

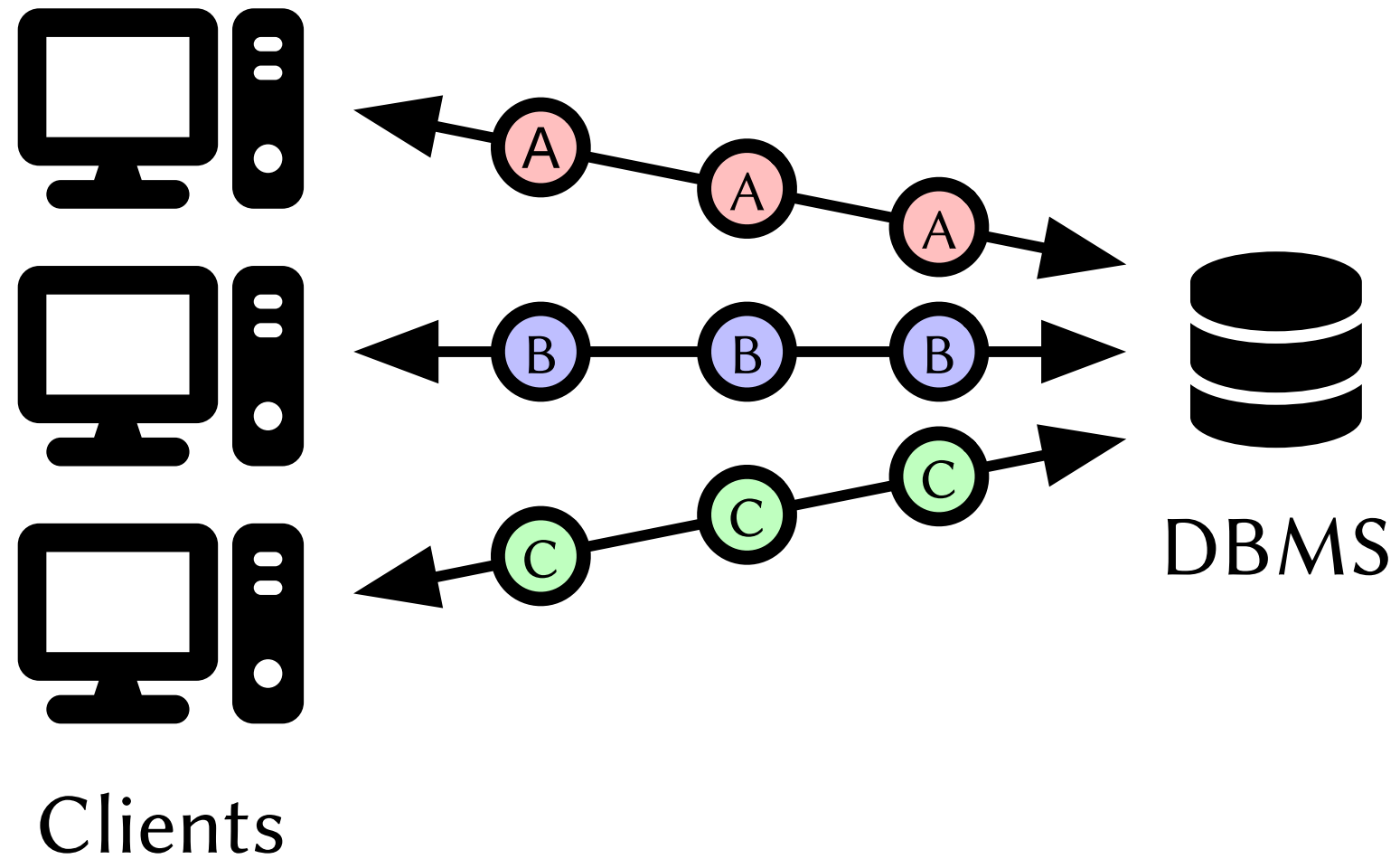
Tigger: A Database Proxy That Bounces With User-Bypass

