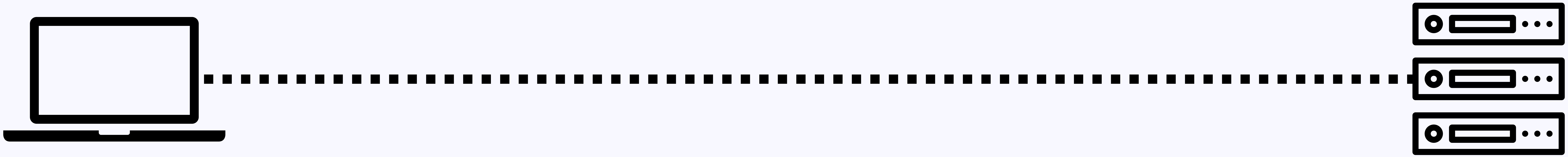
# NetBricks: Taking the V out of NFV

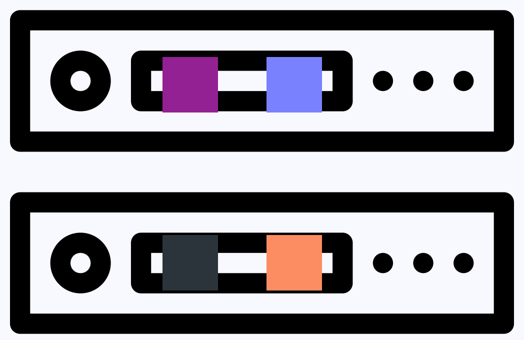
Aurojit Panda, Sangjin Han, Keon Jang, Melvin Walls, Sylvia Ratnasamy, Scott Shenker
UC Berkeley, Google, ICSI

NETSYS

# What the heck is NFV?

# A Short Introduction to NFV





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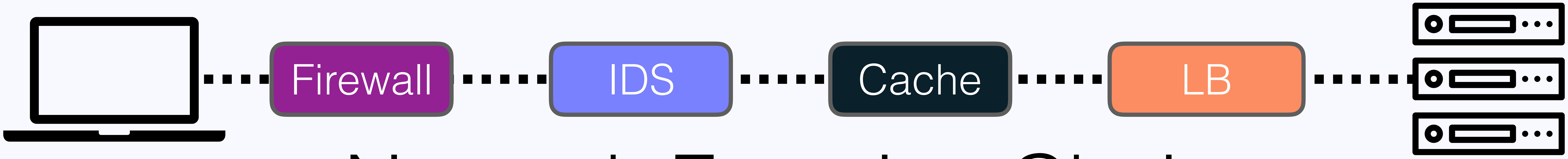


Network Function Chain

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- Simplifies **developing new functionality**: Write software vs design hardware
- Reuse **management tools** from other domains.
- **Consolidation**: Reduce number of hardware boxes in the network.

# Challenges for NFV

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- **Running NFs**
  - **Isolation** and **Performance**

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- **Running NFs**
  - **Isolation** and **Performance**

- **Building NFs**
  - **High-Level Programming** and **Performance**

# Running NFs

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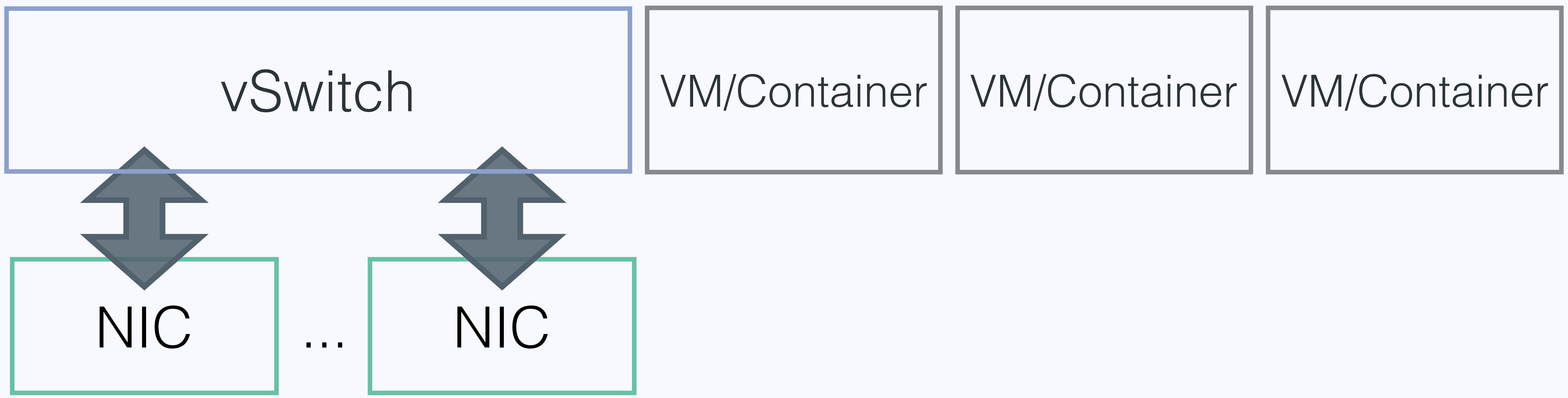


Memory Isolation

Packet Isolation

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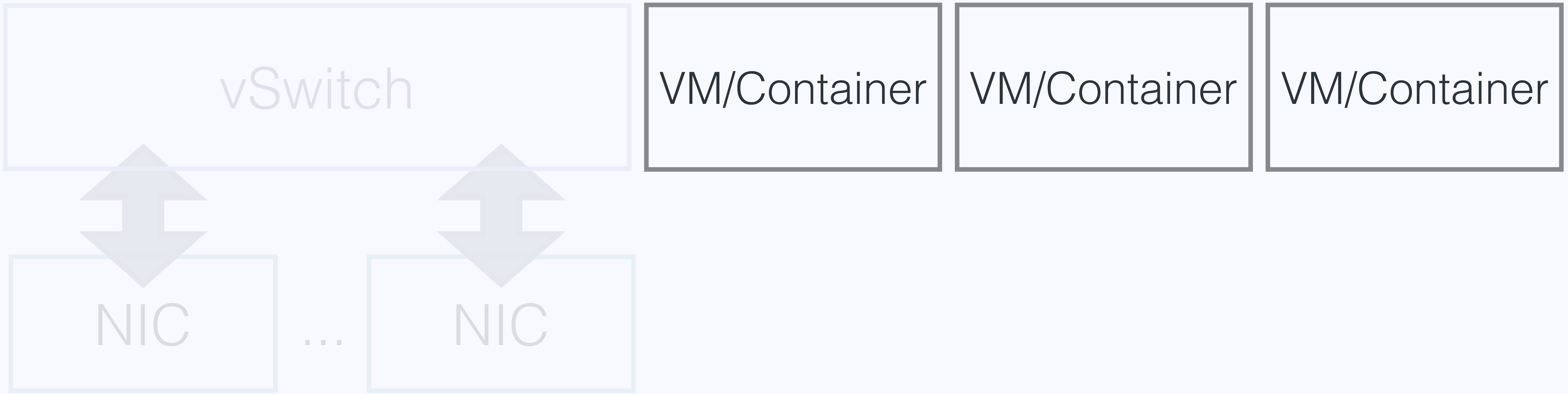


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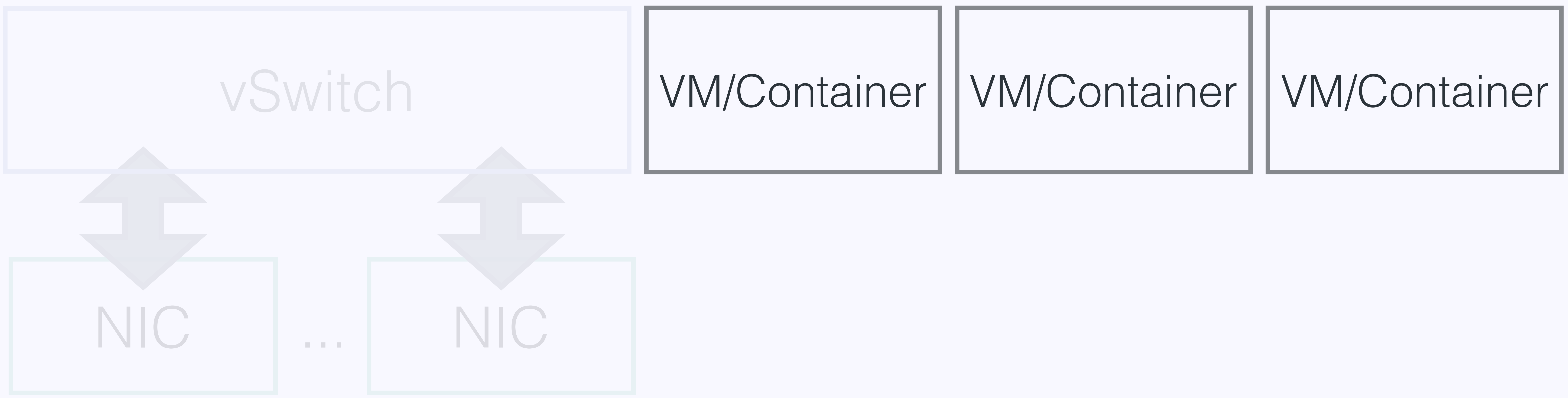


