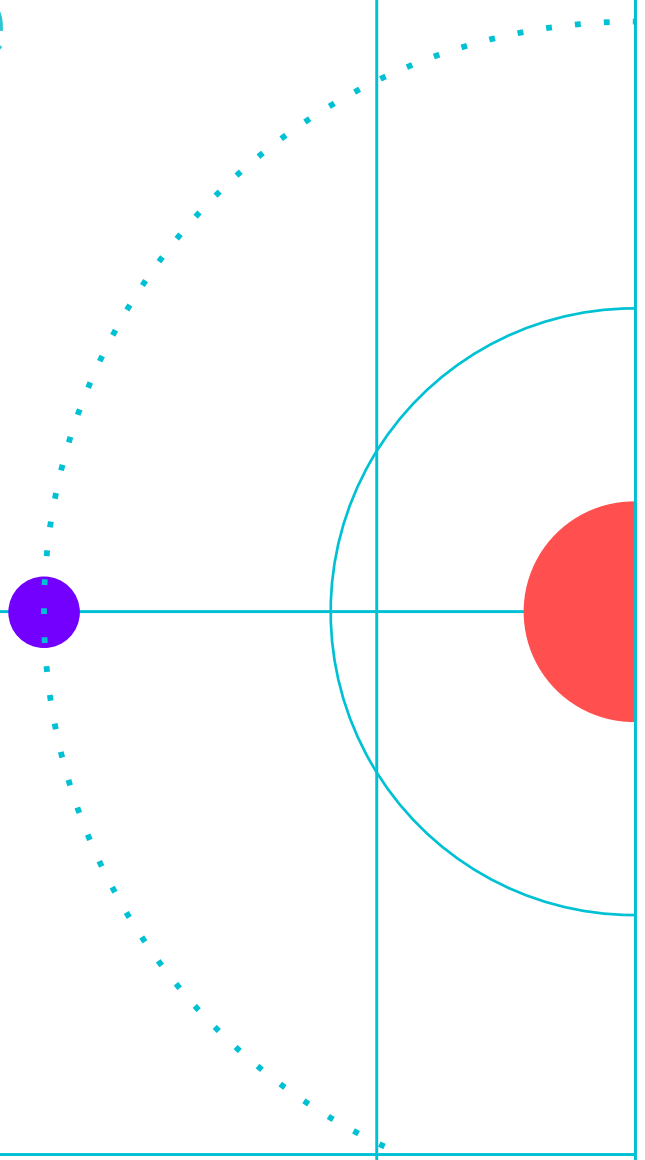
reUpNix: Reconfigurable and Updateable Embedded Systems



TUHH
Technische Universität Hamburg

2023-06-18

Niklas Gollenstede

Sending stuff 🛰️ into space 🚀 is expensive 💰

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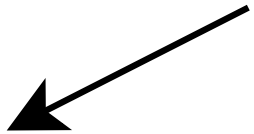
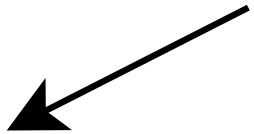


update

Embedded: Updates & Reconfiguration

Sending stuff 🛰️ into space 🚀 is expensive 💰



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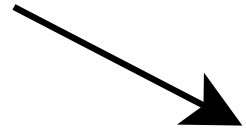

reconfigure

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update

reconfigure

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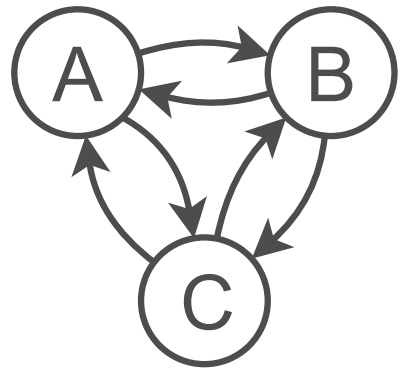
update

reconfigure



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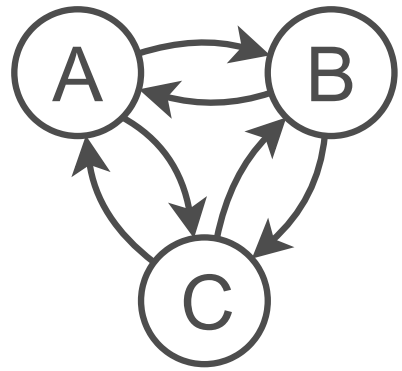
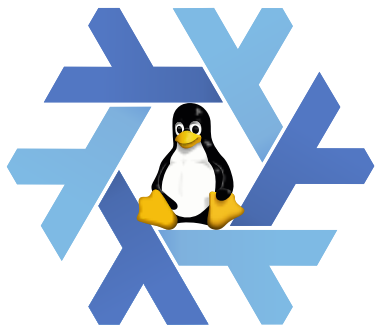
update

reconfigure



NixOS



Embedded: Updates & Reconfiguration

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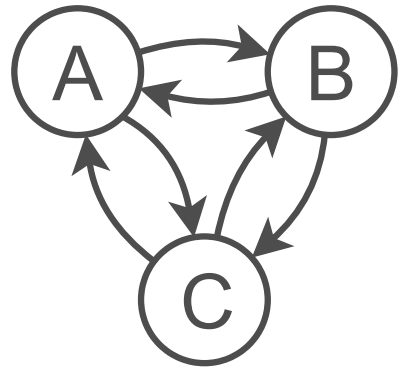
reconfigure



NixOS

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Embedded: Updates & Reconfiguration

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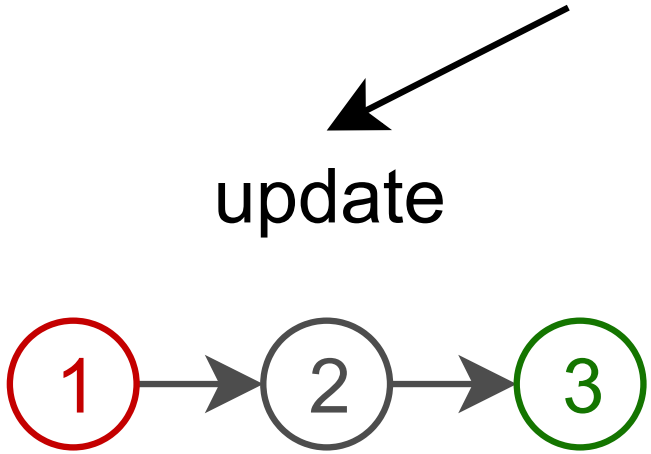
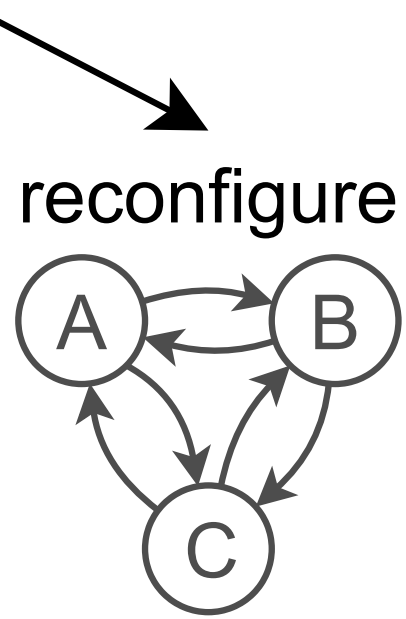
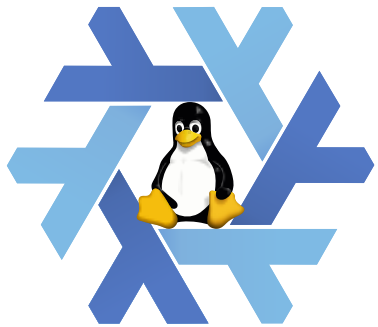




NixOS  : why?

