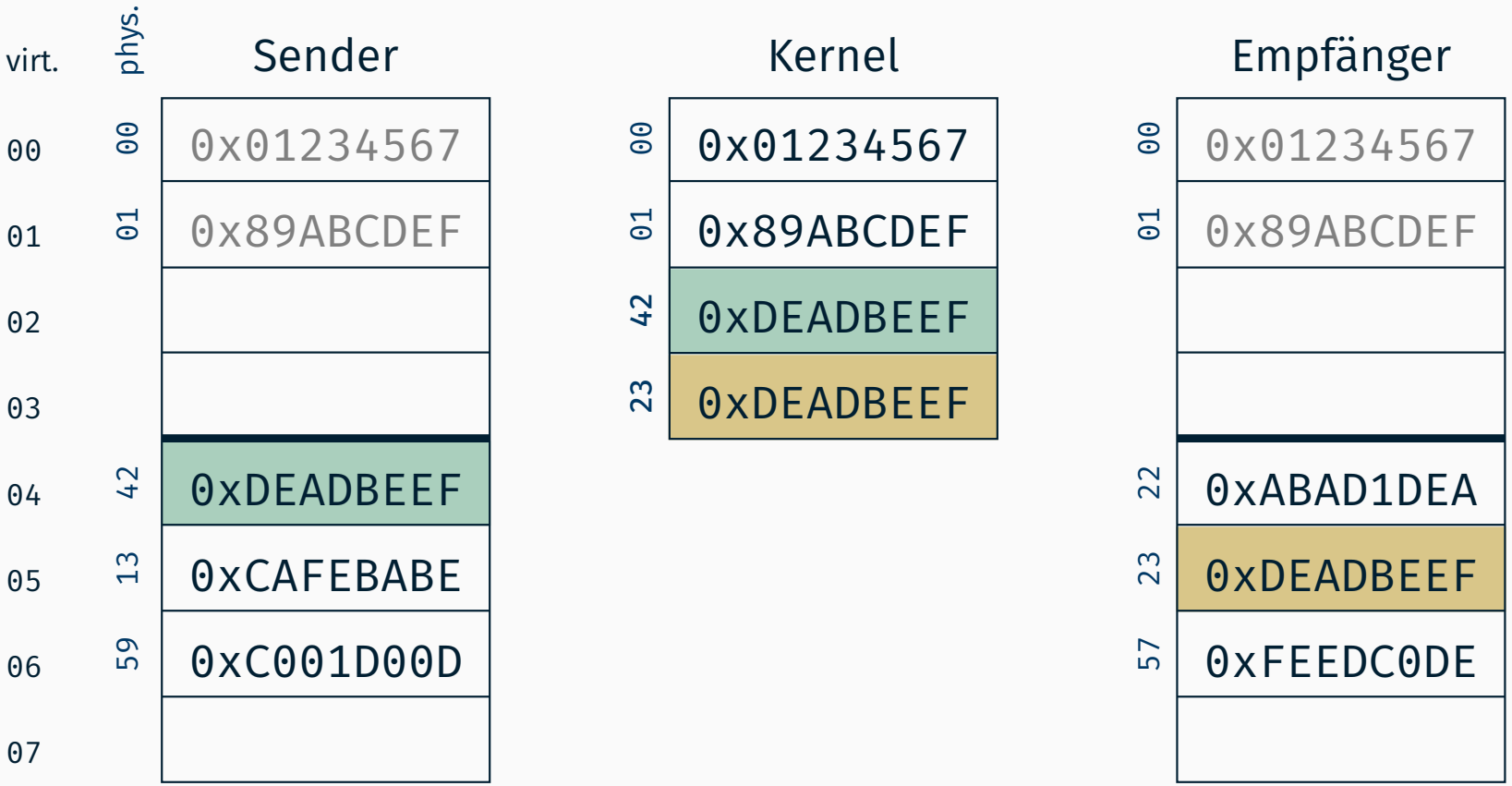

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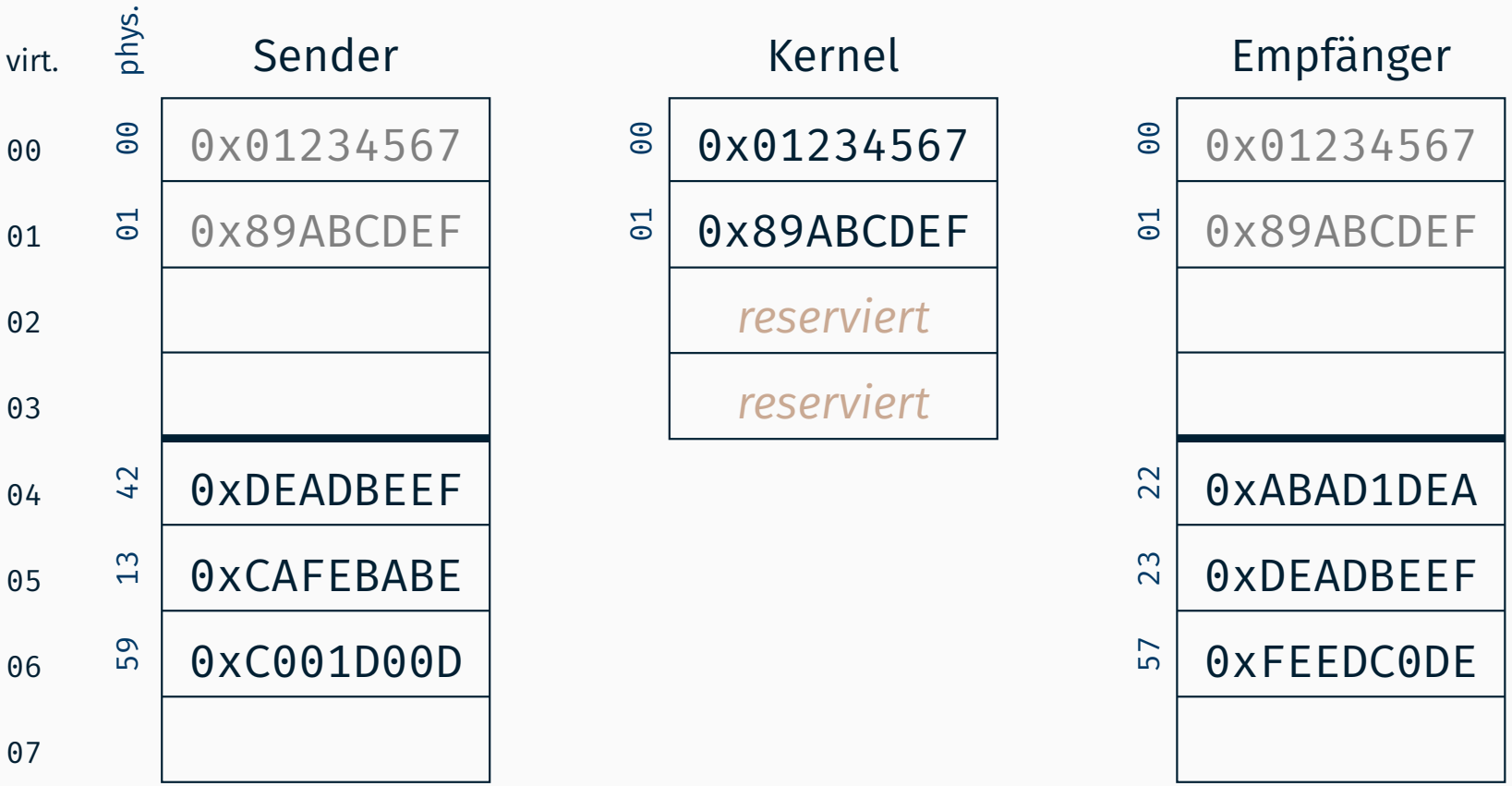

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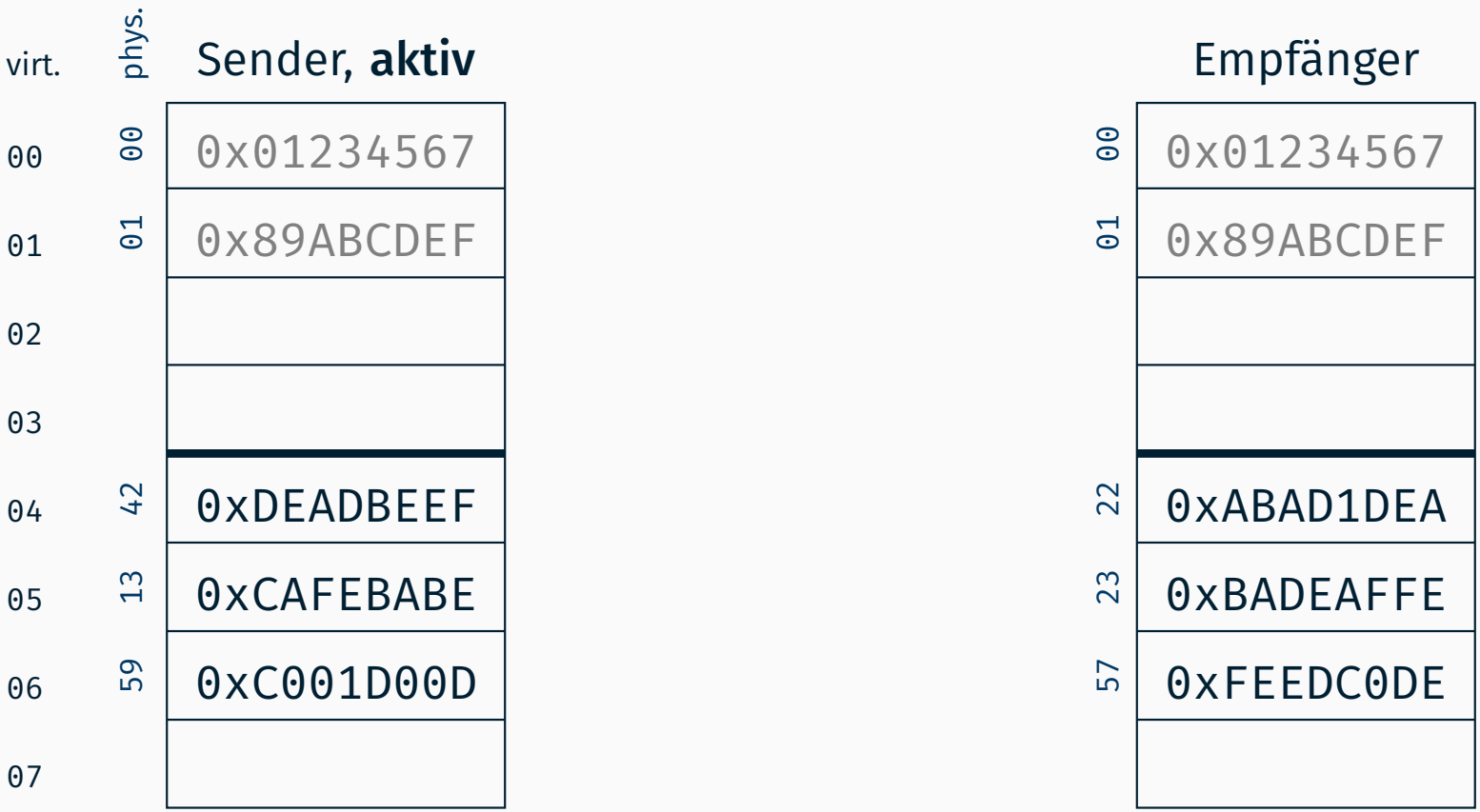