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DBMS Connections

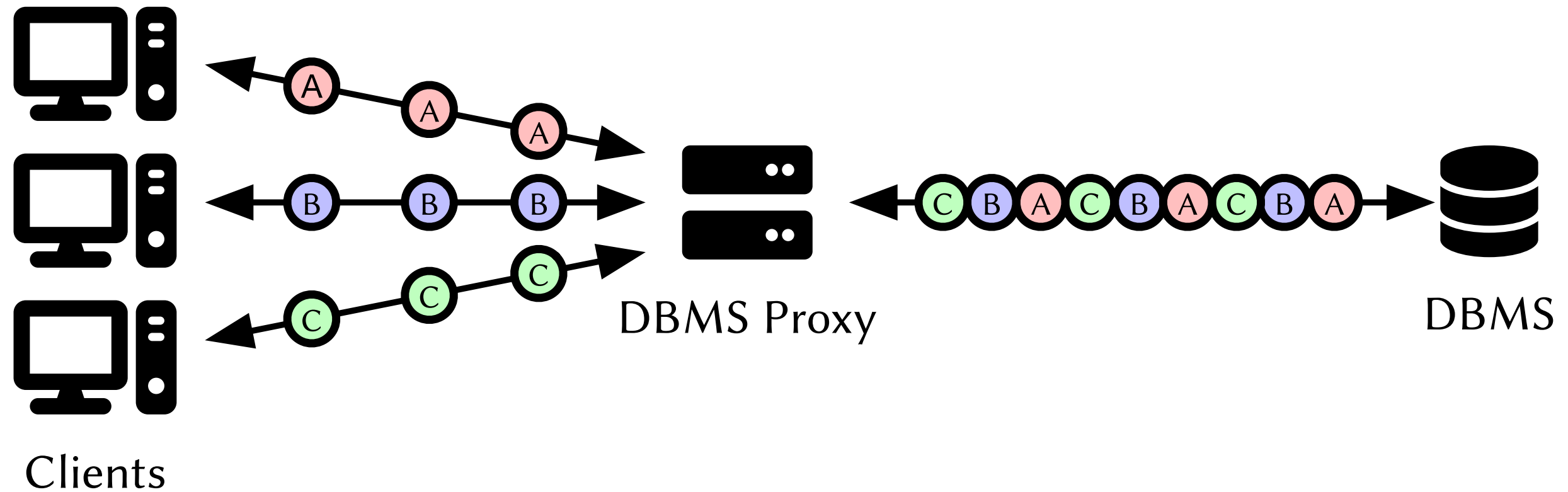


Connection Scaling

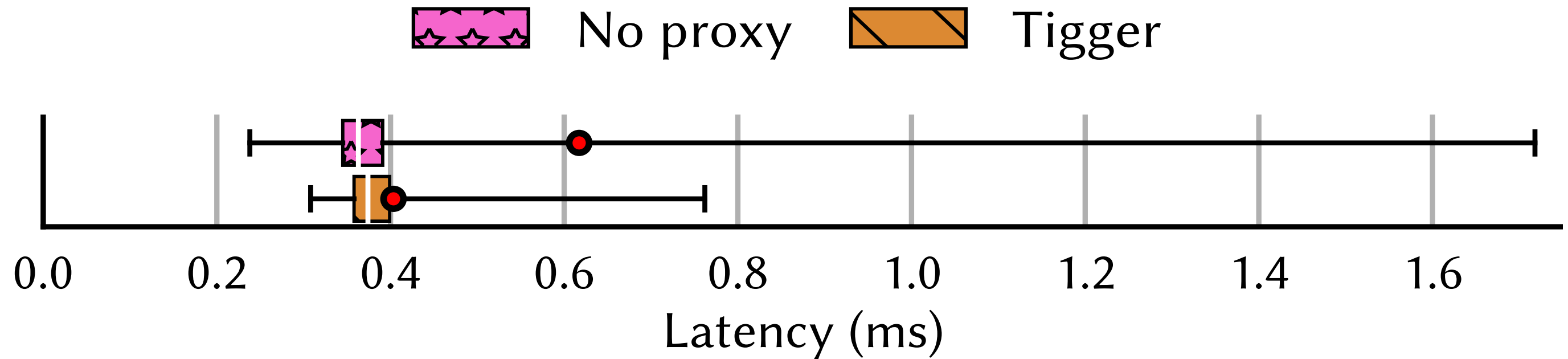
- Autoscaling applications open a lot of connections.
- More connections = slower transaction latencies.
- Each connection = worker (e.g., thread, process).
- Each PostgreSQL connection = MBs of RAM.