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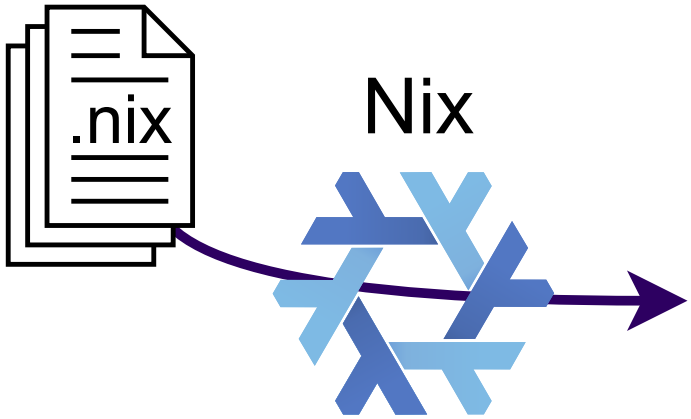
Nix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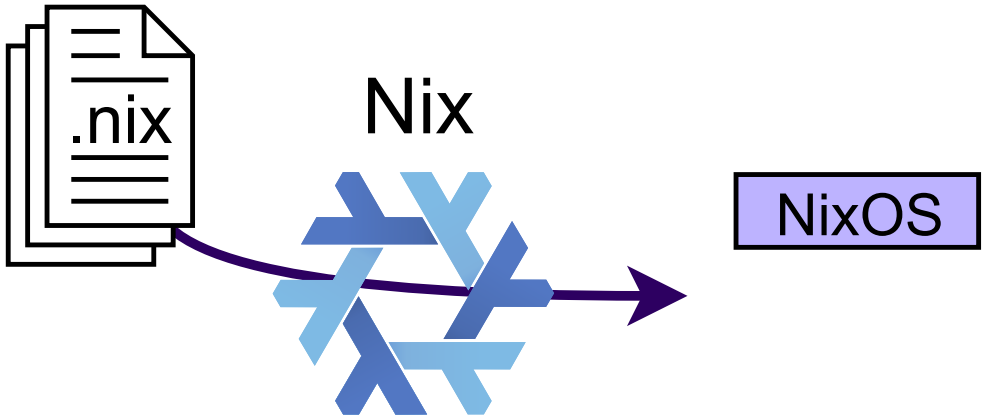
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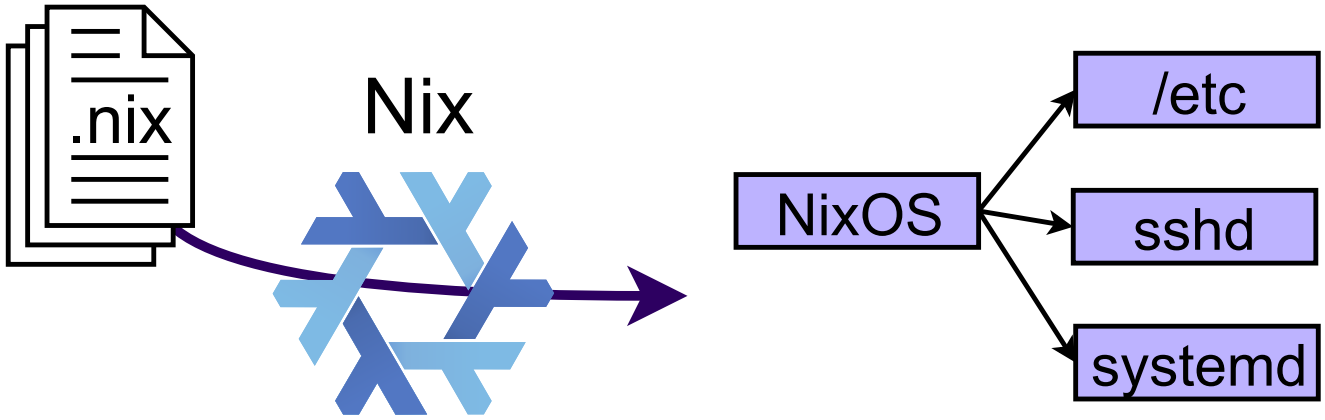
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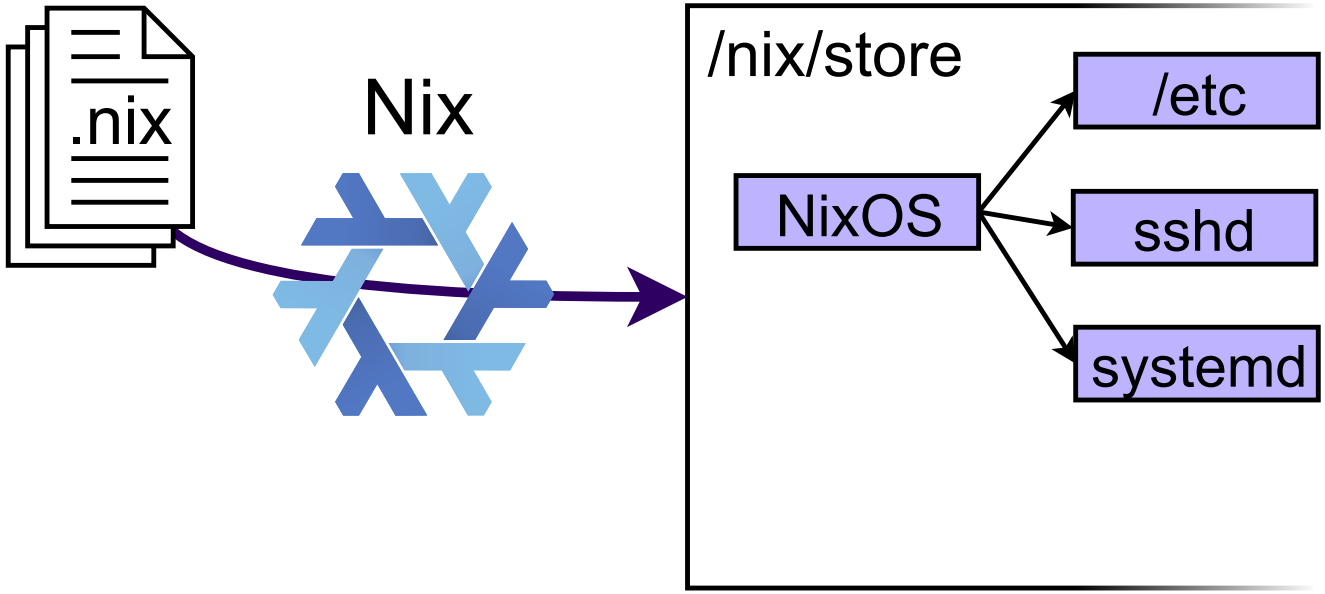
/etc
sshd
systemd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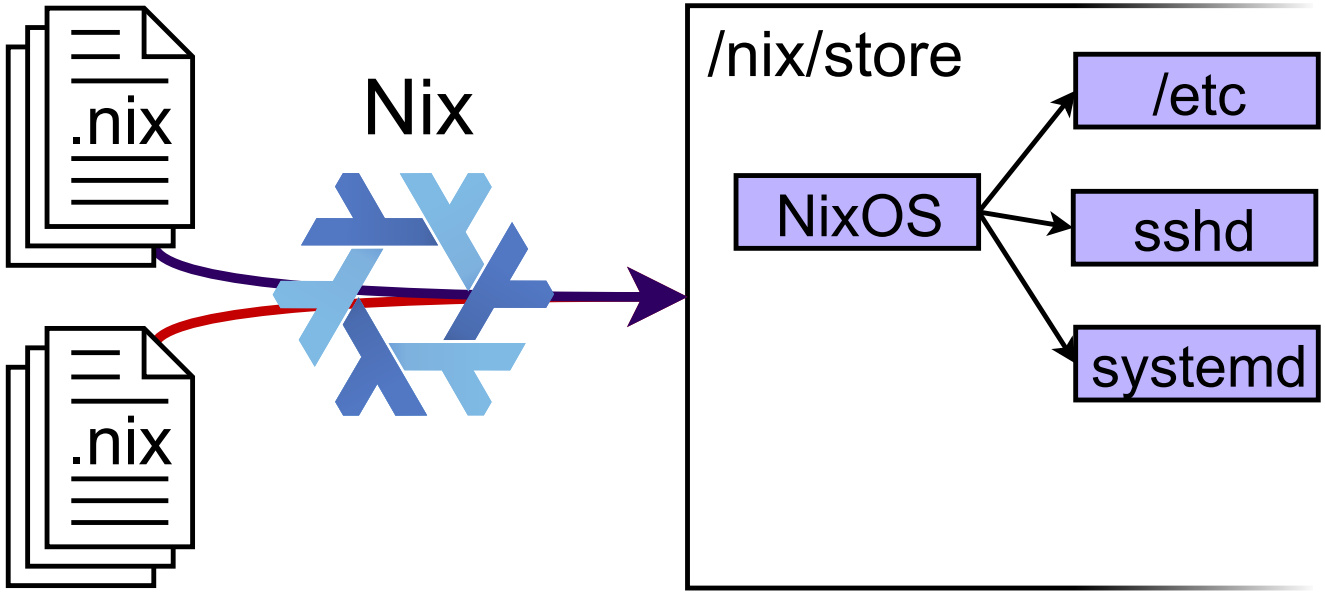
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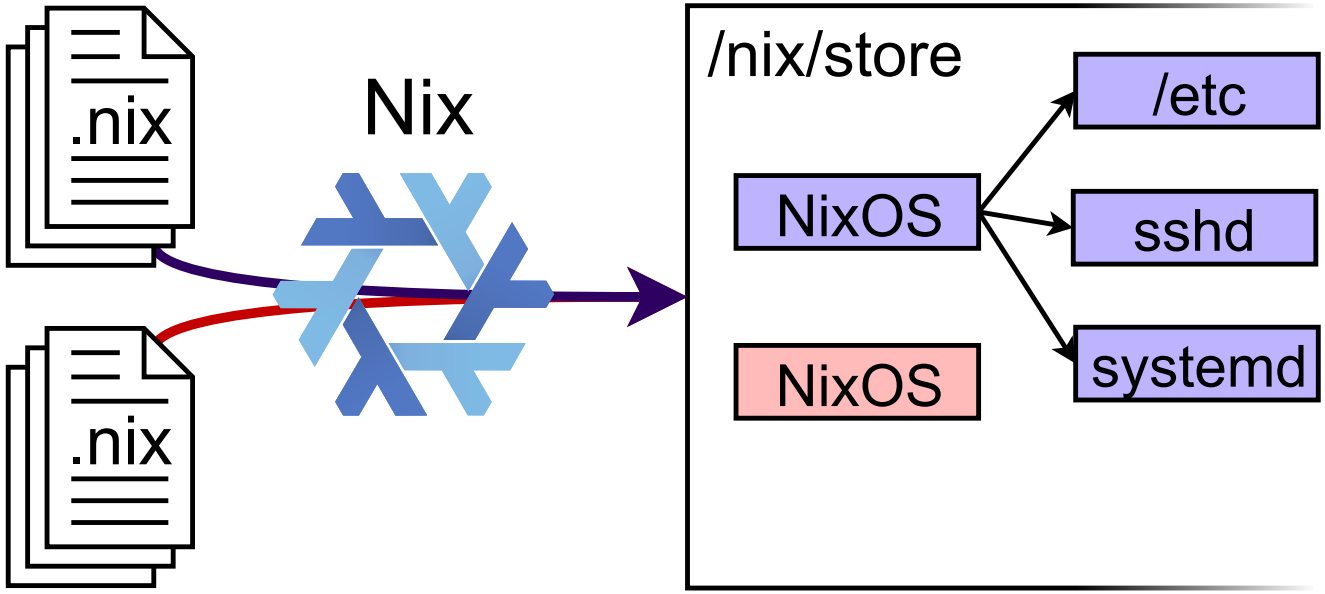
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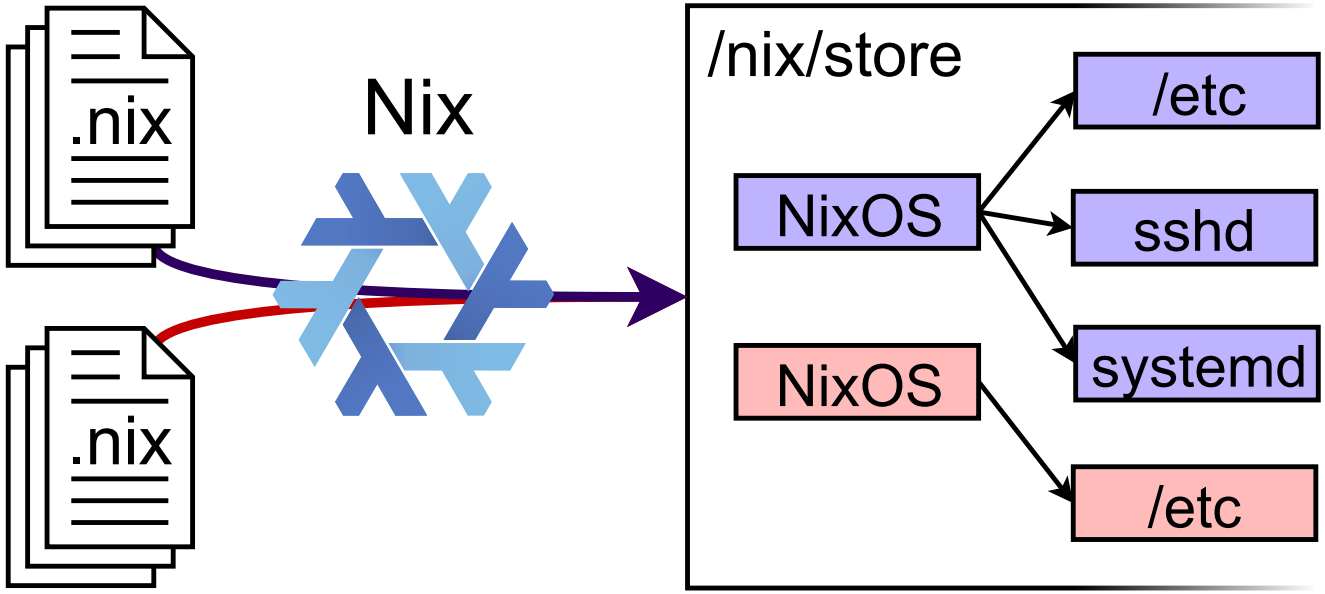
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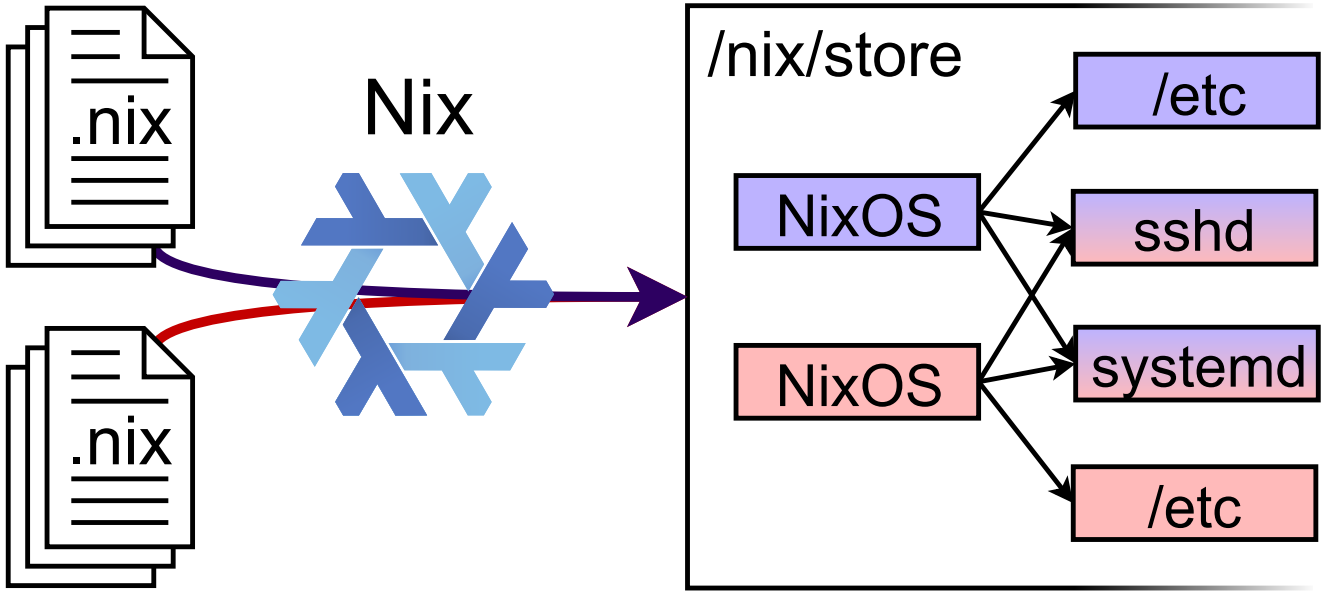
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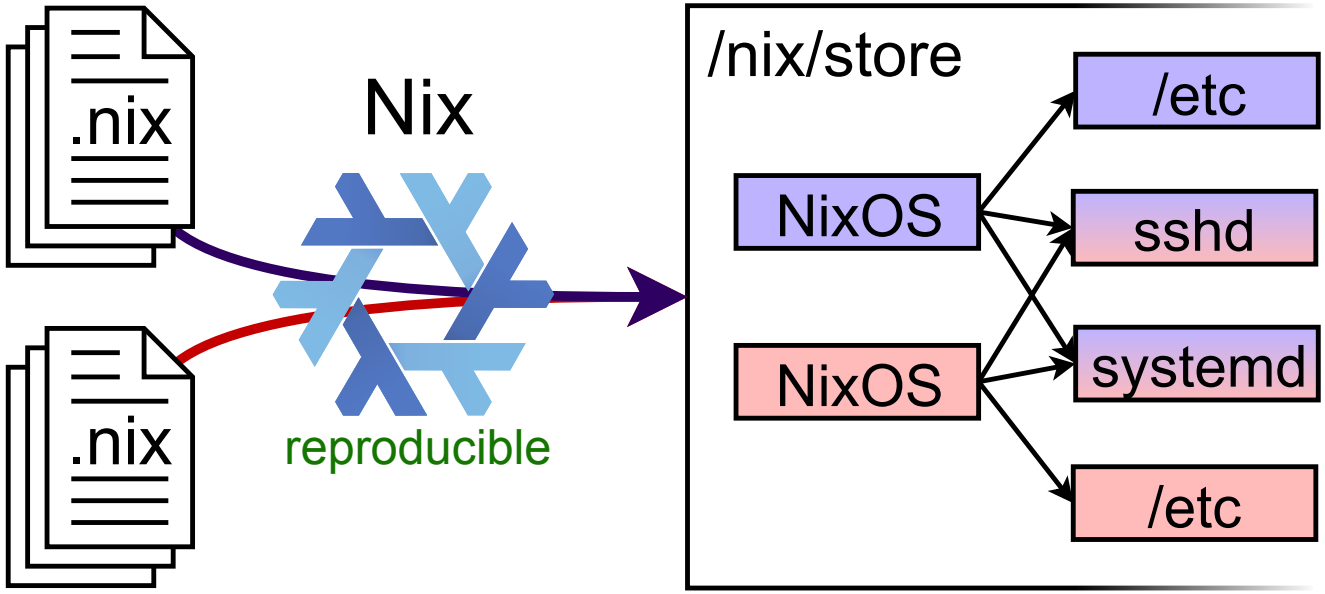
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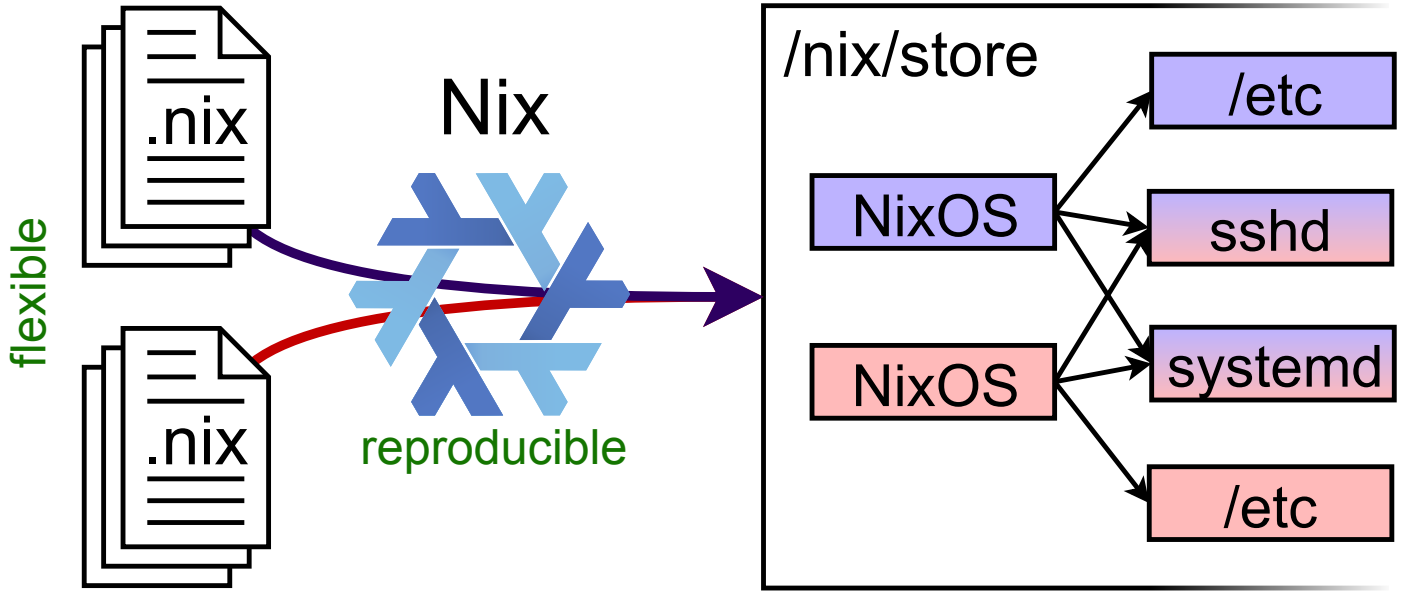
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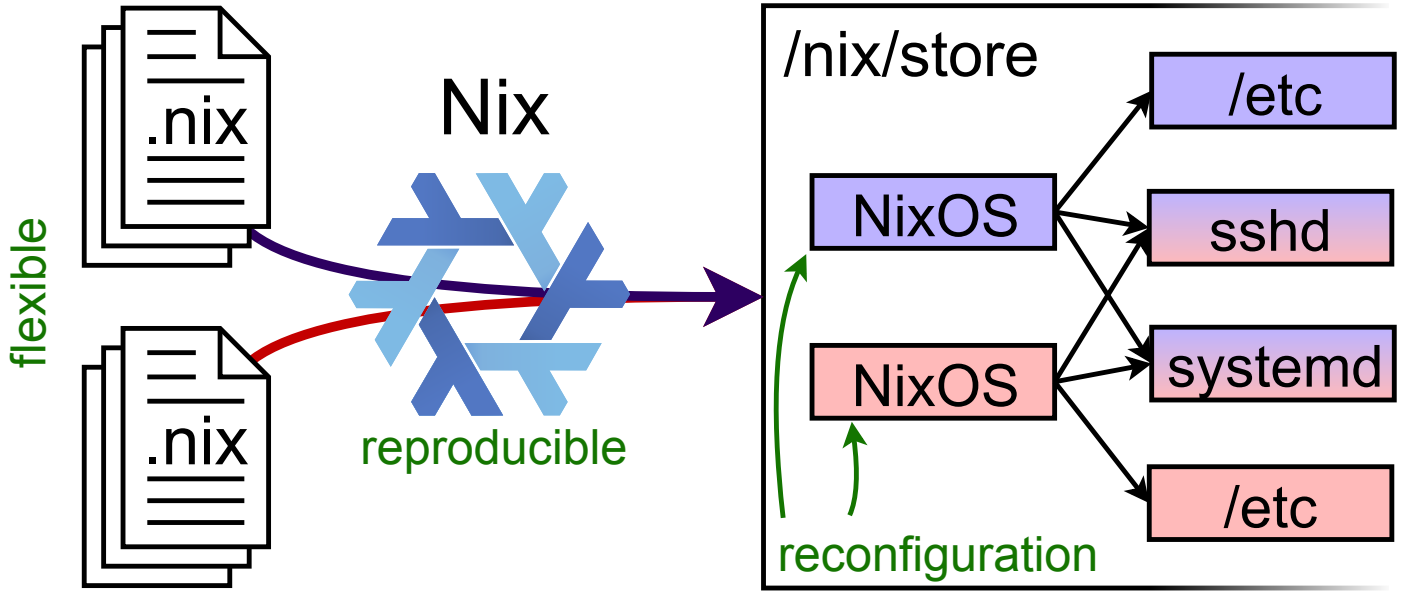
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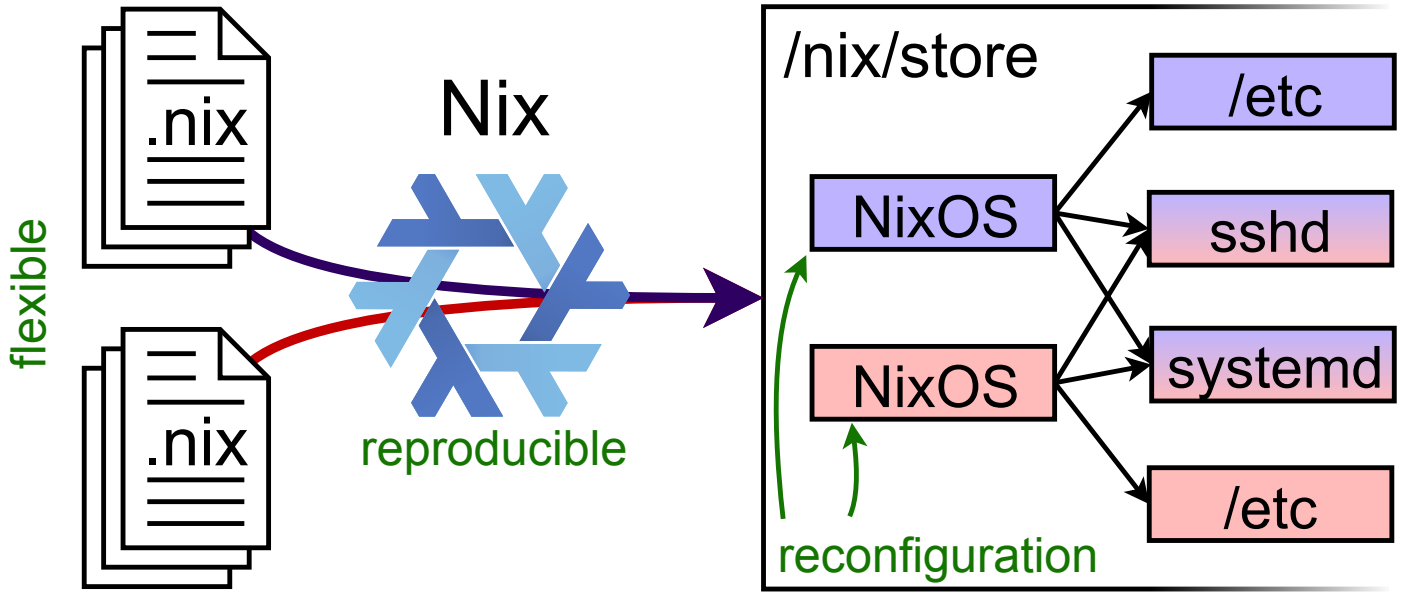
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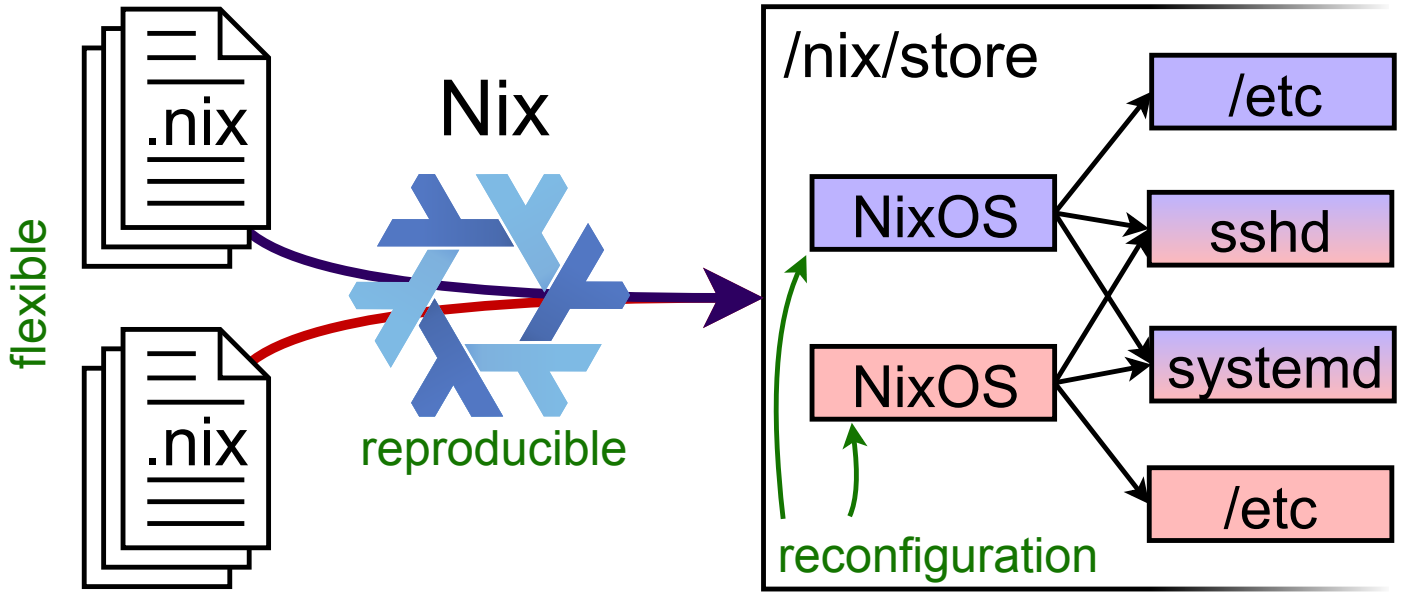
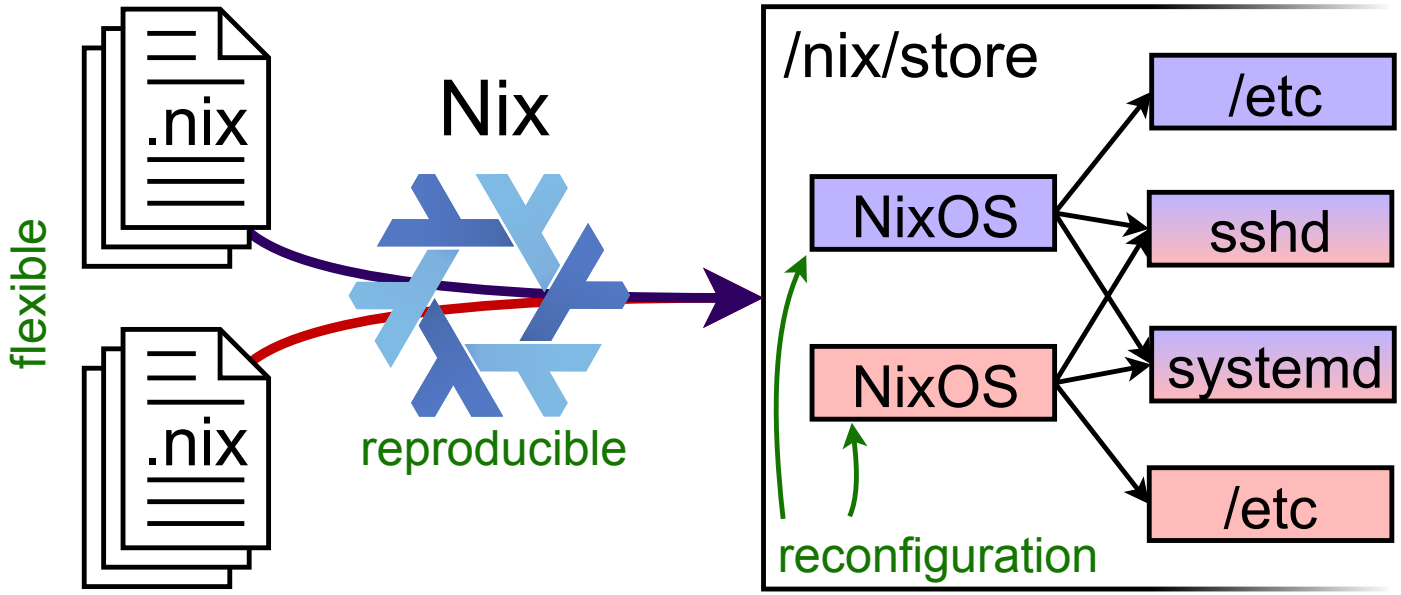
NixOS ✗



