SSICLOPS

Part1: PASTE: Network Stacks Must Integrate with NVMM Abstractions
Part2: Report on ACM HotNets 2016

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With acknowledge to Lars Eggert and Douglas Santry

IIJ-II Seminar

December 26th, Tokyo, Japan

*work done

Motivation

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- Non-Volatile Main Memories (NVMMs)
  - Persistent
  - Byte-addressable
  - Low latency
    - 10s-1000s of ns

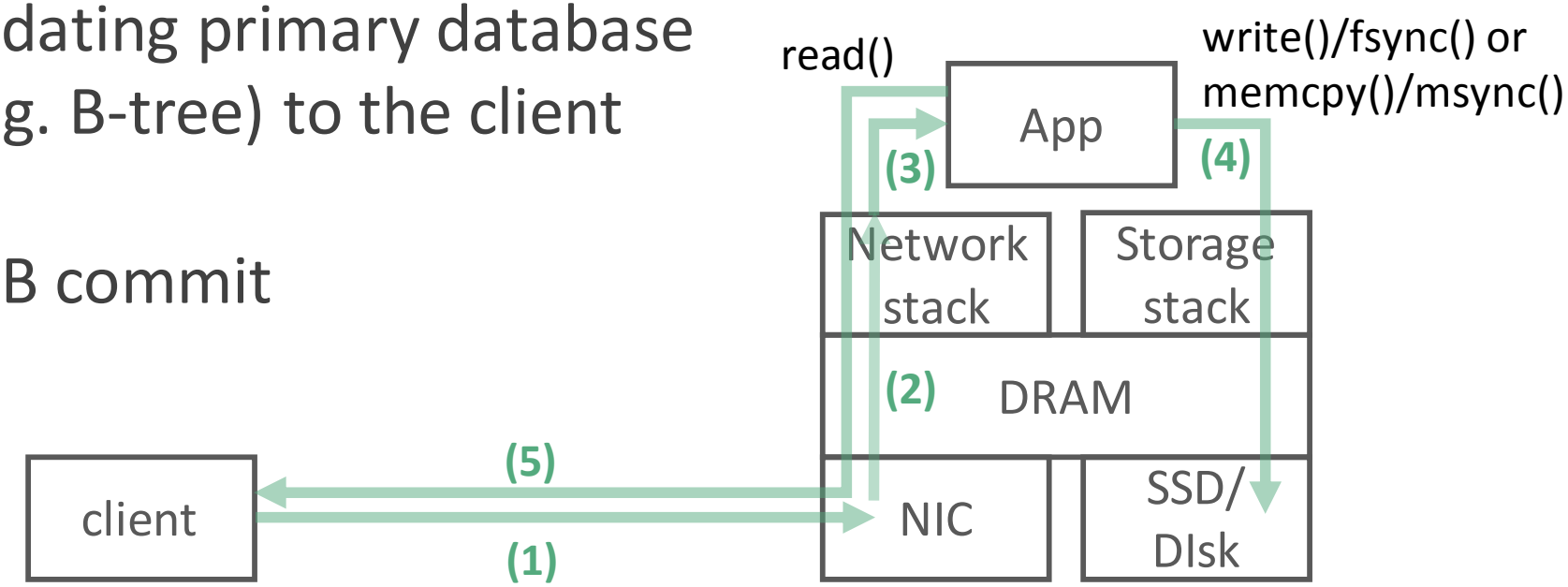
https://www.hpe.com/us/en/servers/persistent-memory.html

- Shift from ***block***- to ***byte***-granularity persistency
  - OS abstractions
    - ***Direct*** access to mmap()-ed ***files***
  - Data structures
    - Filesystems and databases

What are implications for networking?

Case Study: Write-Ahead Logging

- Persist client's request prior to acknowledgment
- Durably store data into a log file to mask overhead of updating primary database (e.g. B-tree) to the client



- 1KB commit
- 2030 us
  - Networking takes 40 us

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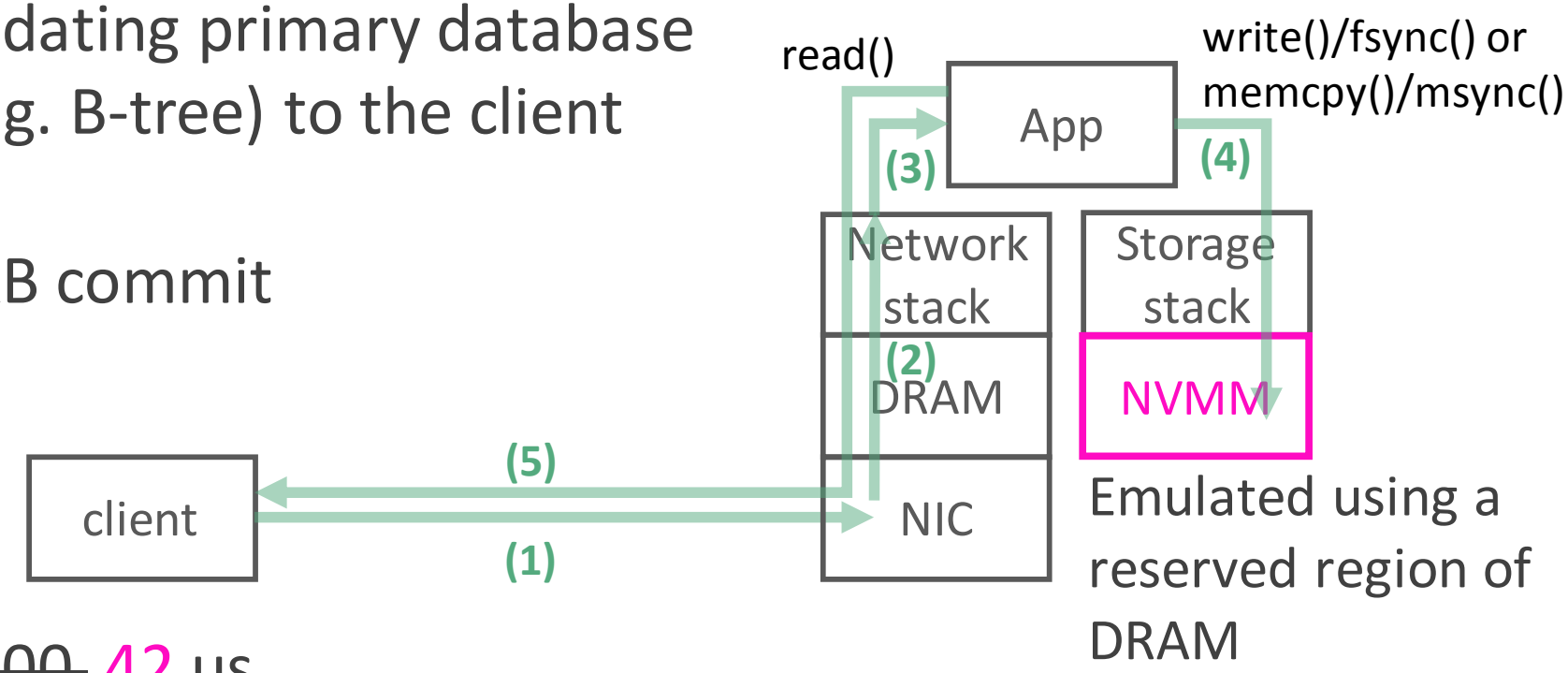

- 1KB commit
- ~~2000~~ 42 us
  - Networking takes 40 us
- This 2 us is not small