Measuring the Memory Overhead of a Postgres Connection
Postgres From Below
Resources consumed by idle PostgreSQL connections
AWS Database Blog

Connection Pooling

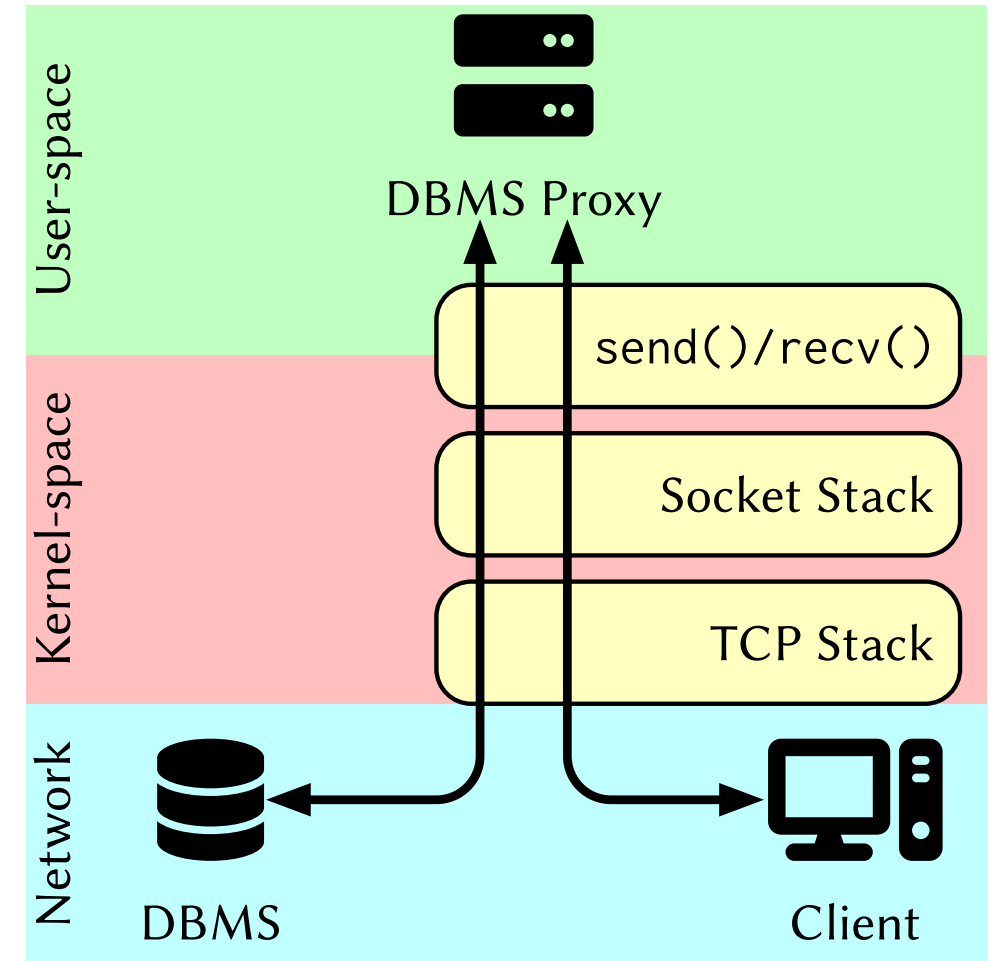


Connection Pooling Performance



User-Space DBMS Proxy

- Traffic goes through OS network stack to apply DBMS protocol logic.
- User-space applications of varying complexity to express parallelism.
- Coordination mechanisms around `send()` and `recv()` system calls.