NixOS ✗
Large base system

⇒

reUpNix contribution
Shrink (~1.1 GiB → 155 MiB)



NixOS ✗

Large base system ⇒

OCI containers inefficient ⇒

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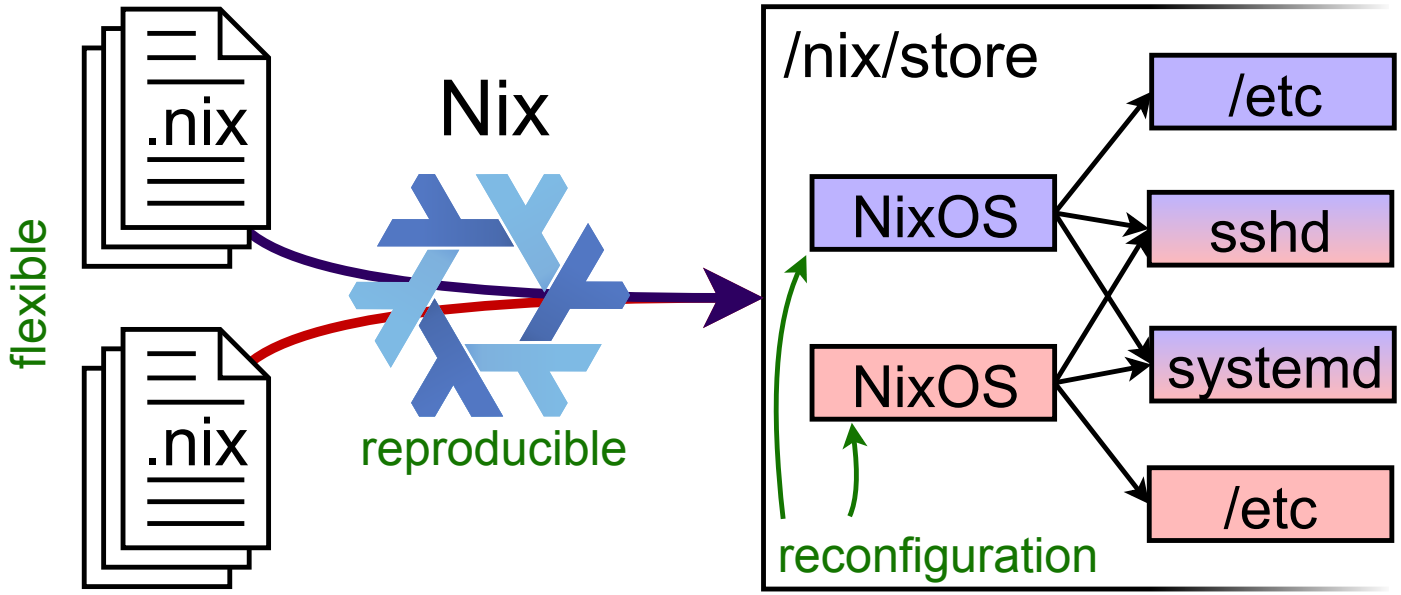
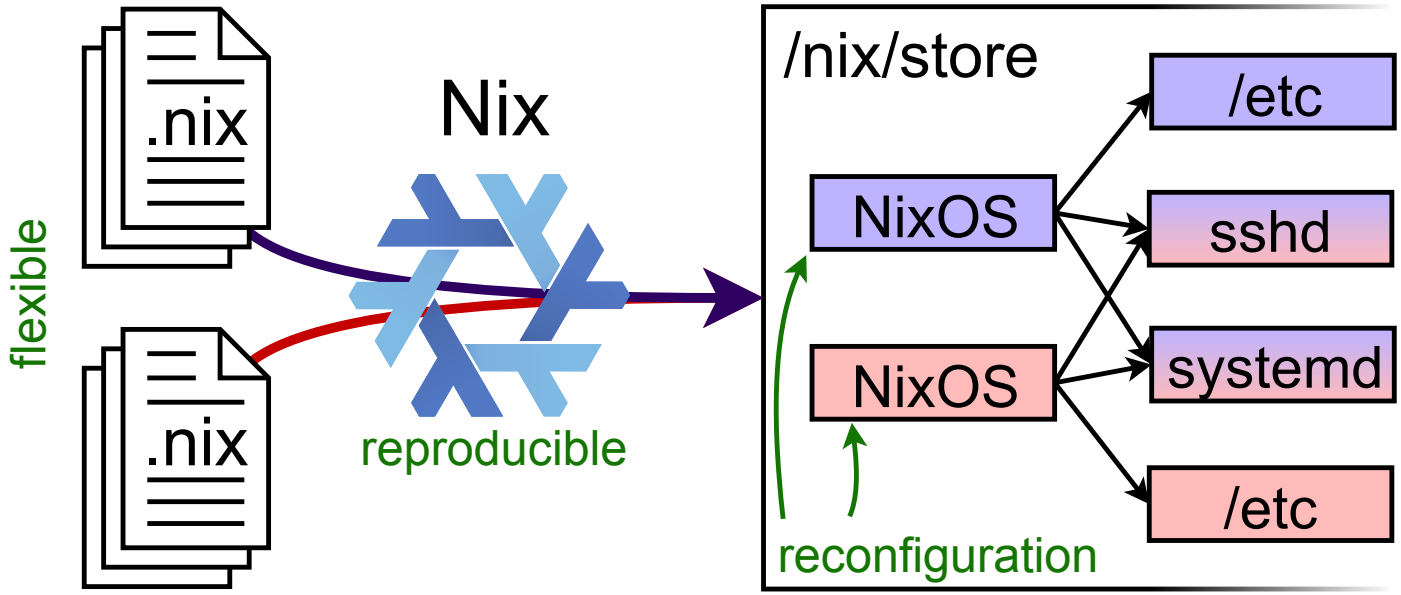
Remove Docker daemon & deduplicate files across images



NixOS ✗		**reUpNix contribution**
Large base system	⇒	Shrink (~1.1 GiB → 155 MiB)
OCI containers inefficient	⇒	Remove Docker daemon & deduplicate files across images
Large system updates	⇒	Differential update transfer



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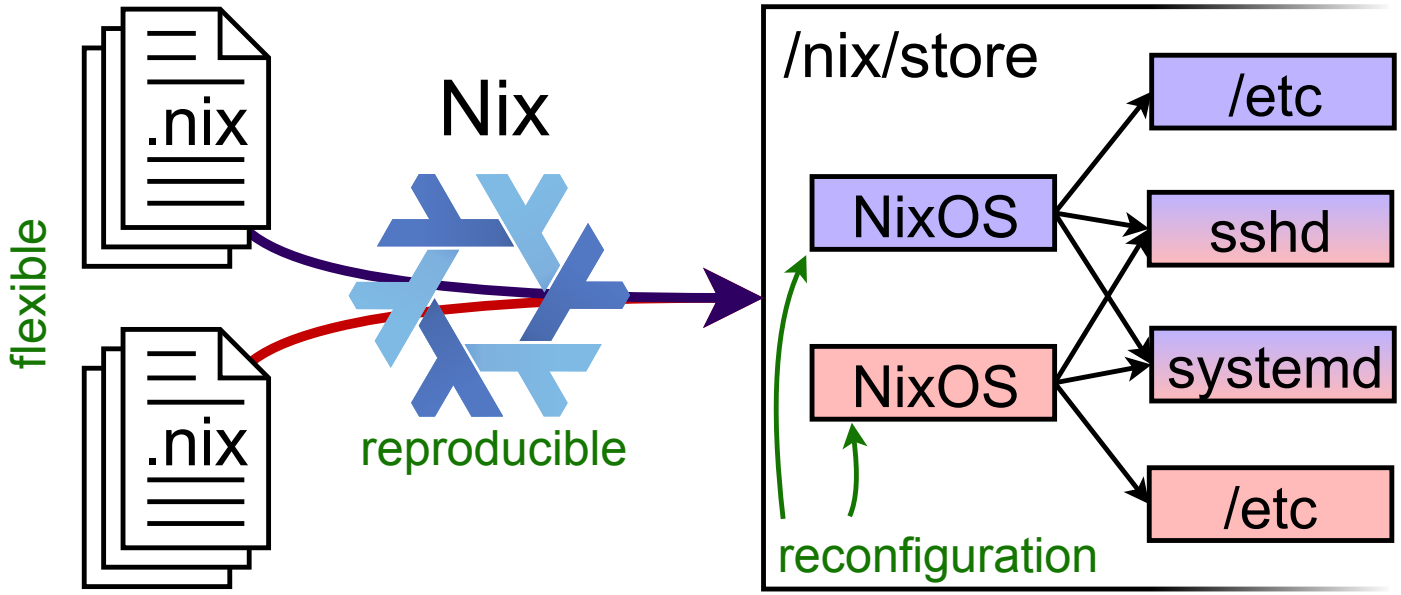

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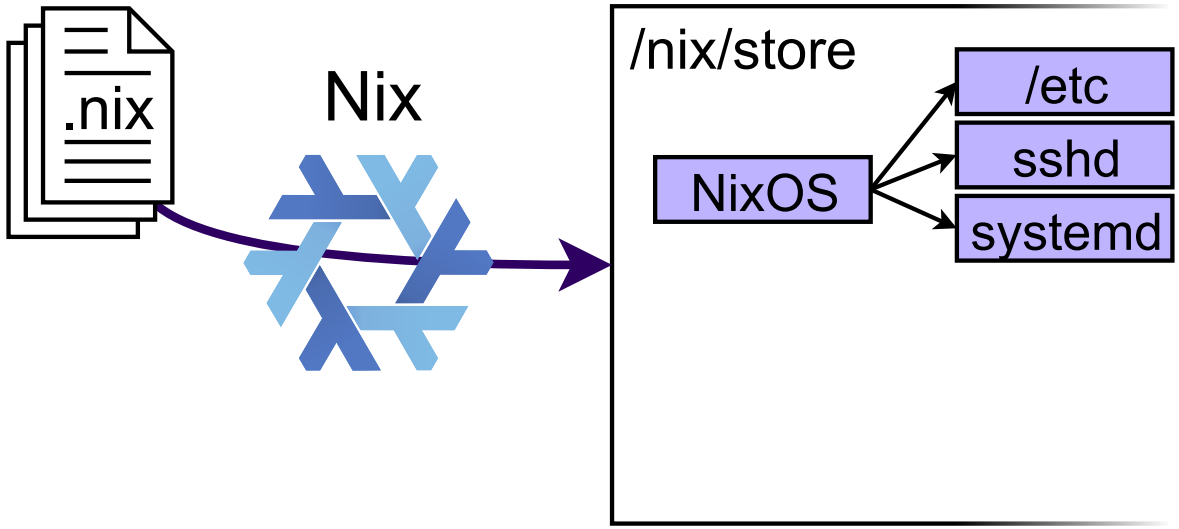
Differential Update Transfer



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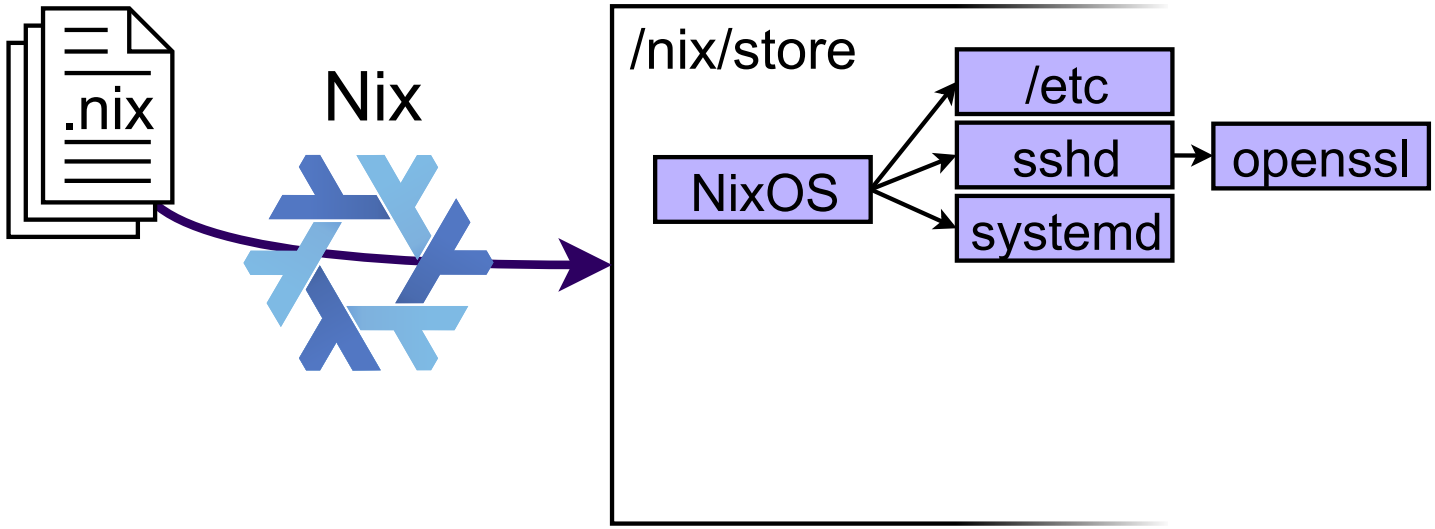

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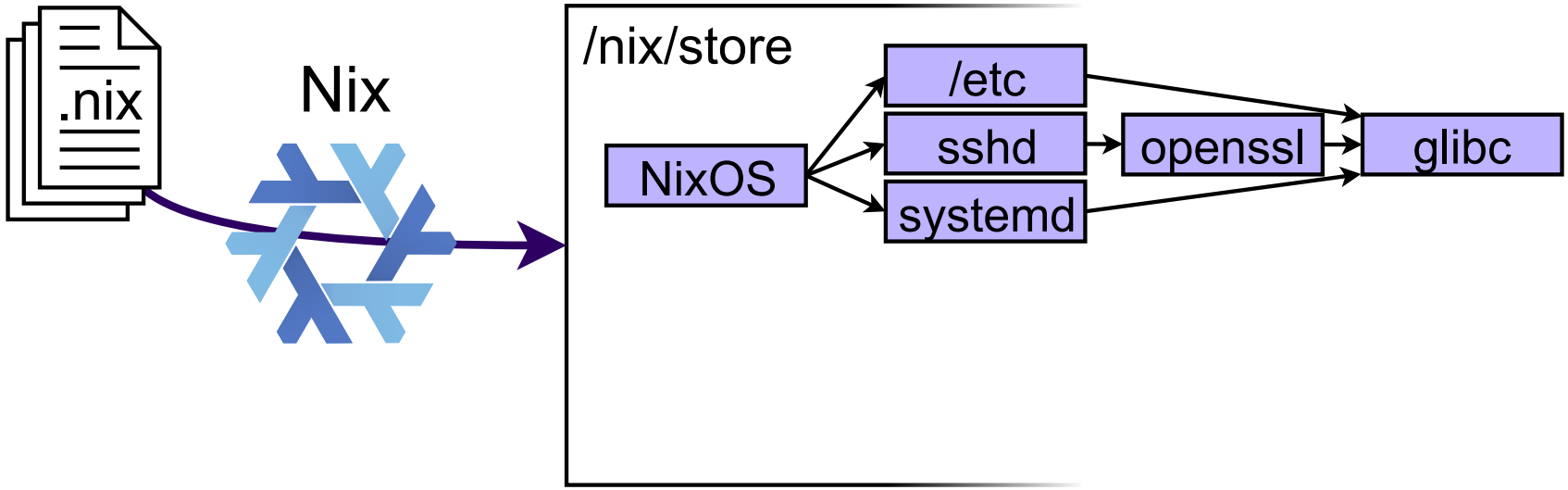