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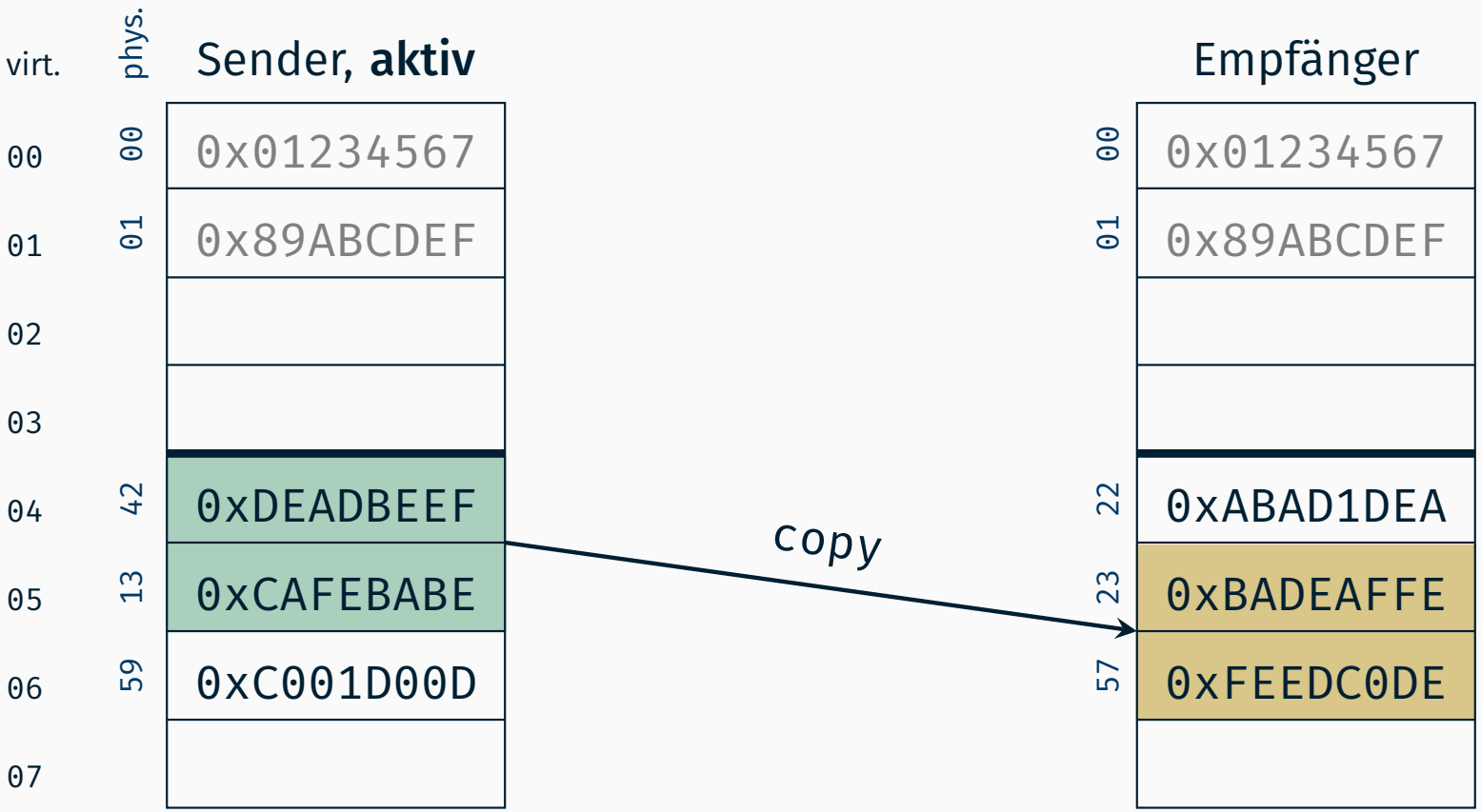

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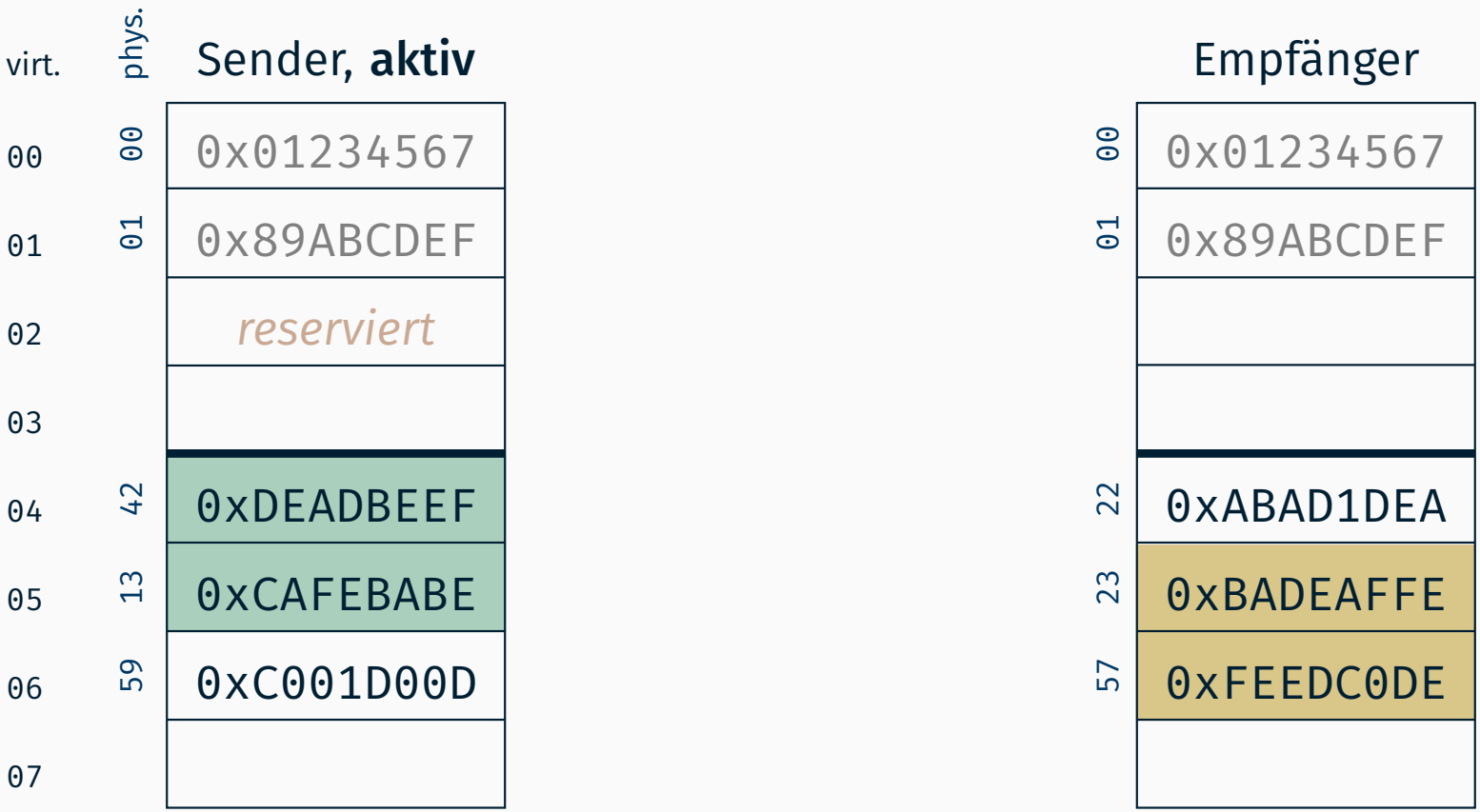

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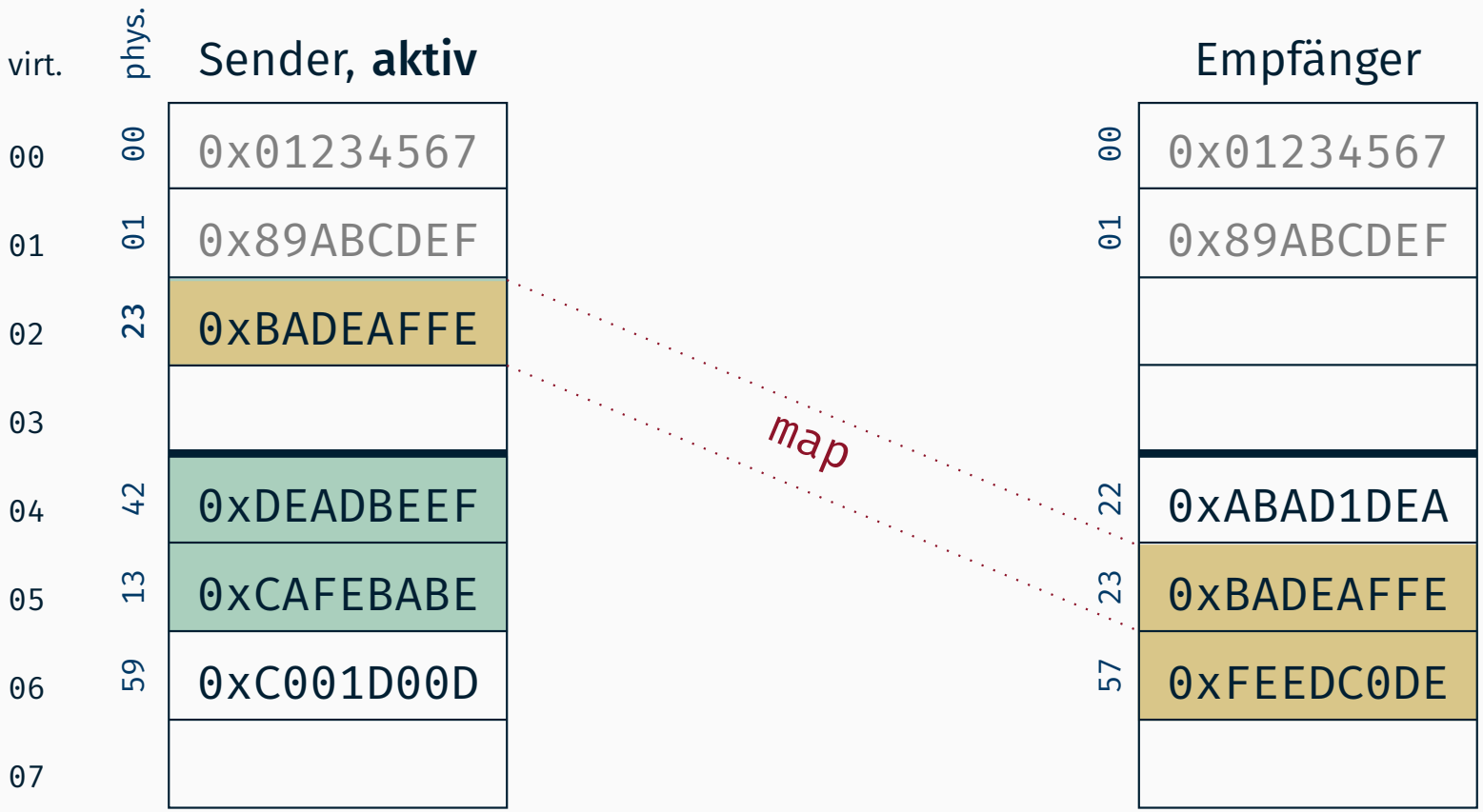

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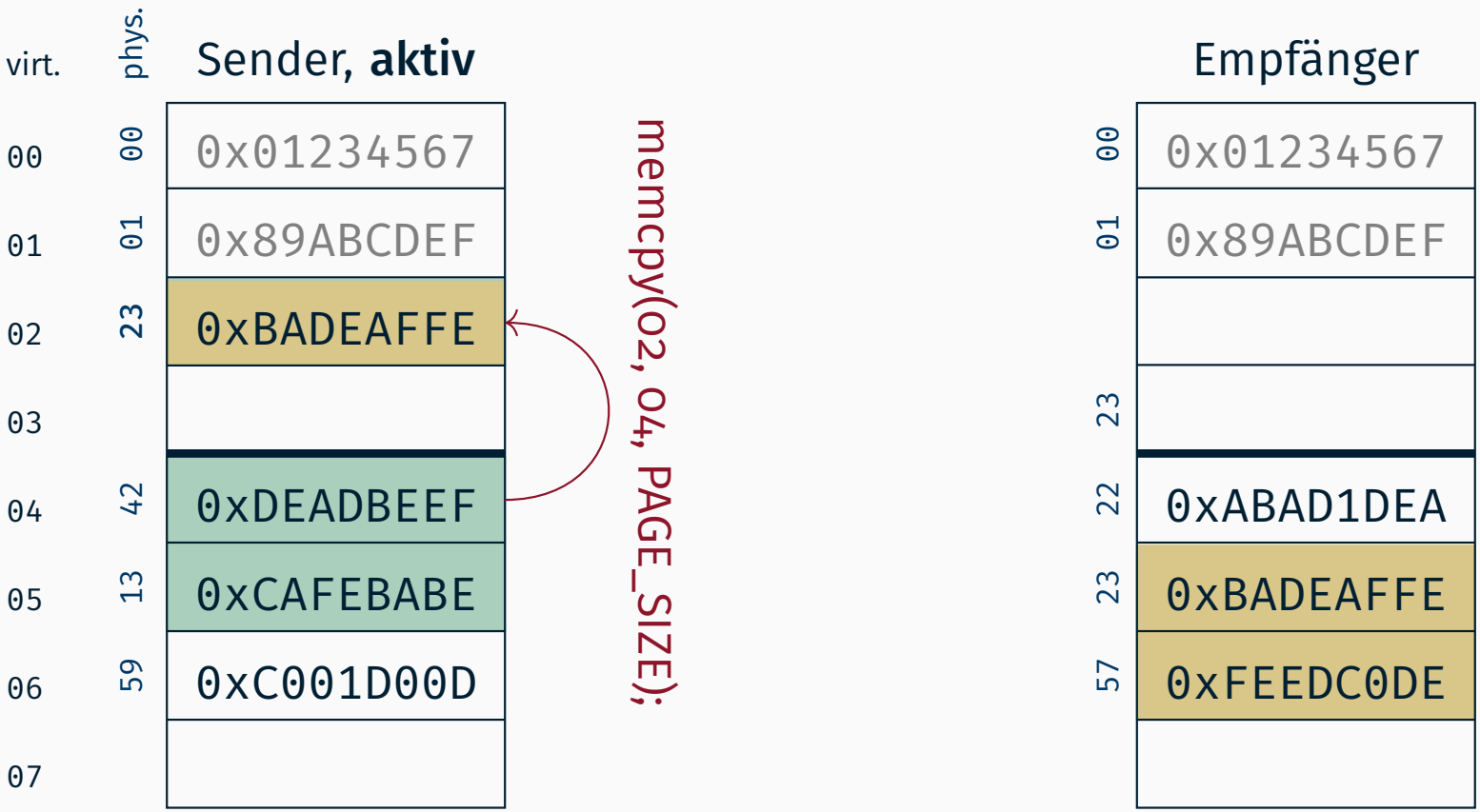