Case Study: Write-Ahead Logging

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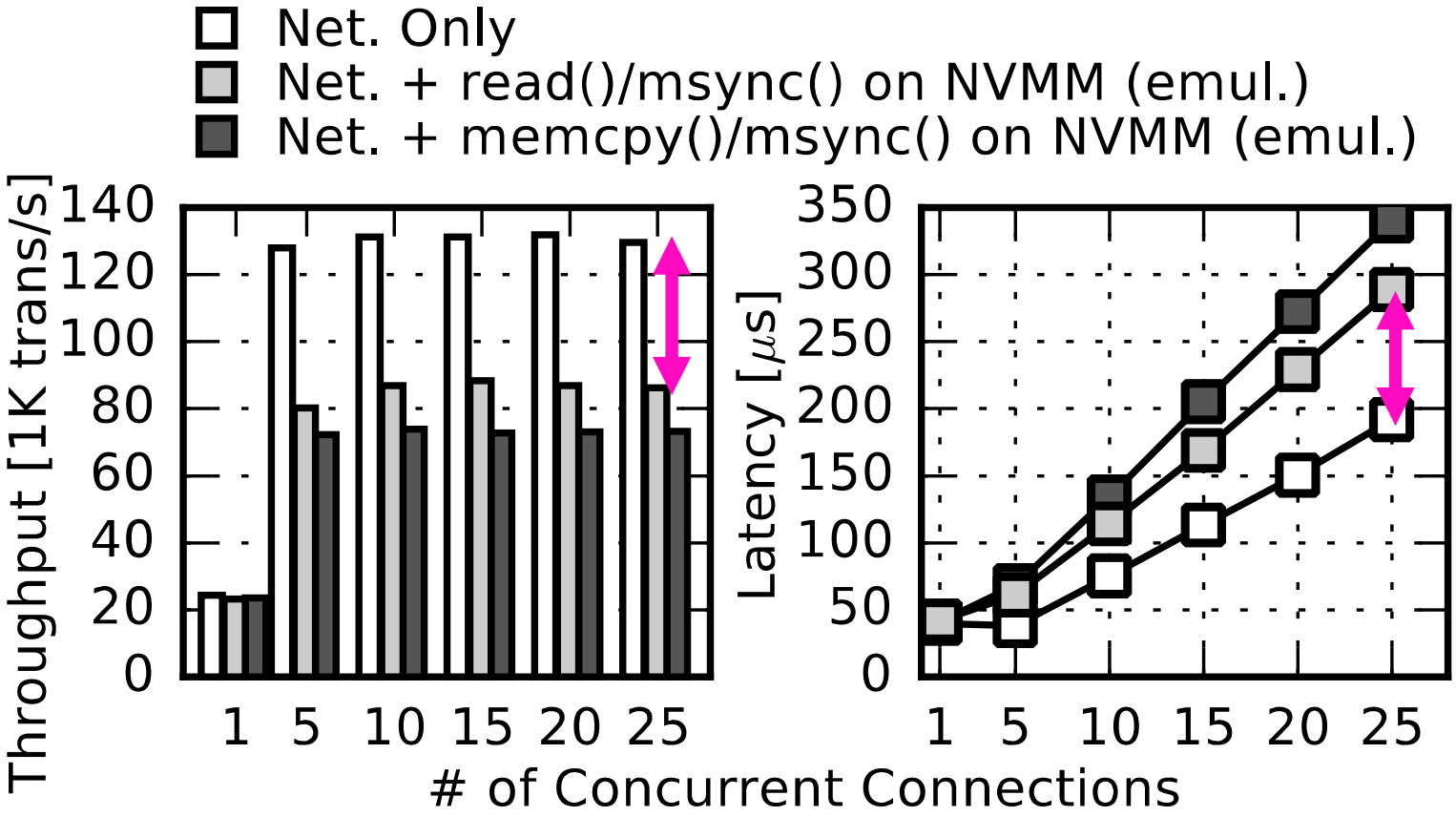
- Parallel requests are serialized on each core



33 % throughput decrease, 50 % latency increase

Data Copies Matter

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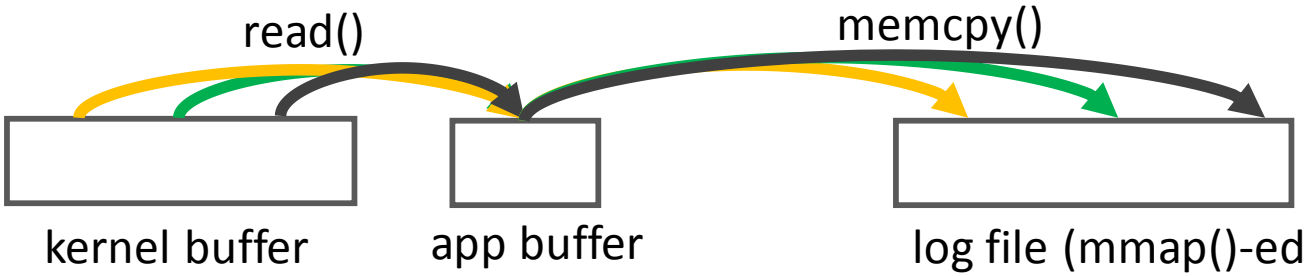
- **Cache Misses**
  - Copy to tmp buffer (e.g., read()) is cheap
  - **Logging always happens to a different destination**



	Overall cache misses	Largest Contributor
Networking only	0.0004 %	net_rx_action() (84%)
Networking + NVMM (read() + memcpy() + msync())	4.4121 %	memcpy() (98%)
Networking + NVMM (read()+msync())	8.3451 %	sys_read() (99 %)

We must avoid data copy for logging!

Packet Store (PASTE) Overview

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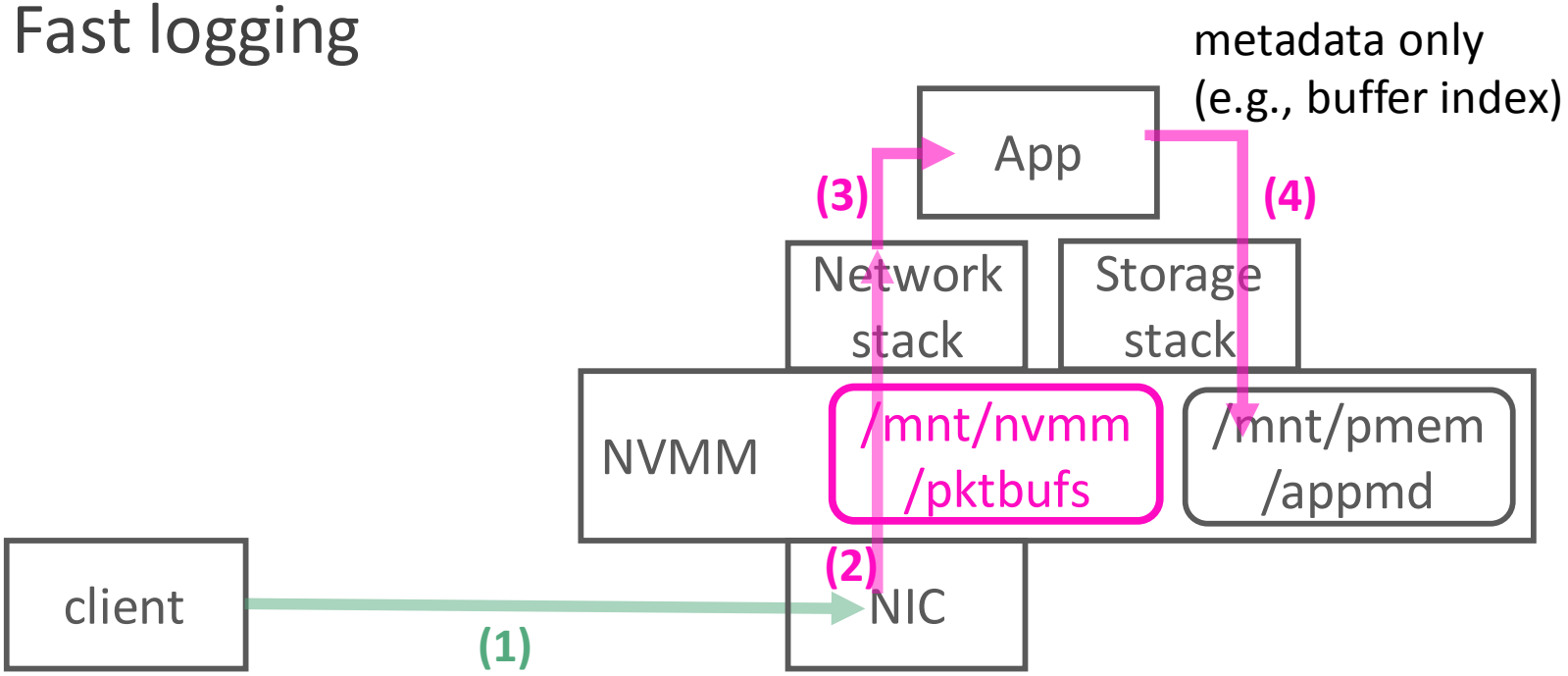
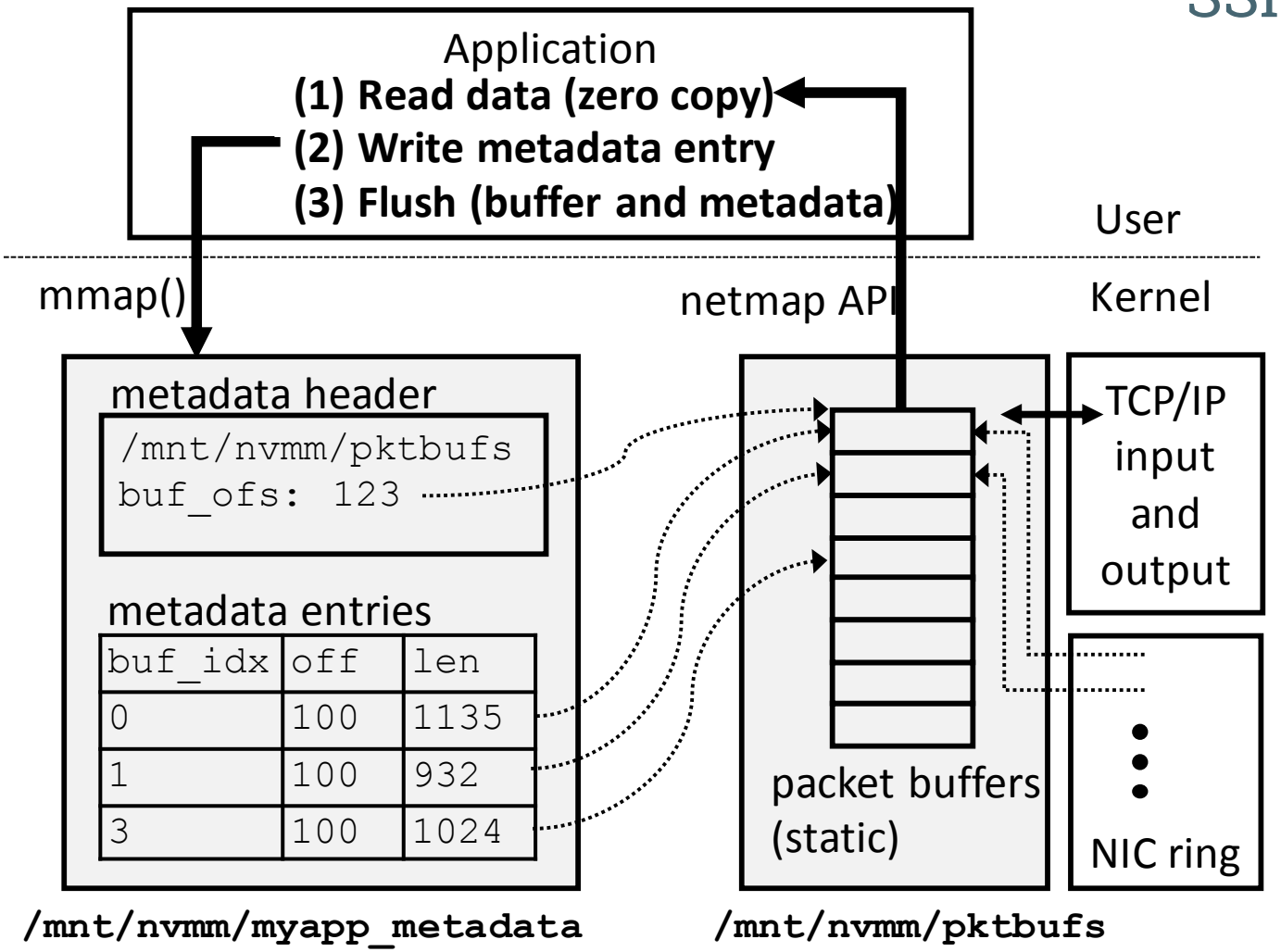
- Static packet buffers on a named NVMM region
  - DMA to NVMM
- Zero-copy APIs
- Fast logging