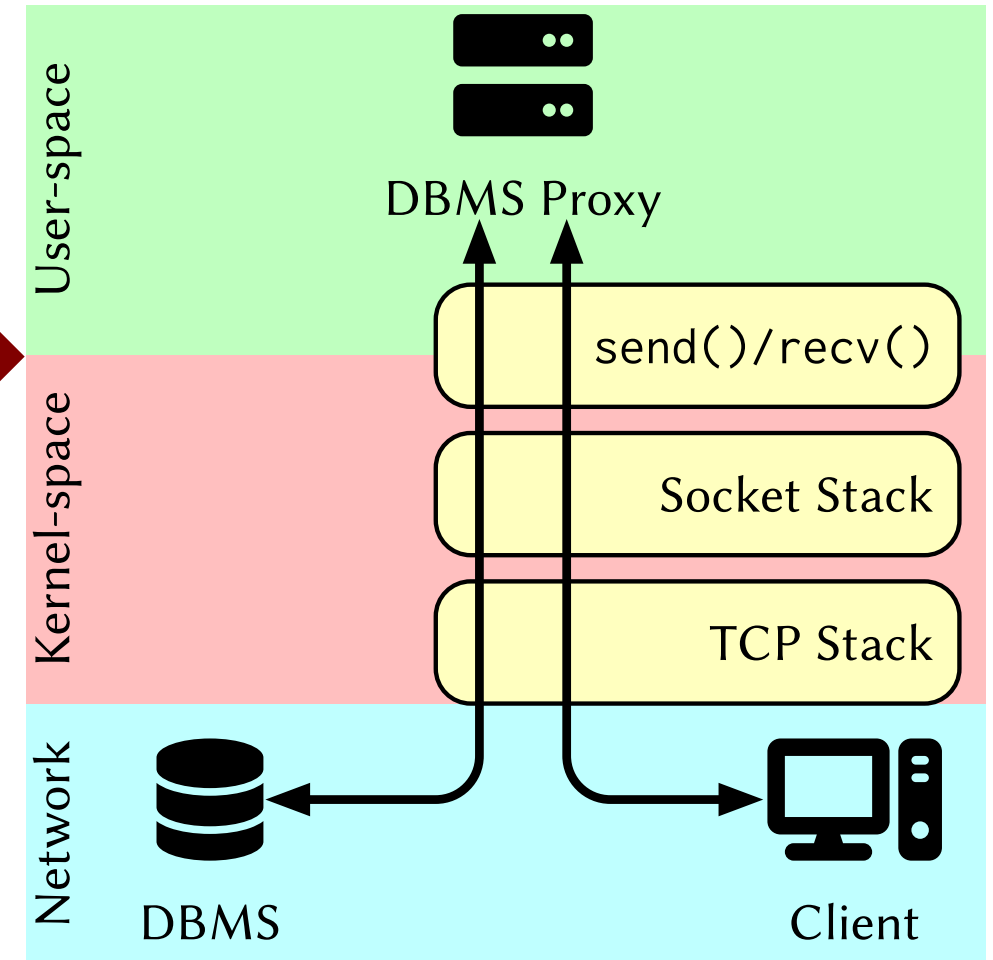


User-space DBMS Proxy

Where Is the Bottleneck?

- Networks are getting faster.
- Operating system

>50% of CPU cycles on memcpy().
- Max throughput: 42Gbps per CPU core.