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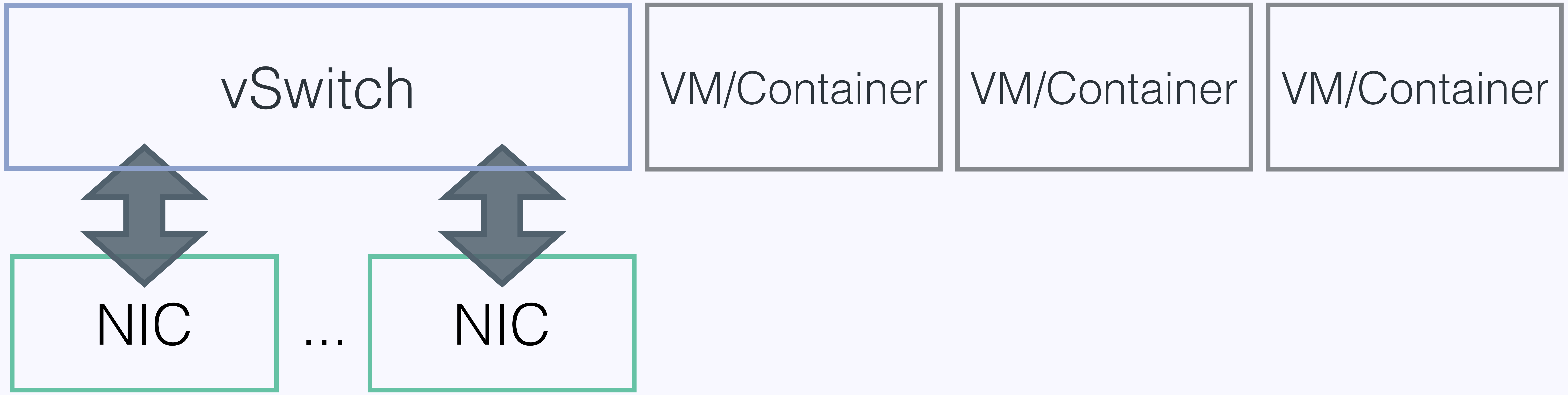


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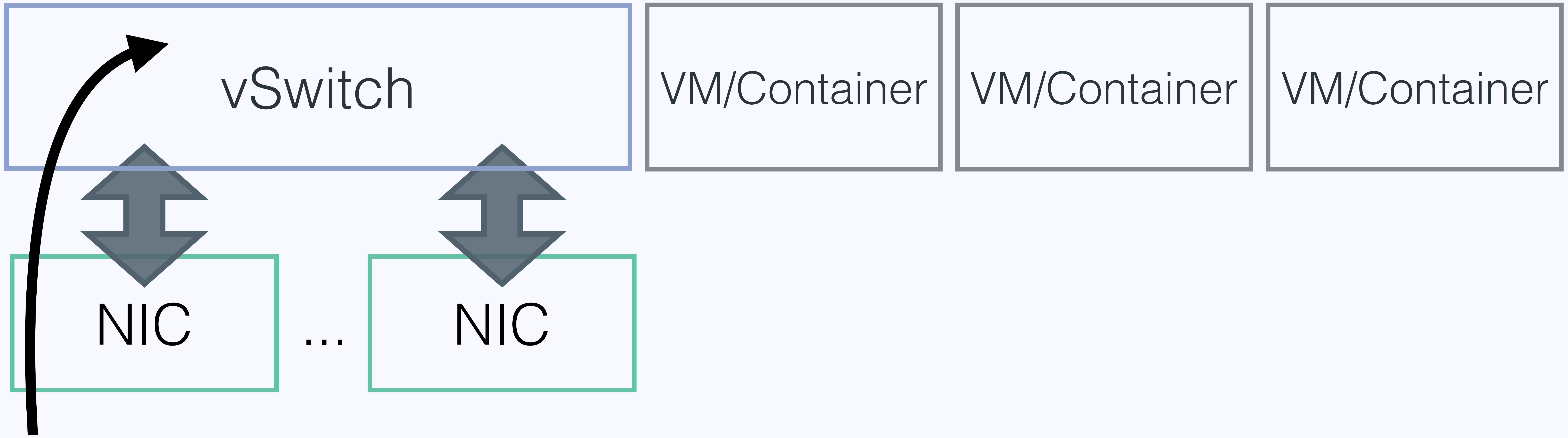


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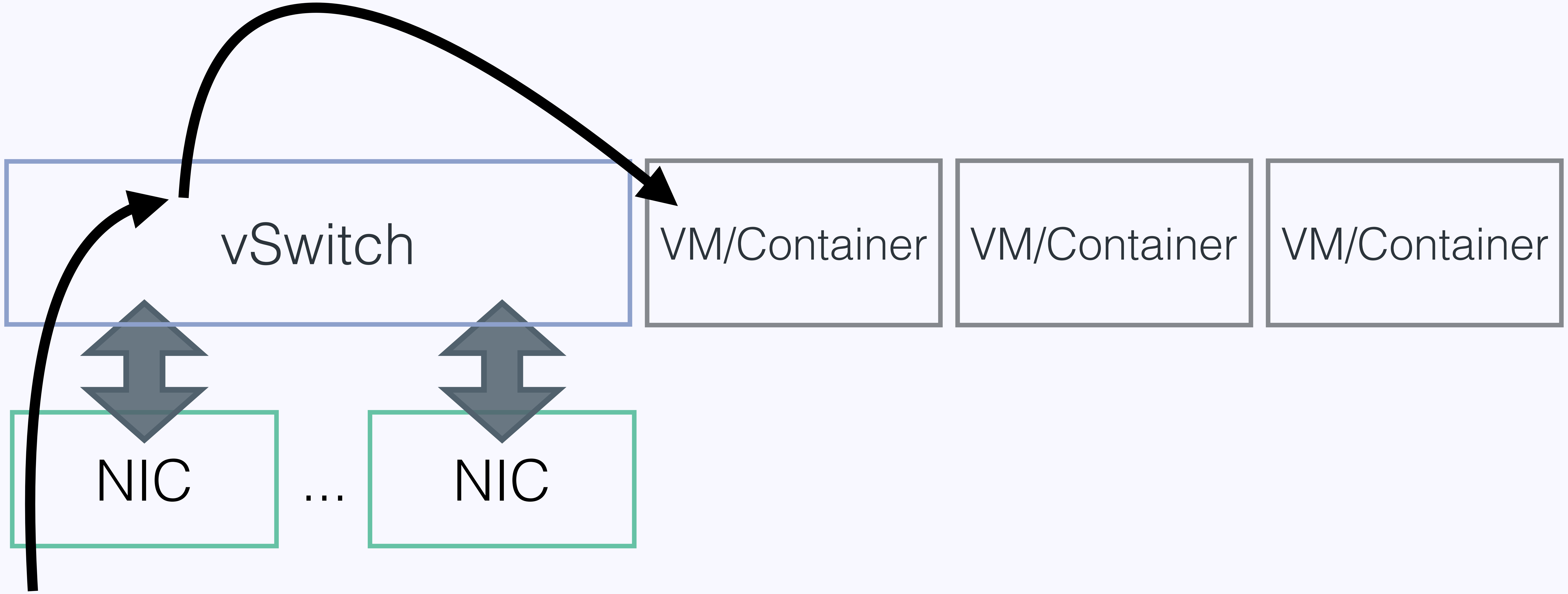