Fast Logging with PASTE

SSICLOPS



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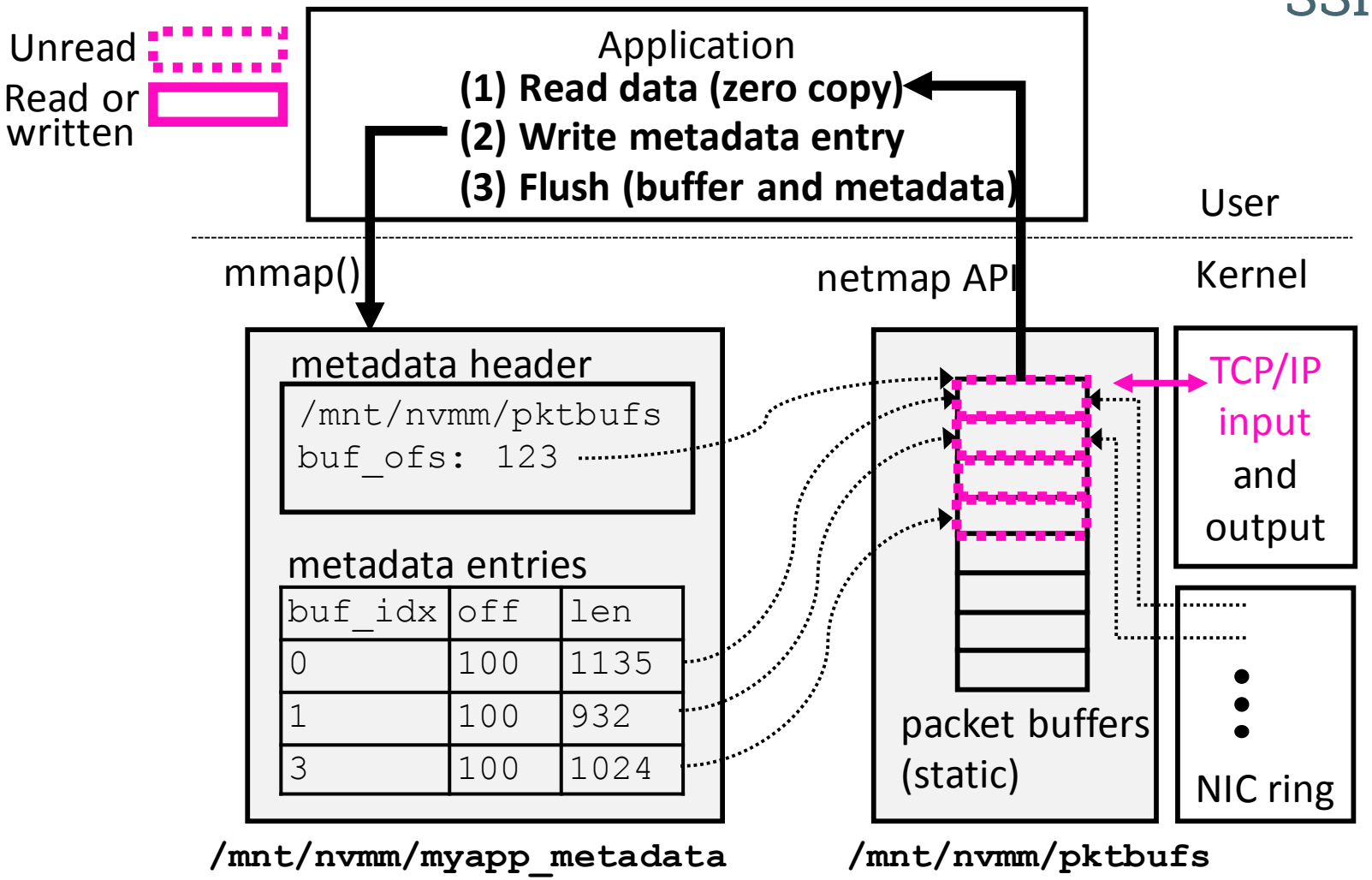

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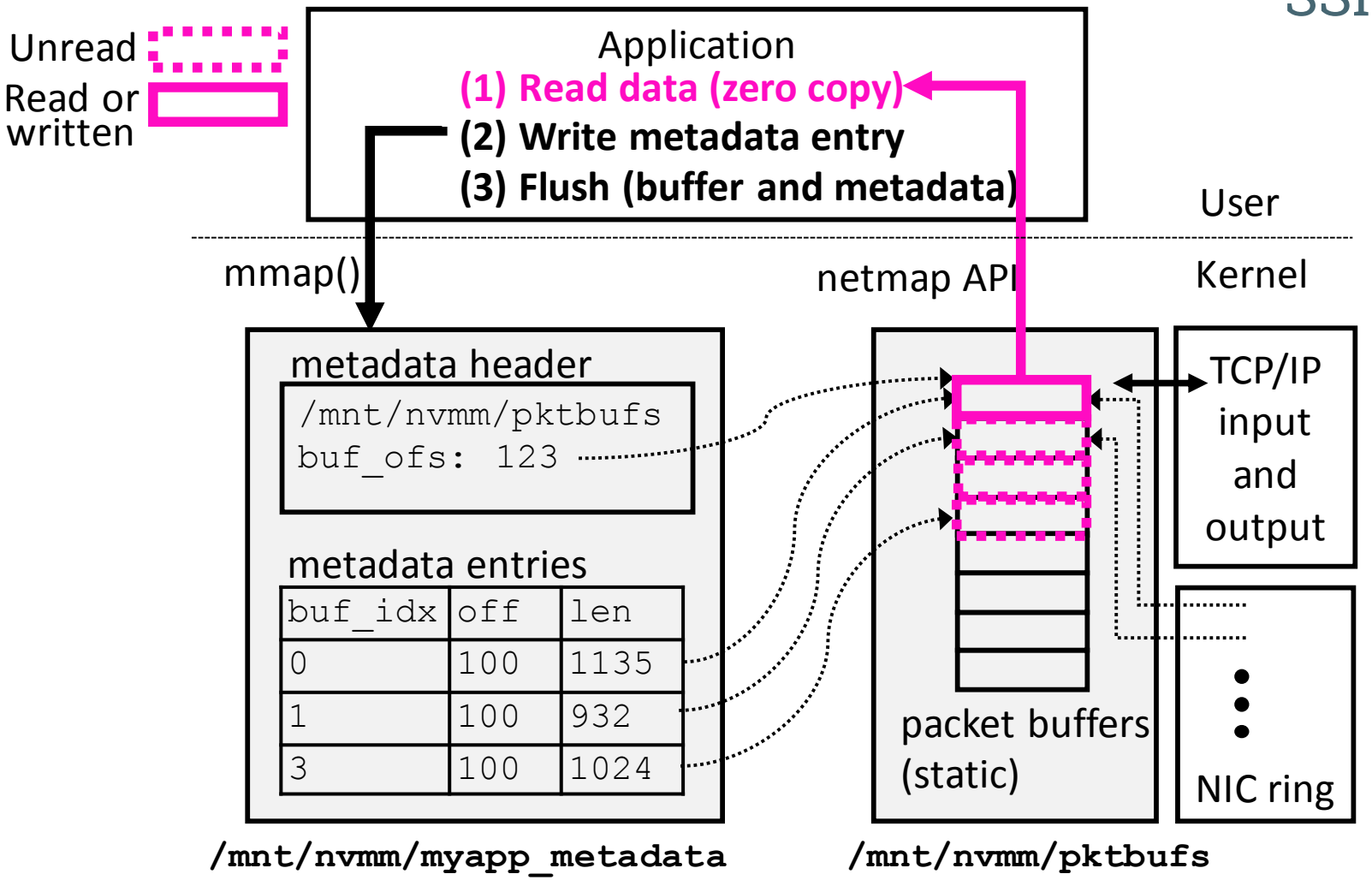