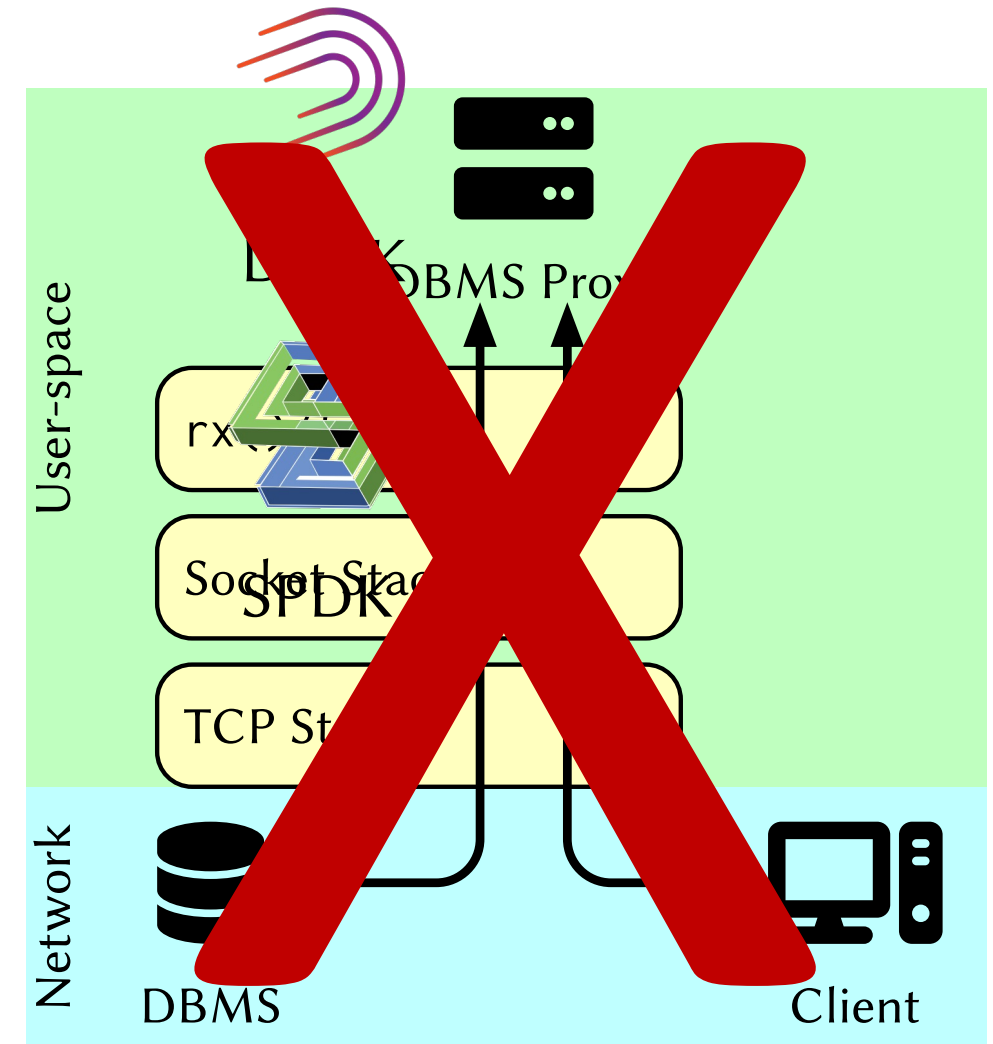


User-space DBMS Proxy

Qizhe Cai et al. Understanding host network stack overheads.
SIGCOMM. 2021.

Kernel-Bypass DBMS Proxy

- Reimplement protocols in user-space.
- Difficult to debug, deploy, and maintain.
- Difficult to optimize.



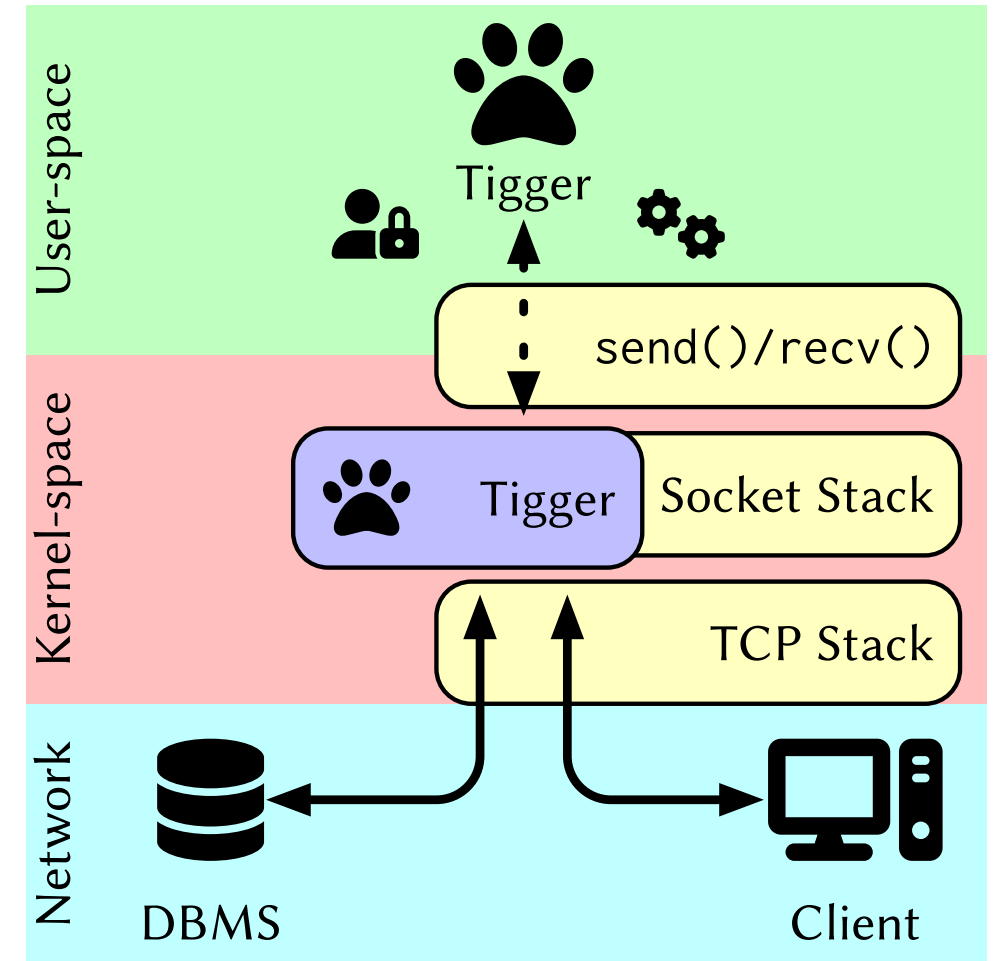
Kernel-bypass DBMS Proxy

William Tu et al. Revisiting the openvSwitch Dataplane Ten Years Later. *SIGCOMM*. 2021.