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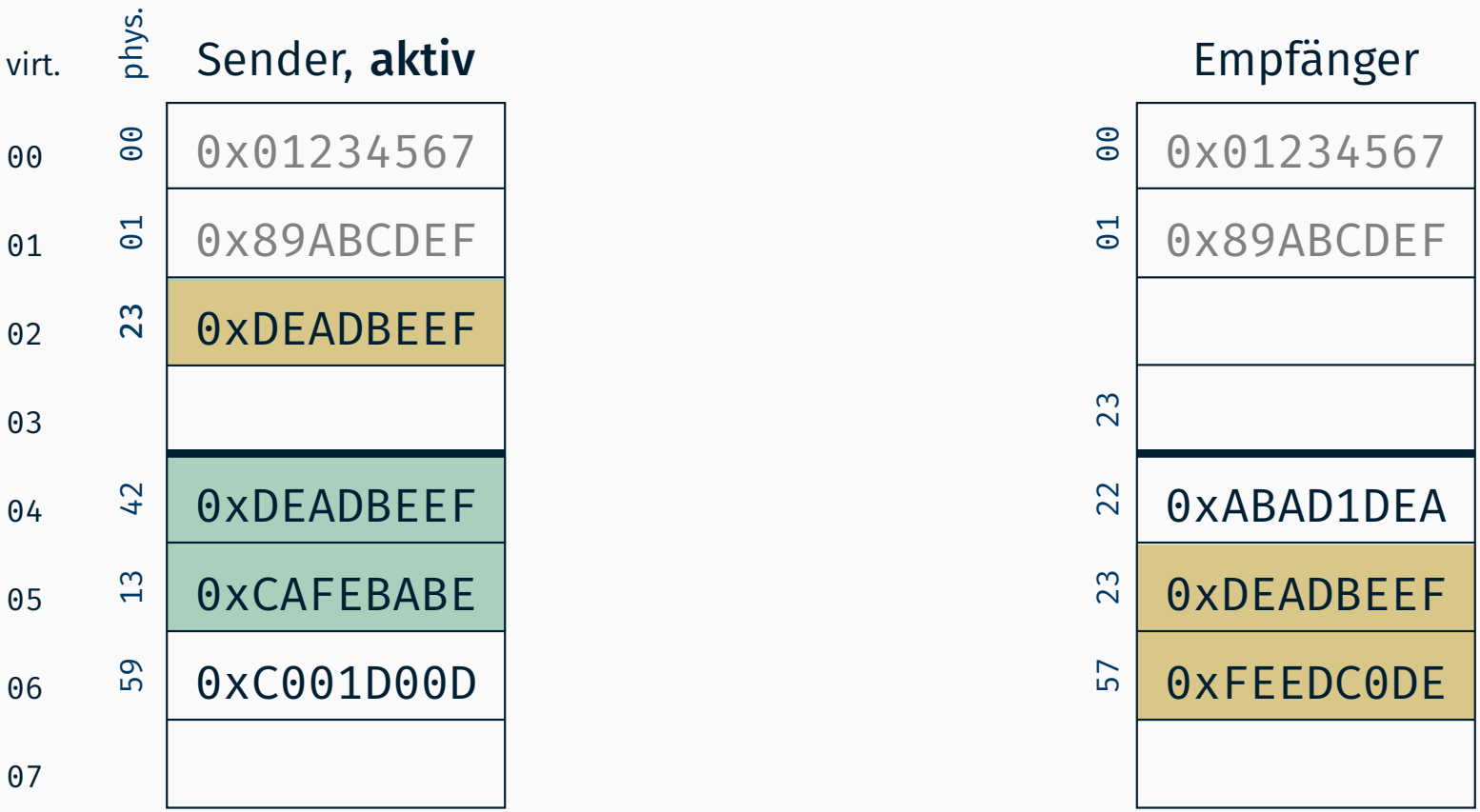

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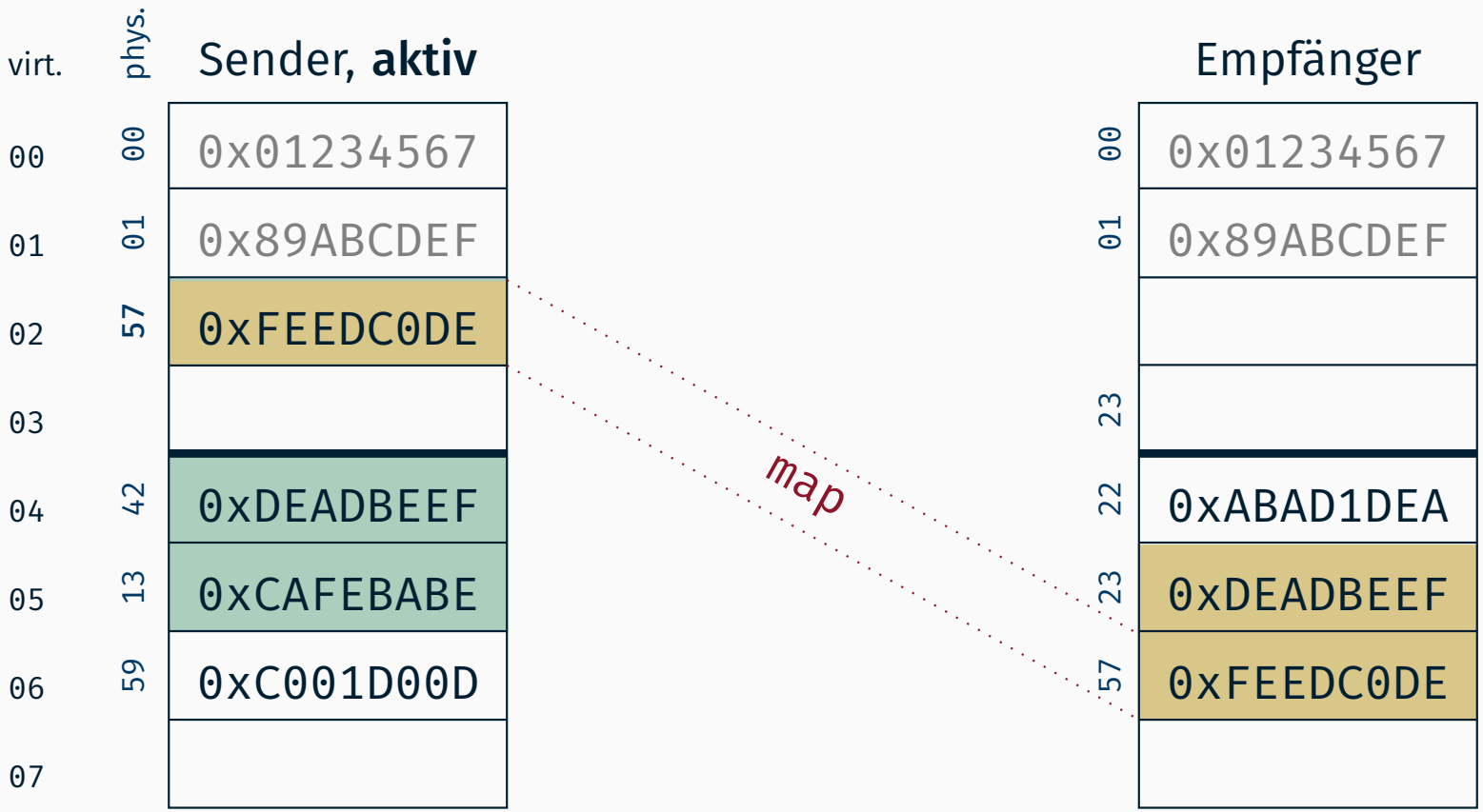

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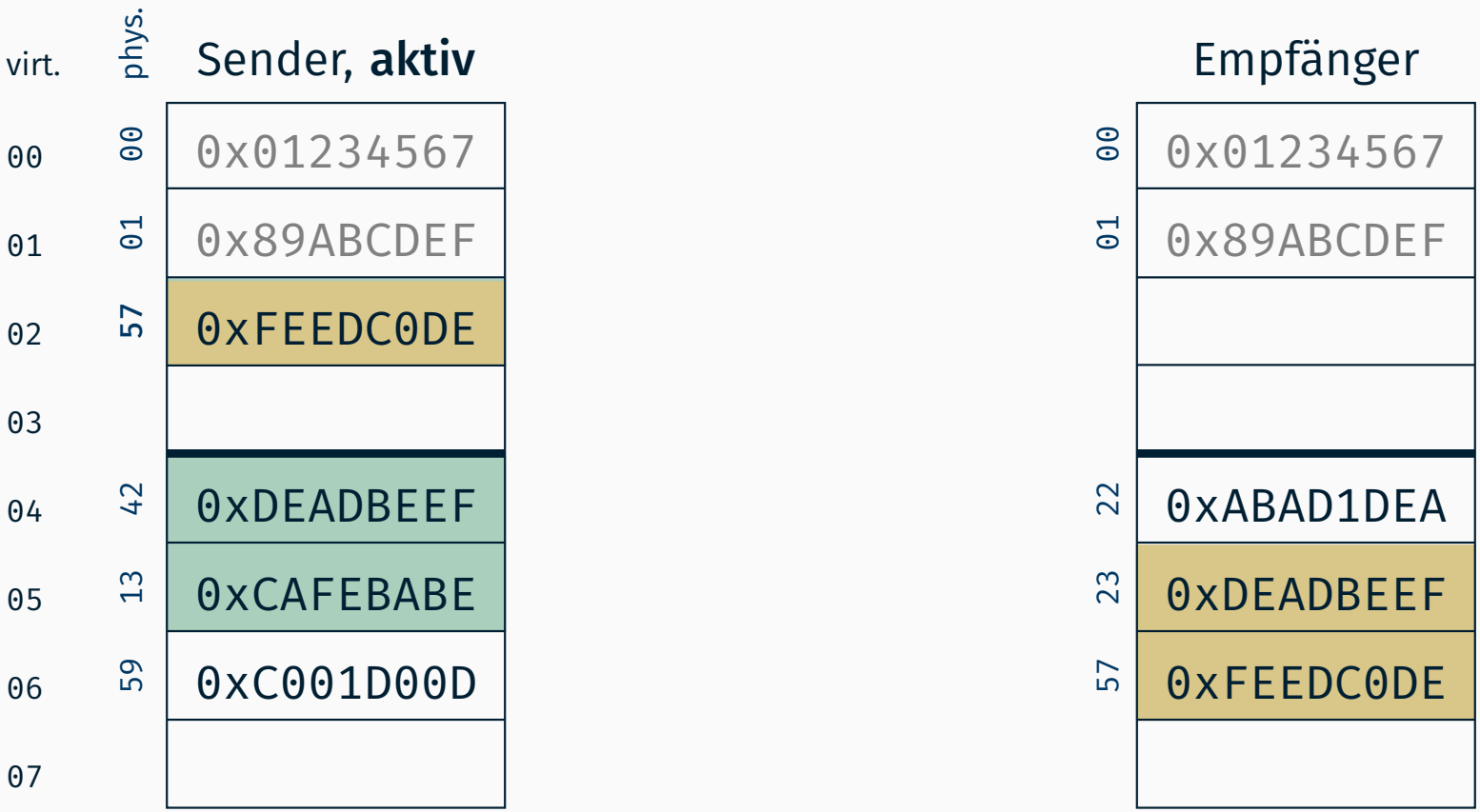