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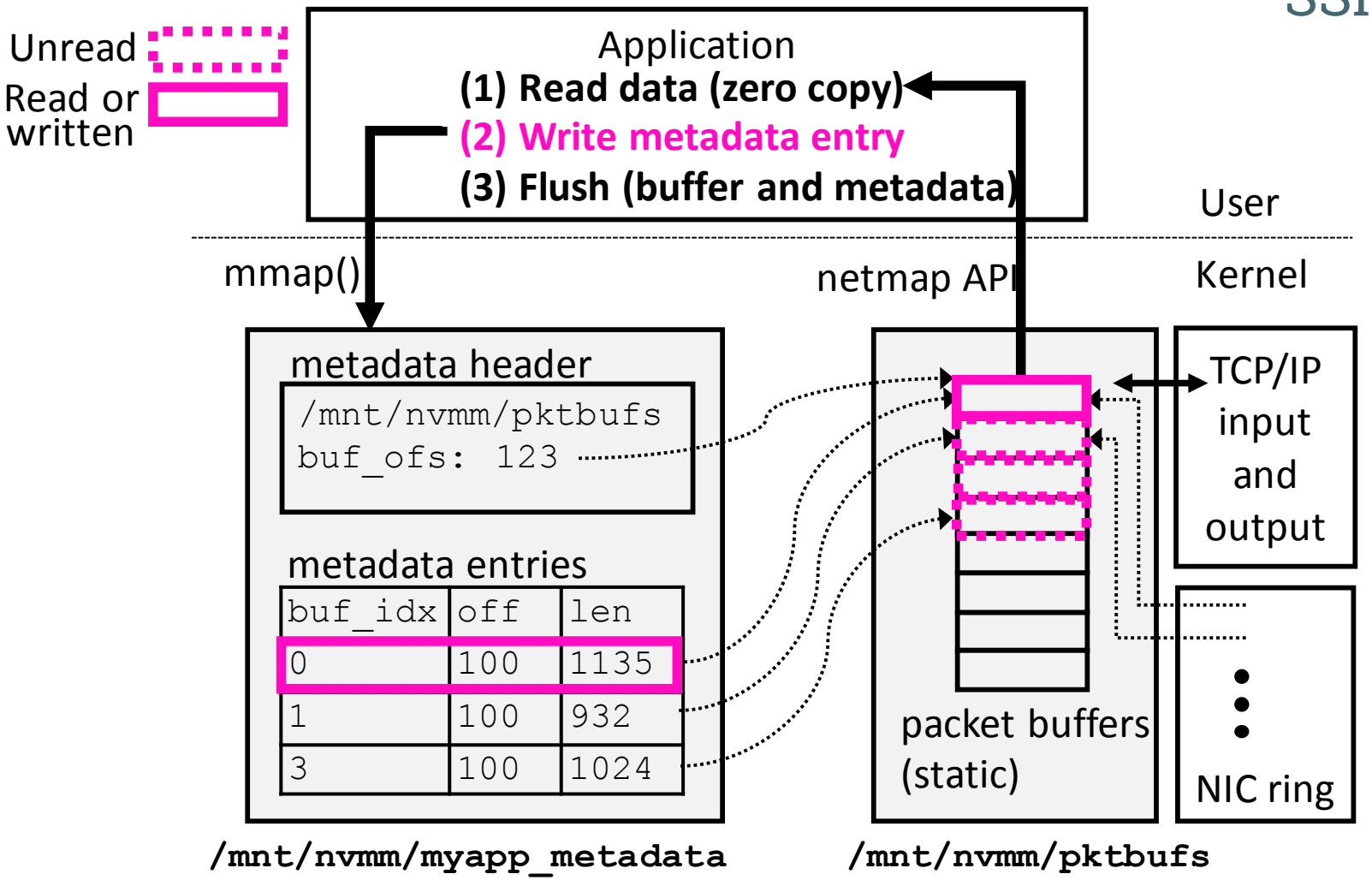

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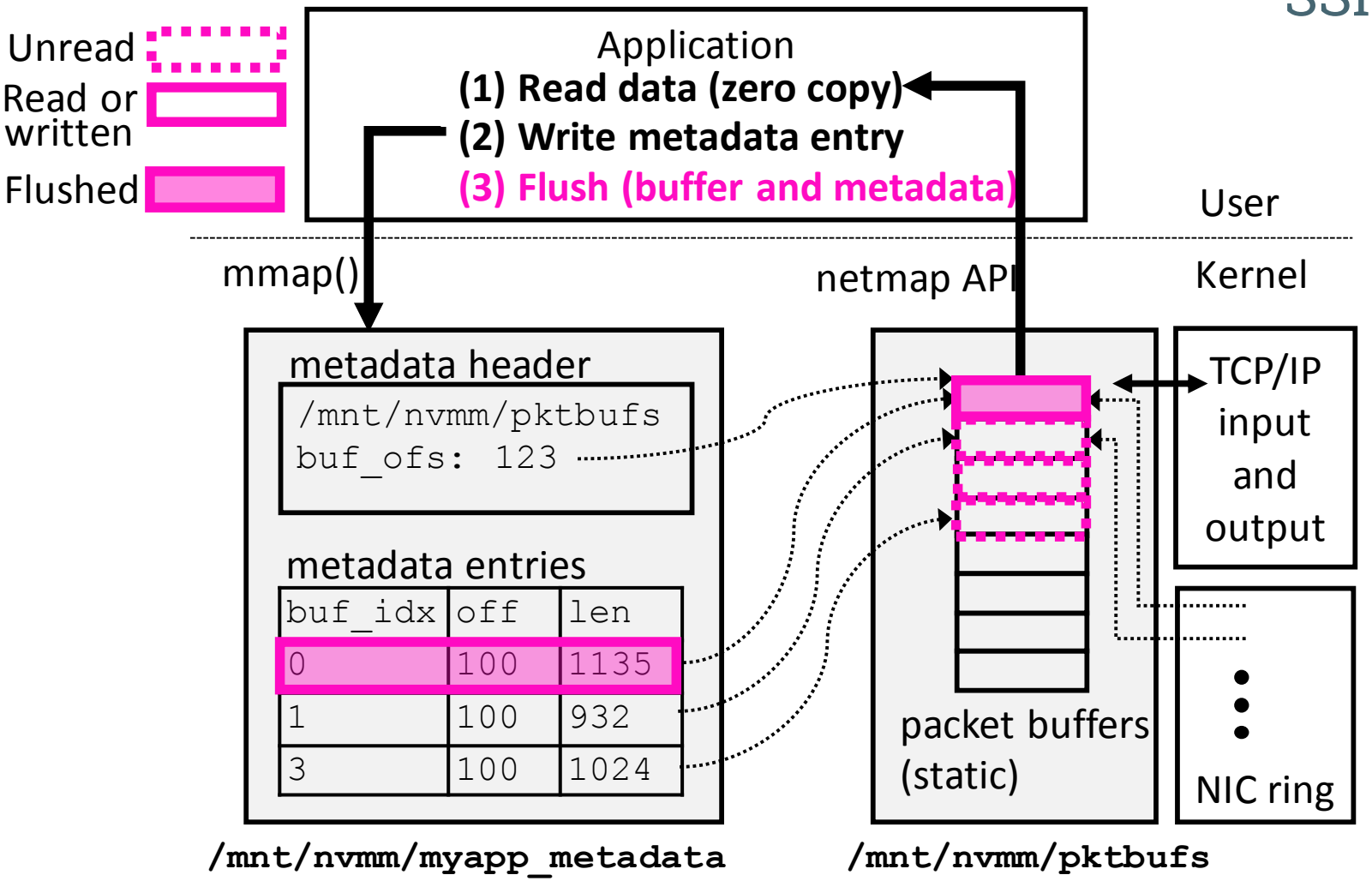

DMA is performed to L3 cache (DDIO)