<https://github.com/xrp-project/BPF-KV/issues/3>

User-Bypass DBMS Proxy

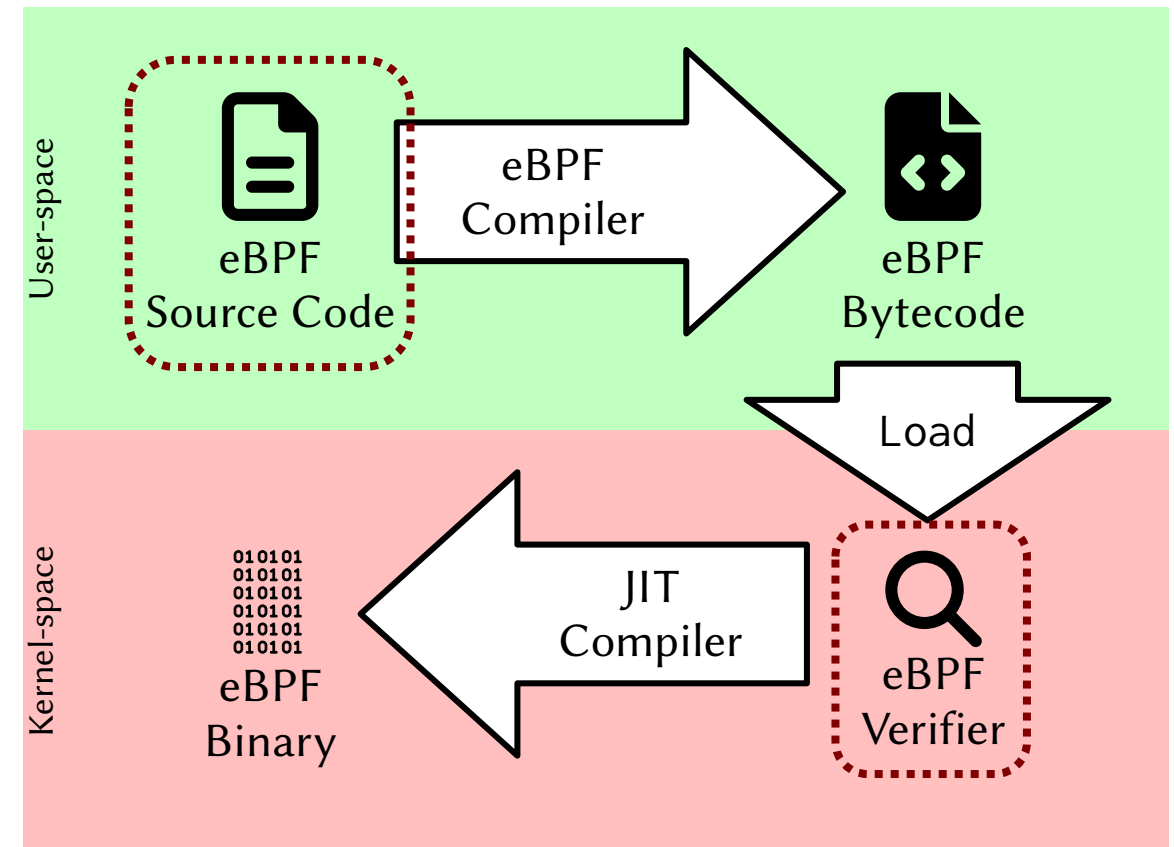
- Don't pull application data up to user-space logic.
- Push application logic down to kernel-space data.
- Zero-copy kernel APIs, avoid system calls and user-space threads.