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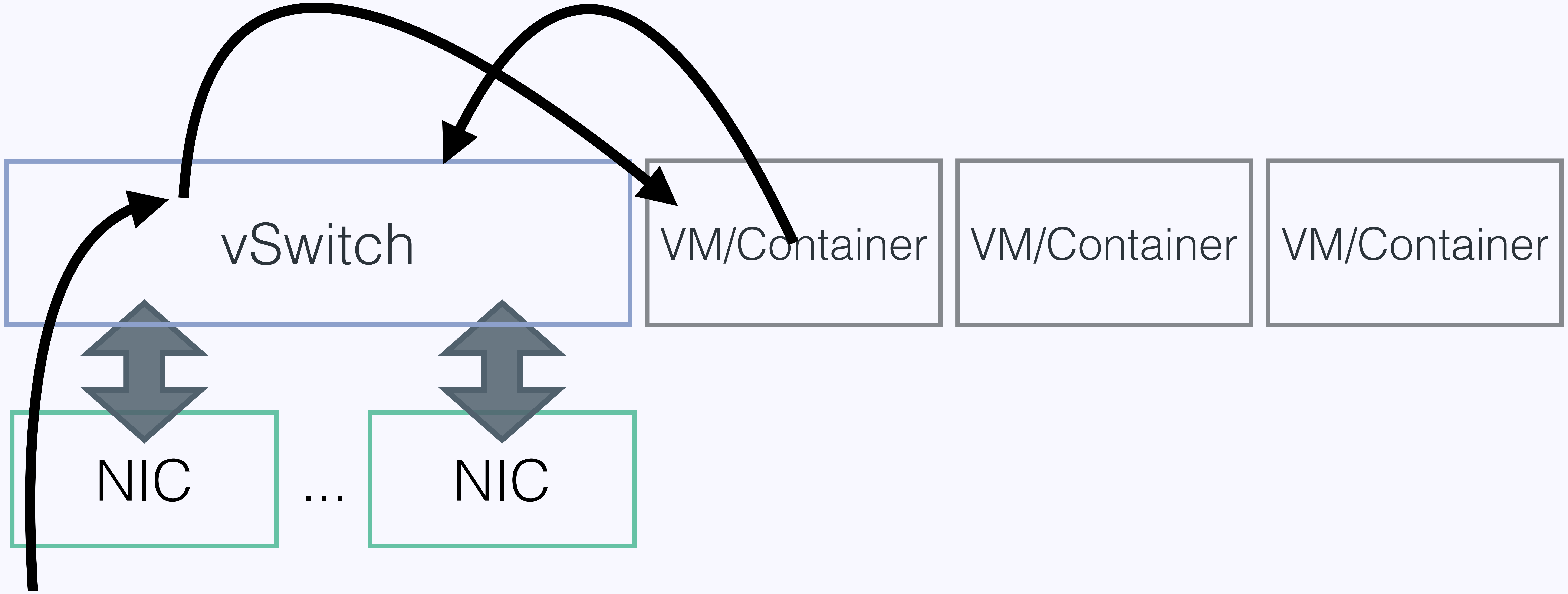


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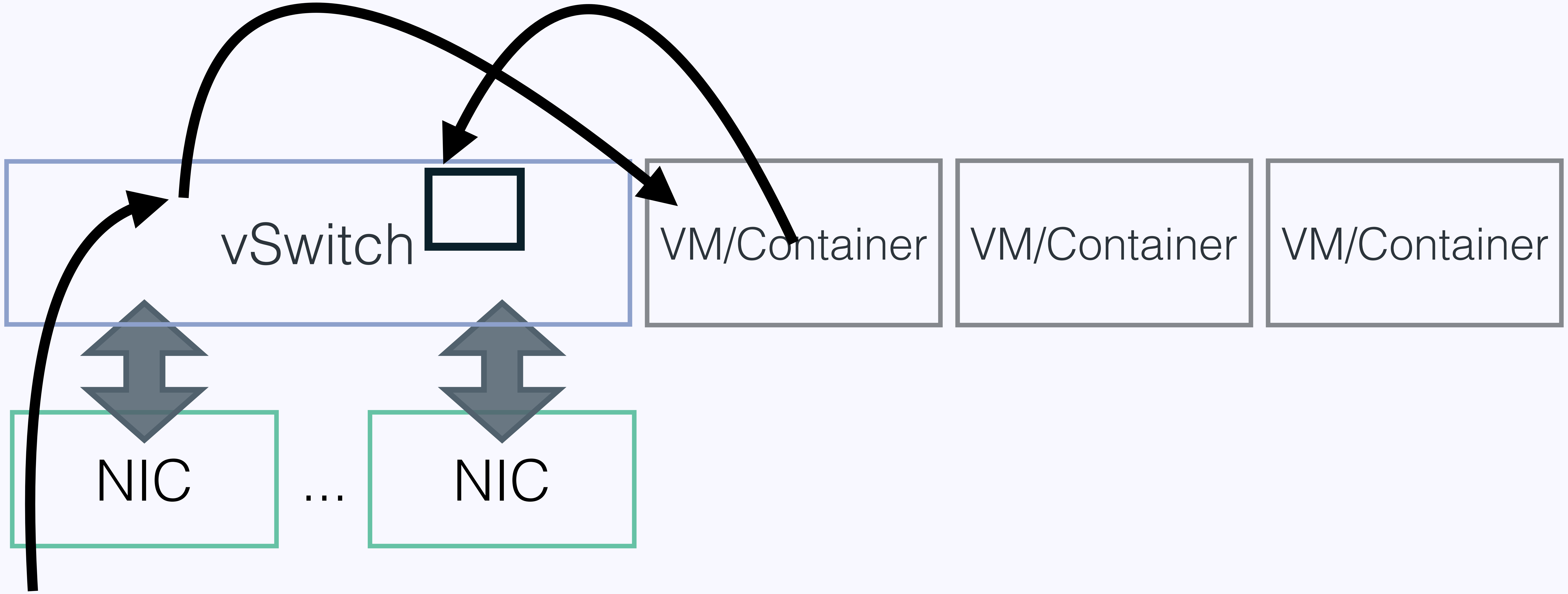


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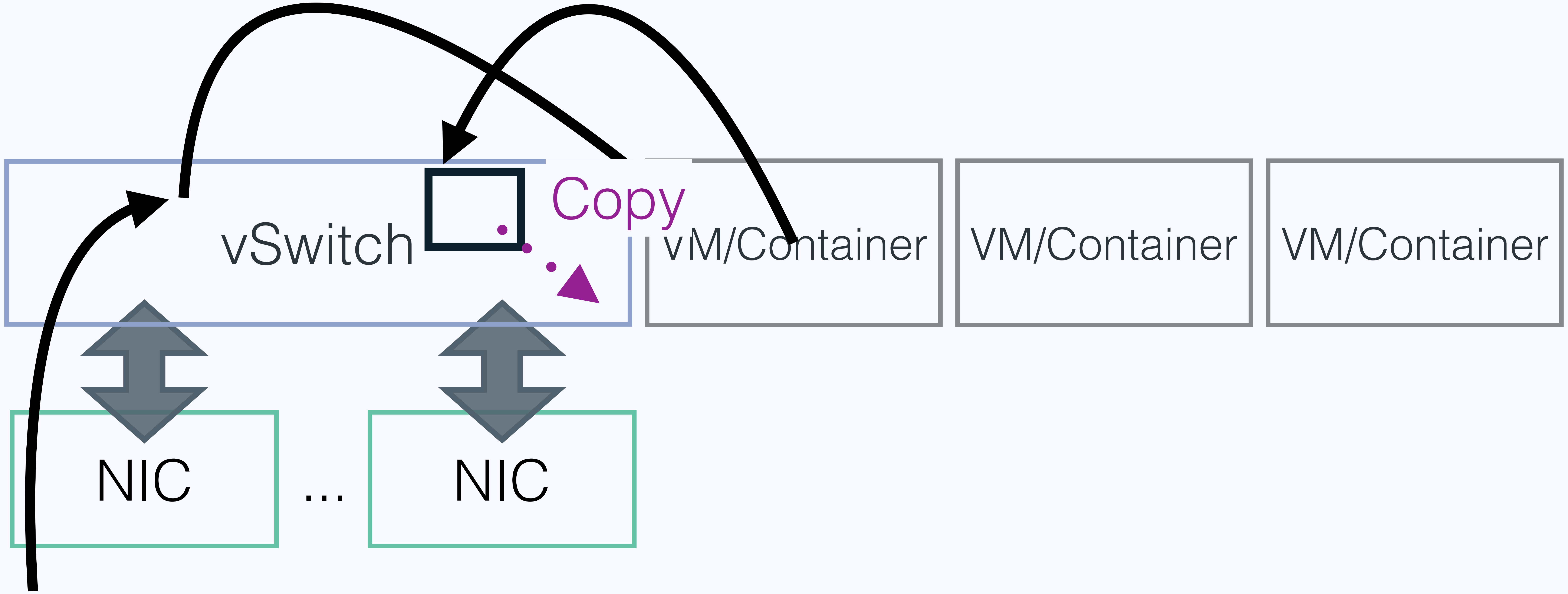