Fast Logging with PASTE

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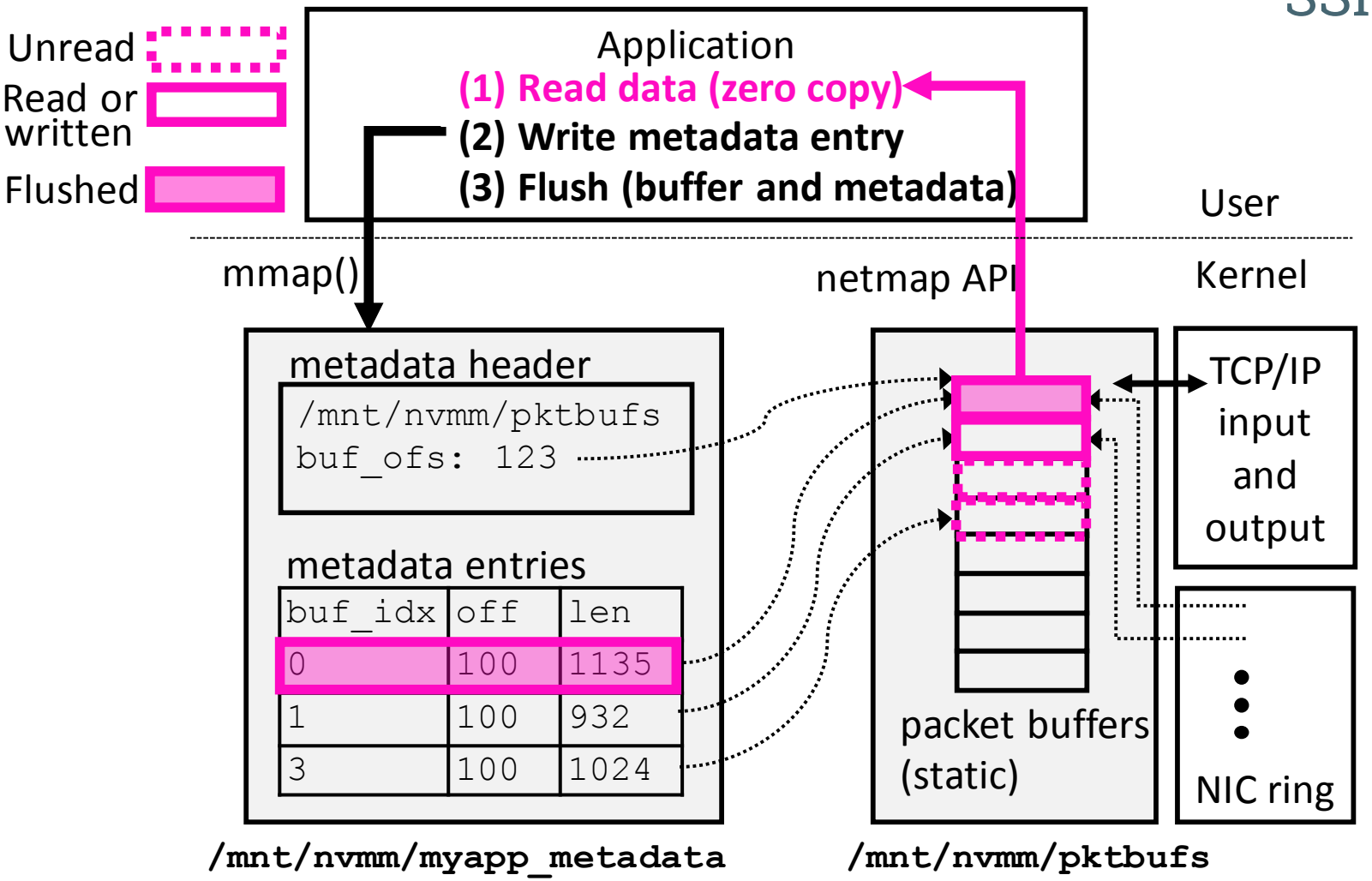

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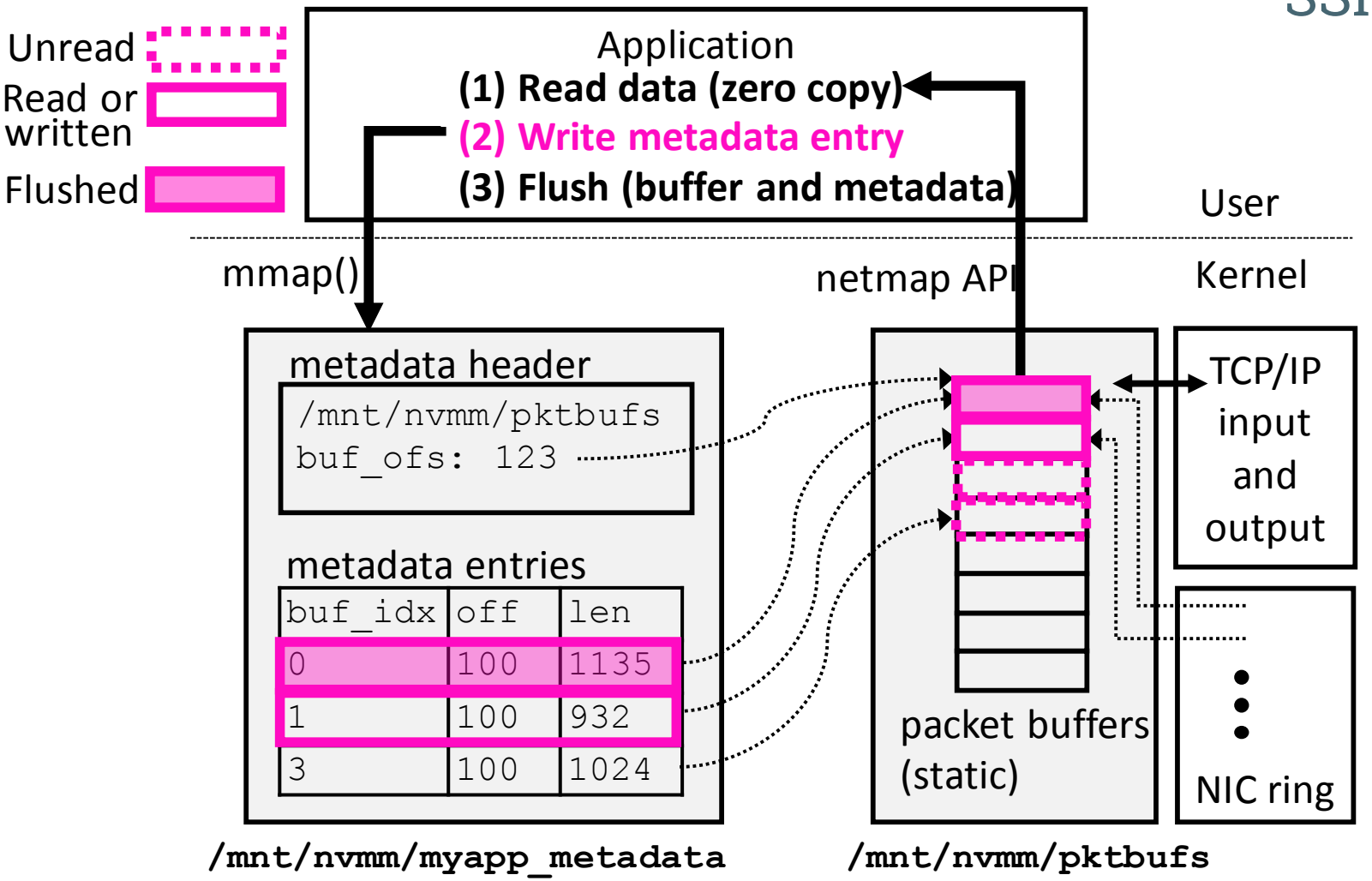