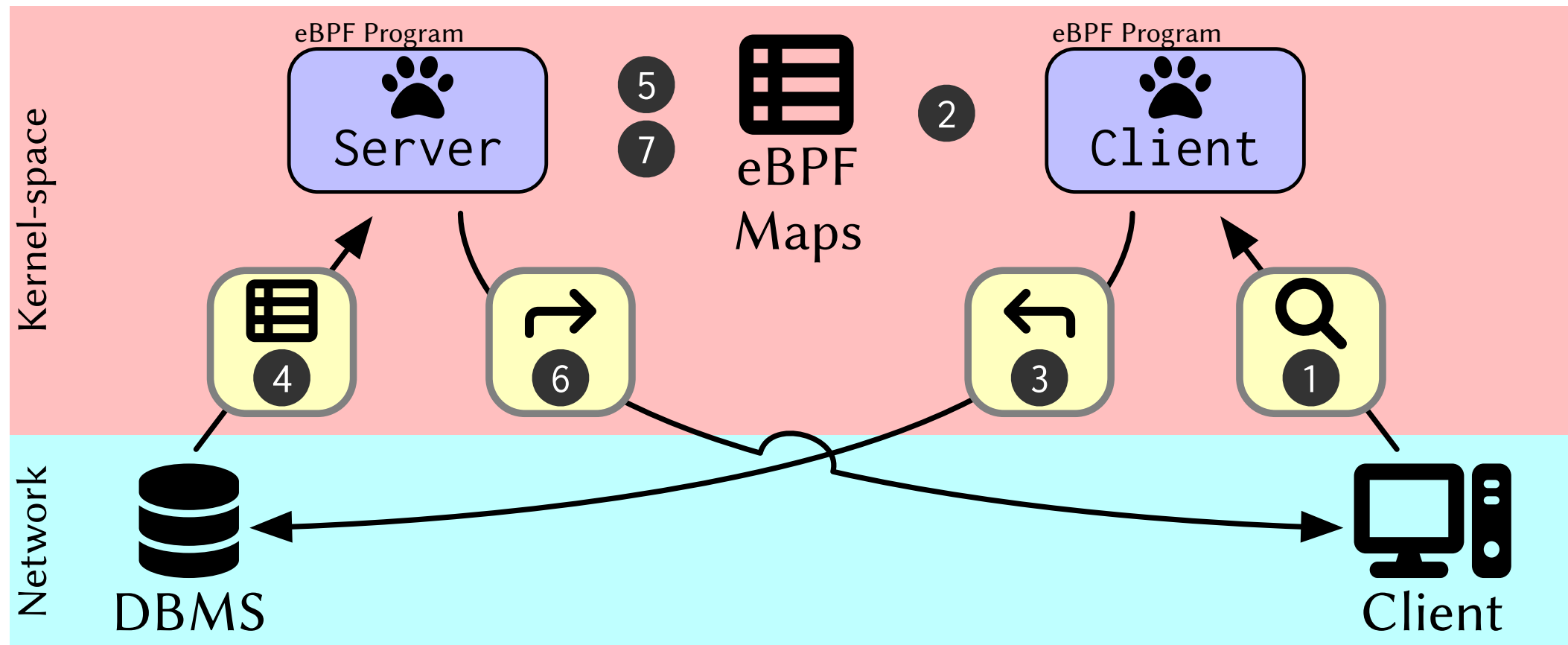
User-bypass DBMS Proxy

extended Berkeley Packet Filter

- Safe, event-driven programs in kernel-space.
- Write in C and compile to eBPF.
- Verifier constraints:
 - # instructions, boundedness, memory safety, limited API.