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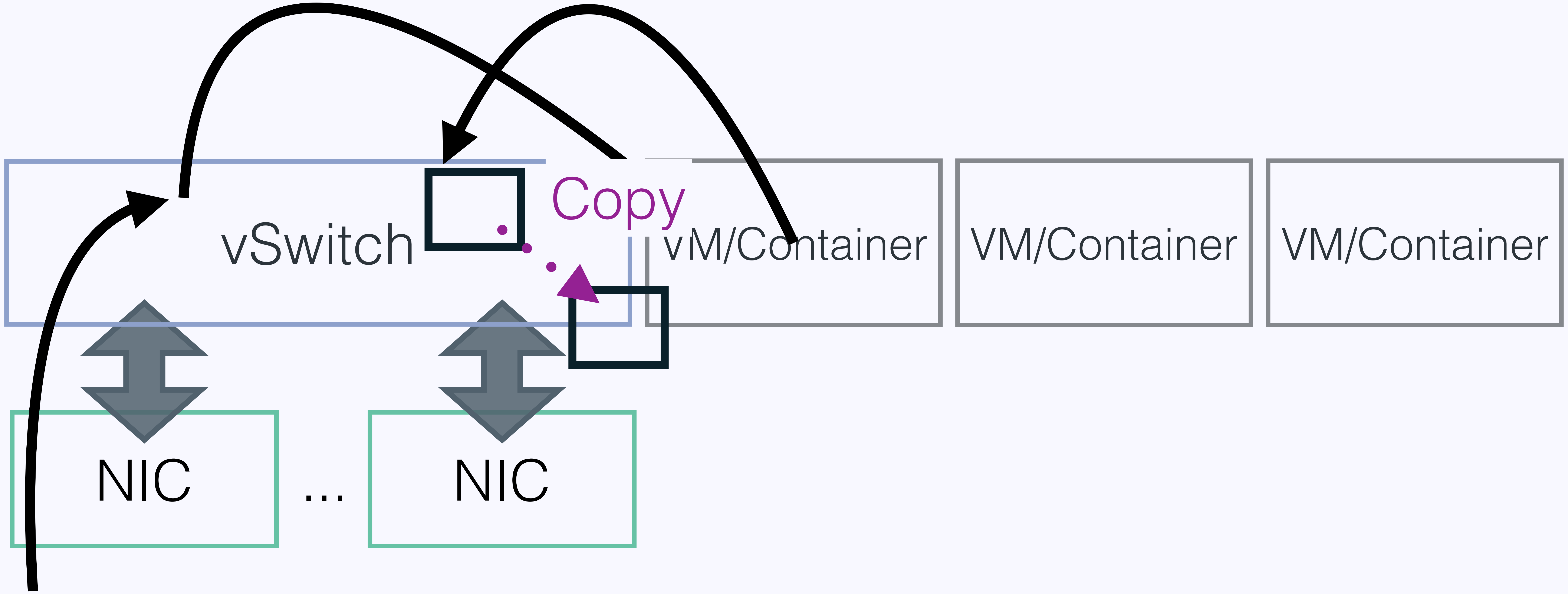


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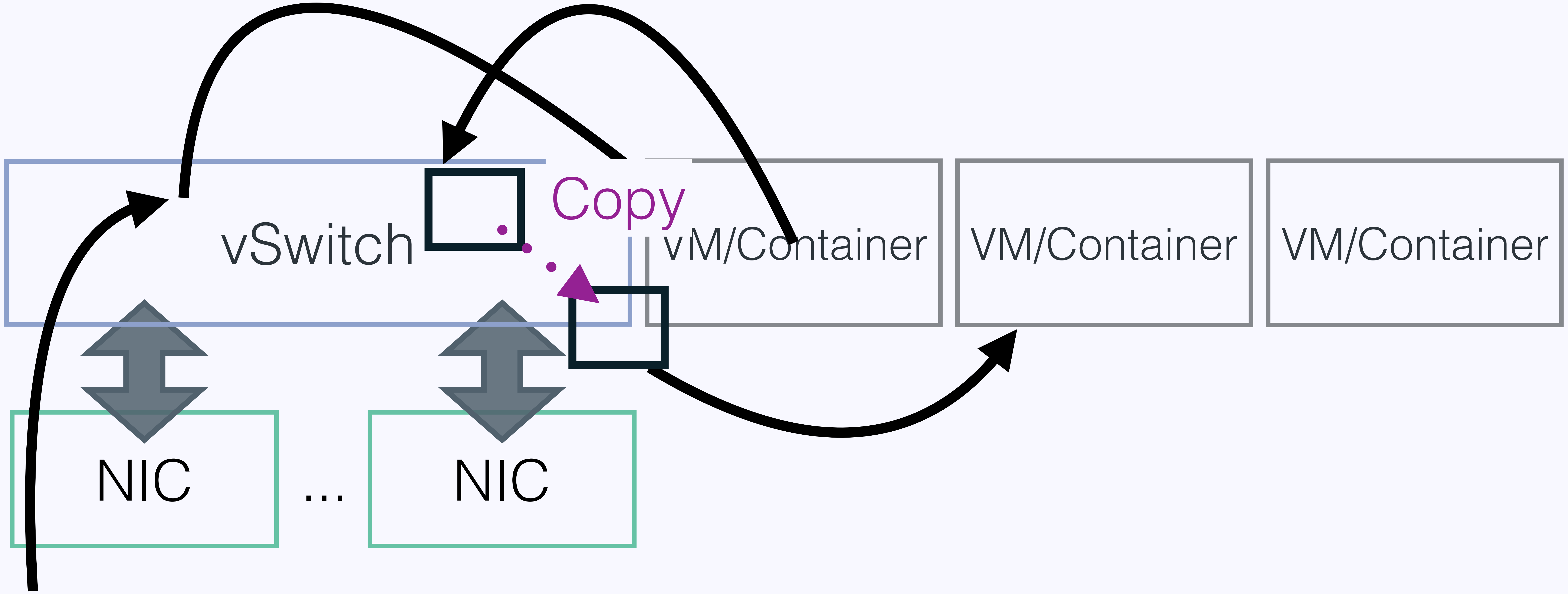


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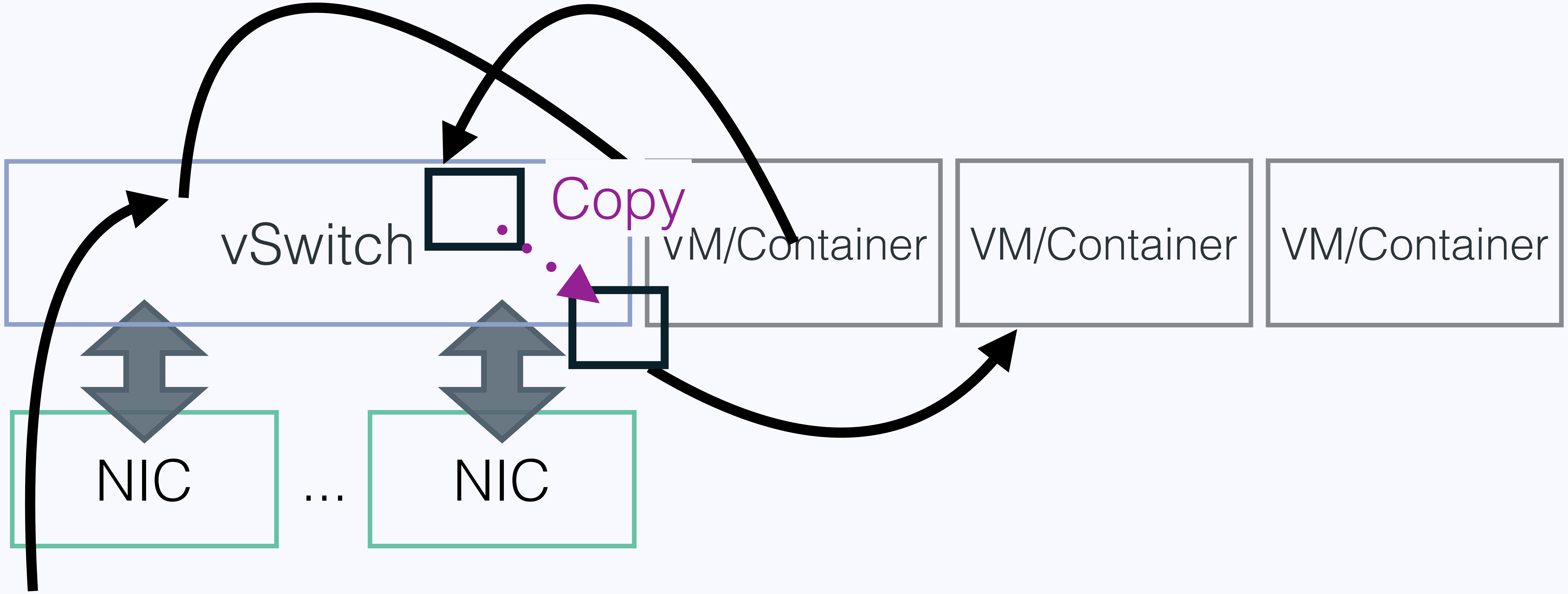