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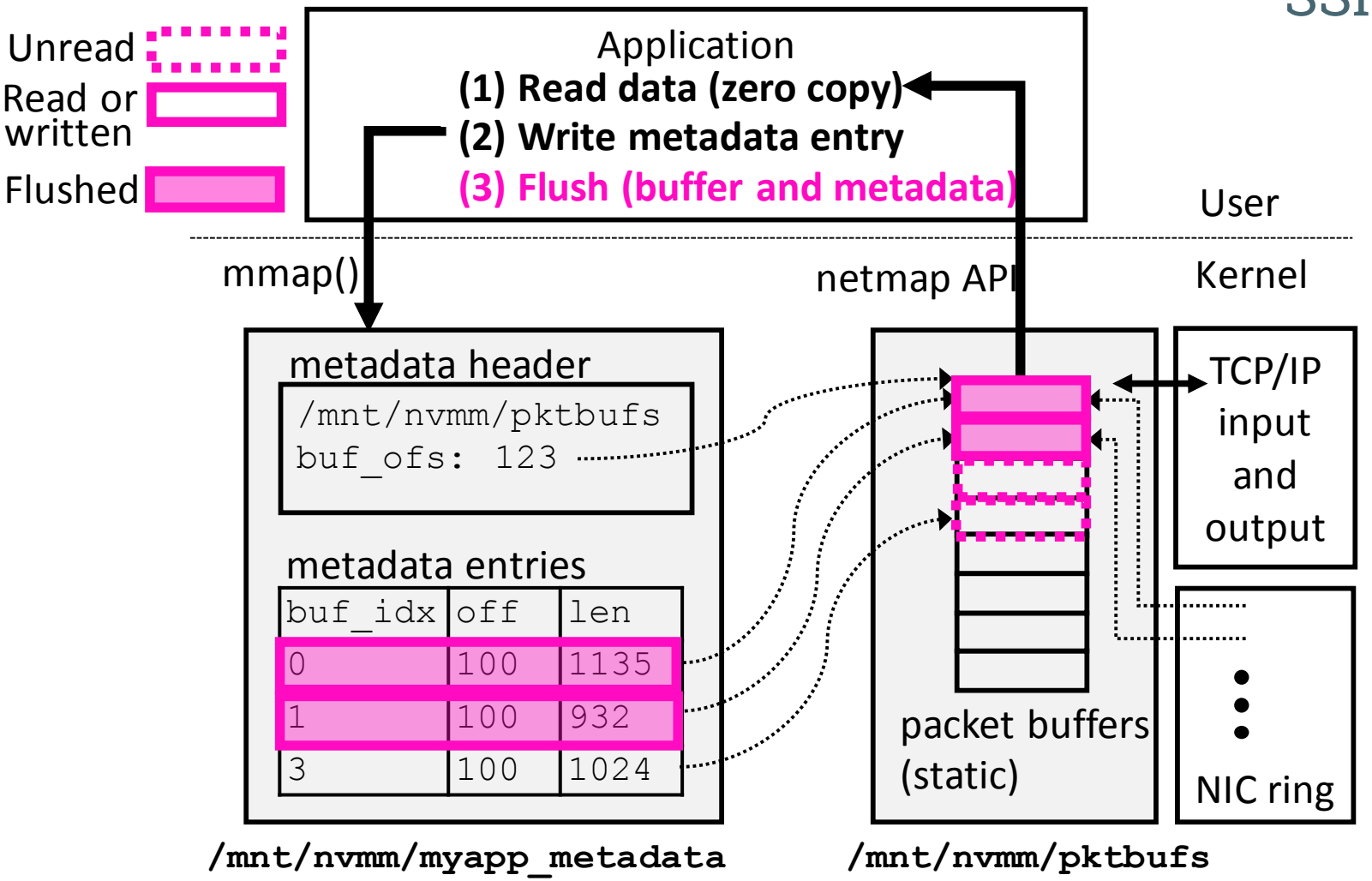

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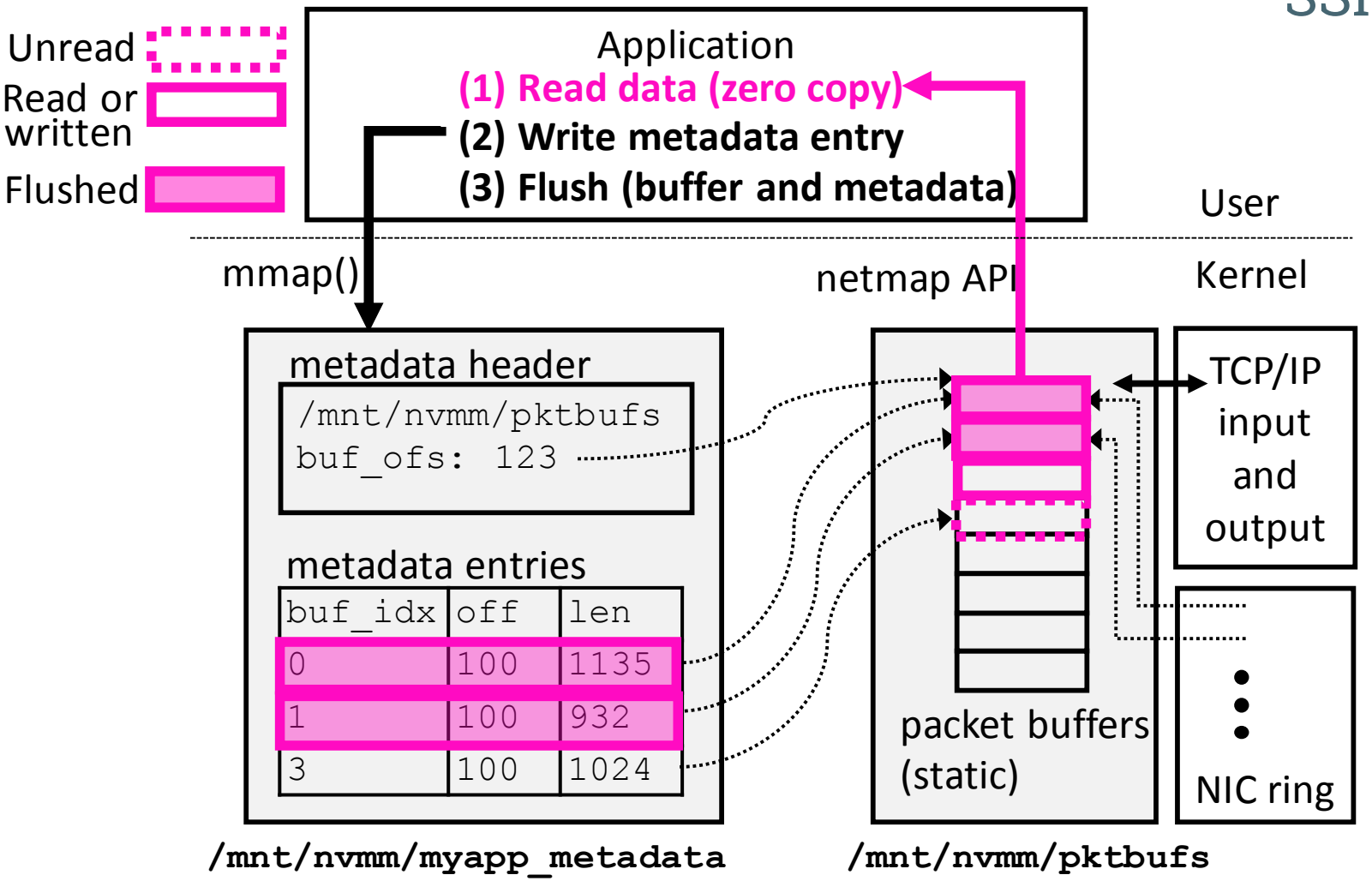

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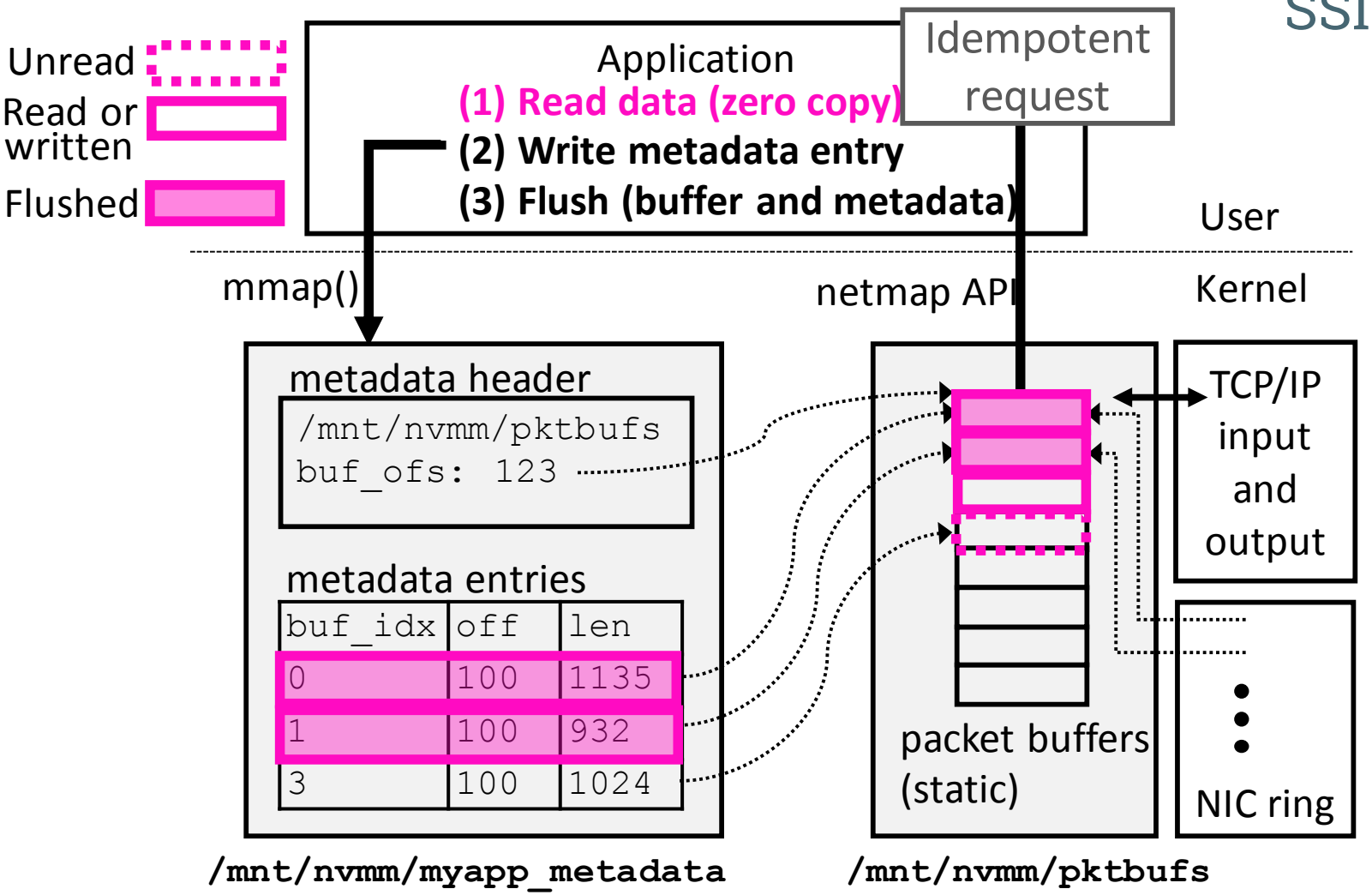