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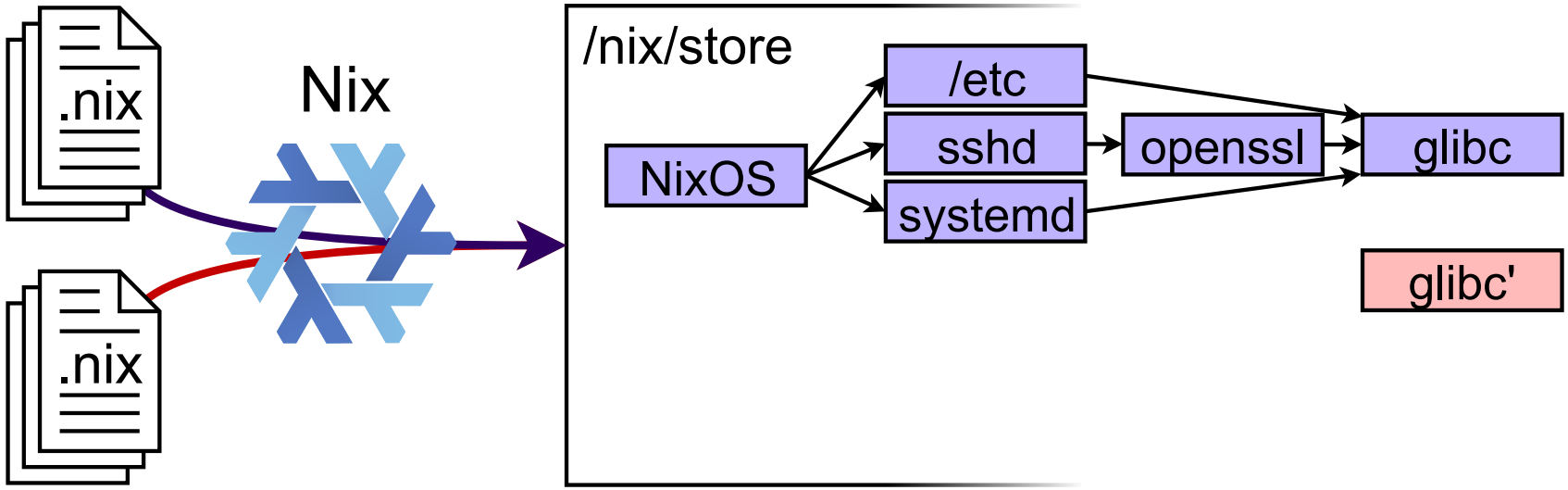

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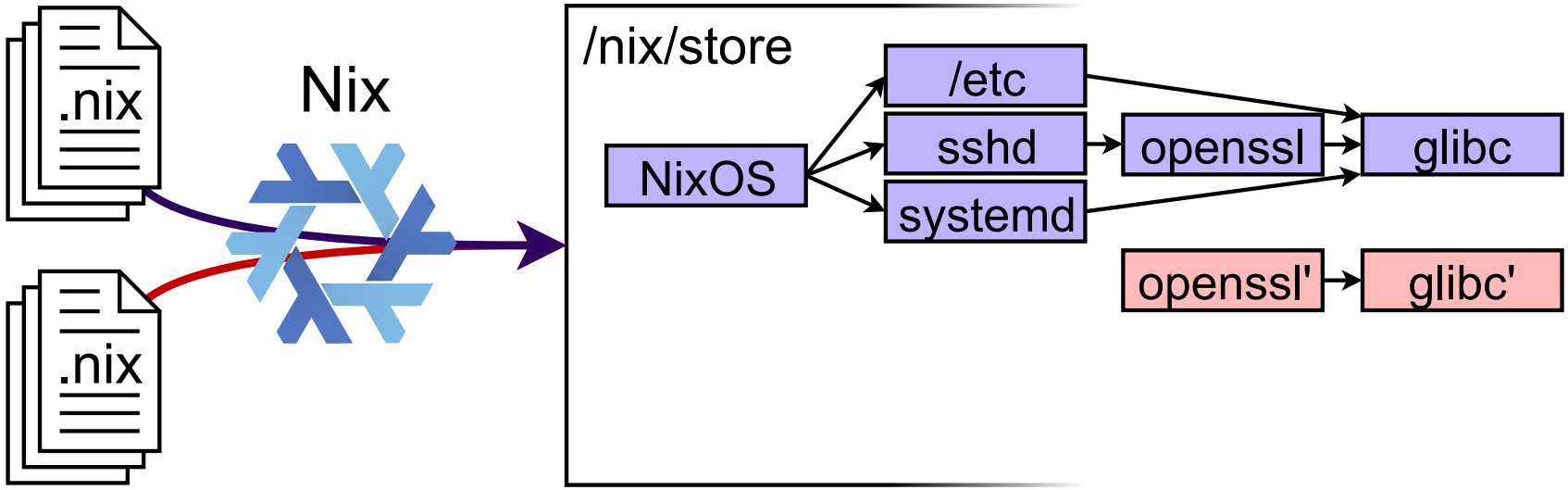

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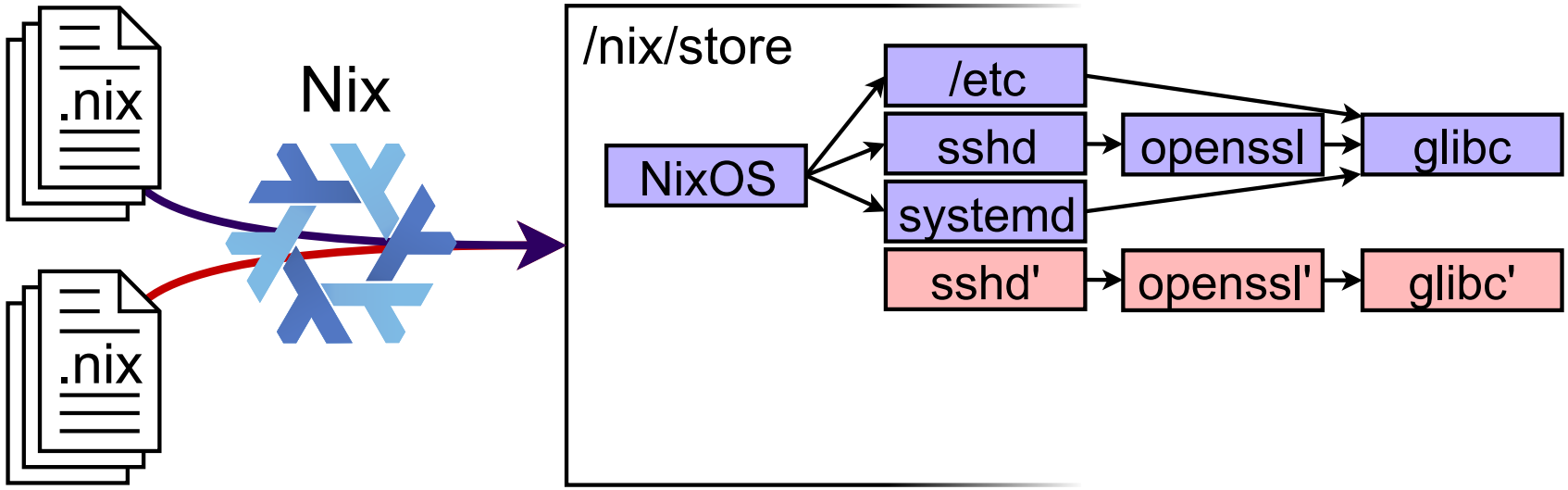

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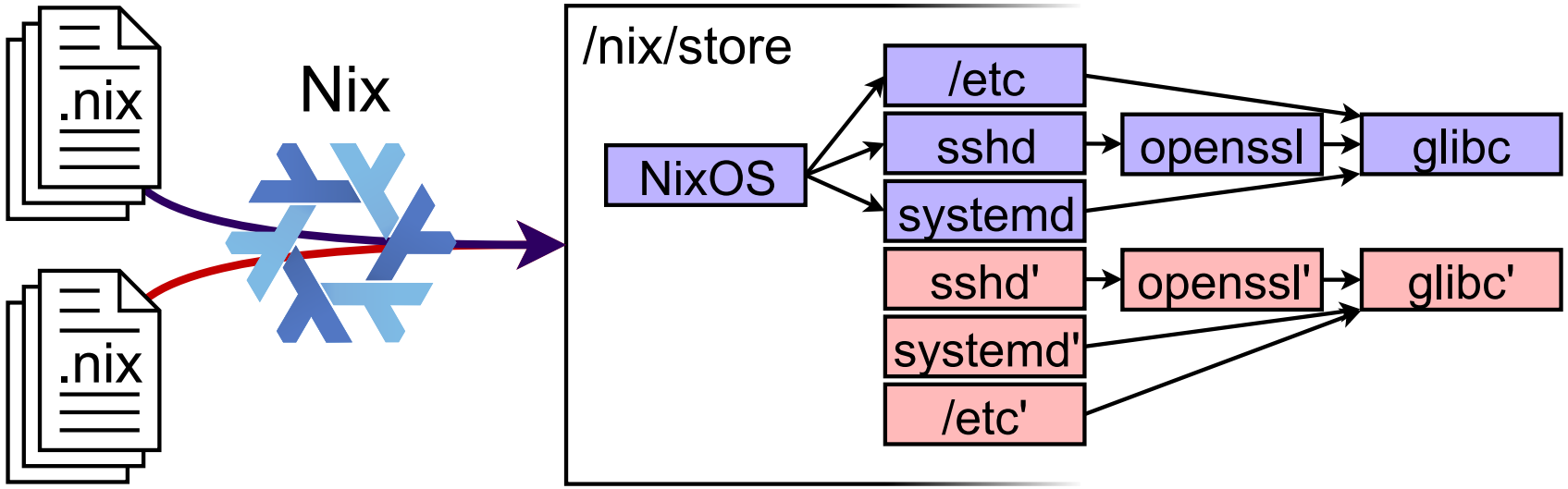

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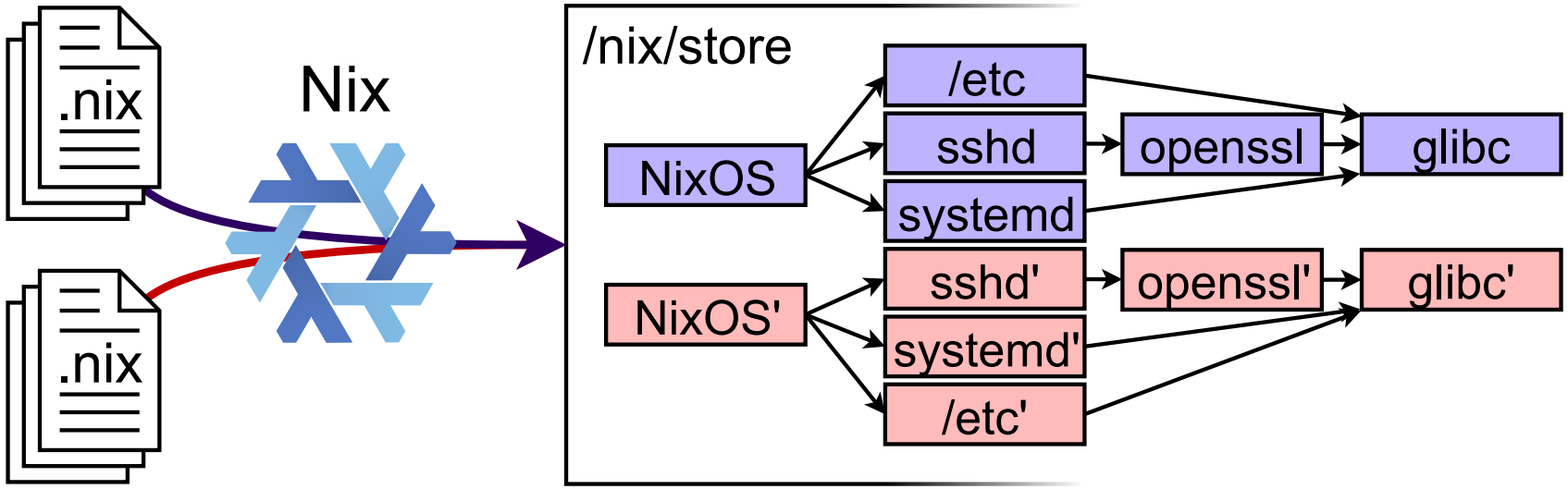

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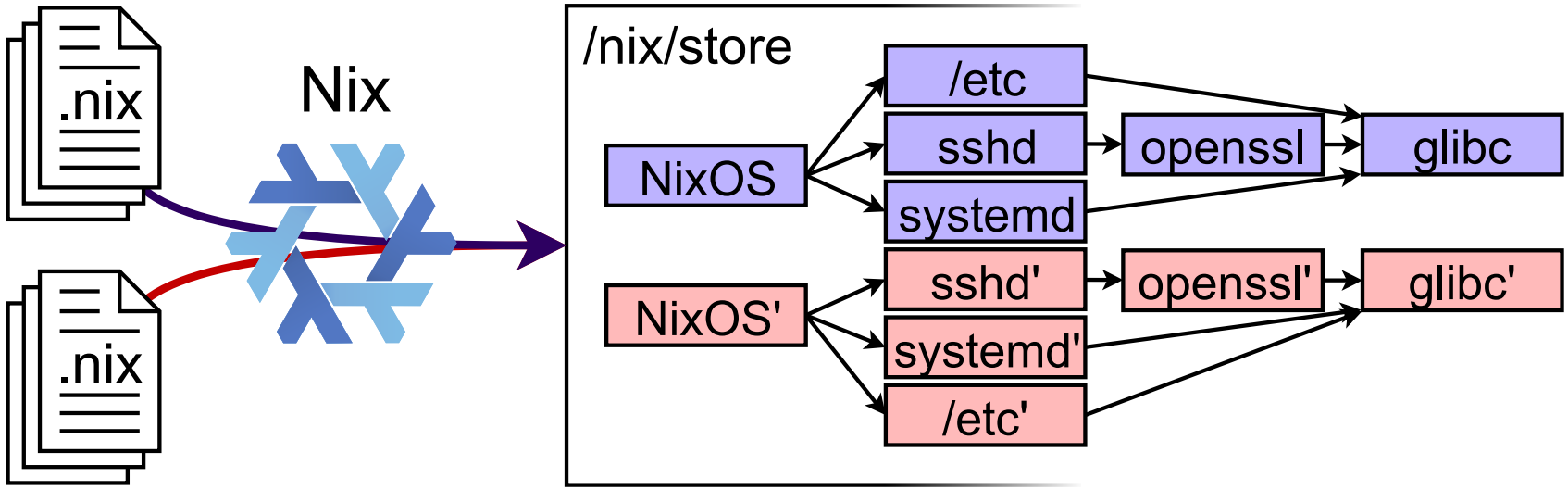
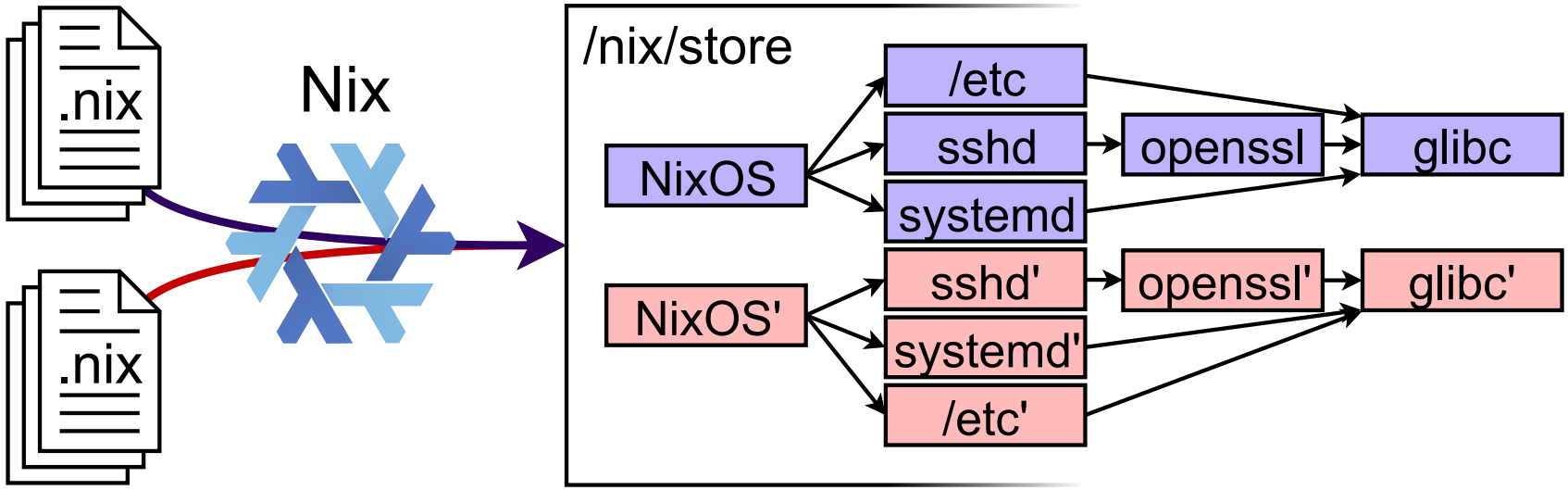


- Many/all new components, but very similar component exists

Differential Update Transfer



- Many/all new components, but very similar component exists
- Find “before” component, update differentially