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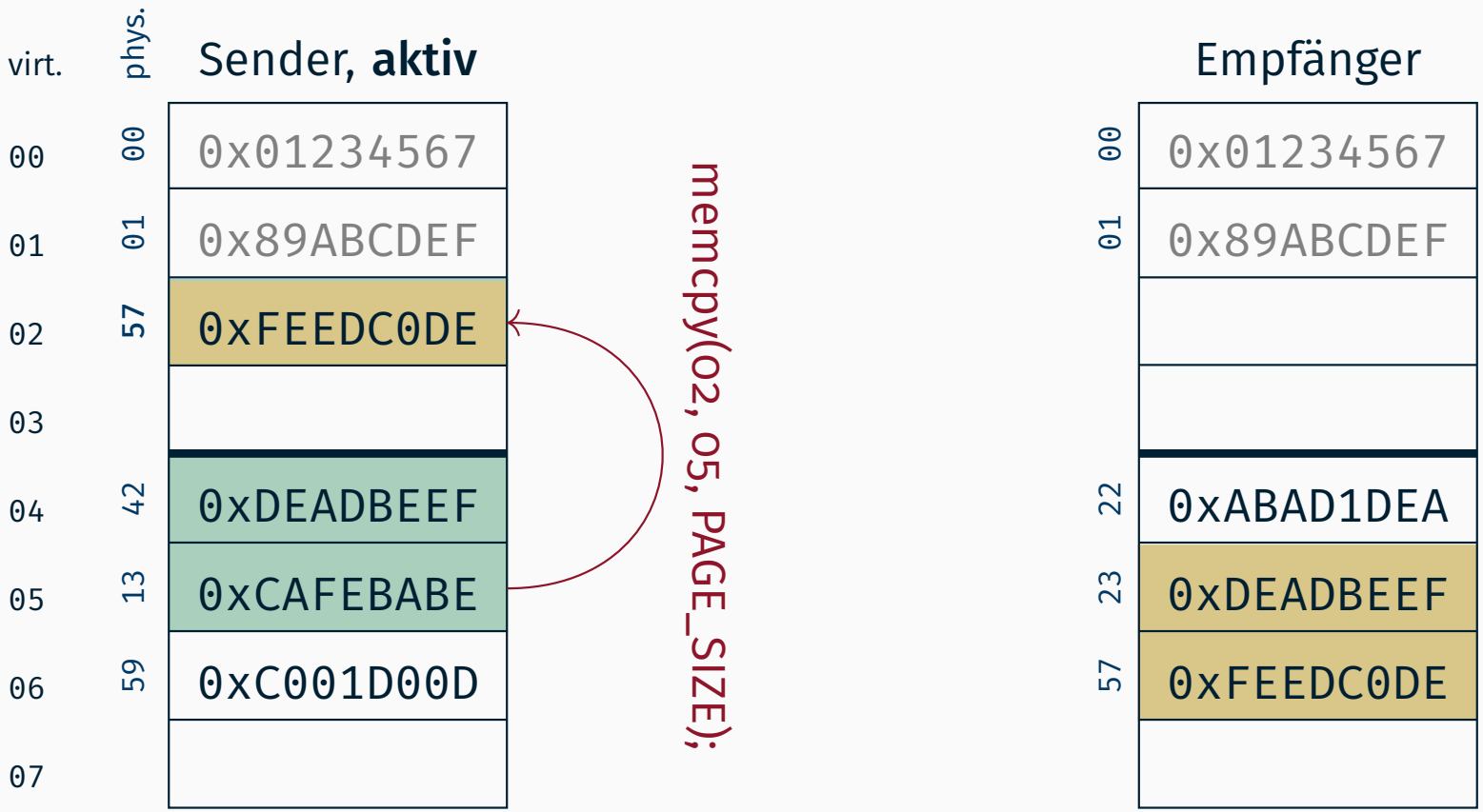

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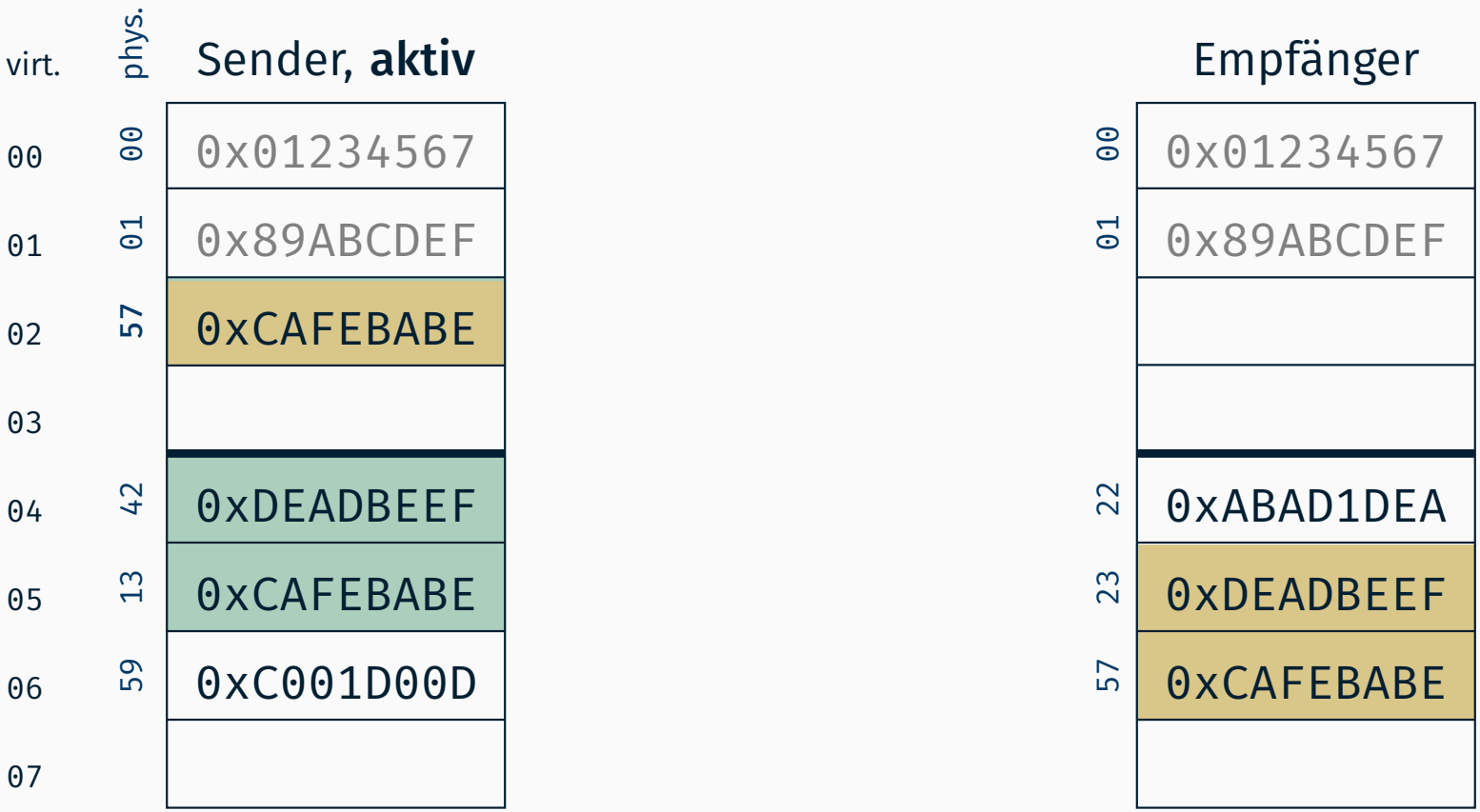

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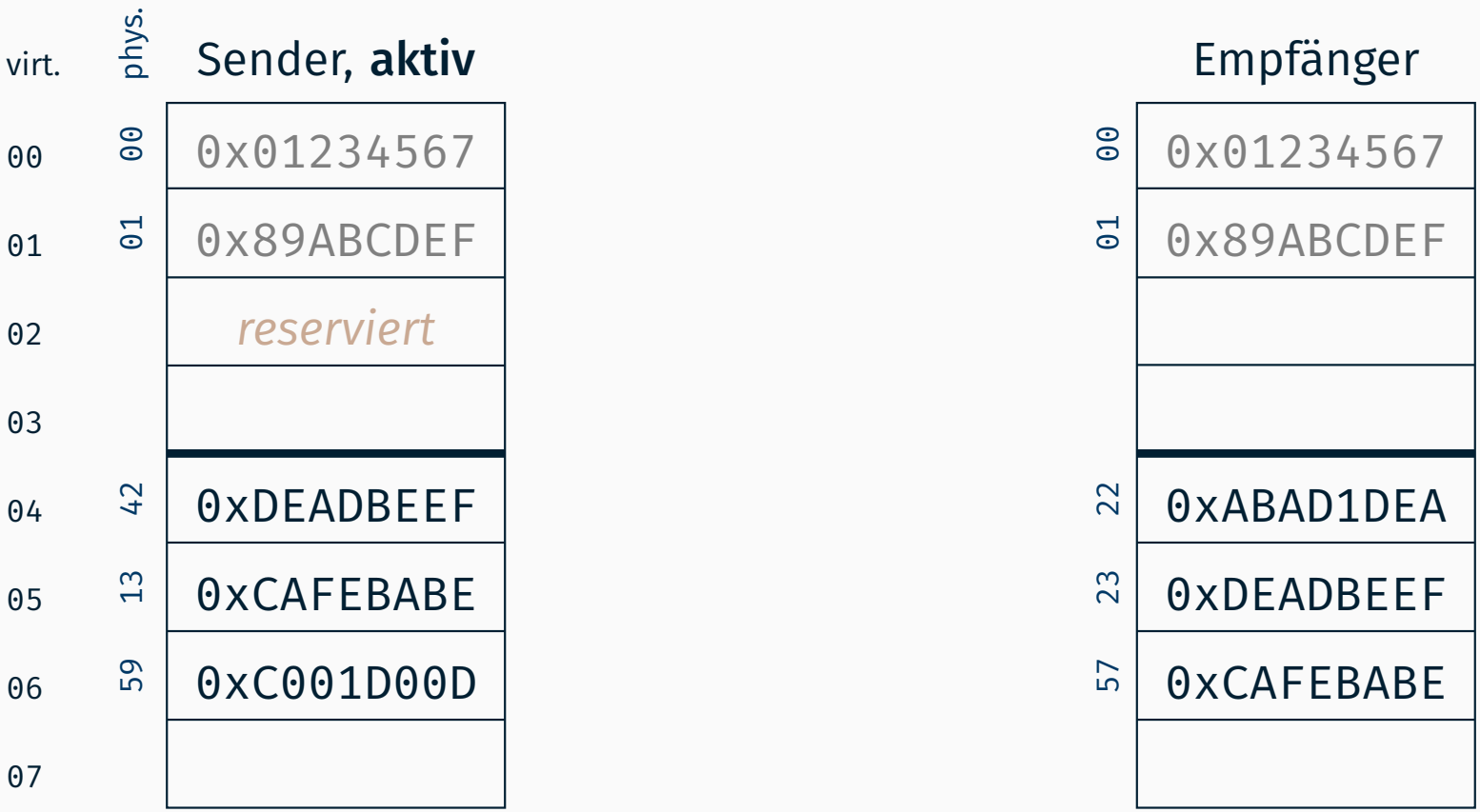

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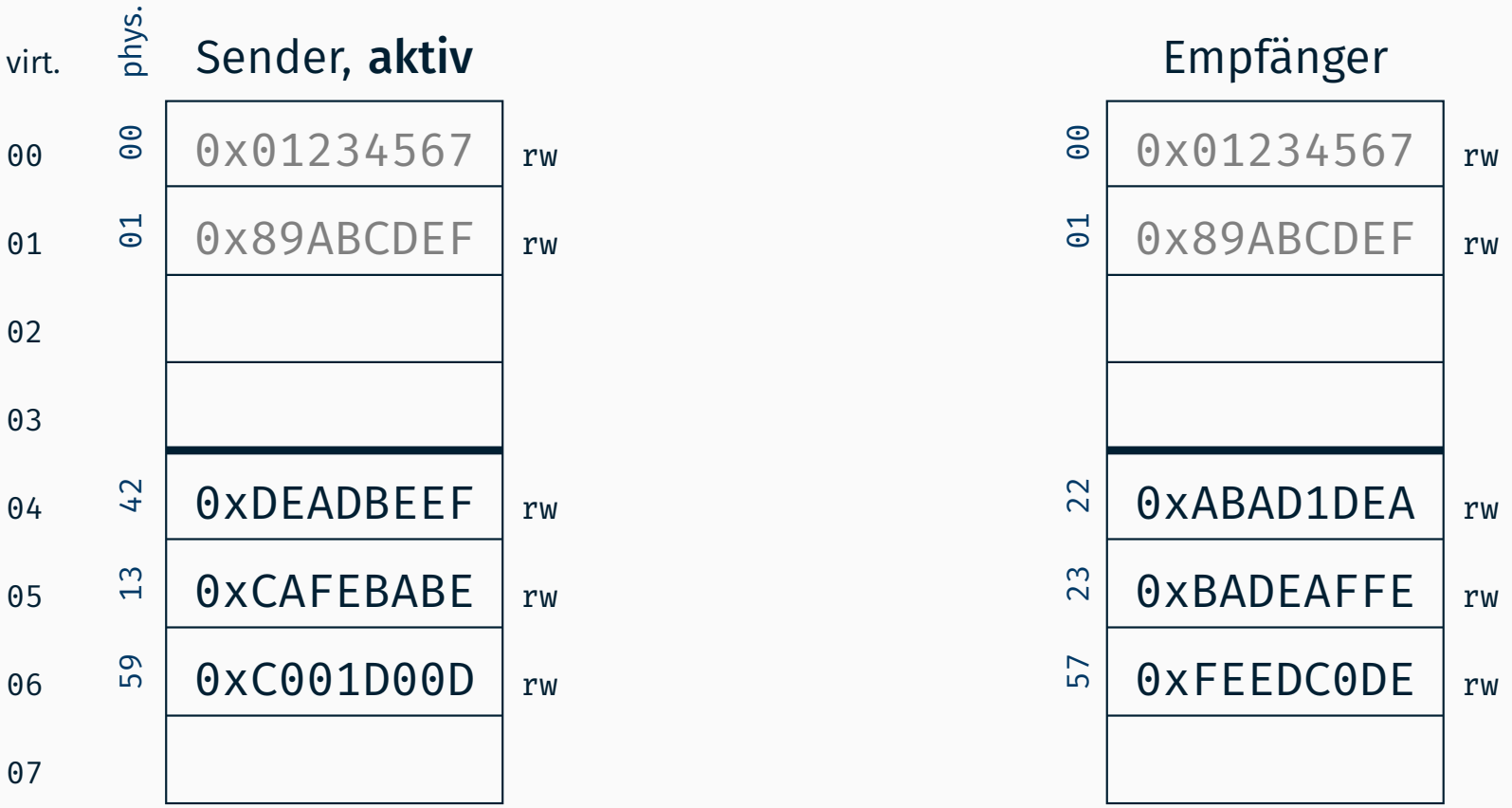