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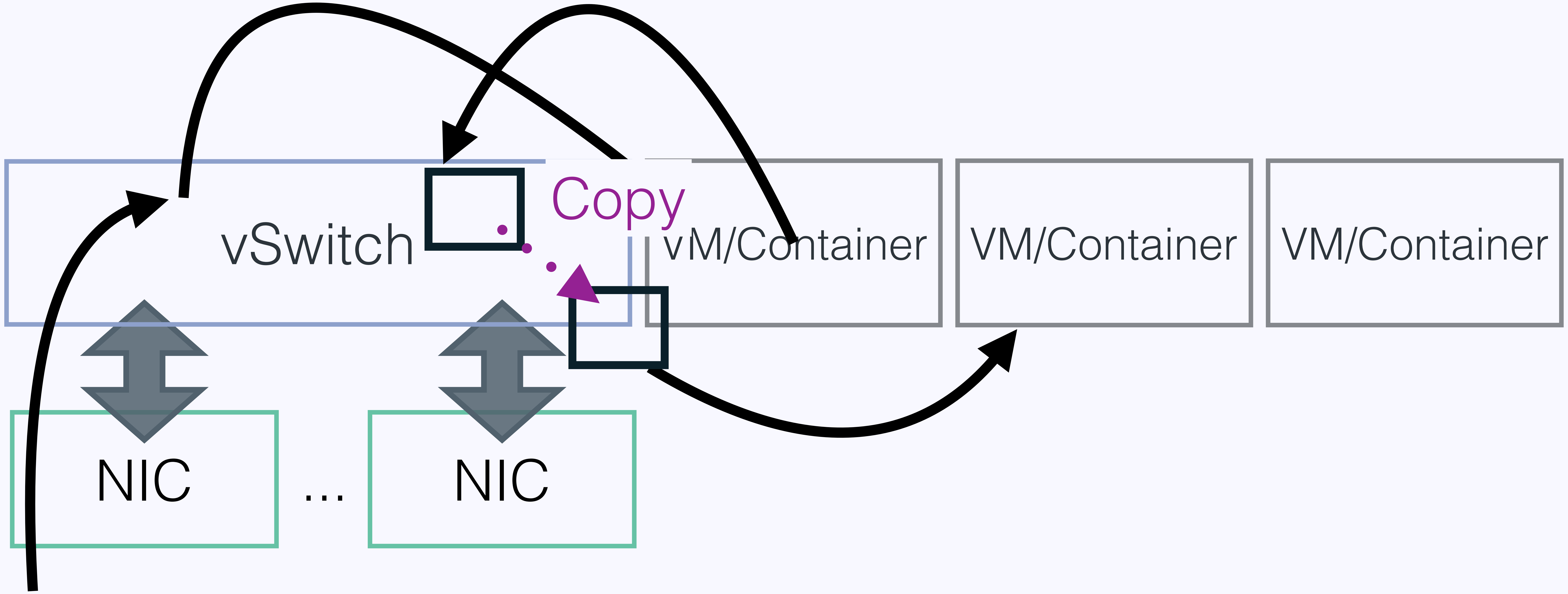


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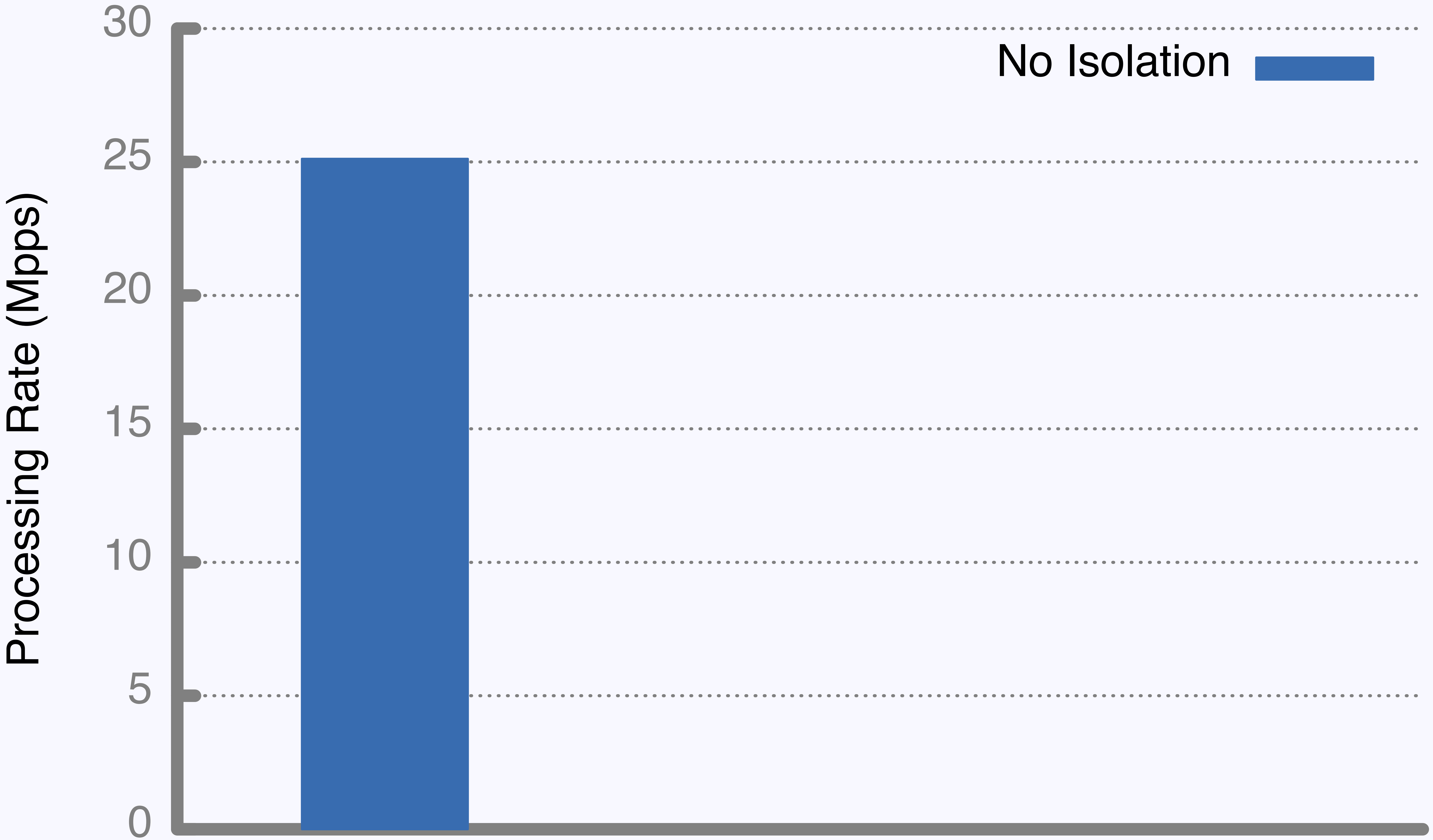

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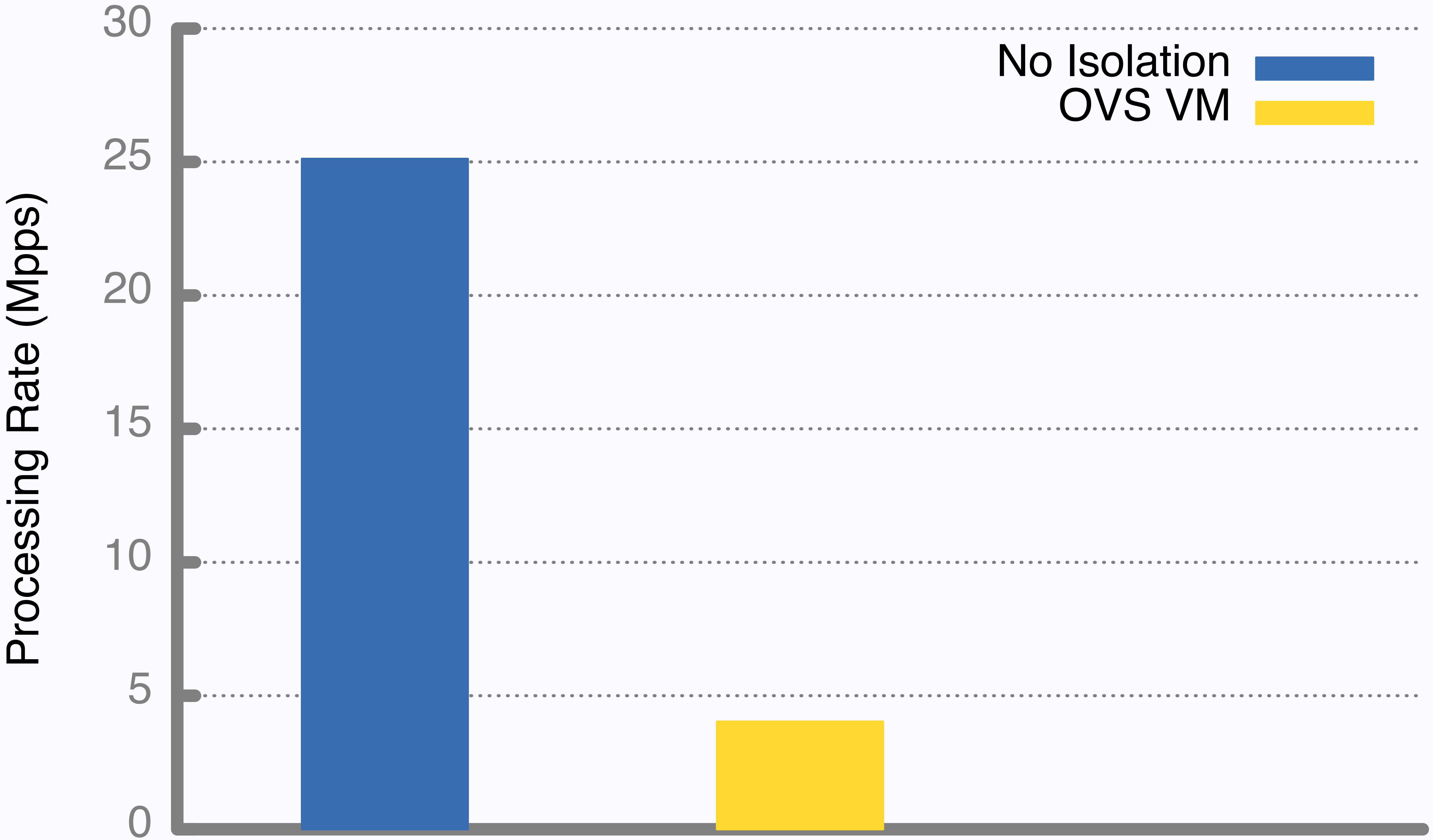