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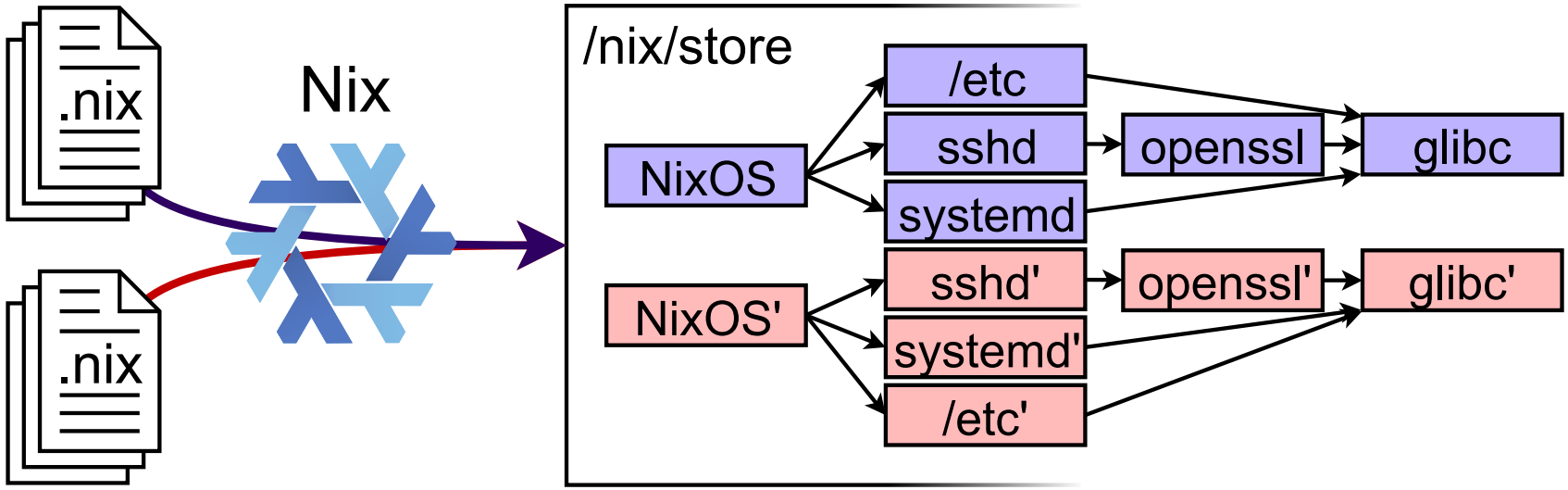

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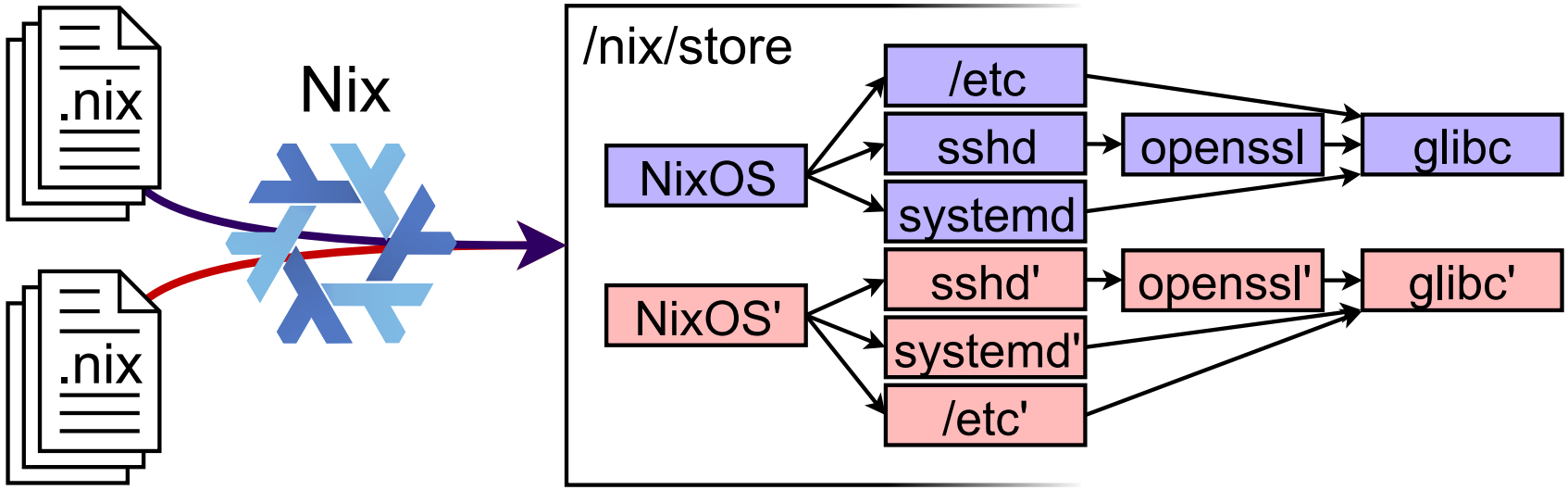

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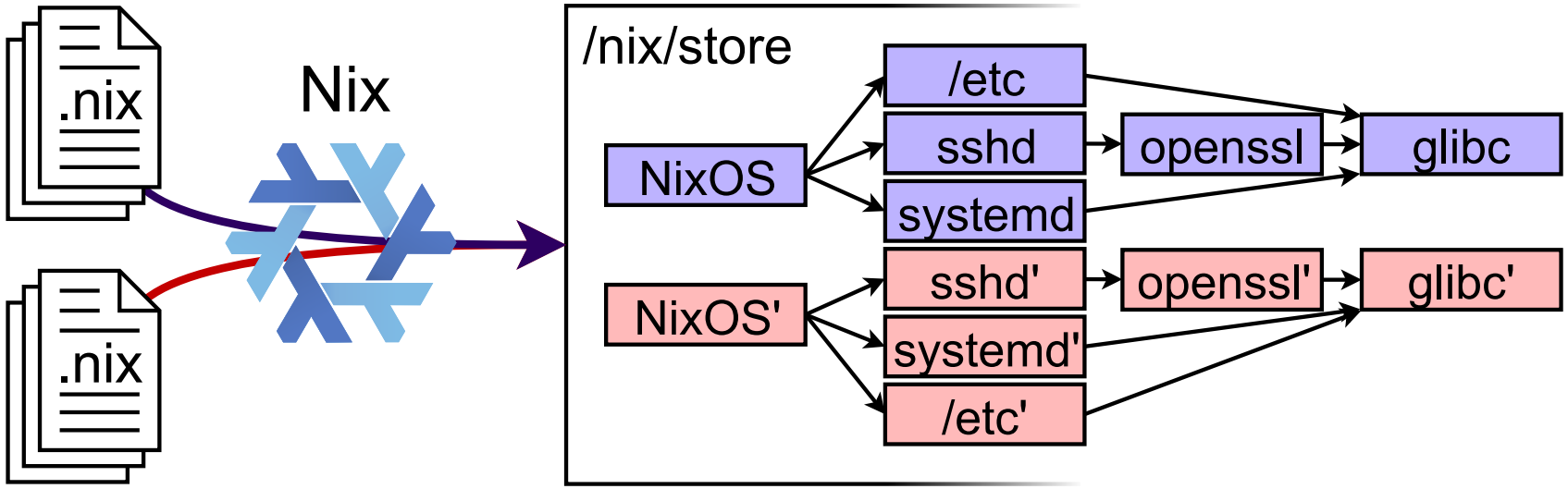

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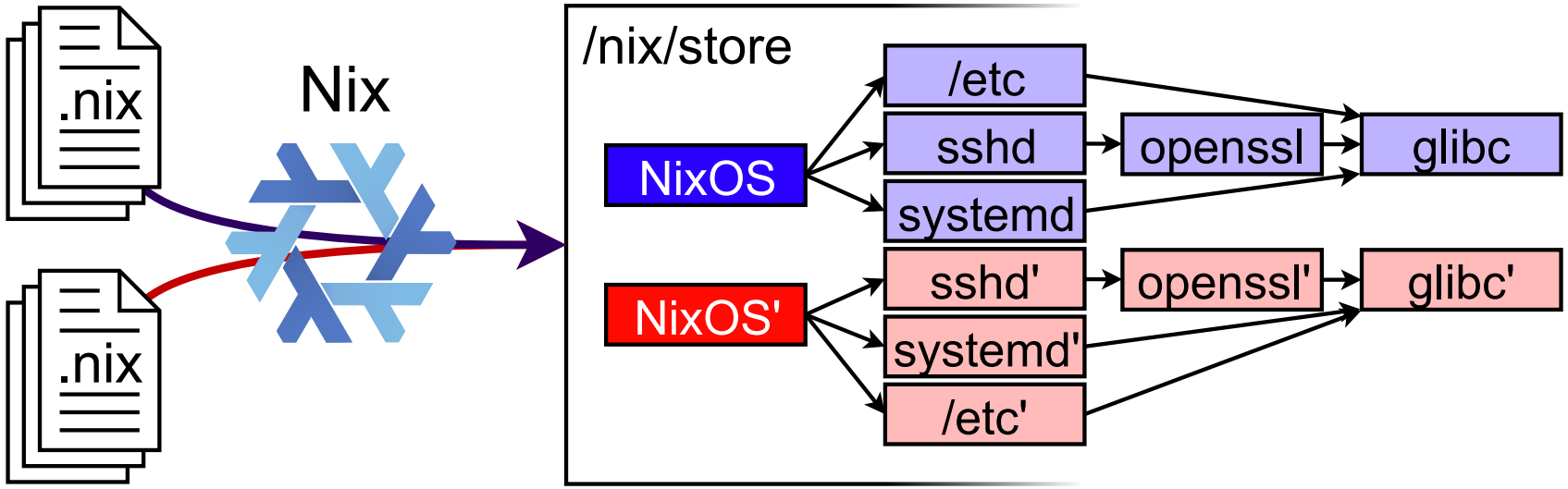

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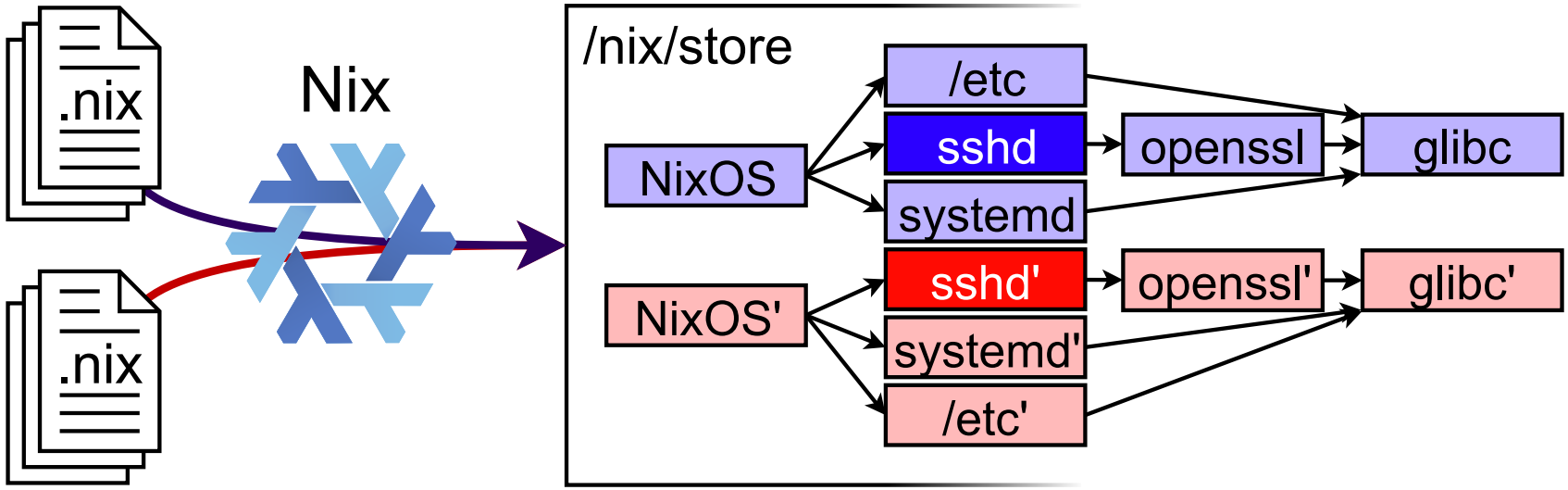
Differential Update Transfer



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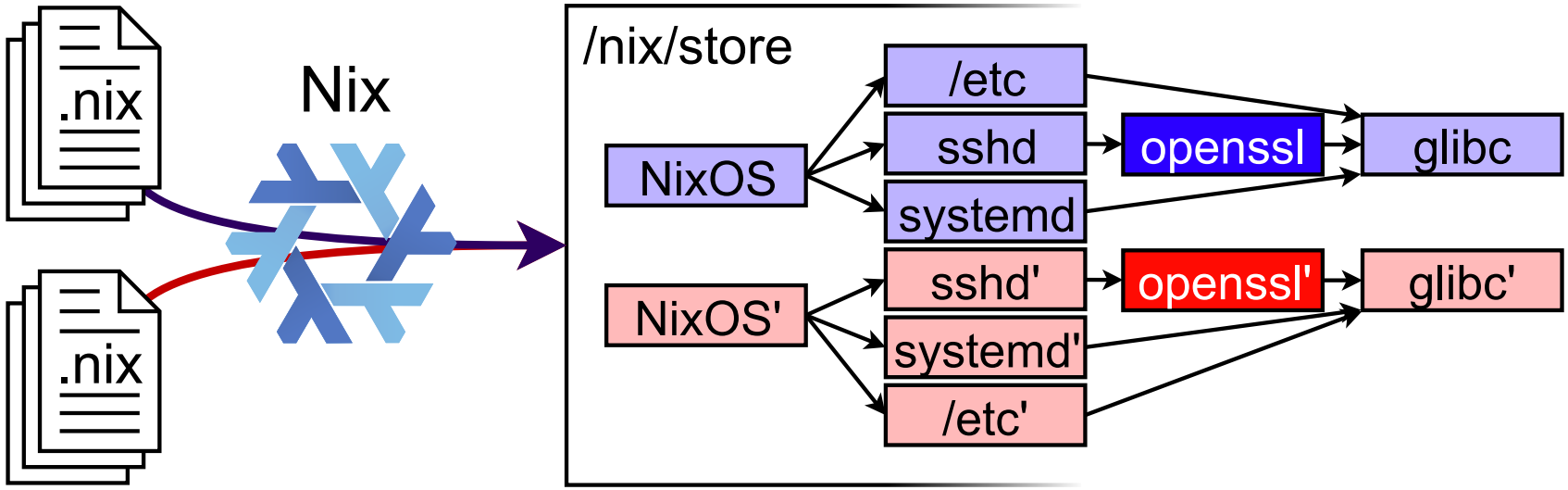

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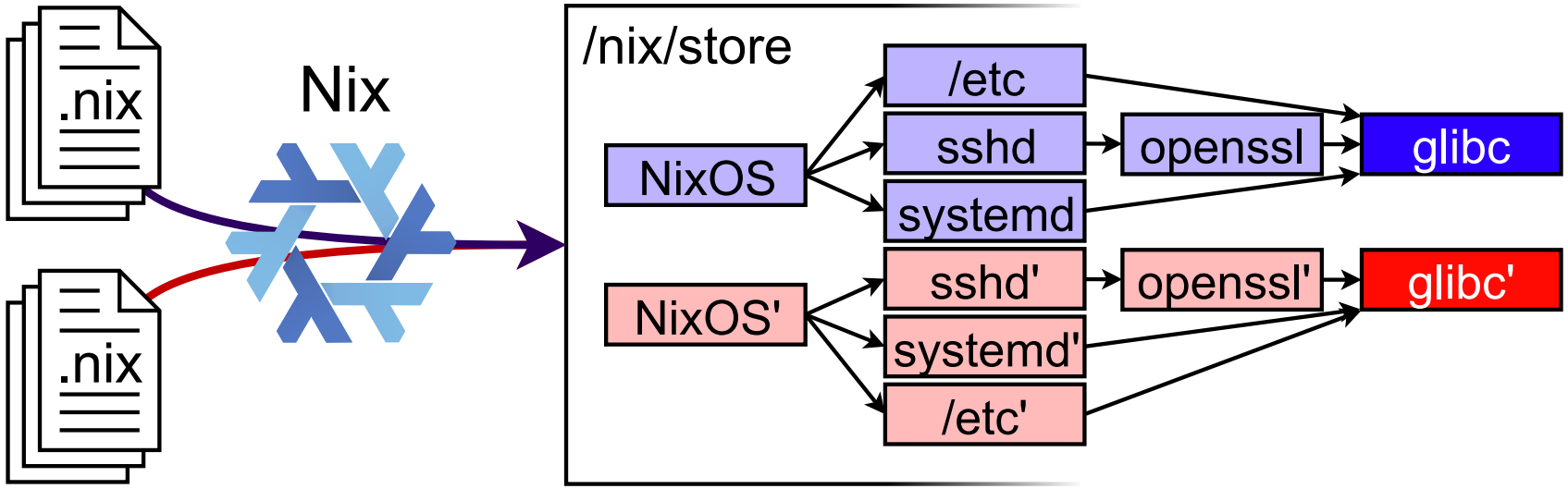

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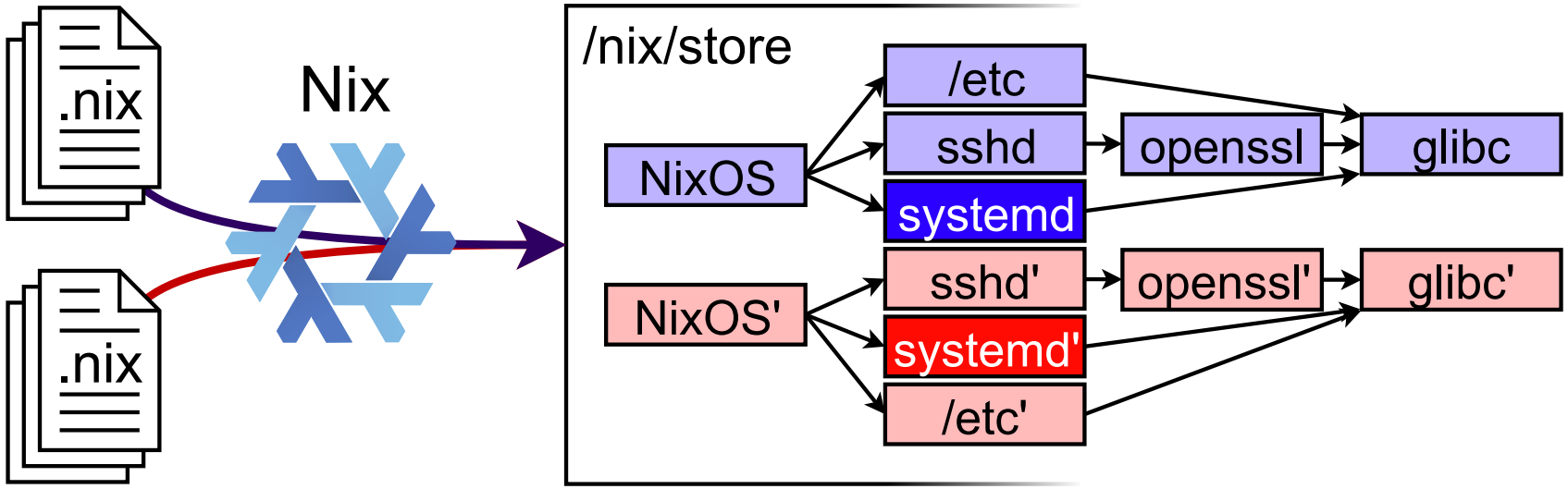
Differential Update Transfer