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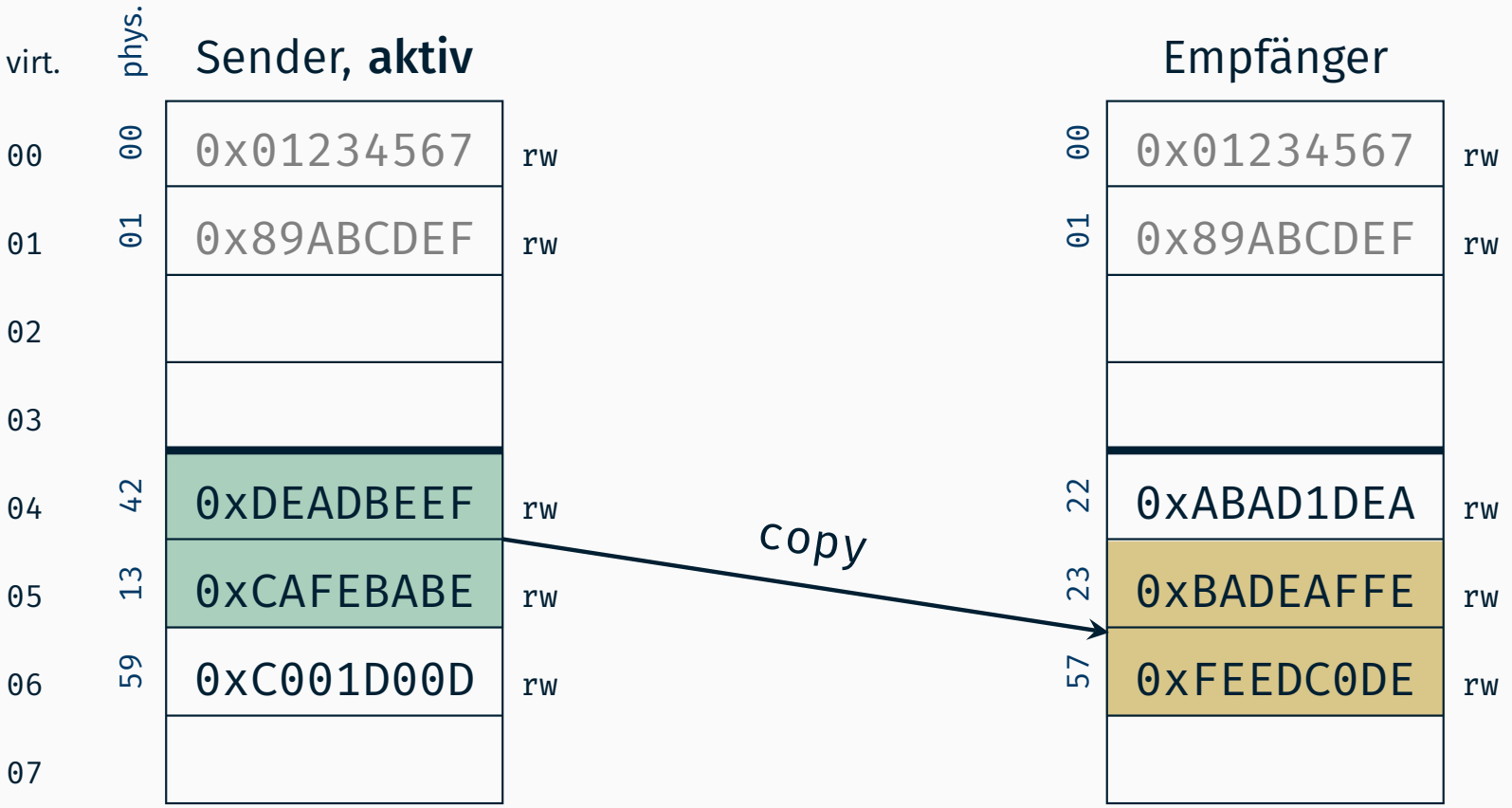

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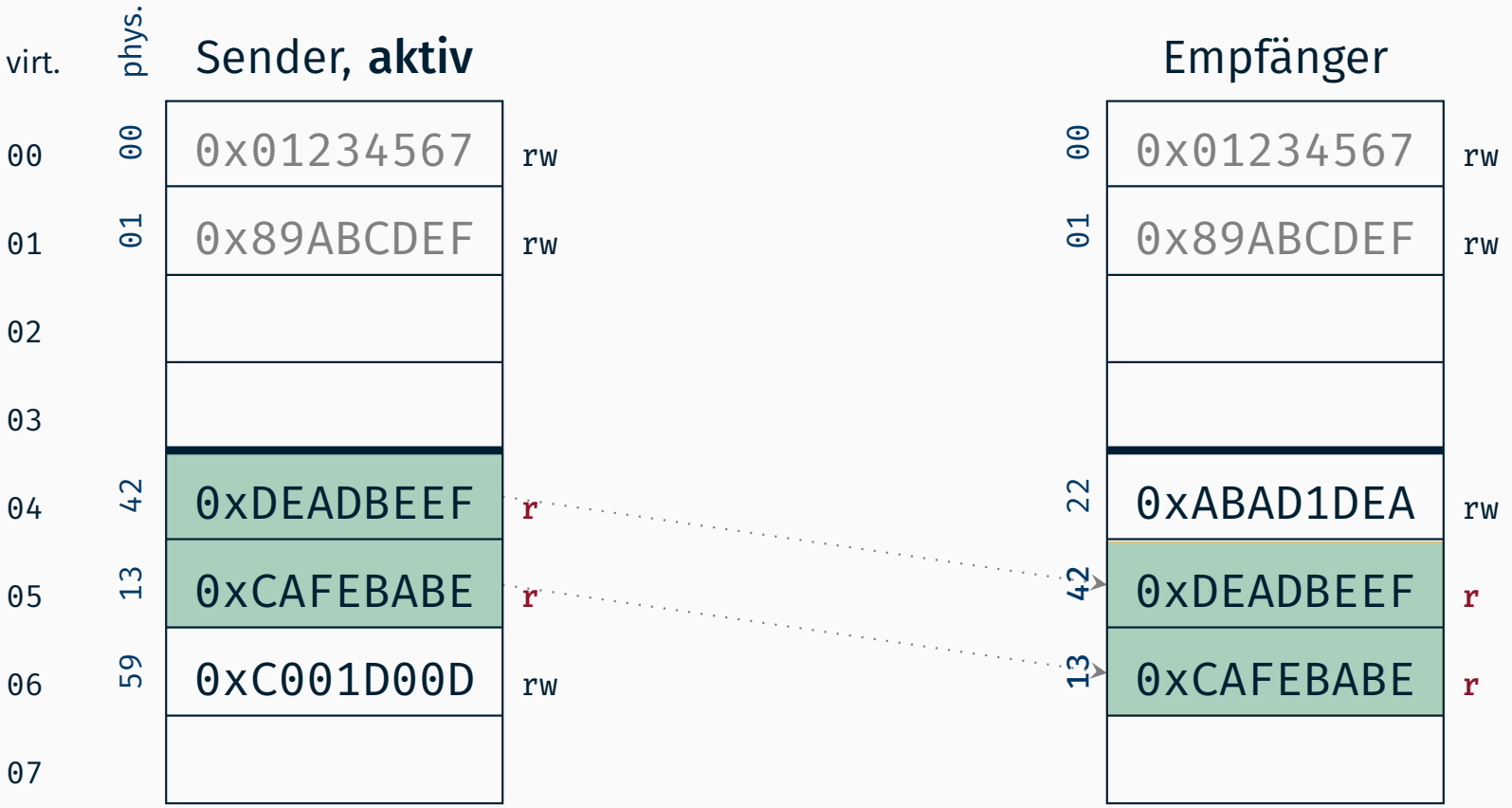

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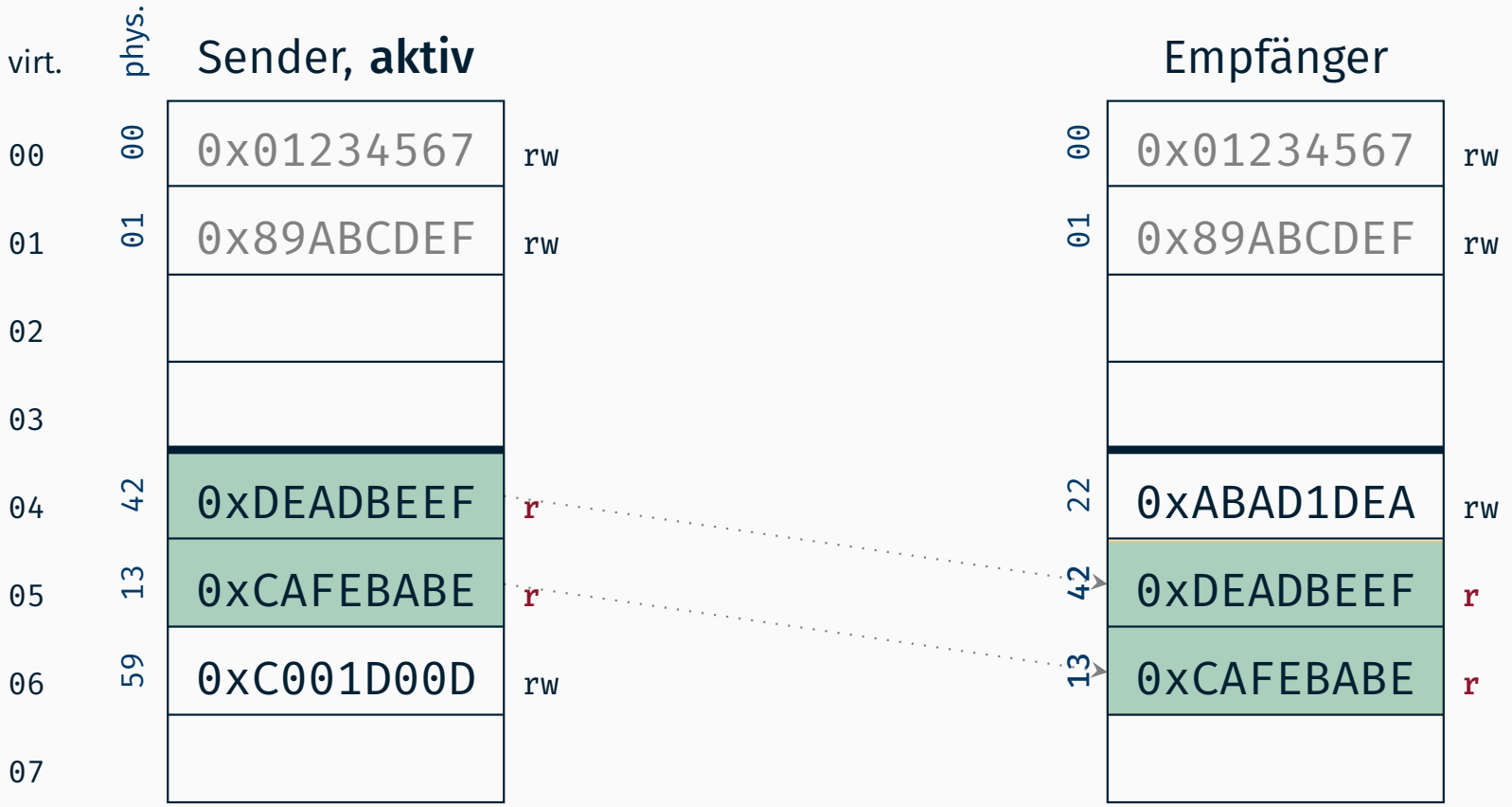