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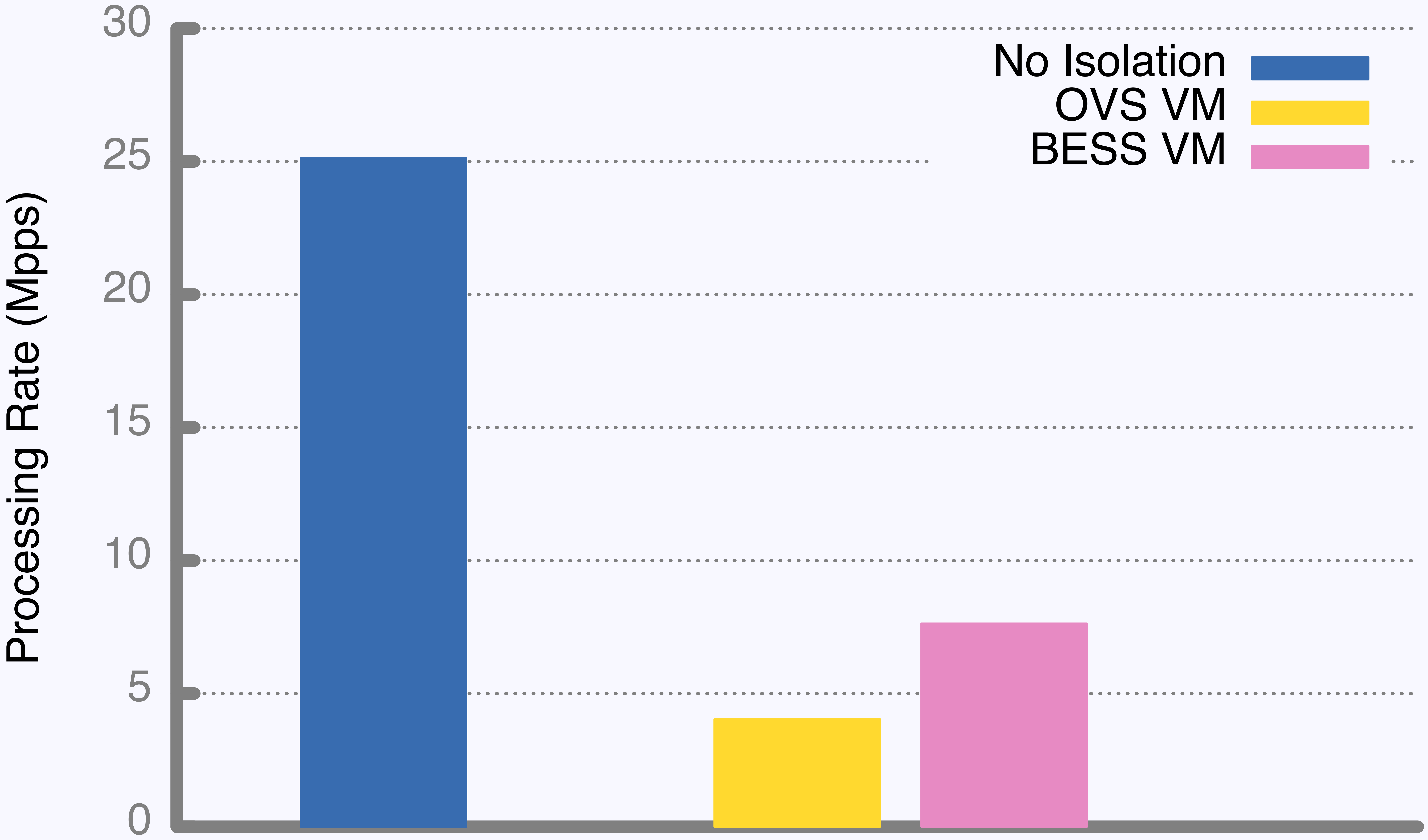

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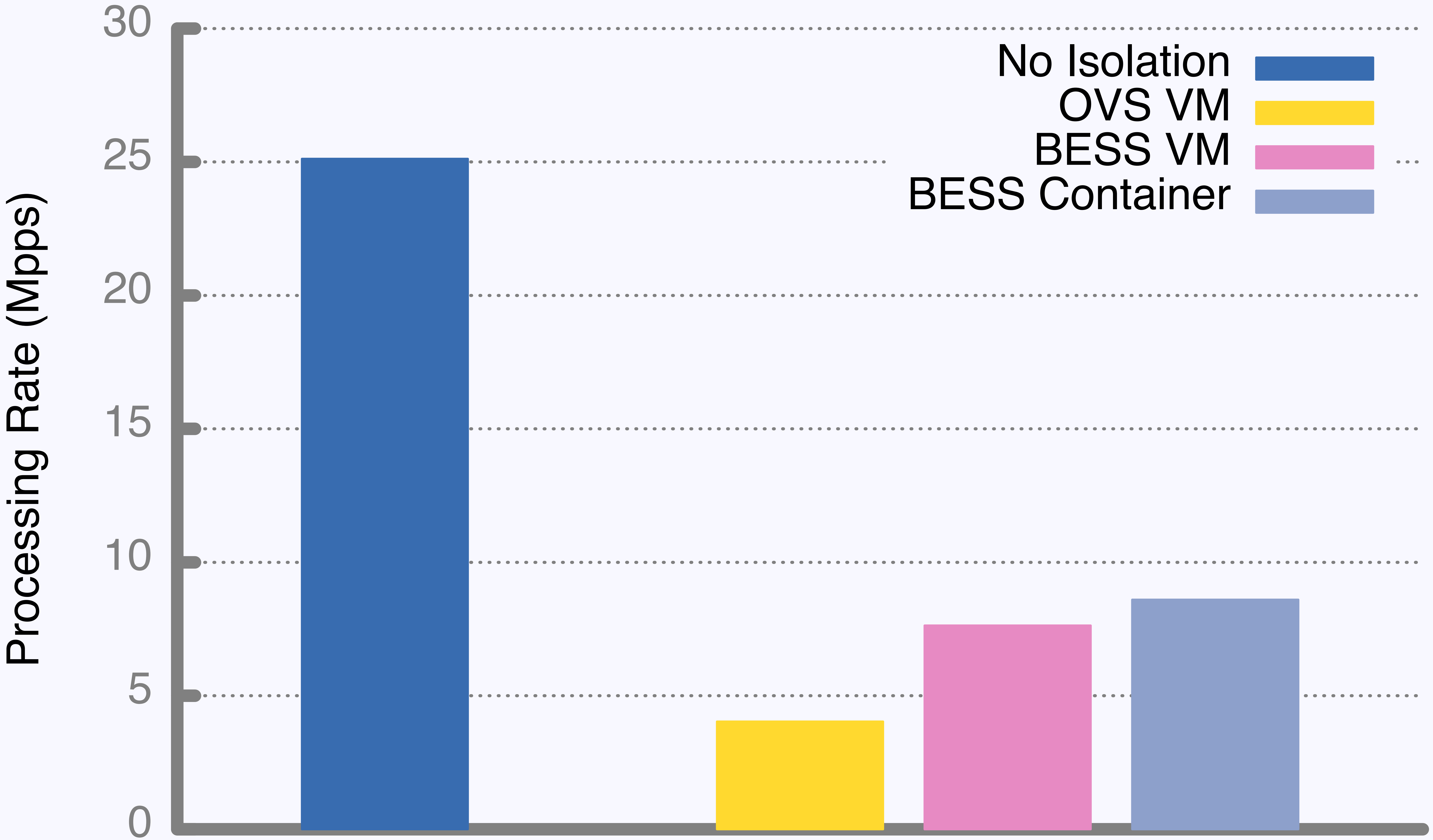