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Unnecessary data is not flushed to DIMM

Fast Logging with PASTE

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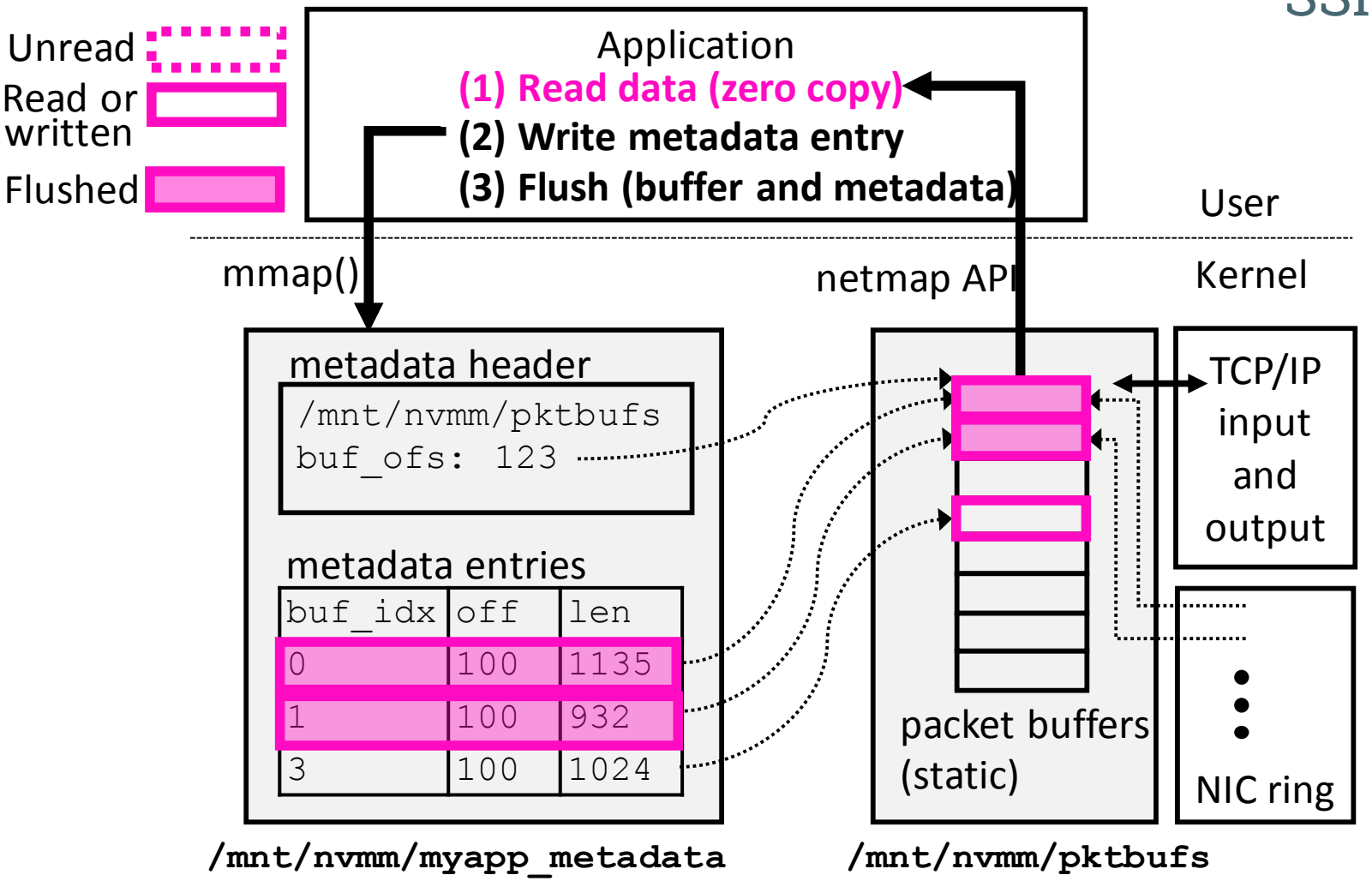

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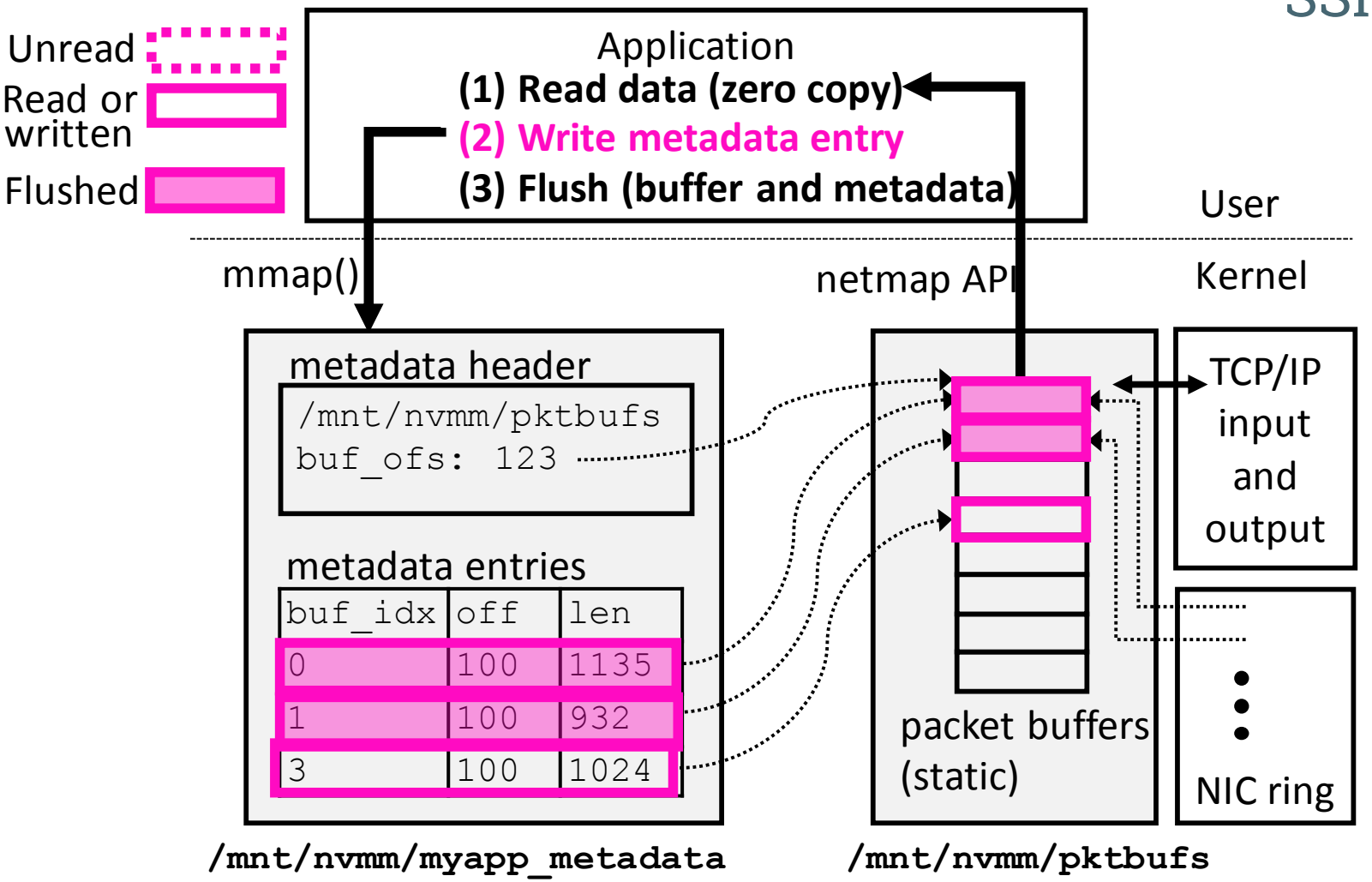