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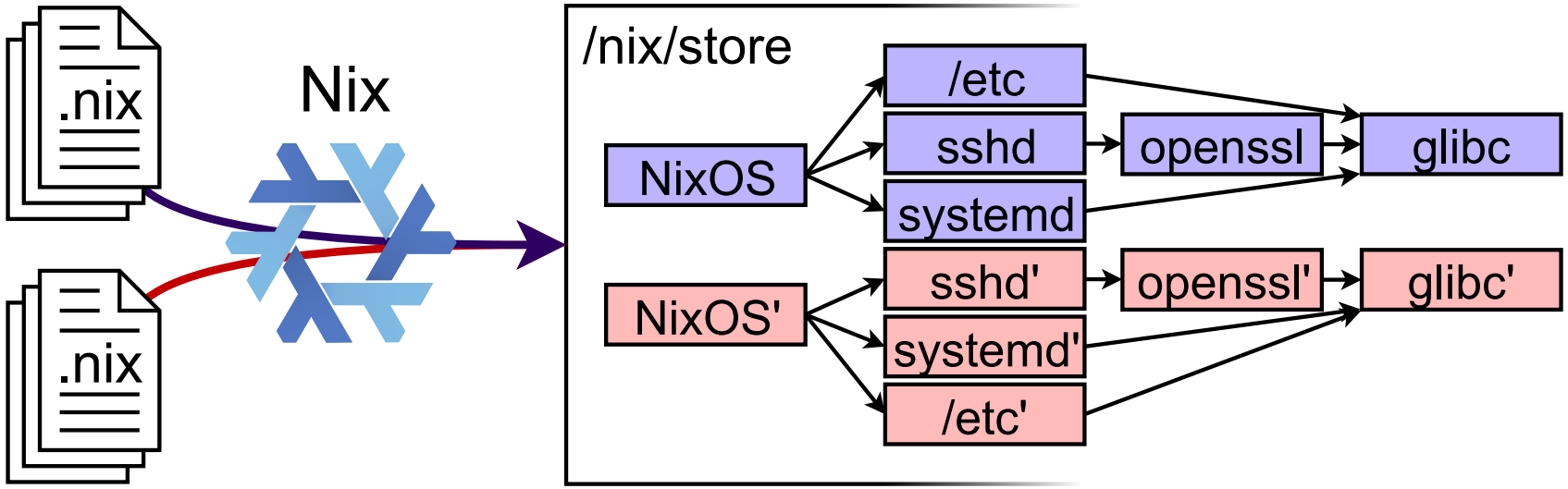

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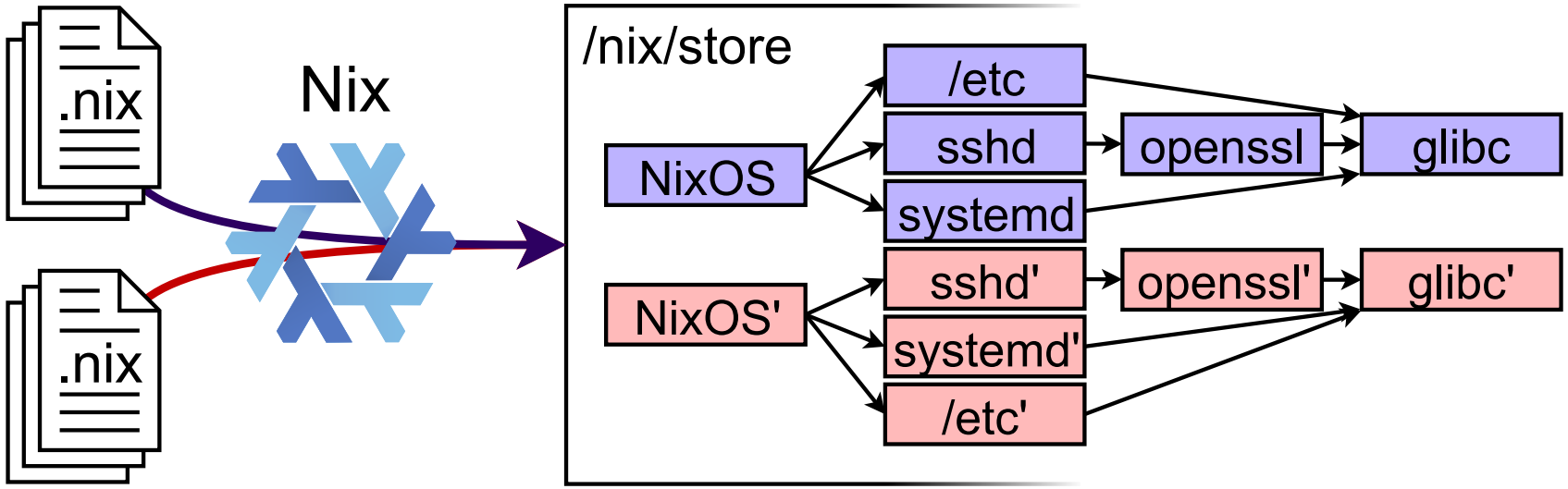

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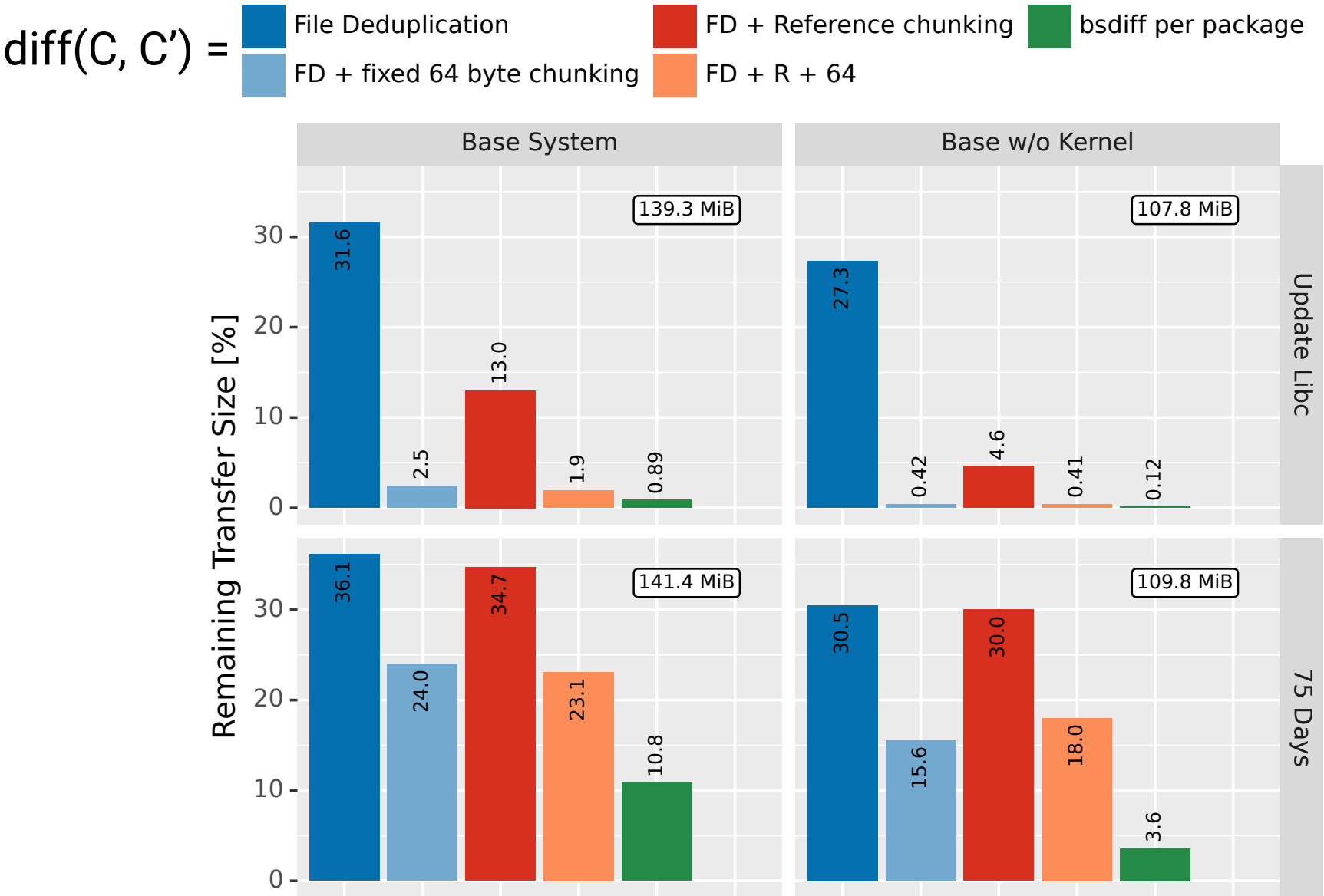
Differential Update Transfer: Results



Atomic Bootloader Updates

TUHH

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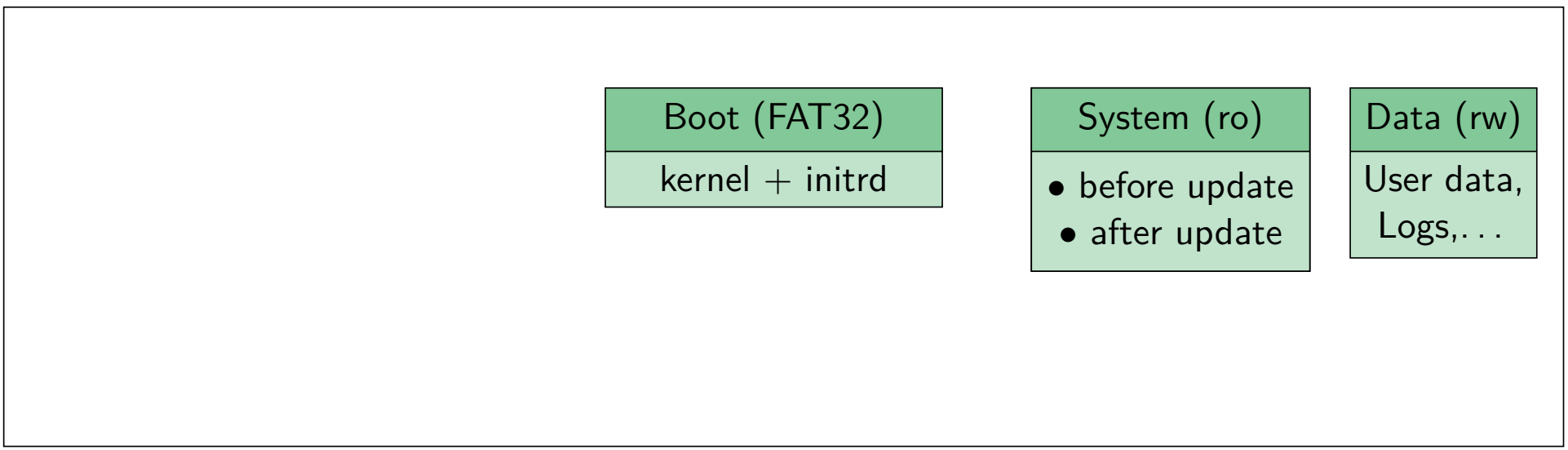

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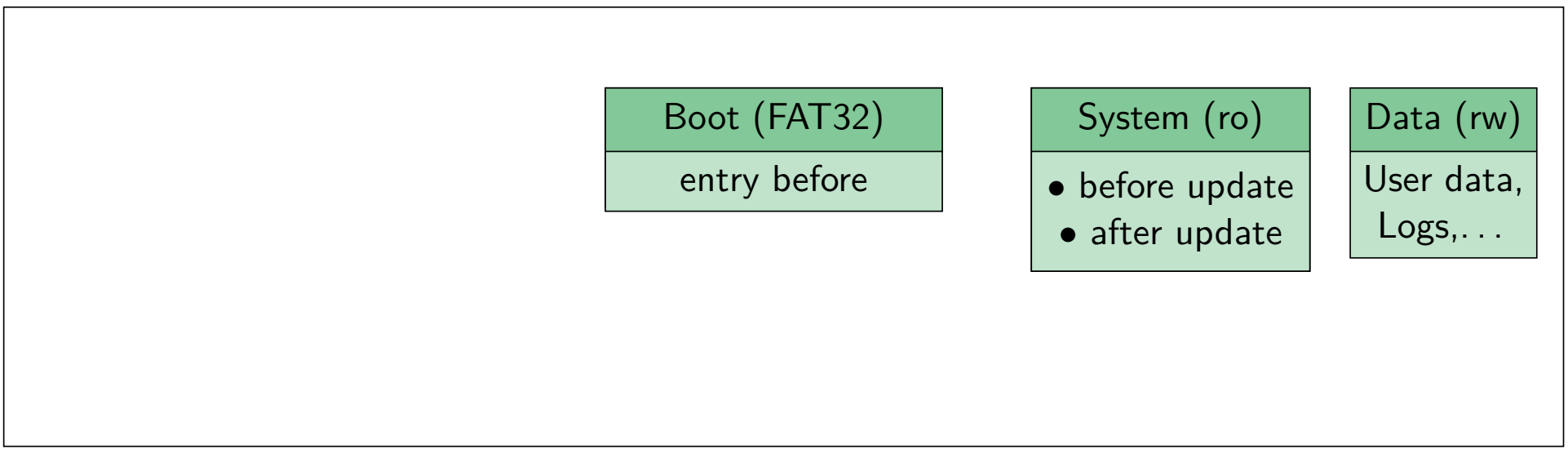

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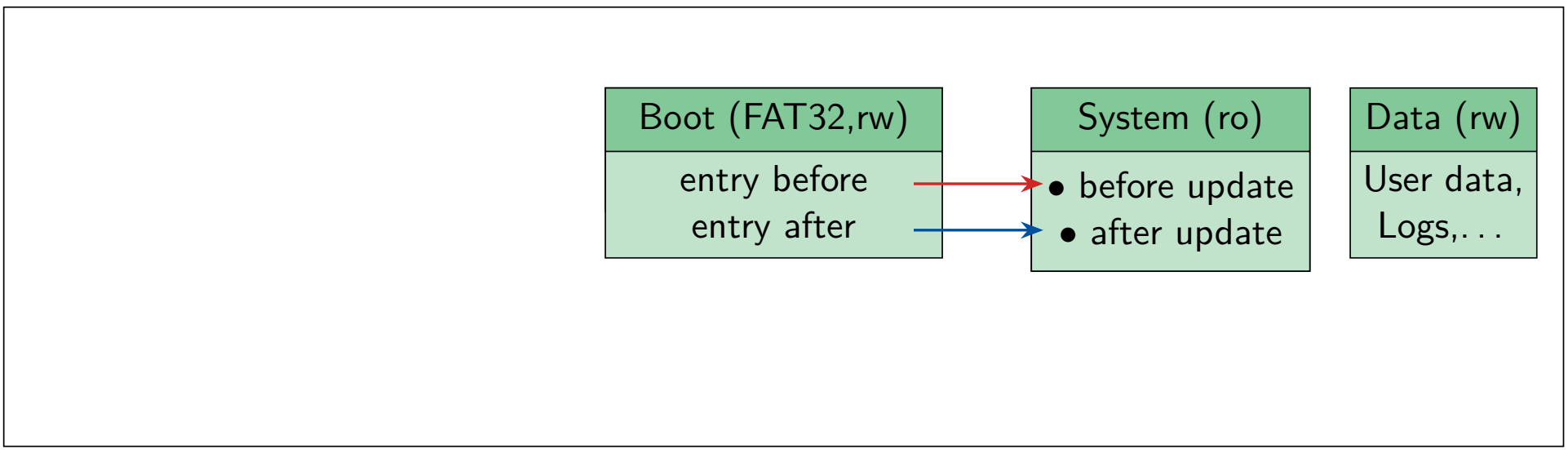

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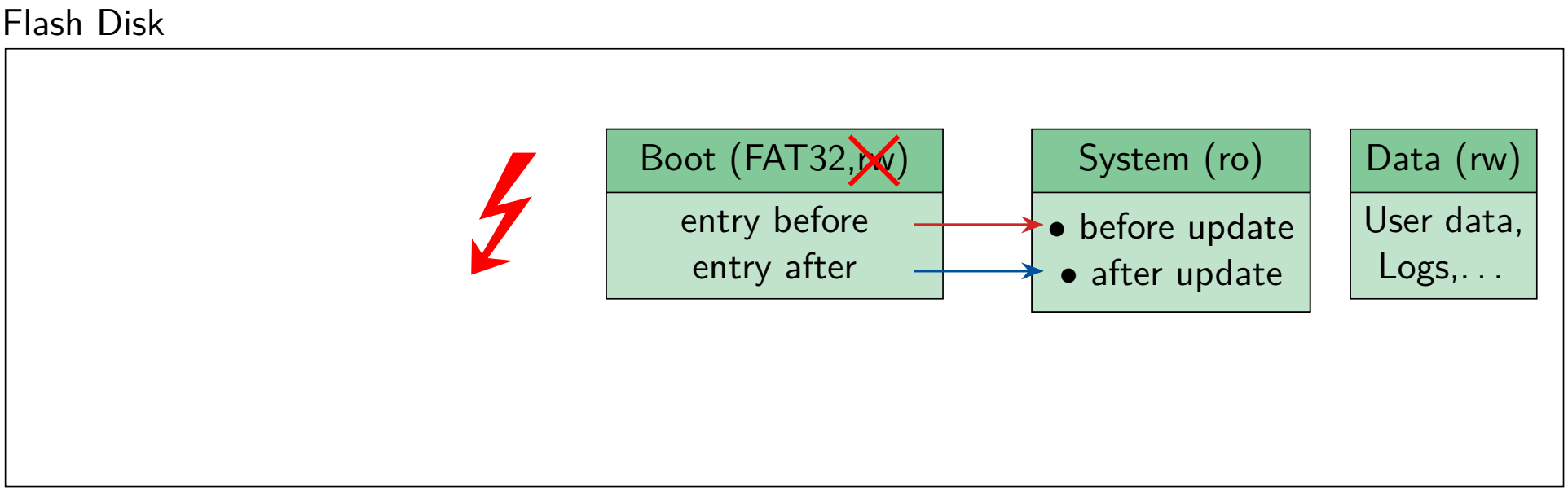