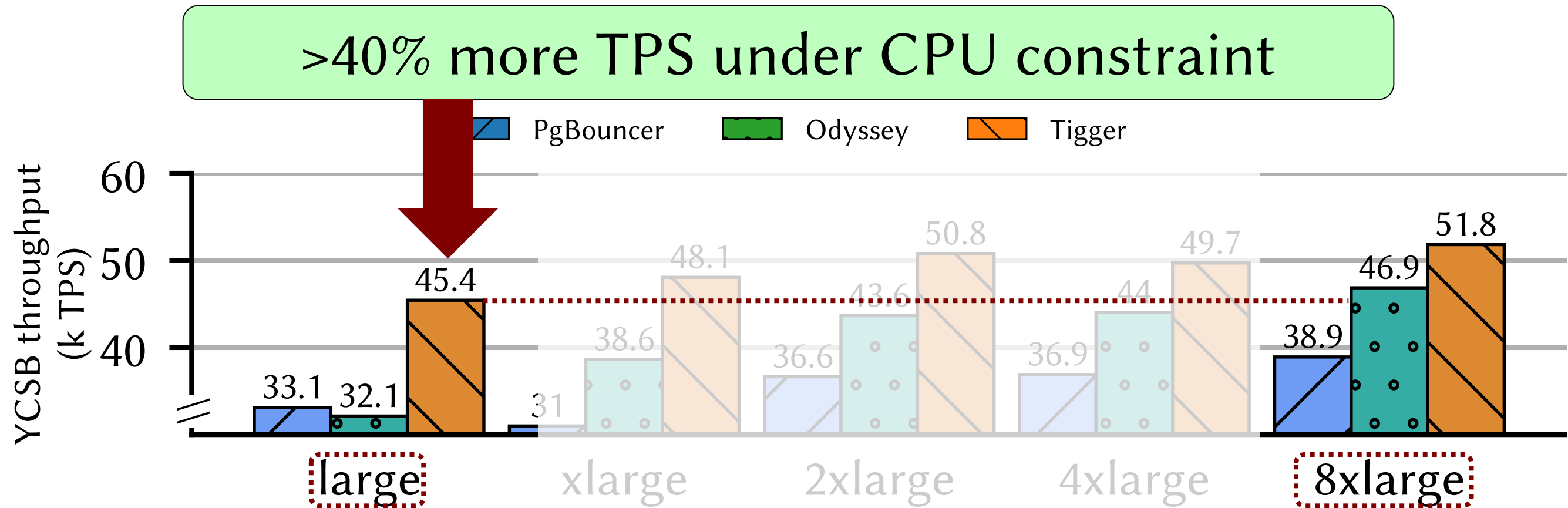
Tigger Connection Pooling



Experimental Setup

- Proxies:
 - PgBouncer v1.17
 - Yandex Odyssey v1.3
 - Tigger
- Dedicated AWS EC2 c6i instances. Postgres v14.5. Ubuntu 22.04.
- BenchBase: YCSB

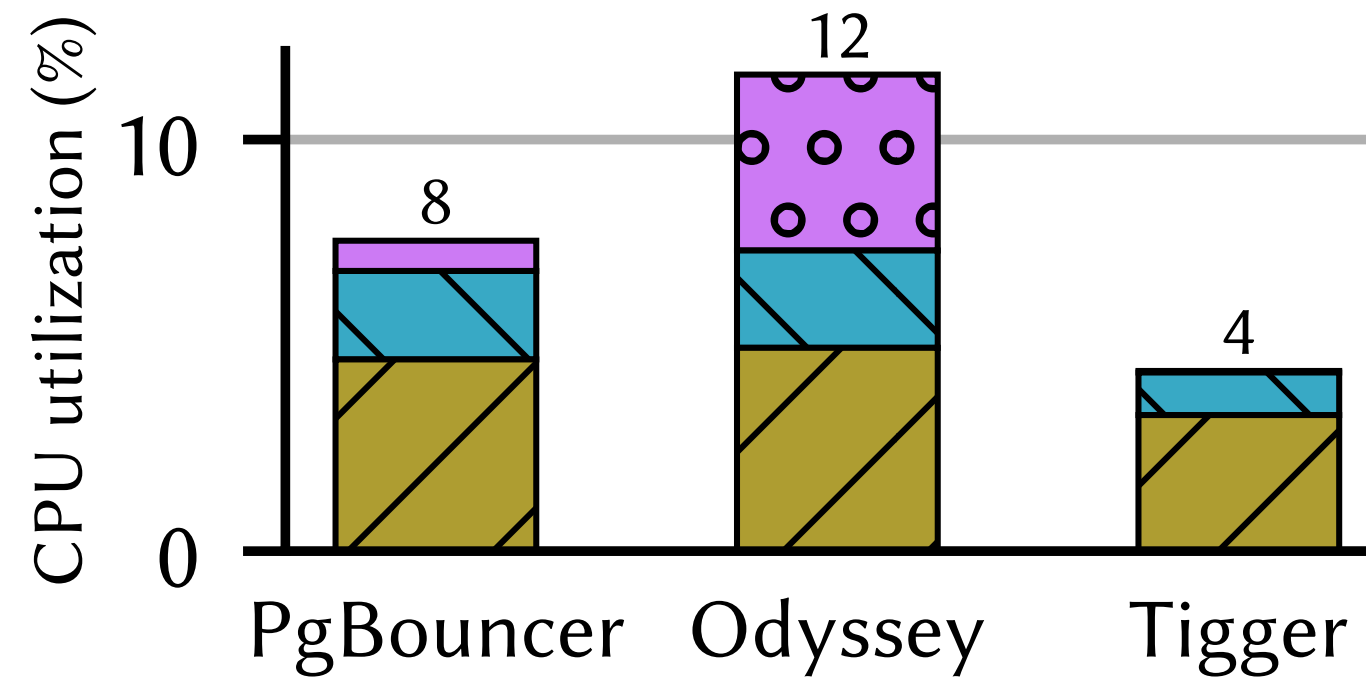
Connection Pooling Throughput



8x cost for Odyssey to match Tigger's performance

Connection Pooling CPU Breakdown

 % User  % Kernel  % Software Interrupts



Takeaways

- DBMS proxies are useful in large cloud deployments.
- *User-bypass* relies on eBPF to safely push application logic into the kernel, avoiding system call overhead and user-space threads.
- *Tigger's* user-bypass offers the lowest latency and lowest CPU utilization for DBMS proxies.

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