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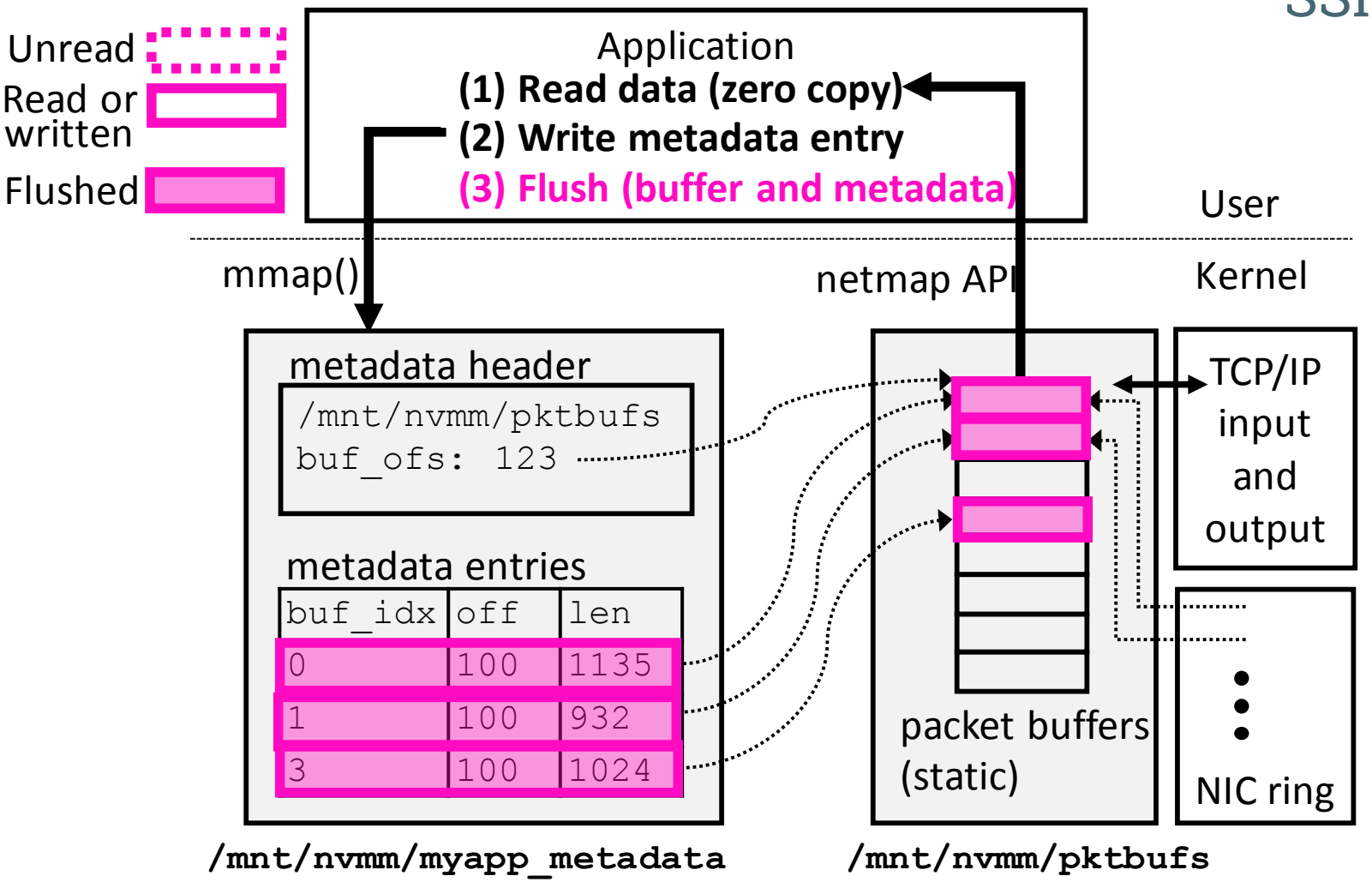

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Implementation

- Extension to netmap memory allocator
  - Claim packet buffers from a given file backed by NVMM
    - e.g., pkt-gen -i eth1@/mnt/pmem/bufs -f rx
- Server app using the netmap API can easily implement logging

Preliminary Results

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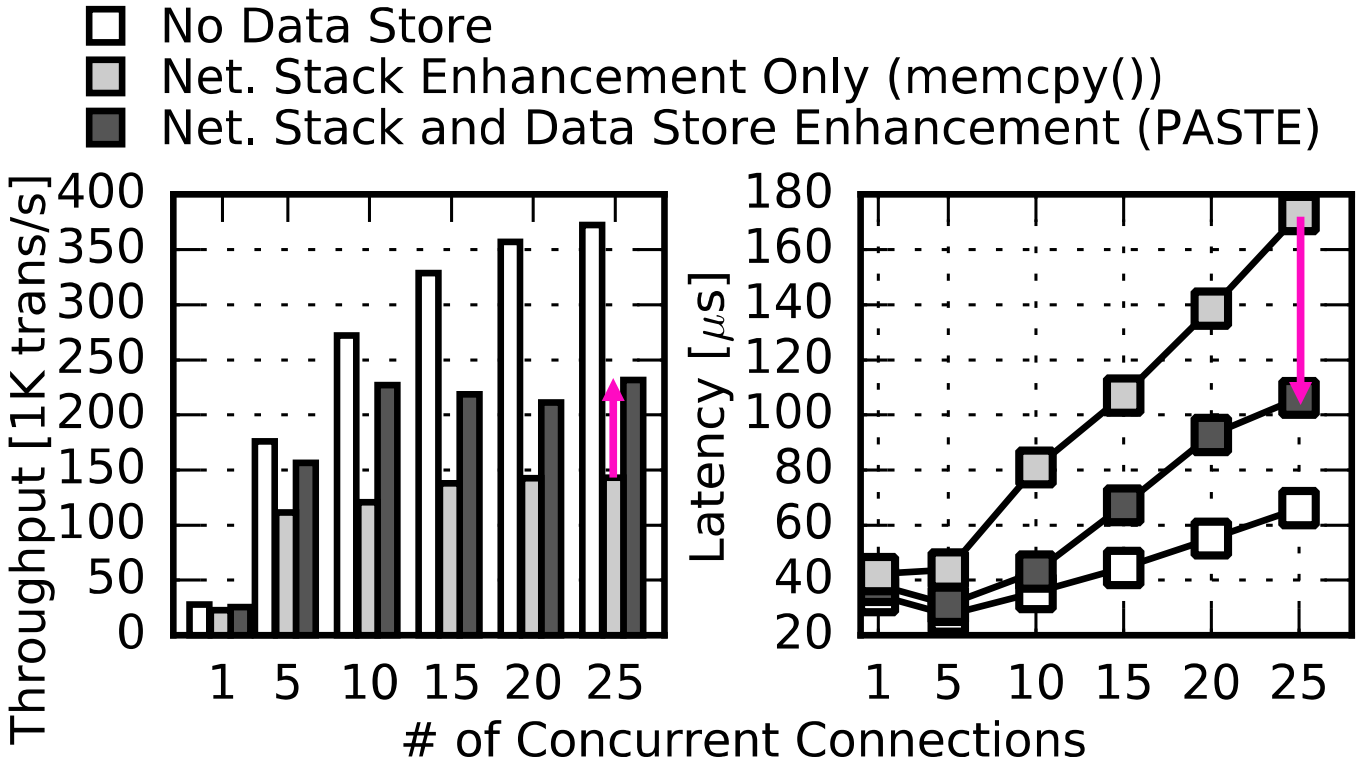
- Implementation
  - Extend the netmap framework
    - Stackmap for TCP/IP



10-88 % throughput increase, 9-46 % latency reduction

Related Work

- Enhanced network stacks
  - MegaPipe (OSDI'12), Stackmap (ATC'16), Fastsocket (ASPLOS'16)
  - IX and Arrakis (OSDI'14), mTCP (NSDI'13), Sandstorm (SIGCOMM'14), MICA (NSDI'14)

No NVMM aware

- NVMM filesystems
  - BPFS (SOSP'09), NOVA (FAST'15)
- NVMM databases
  - NVWAL (ASPLOS'15), REWIND (VLDB'15), NV-Tree (FAST'15)

No networking aware

Conclusion

PASTE: Fast logging with named packet buffers on NVMM and zero-copy API

- Implications
  - Network stacks are now a bottleneck for durably storing data
  - Improving network and storage stacks in isolation is not enough
  - We need new stacks design

HotNets 2016 Reports

- ACM Workshop on Hot Topics in Networks
  - Focus on new ideas and future directions in networking
- November 9-10 2016 @ Atlanta
- ~90 attendees (Invitation only)
  - 1 author per paper
  - Invited people in the community
  - Lottery

Submission and Reviews

- 30 papers (out of 108 submitted)
- 3-6 reviews
  - 48 papers on PC discussion
- We submitted 2 papers
  - 1 rejected (received 4 reviews)
    - 3 weak rejects + 1 weak accept
  - 1 accepted (received 6 reviews)
    - 1 accept + 4 weak accepts + 1 weak reject

Workshop Format

- Format was awesome
  - Very friendly – like a university internal workshop
  - Young people can be active
  - Senior people (incl. TPCs) comment and/or raise discussion

Workshop Topics

- ISPs
  - Frontier networks, Traffic engineering using MPTCP, monitoring
- Resource allocation
  - ML for cluster scheduling etc, blockchain for the Internet (BGP, DNS)
- Container networking
  - RDMA-based interfaces
- Social networks and clouds
  - SaaS, recommendation etc
- Datacenters
  - Topology, deadlockes in RDMA networks, debugging
- Mobile
  - Low-energy consumption network stack, network personalization
- Network monitoring and analysis
  - Using programmable switches
- Wireless (MIT)
- NF modeling verification
- DDoS