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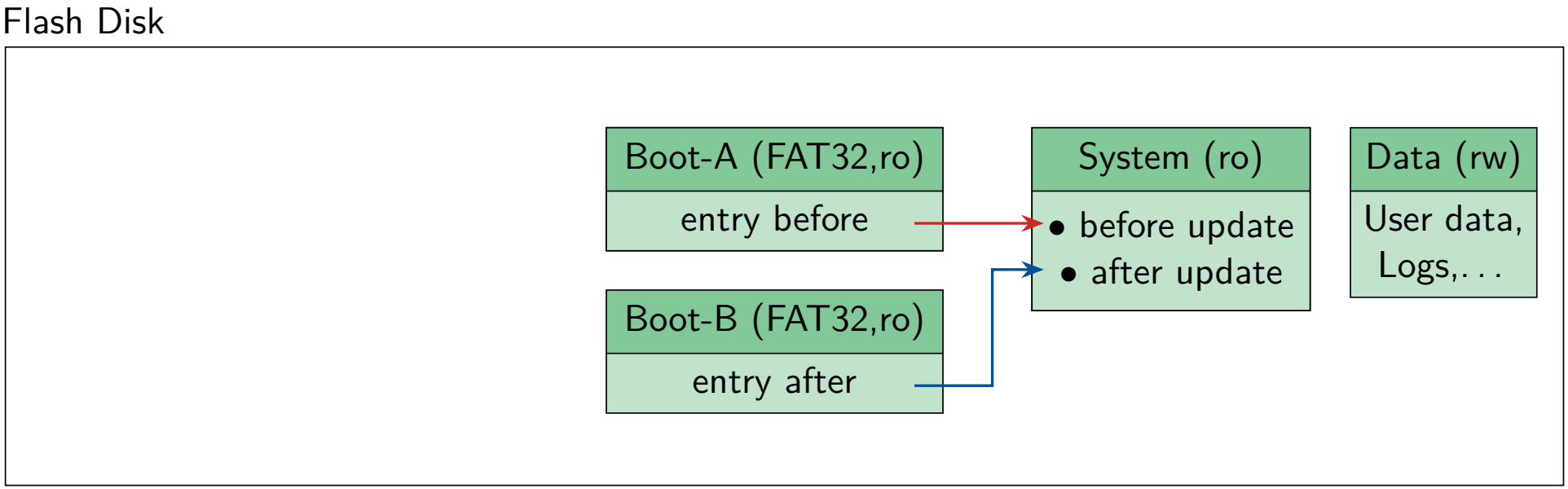

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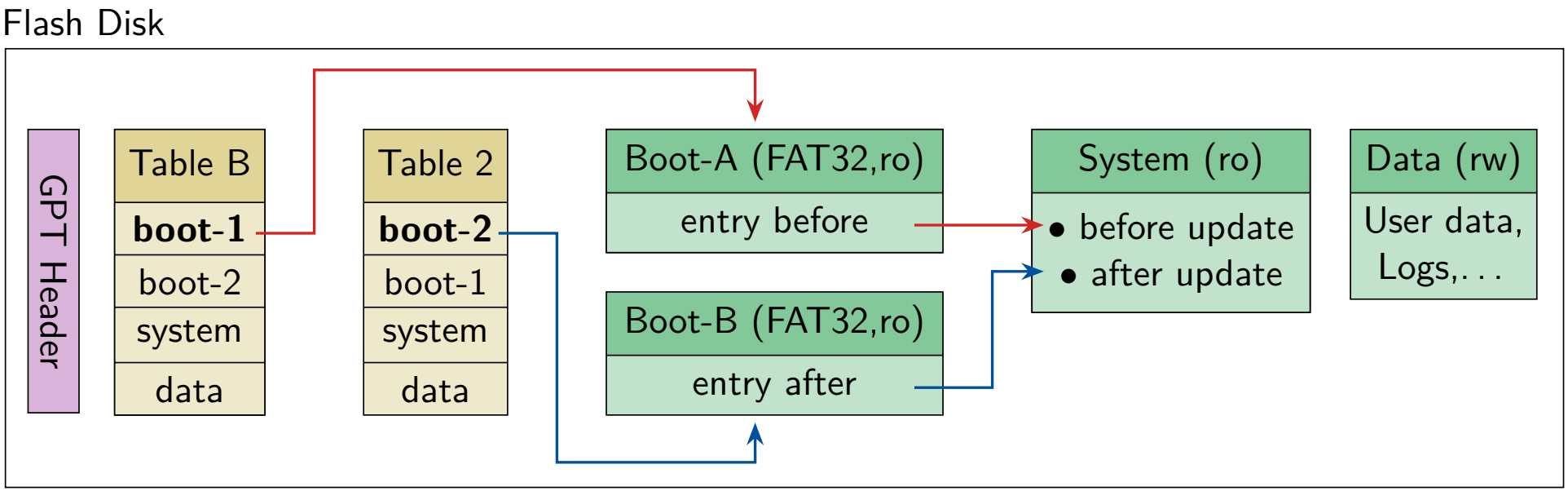

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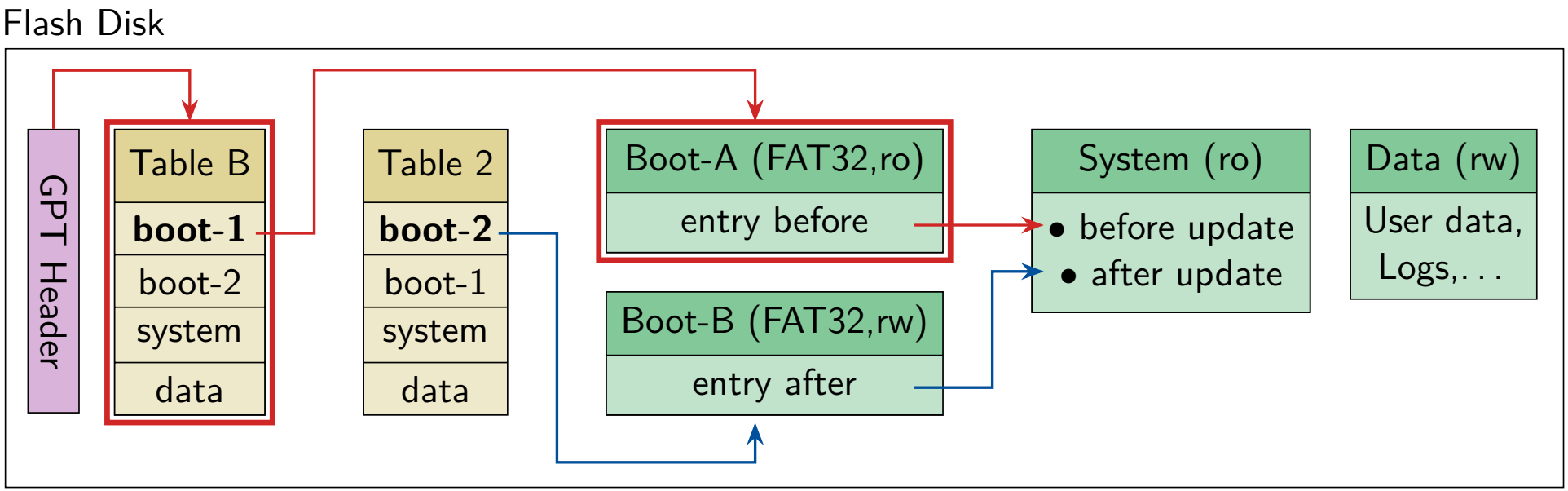

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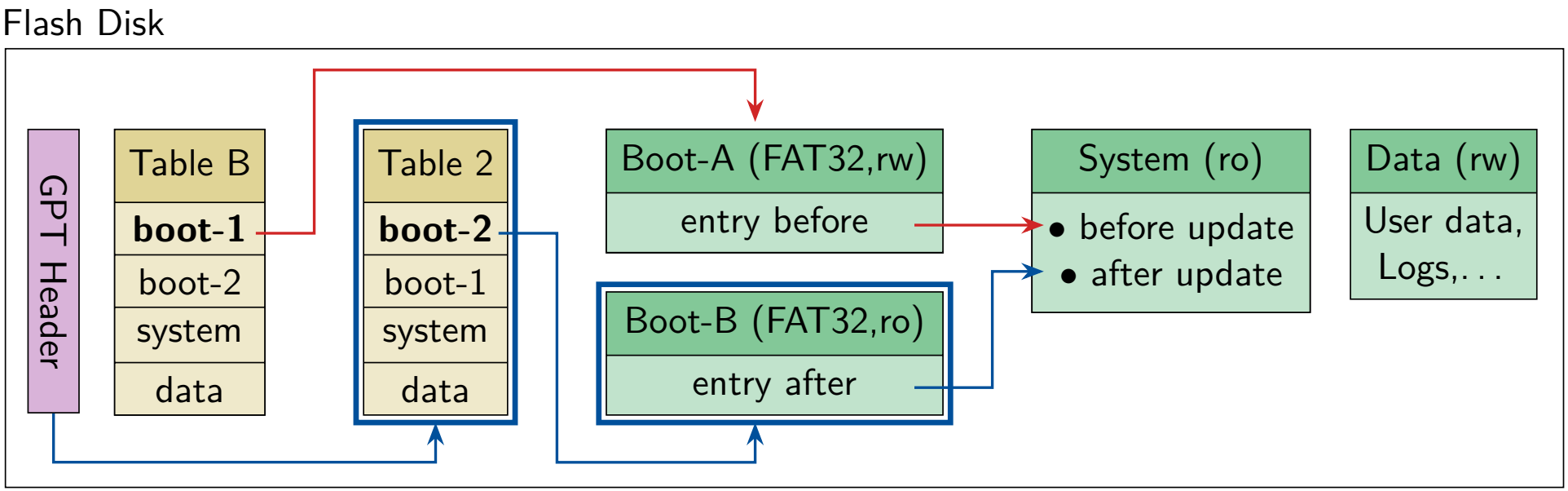

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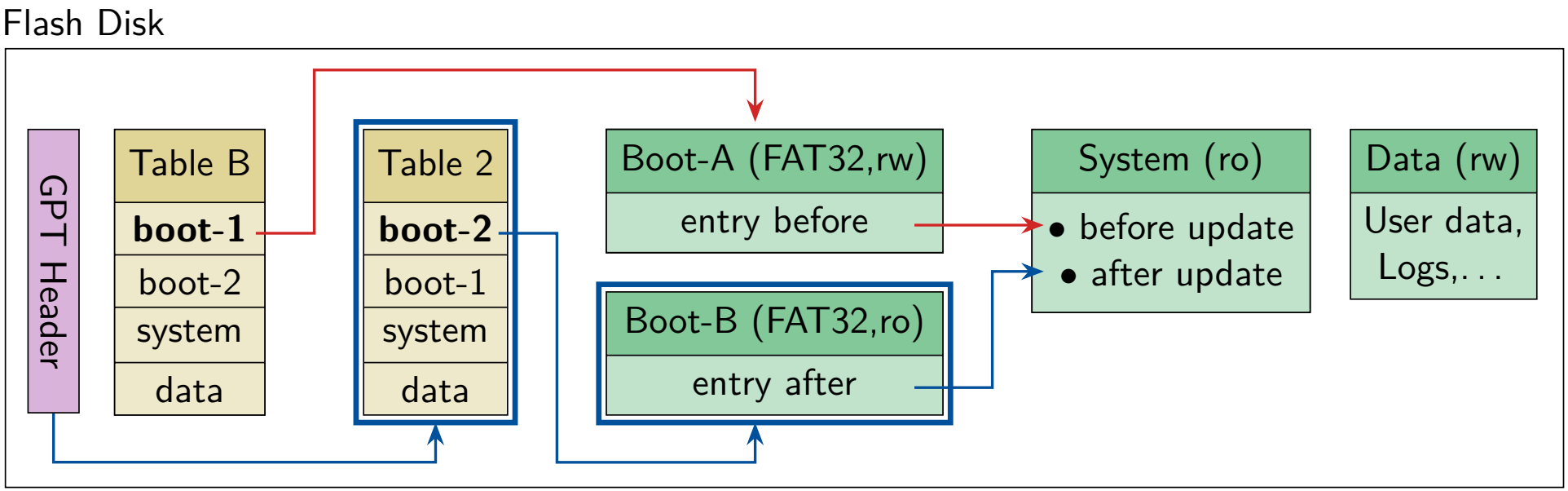

⇒ applicable to other operating systems!

Reconfiguration

TUHH

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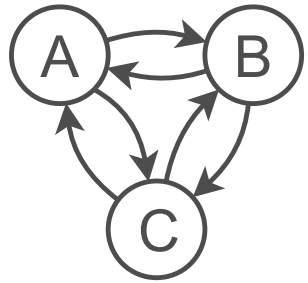
Reconfigure: 

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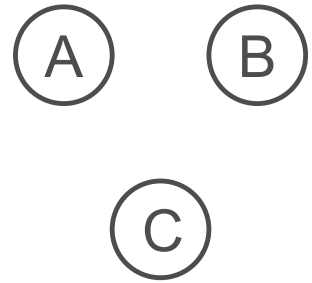
Reconfigure: 

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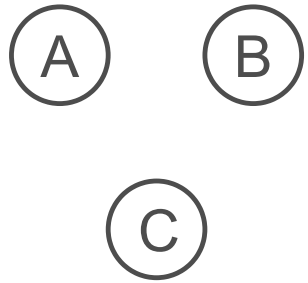
Reconfigure: 

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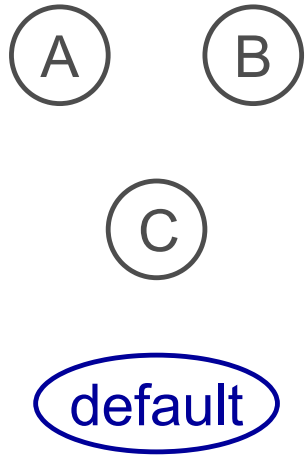
Reconfigure: 

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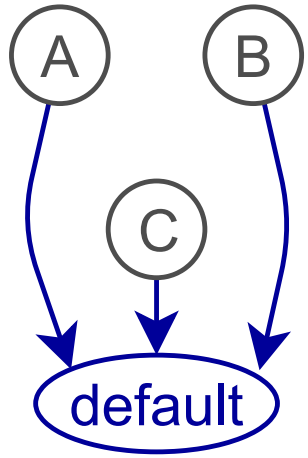
Reconfigure: 

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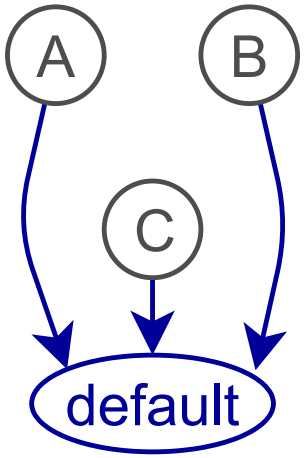

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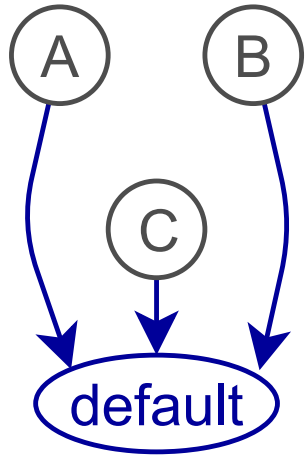
Reconfigure: 

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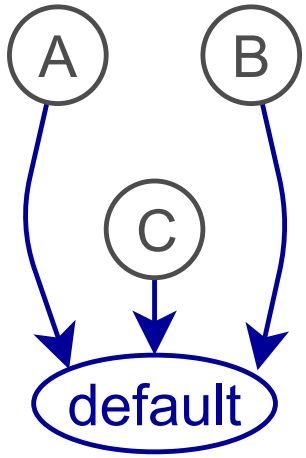

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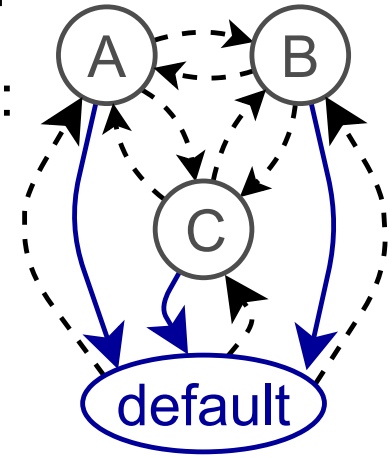
Reconfigure: 

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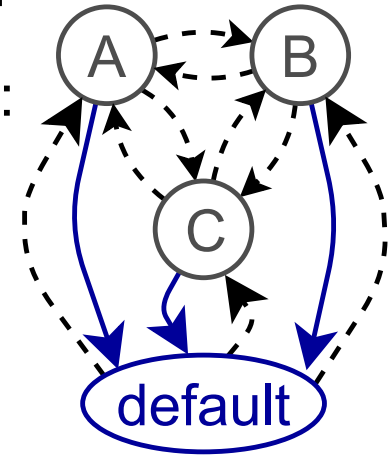
Reconfigure: 