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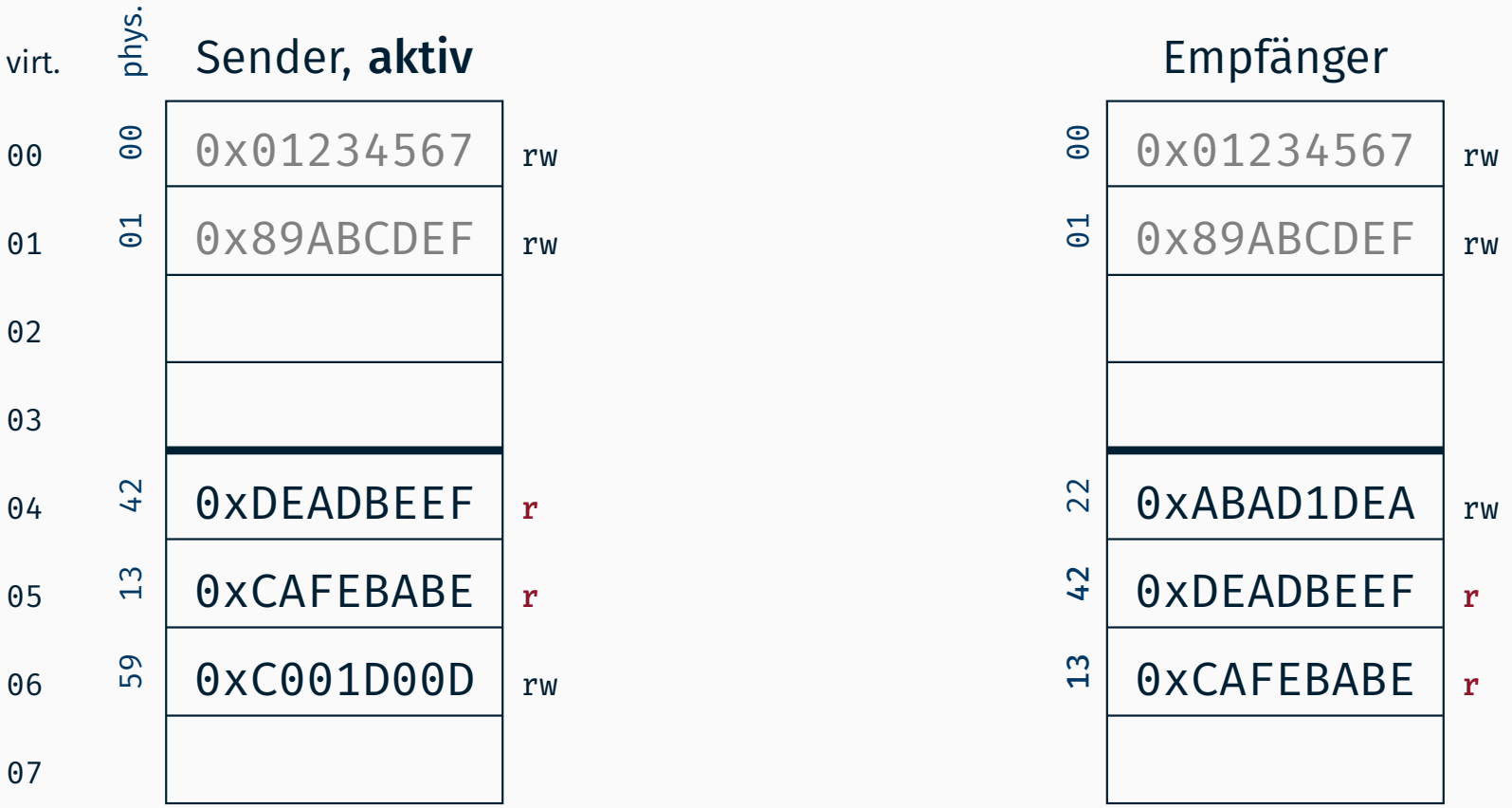

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Wann/wo werden Seiten tatsächlich kopiert?

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- Im Pagefault-Handler (Trap bei Schreibzugriffen)

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Implementierung des Referenzzählers?

- (z.B.) Shadow-Pagetable

```
PTE_Counter {
    uint32_t present:1,
             counter:31;
};
```

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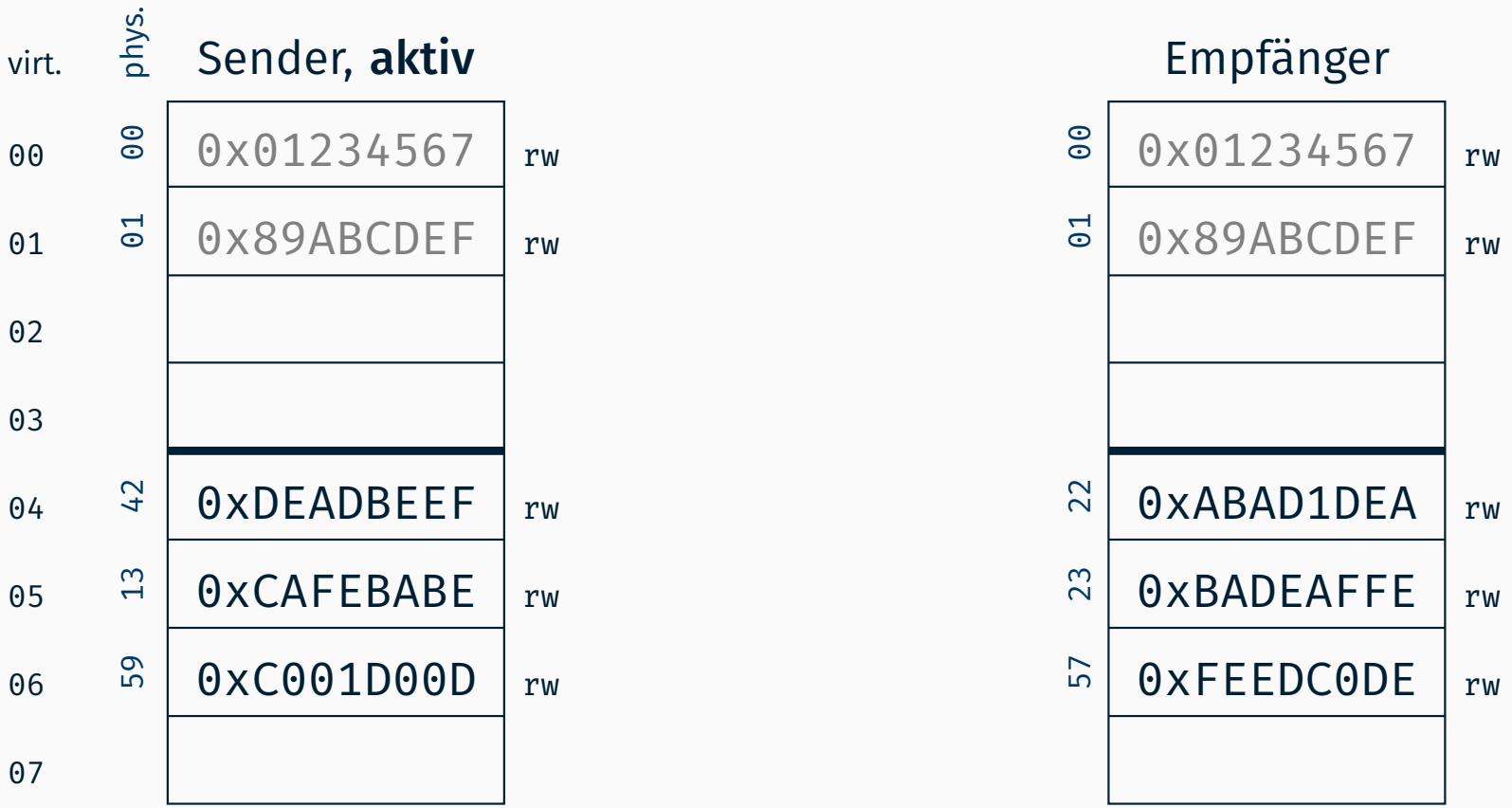
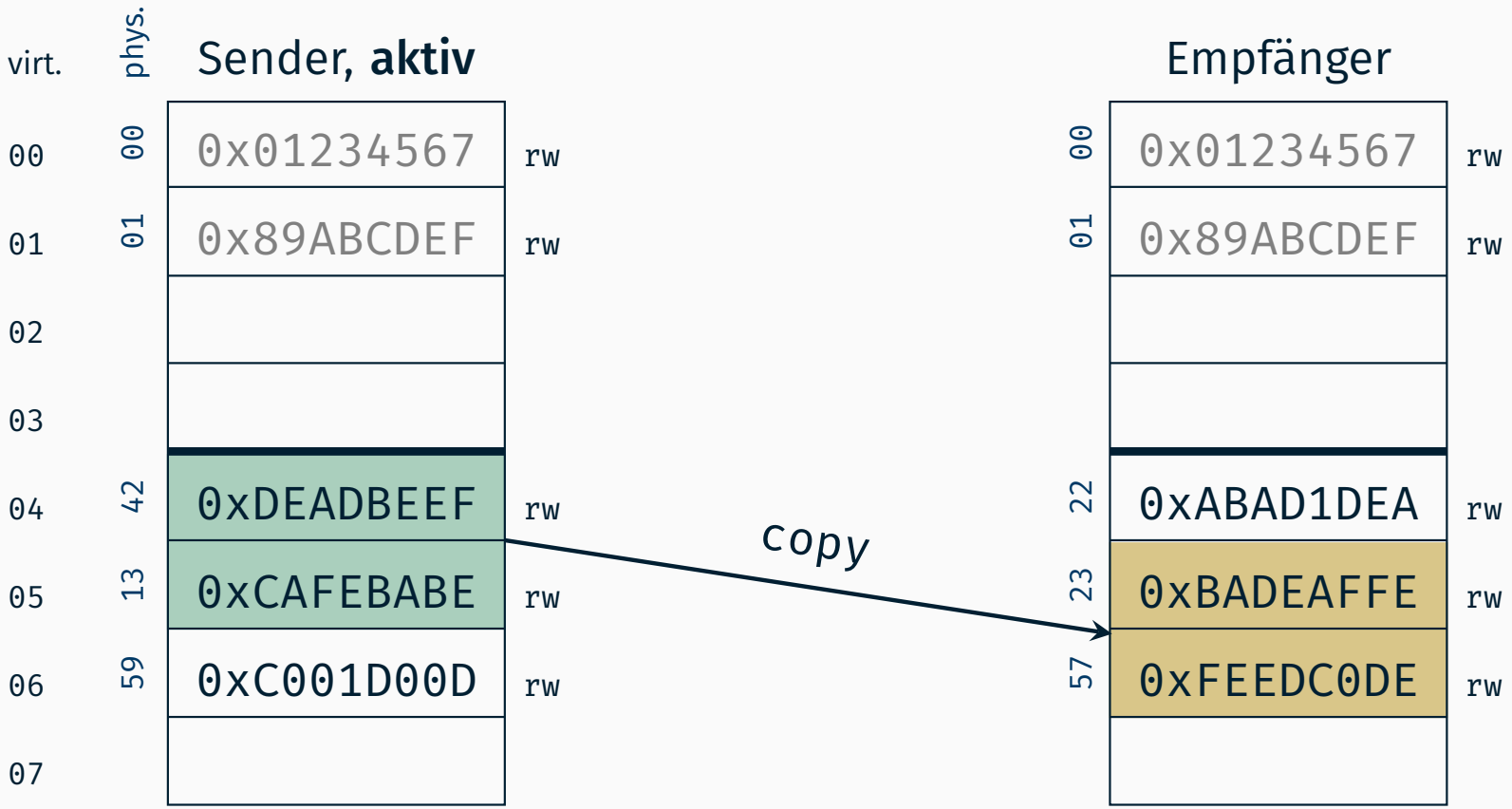


Referenzzähler:

phys.	...	12	13	14	...	21	22	23	...	42	...	57	58	59	...
Ref.	...	0	1	0	...	0	1	1	...	1	...	1	0	1	...

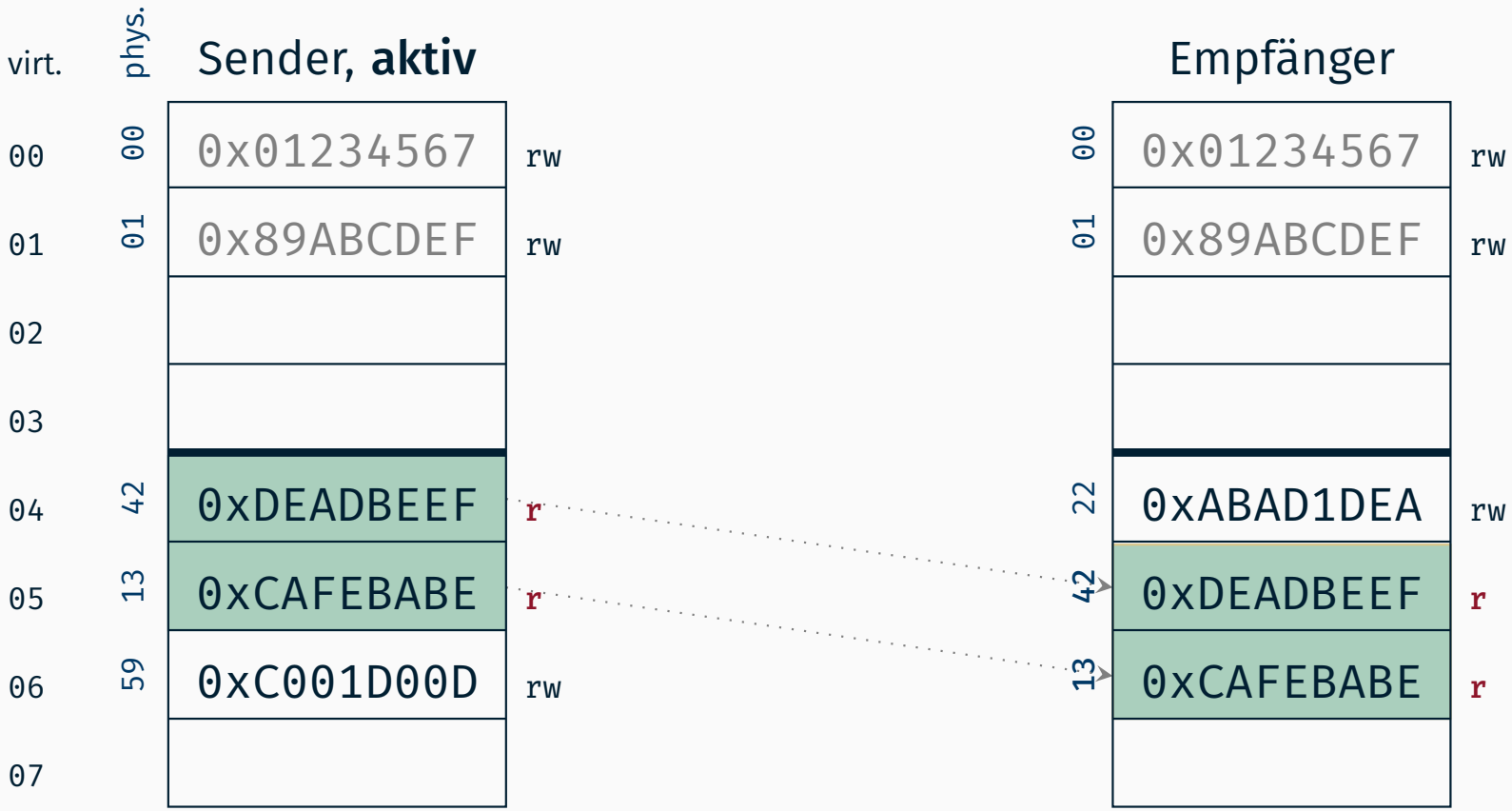
Copy-on-Write



Referenzzähler:

phys.	...	12	13	14	...	21	22	23	...	42	...	57	58	59	...
Ref.	...	0	1	0	...	0	1	1	...	1	...	1	0	1	...