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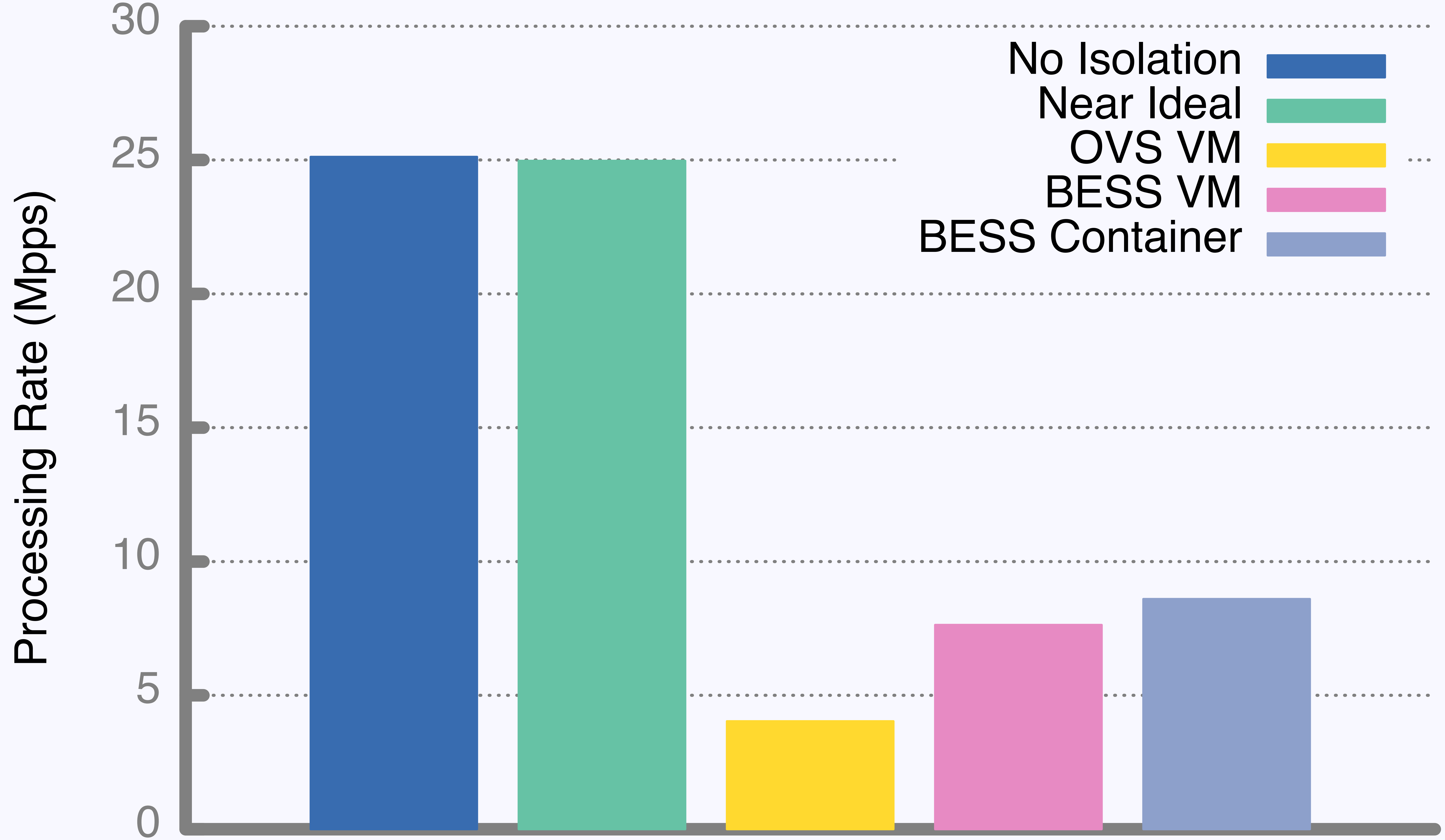

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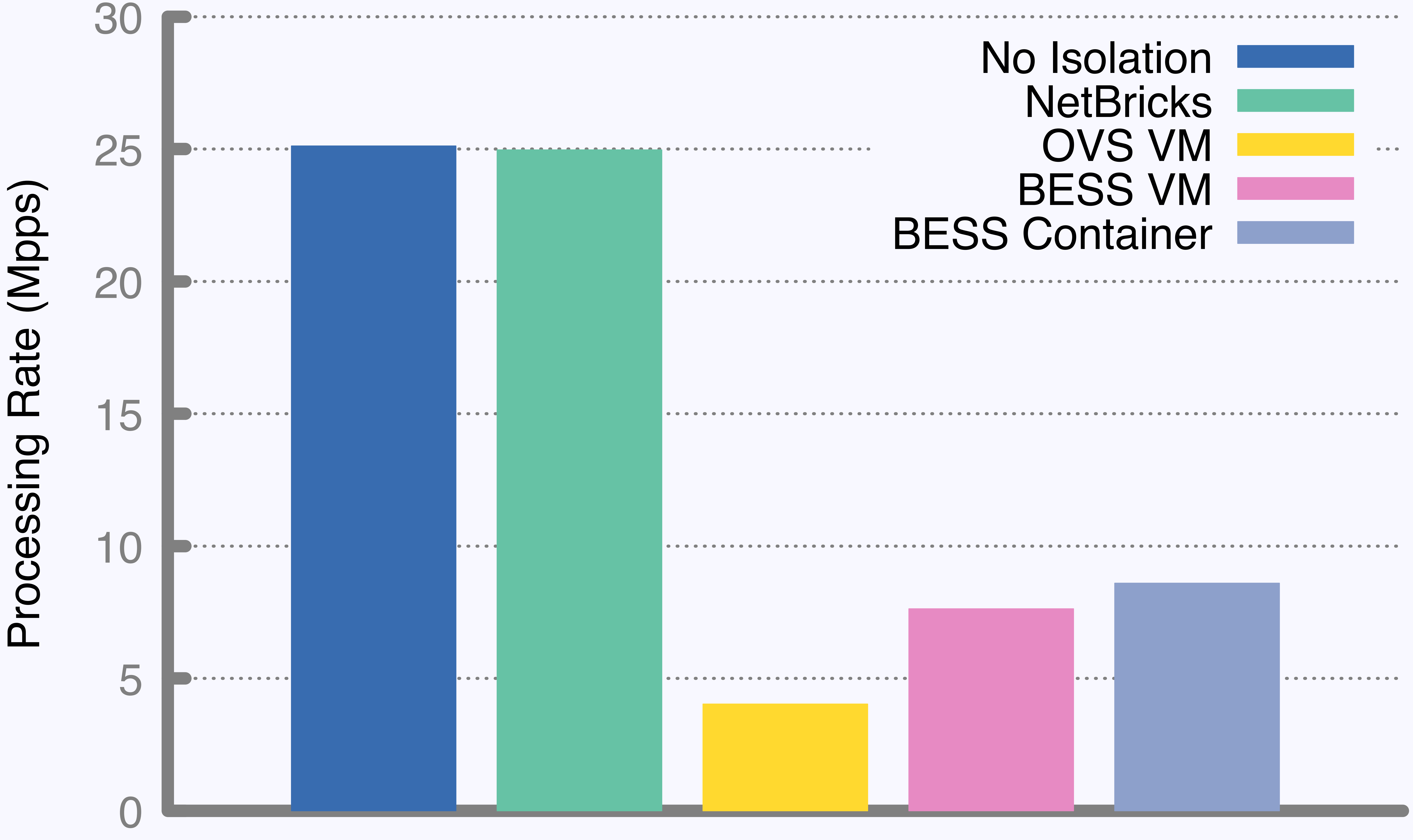

# NetBricks Runtime Architecture

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# What about Isolation?

# Provide Isolation through Software

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- VMs and containers impose cost on packets crossing isolation boundaries.
  - Frequent operation for many NFs which must support 10s of MPPS.
- **Insight**: Use type checking (compile time) and runtime checks for isolation.
  - Isolation costs largely paid at compile time (small runtime costs).

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    - Unique types ensure references destroyed after certain calls.
    - Ensure only one NF has a reference to a packet.
    - Enables zero copy packet I/O.
- All of these features implemented on top of **Rust**.

# Software can provide both Memory and Packet Isolation

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- Reduce memory and cache pressure for NFV deployments.
  - Zero copy I/O => do not need to copy packets around.

# Challenges for NFV

- **Running NFs**
  - **Isolation** and **Performance**

- **Building NFs**
  - **High-Level Programming** and **Performance**

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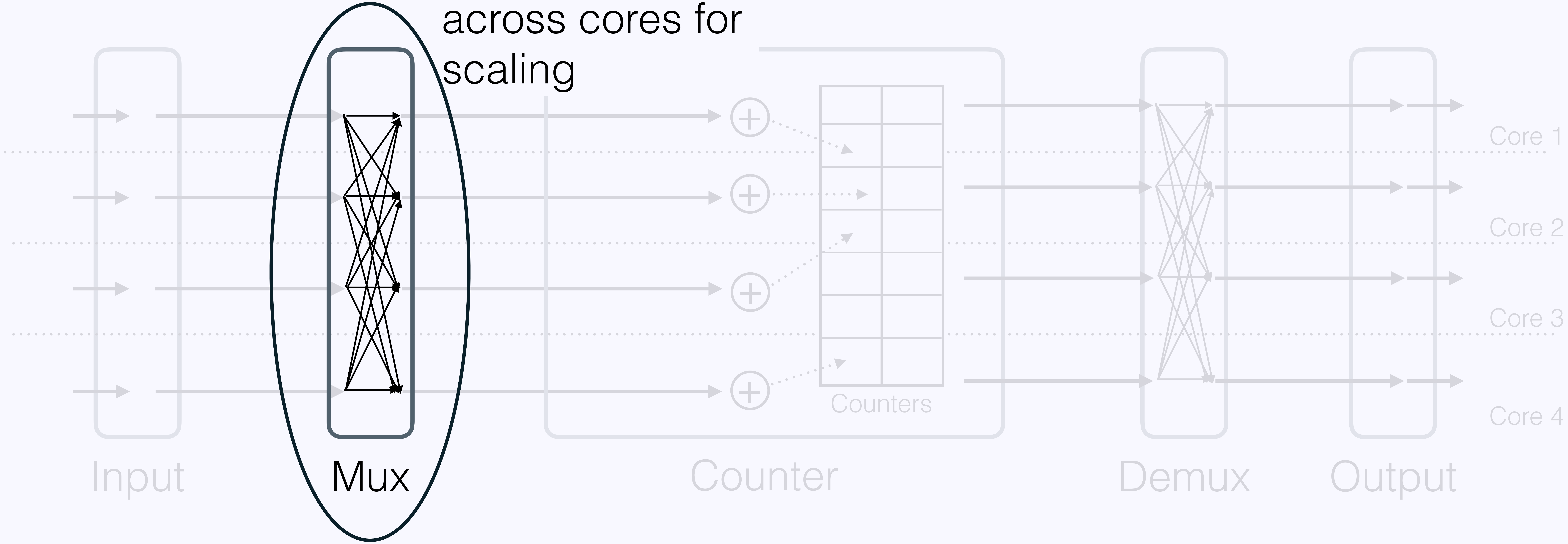
- What happened in other areas
  - MPI to Map Reduce, etc.