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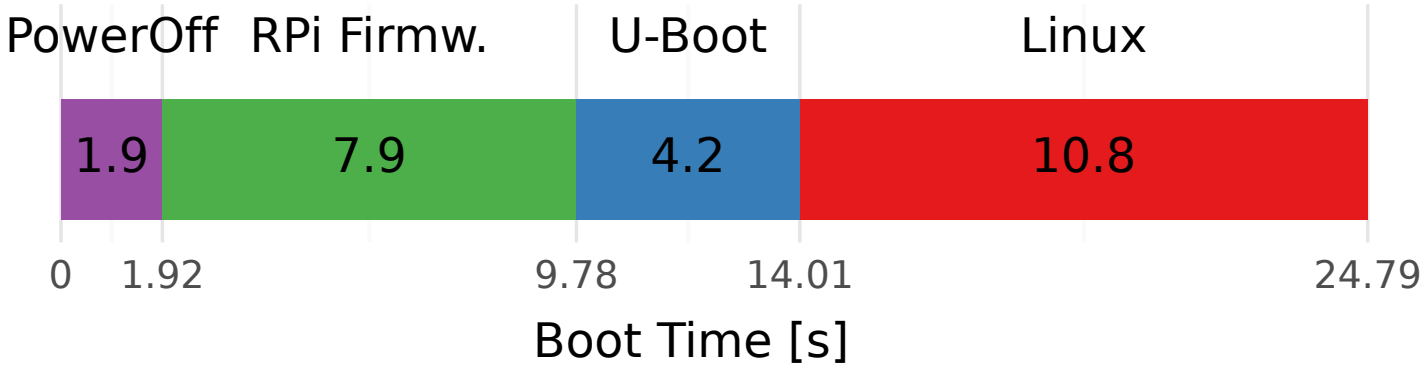
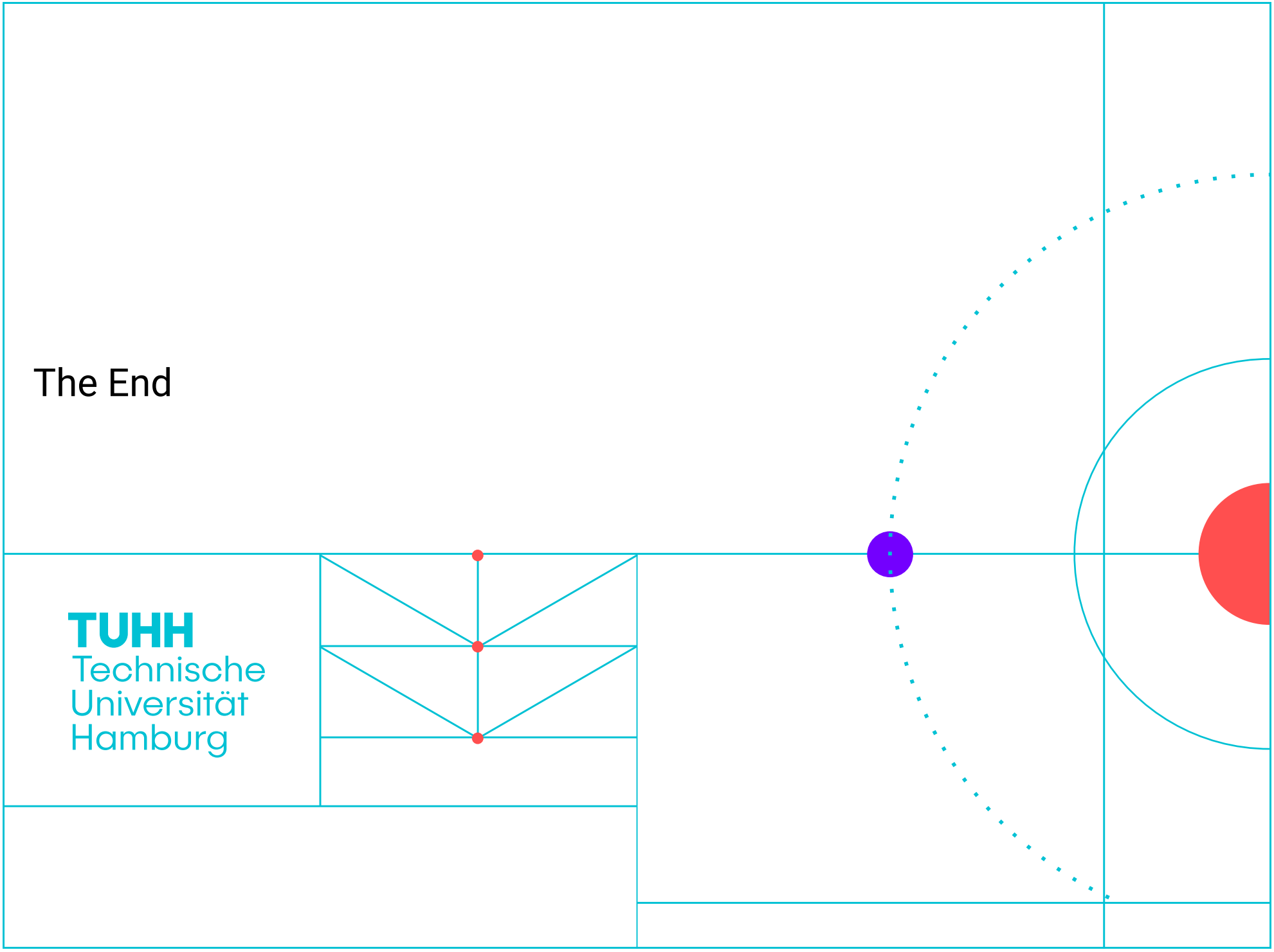
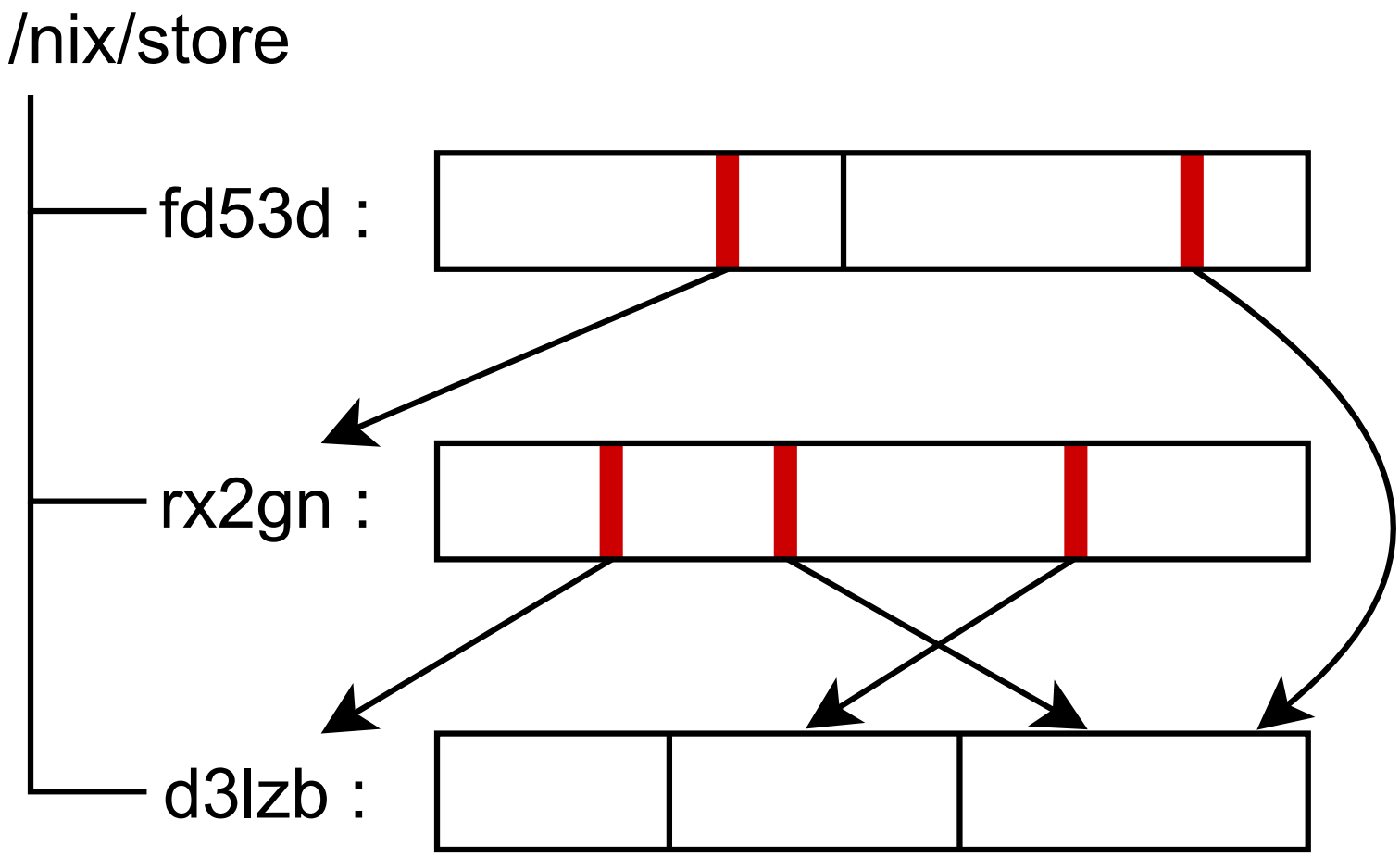


Summary

- NixOS: flexible, reproducible, predictable, reconfigurable
  - Not suited for embedded
- Solved NixOS problems for embedded
  - Reduced system size (~1.1 GiB → 155 MiB)
  - Updates up to 99.88 % smaller (mitigate change amplification)
  - Atomic bootloader config update (switch A/B part via GPT)
- reUpNix key features
  - Reconfiguration / multi-system setup
  - Efficient OCI services (w/o Docker, file-deduplicated)
  - Unidirectional communication update transfers

The End

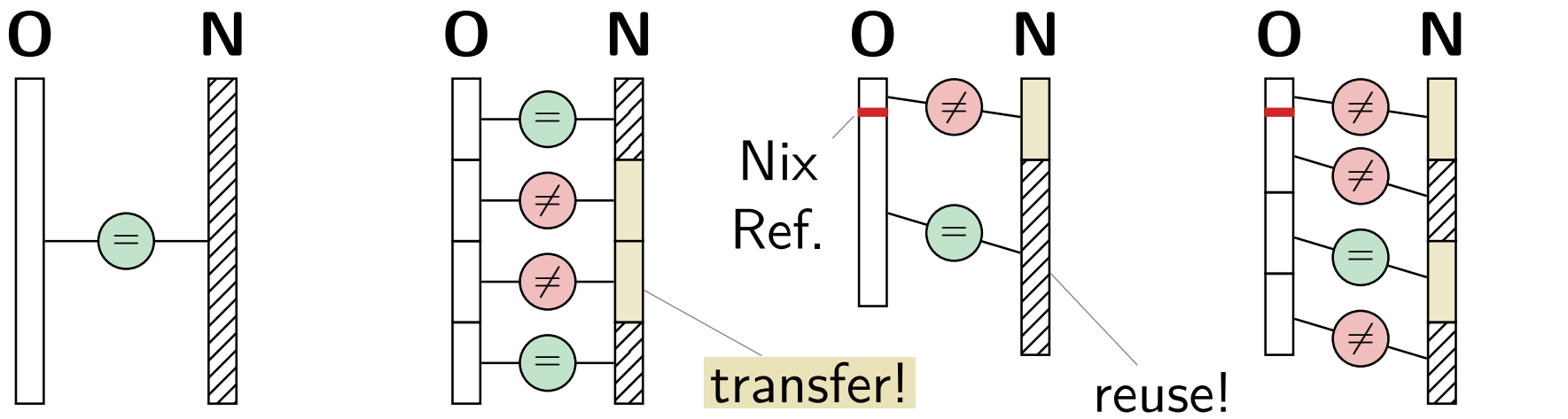



/nix/store
fd53d :
rx2gn :
d3lzb :

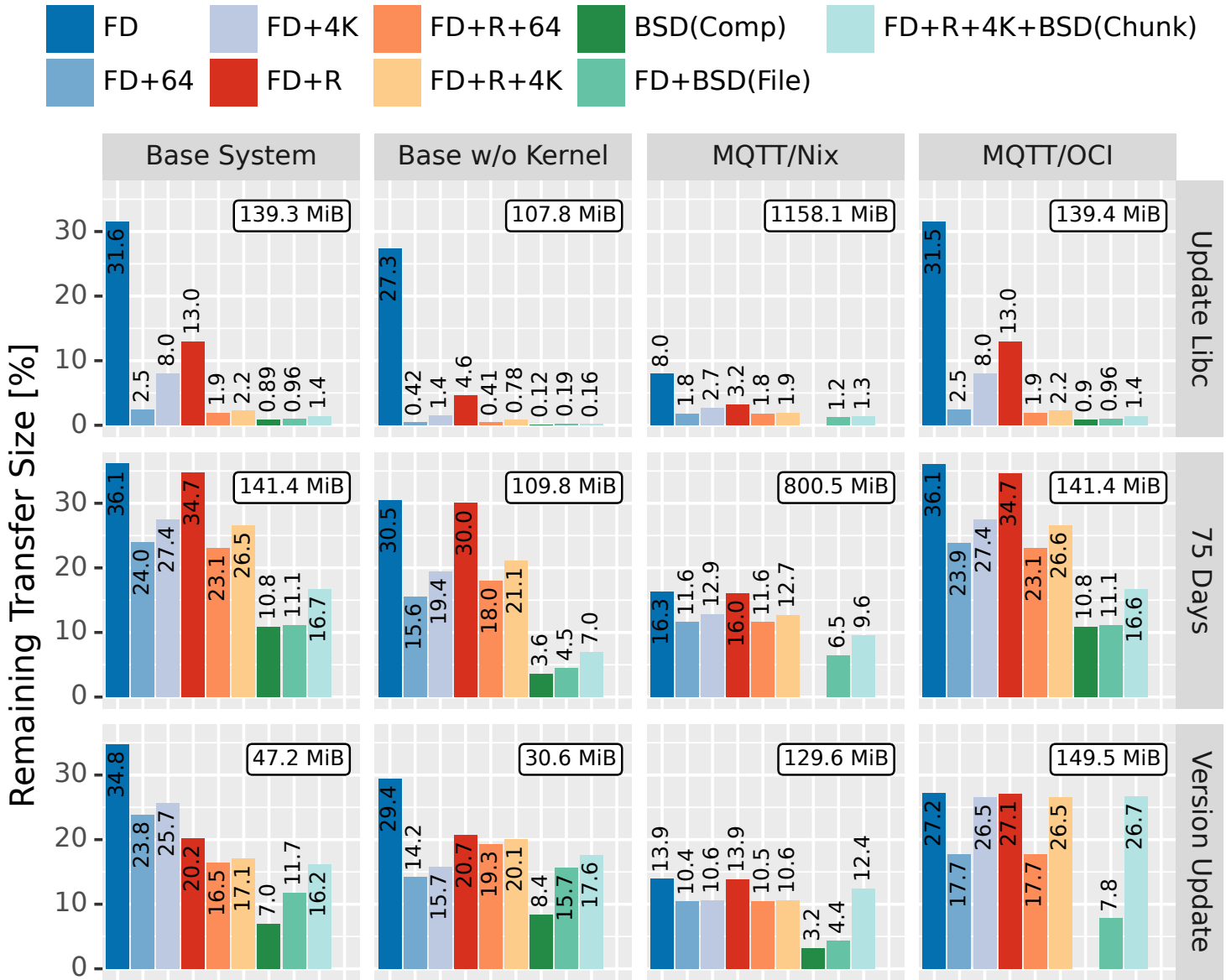
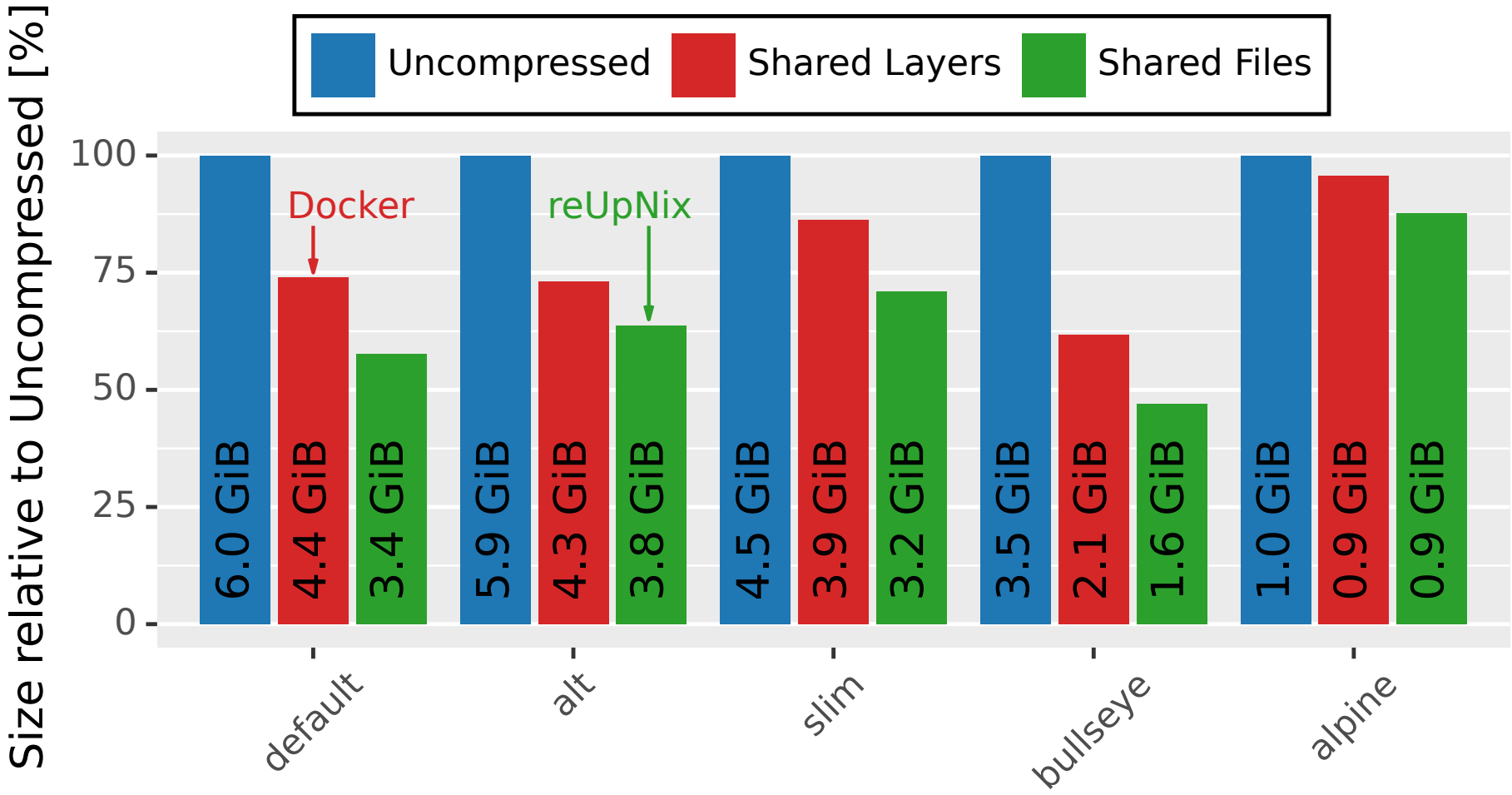
Update Deduplication

TUHH

(a) File Dedup. (b) Blocks (c) Refs (d) Ref+Block



Update Transfer Size



OCI Container Storage Cost