Copy-on-Write



Referenzzähler:

phys.	...	12	13	14	...	21	22	23	...	42	...	57	58	59	...
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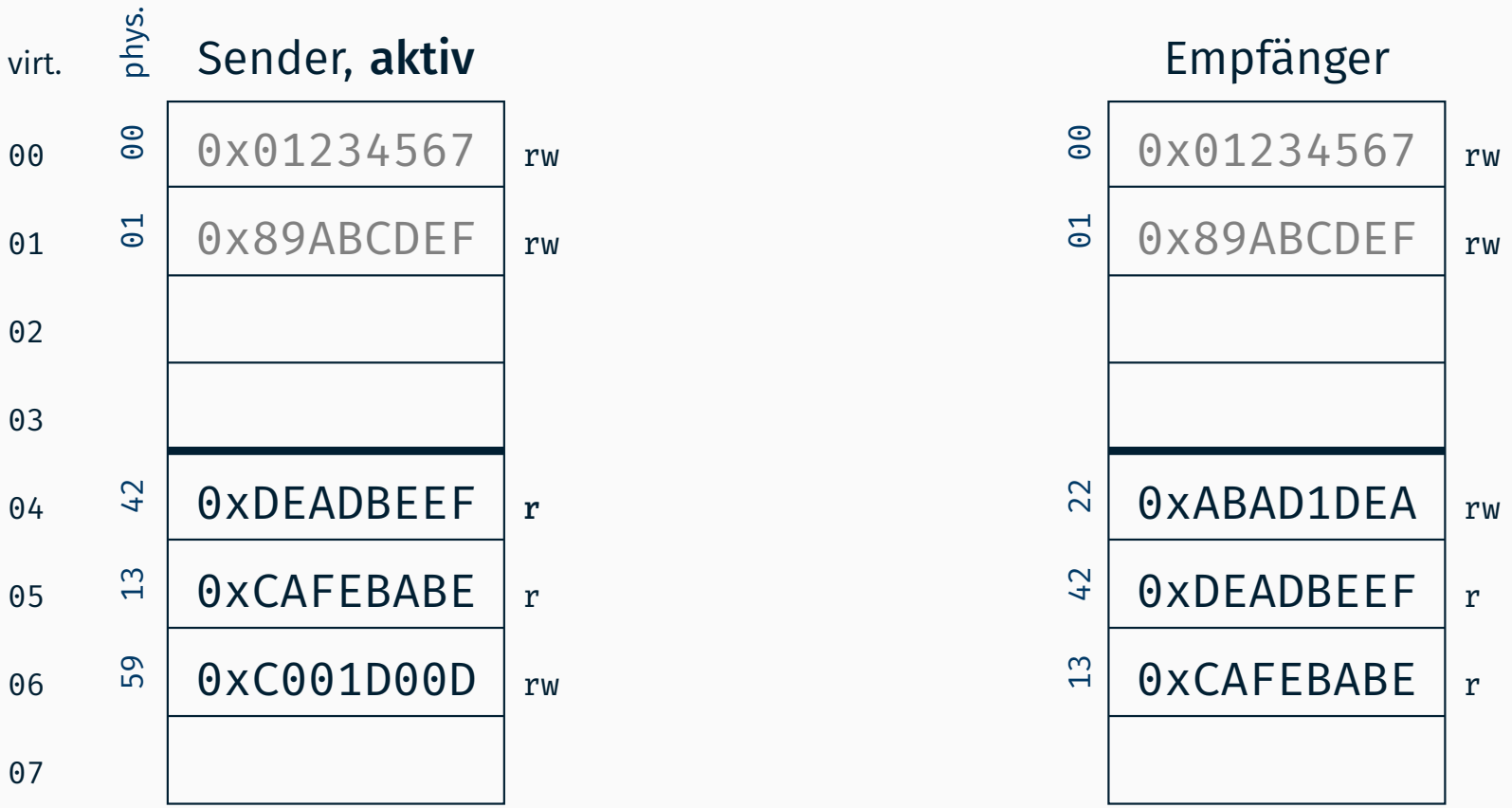
Copy-on-Write



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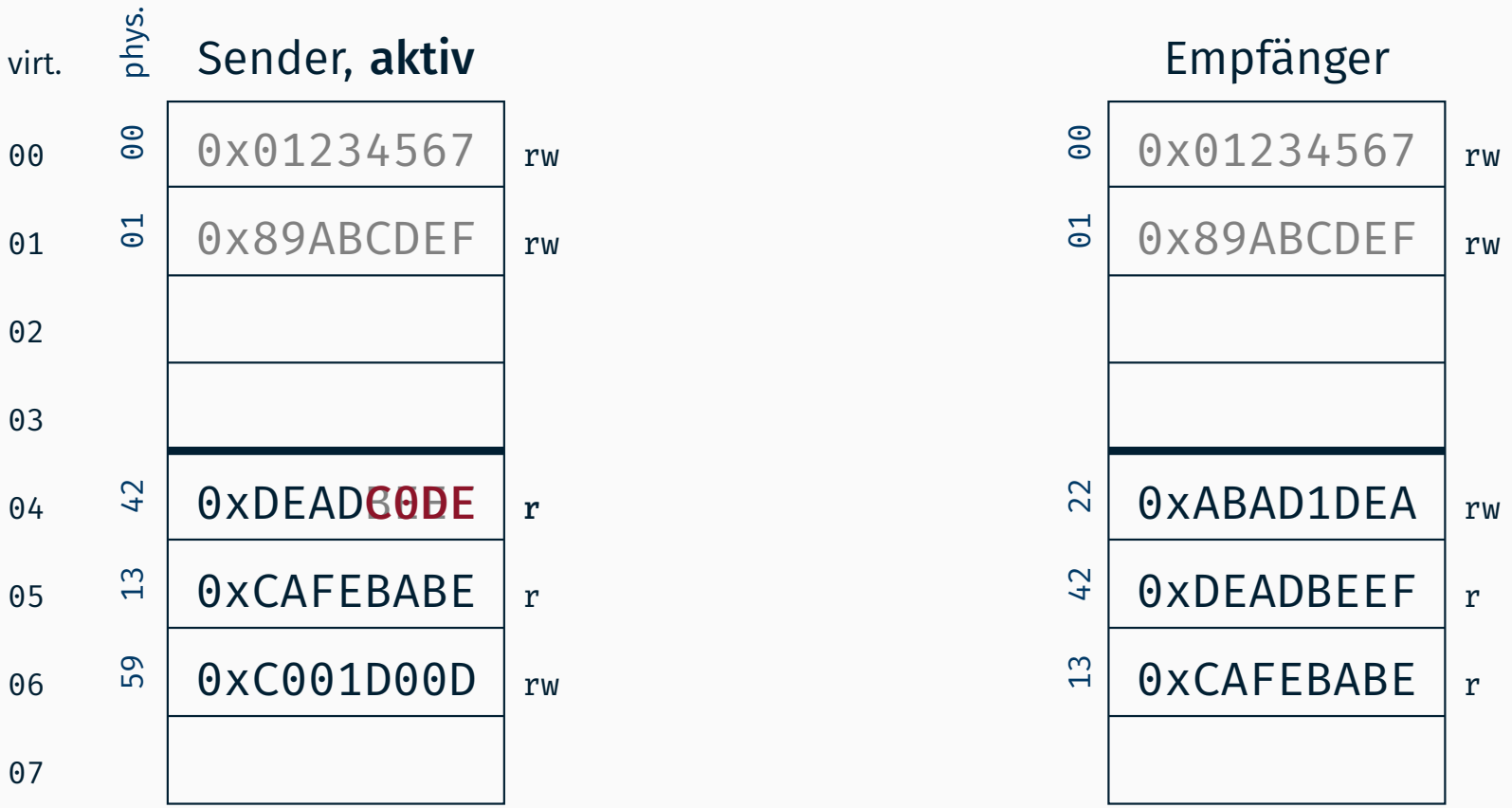
phys.	...	12	13	14	...	21	22	23	...	42	...	57	58	59	...
Ref.	...	0	2	0	...	0	1	0	...	2	...	0	0	1	...

Copy-on-Write



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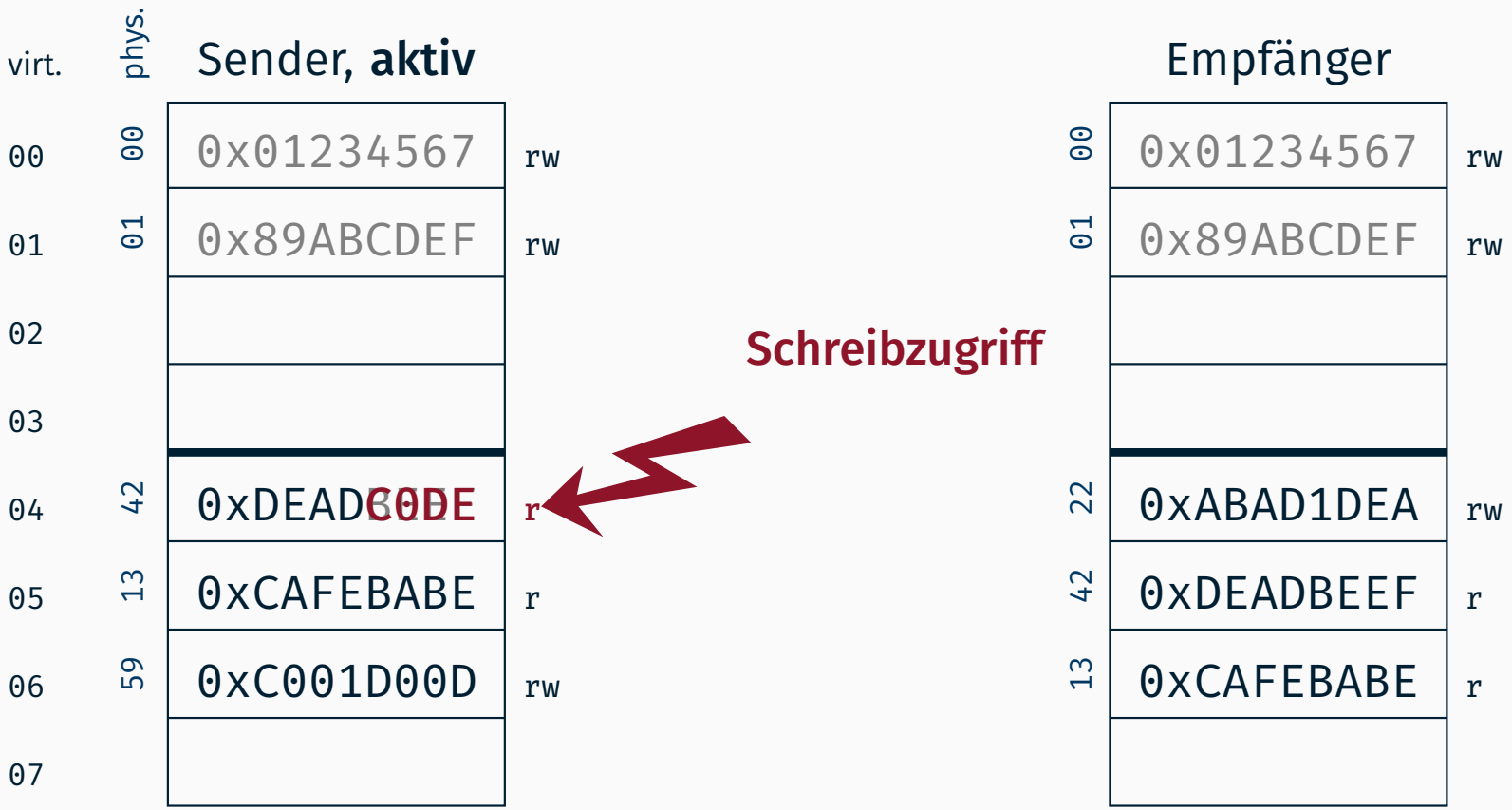
Ref.	...	0	2	0	...	0	1	0	...	2	...	0	0	1	...