# Abstractions

| | |
|---|---|
| **Packet Processing Abstractions** | |
| Parse/Deparse | Parse (or undo parsing for) a header from the packet. |
| Transform | Operate on the packet header and payload. |
| Filter | Drop packet whose header or payload meet some criterion. |
| **Byte Stream Processing Abstractions** | |
| Window | Use a sliding window to gather packet payload and call a function. |
| Packetize | Segment a byte array into a sequence of packets, |
| **Control Flow** | |
| Group By | Branch control flow between abstractions. |
| Shuffle | Shuffle packets across processing cores. |
| Merge | Merge control from branches. |
| **State Abstractions** | |
| Bounded Consistency State | State store with tunable consistency specification. |
| **Schedulabe Abstractions** | |
| Invoke | Periodically execute a function. |

# Shuffle Abstraction

Spread packets across cores for scaling



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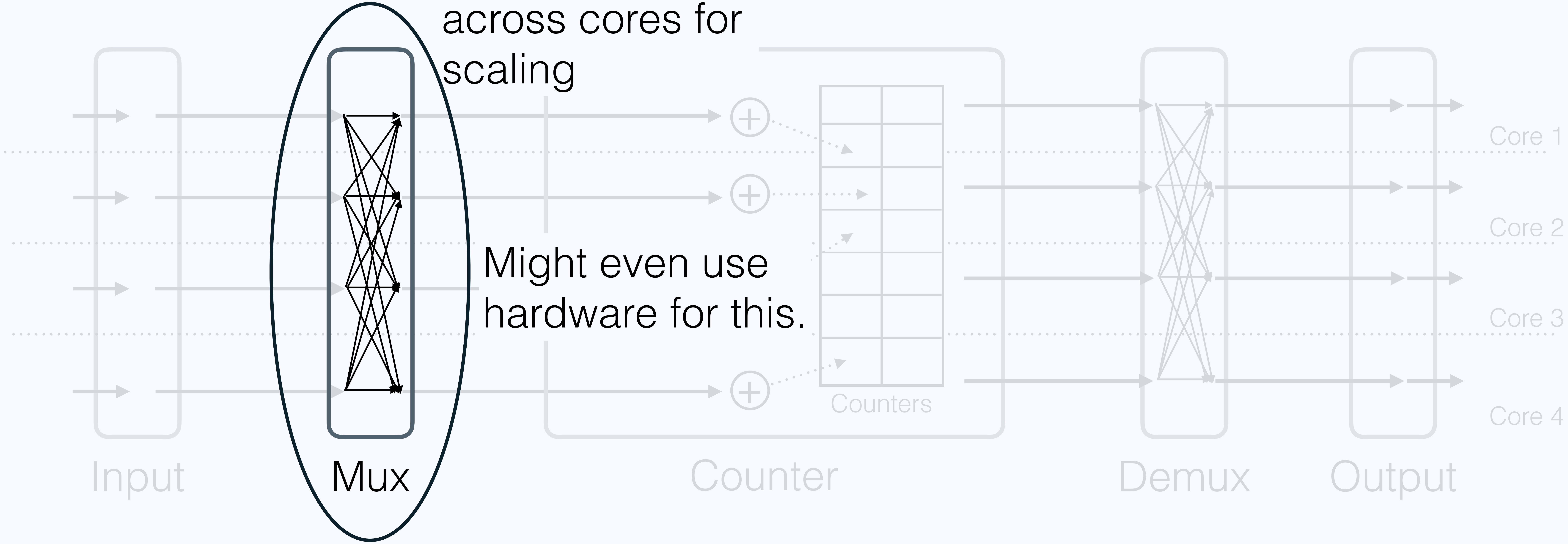
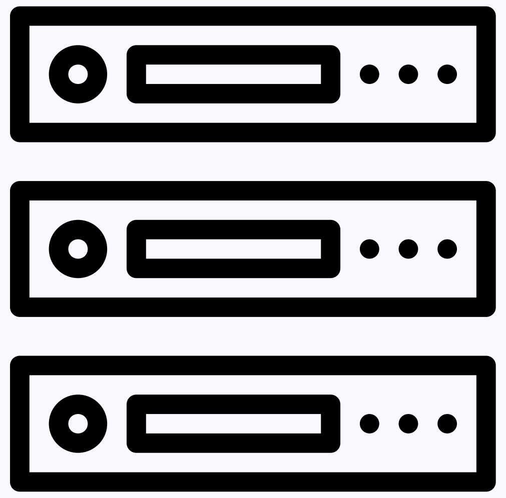
Might even use hardware for this.



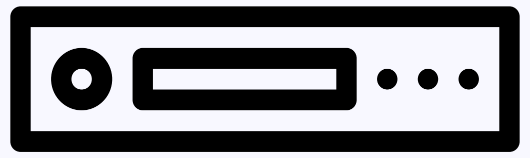
# Example NF: Maglev

- **Maglev**: Load balancer from Google (NSDI'16).
- Main contribution: a **novel consistent hashing algorithm.**
  - Most of the work in common optimization: batching, scaling cross core.
- NetBricks implementation: **105 lines, 2 hours of grad student time**.
- Comparable performance to optimized code

## Managing NFs



## Building and Running NFs



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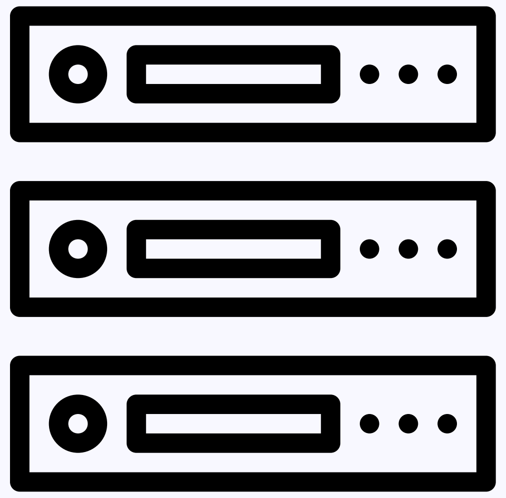

E2 (SOSP’15)

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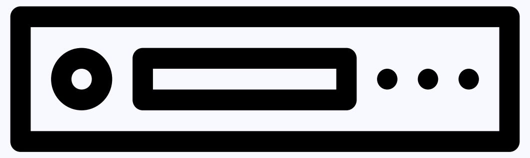

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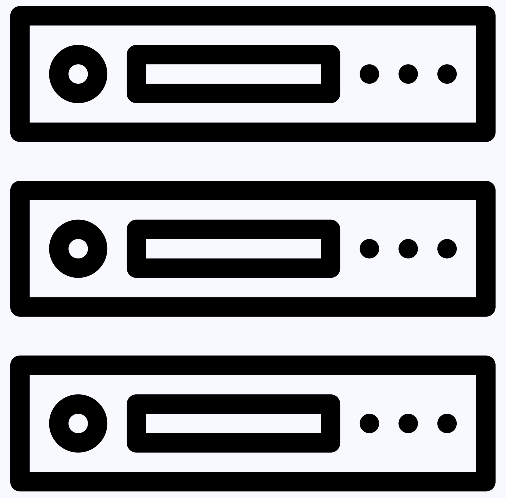

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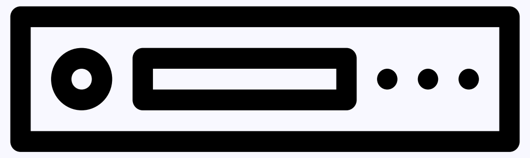

VM Isolation

NetVM (IEEE TNSM)
ClickOS (NSDI'14)
HyperSwitch (ATC'13)
mSwitch (SOSR'15)

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# Conclusion

- Performance demands for NFV require forwarding 10-100 MPPS.
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- Requires low level optimization, slowing down NF development.
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Code available at **http://netbricks.io/**

# Backup

# Both Memory Isolation and I/O Induce Overheads