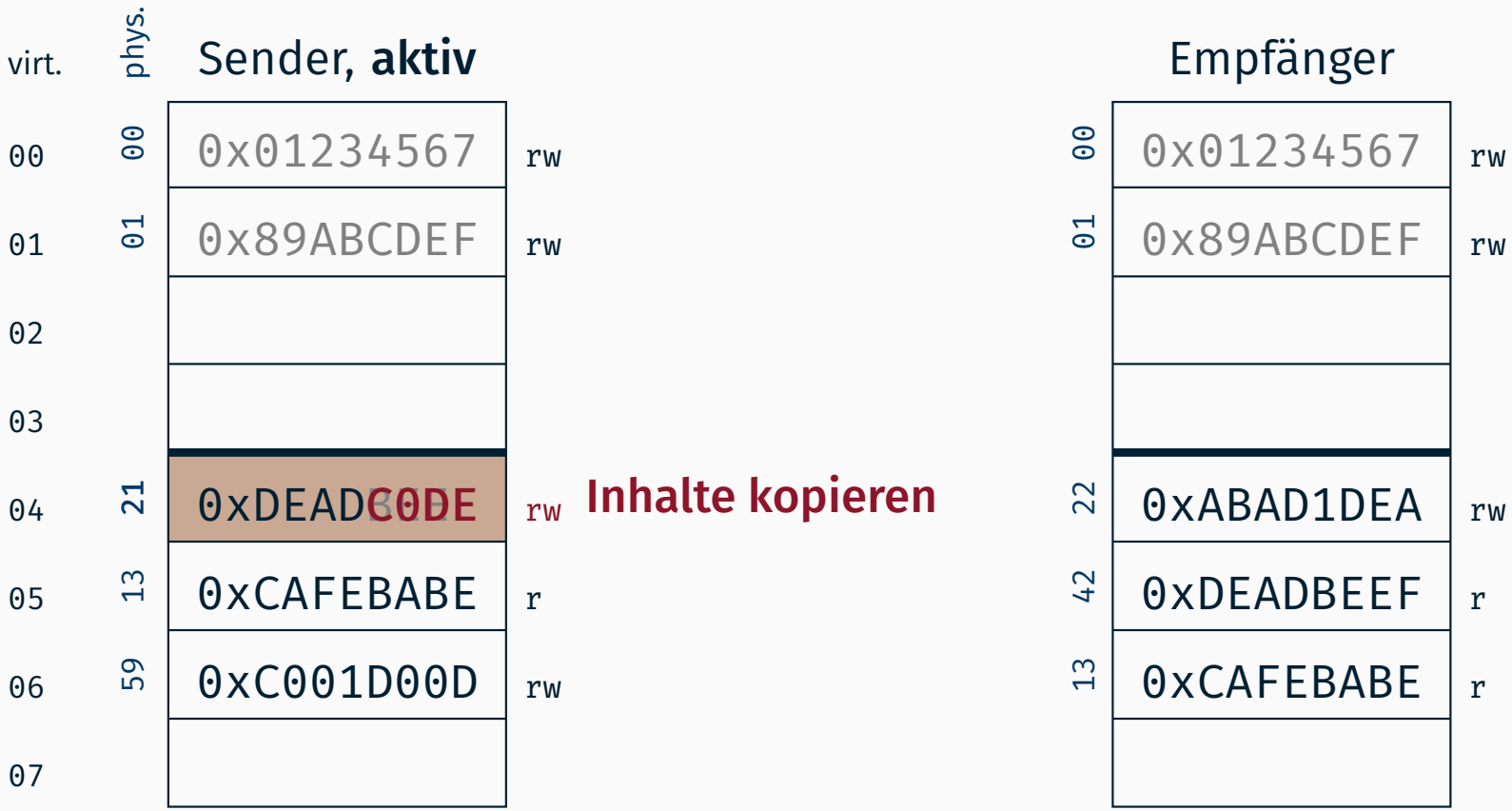
Copy-on-Write



Referenzzähler:

phys.	...	12	13	14	...	21	22	23	...	42	...	57	58	59	...
Ref.	...	0	2	0	...	0	1	0	...	2	...	0	0	1	...

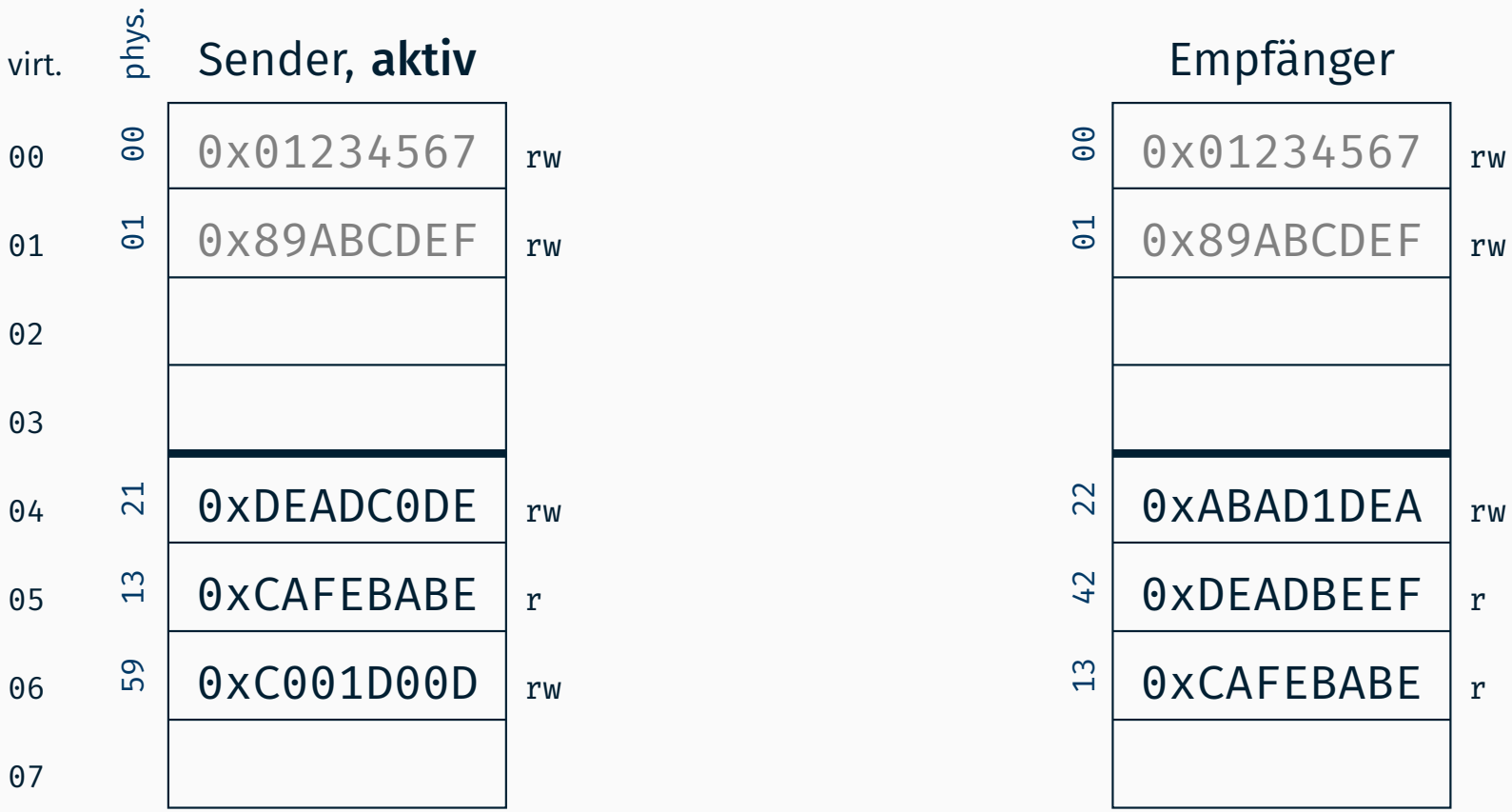
Copy-on-Write



Referenzzähler:

phys.	...	12	13	14	...	21	22	23	...	42	...	57	58	59	...
Ref.	...	0	2	0	...	1	1	0	...	1	...	0	0	1	...

Copy-on-Write



Referenzzähler:

phys.	...	12	13	14	...	21	22	23	...	42	...	57	58	59	...
Ref.	...	0	2	0	...	1	1	0	...	1	...	0	0	1	...

Seitenfehler-Behandlung

Umsetzung von Copy-on-Write mittels Pagefaults (`int 14/0xe`)

- eigener Handler, parallel zu Systemaufruf und Interrupts

Seitenfehler-Behandlung

Umsetzung von Copy-on-Write mittels Pagefaults (`int 14/0xe`)

- eigener Handler, parallel zu Systemaufruf und Interrupts

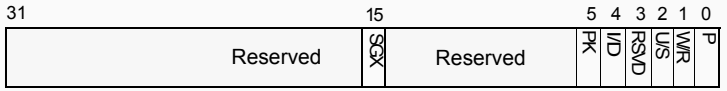
Informationen über Seitenfehler

- Adresse, die Fehler verursacht hat, liegt in `cr2`
- Fehlercode auf dem Kernel-Stack

Seitenfehler-Behandlung (cont.)

Fehlercode auf dem Kernel-Stack

Von Hardware nach dem Kontext abgelegt ($\rightarrow$ wegräumen!)

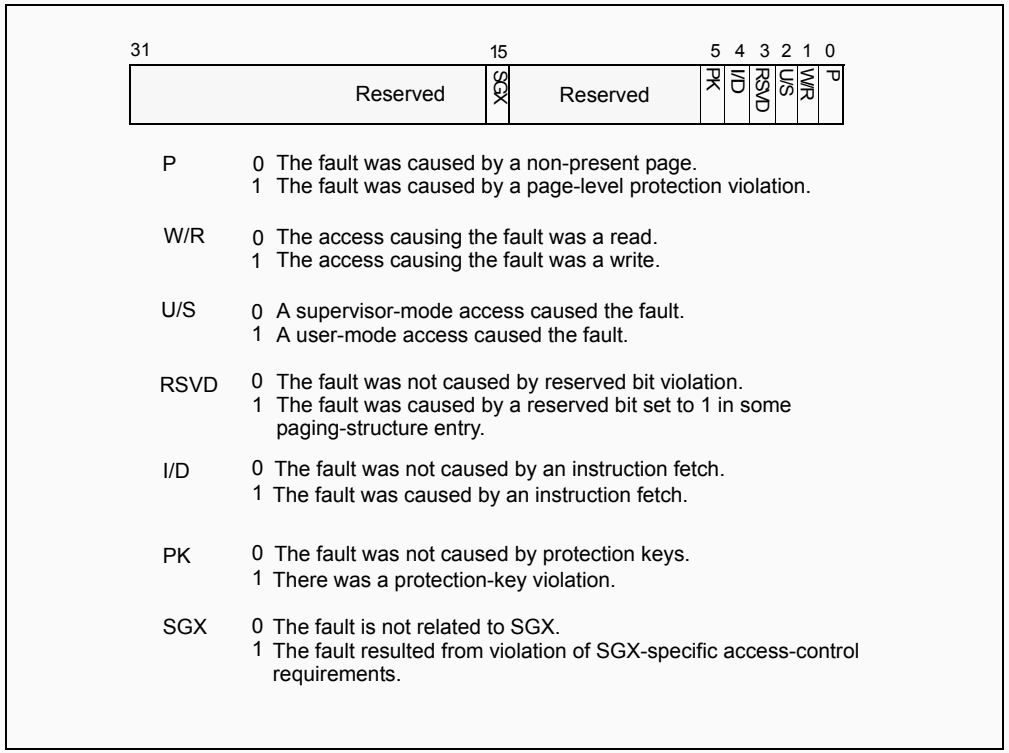


P	0	The fault was caused by a non-present page.
	1	The fault was caused by a page-level protection violation.
W/R	0	The access causing the fault was a read.
	1	The access causing the fault was a write.
U/S	0	A supervisor-mode access caused the fault.
	1	A user-mode access caused the fault.
RSVD	0	The fault was not caused by reserved bit violation.
	1	The fault was caused by a reserved bit set to 1 in some paging-structure entry.
I/D	0	The fault was not caused by an instruction fetch.
	1	The fault was caused by an instruction fetch.
PK	0	The fault was not caused by protection keys.
	1	There was a protection-key violation.
SGX	0	The fault is not related to SGX.
	1	The fault resulted from violation of SGX-specific access-control requirements.

Seitenfehler-Behandlung (cont.)

Fehlercode auf dem Kernel-Stack

Von Hardware nach dem Kontext abgelegt ($\rightarrow$ wegräumen!)



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	1	There was a protection-key violation.
SGX	0	The fault is not related to SGX.
	1	The fault resulted from violation of SGX-specific access-control requirements.

Copy-on-Write: `P=1`, `W/R=1`, `U/S=1`, PT-Eintrag read-only

Neue Prozesse erzeugen

Wir implementieren `fork`

- Soll **Copy-on-Write** für gesamten User-Bereich nutzen (auch Stack!)
- Rückgabewert: ID des jeweils anderen

- Neuer Prozess $\rightarrow$ Wechsel von Ring 0 nach Ring 3
  $\Rightarrow$ Rückgabewert, Instruktions-/Stapel-Zeiger

Fragen?