

PROPOSAL DEFENSE

Traffic-Aware Live VM Migration

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Background

Background

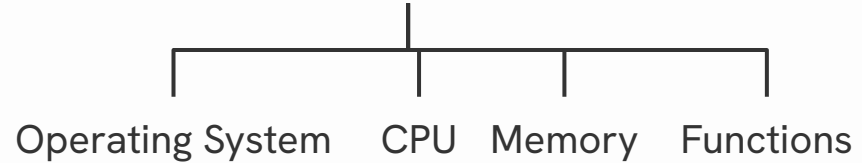
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Virtualization

Allows multiple machines to access the same physical resources simultaneously.

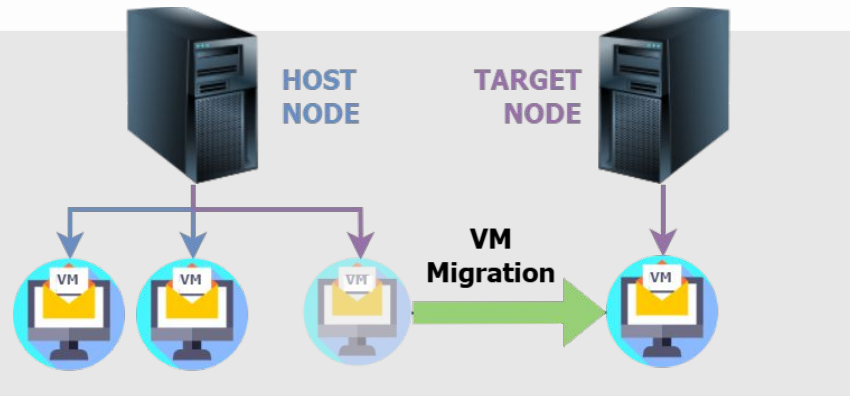
Virtual Machine (VM)

emulates



VM Migration

Moving a VM from one physical node to another.



VM Migration

Cold/ Non-live migration

Stops the VM, migrates VM to the destination and resumes.

Live migration

Migrates a VM instantaneously while it's running.

- Pre-Copy
- Post-Copy
- Hybrid

Live Migration

Performance Metrics

Migration time

Time required to complete the entire migration process.

Downtime

Duration during which the services provided by the VMs become inaccessible to users.

Performance degradation

Slowdown of the applications running on the migrating VMs during the migration.

Total migrated data

Volume of migrated data.

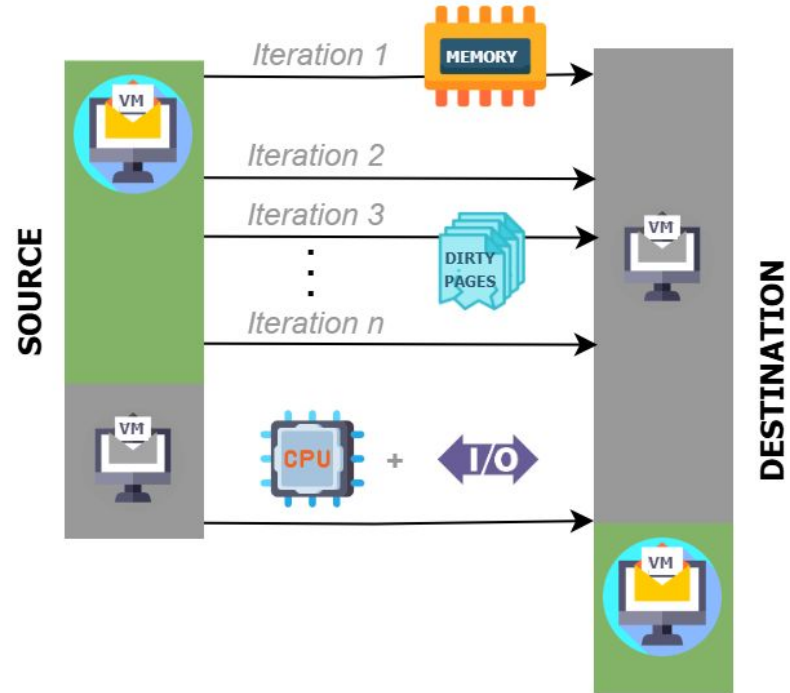
Live Migration Techniques

Pre-Copy Migration

Memory transfer.

Stop-and-copy.

Starts running at destination.



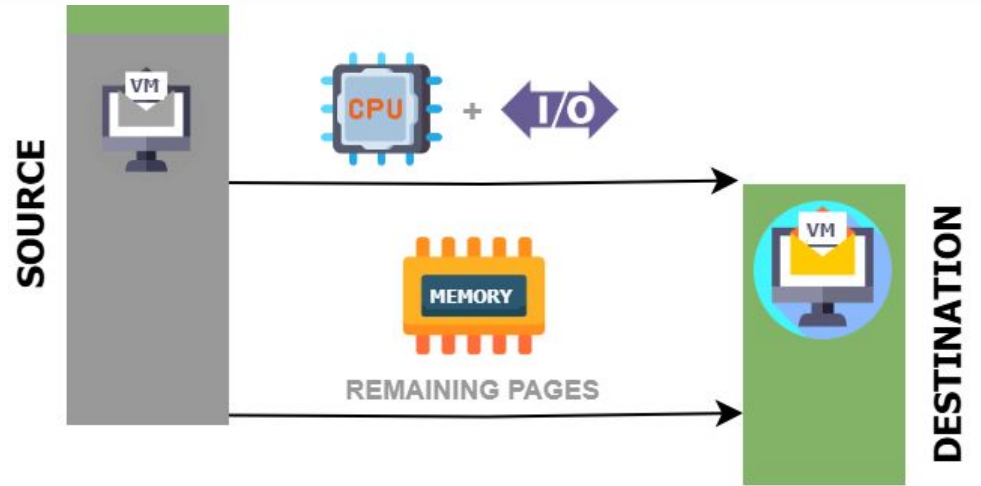
Live Migration Techniques

Post-Copy Migration

Suspends VM at source and resumes it at the destination.

Source proactively pushes remaining pages.

Fetches page faults.



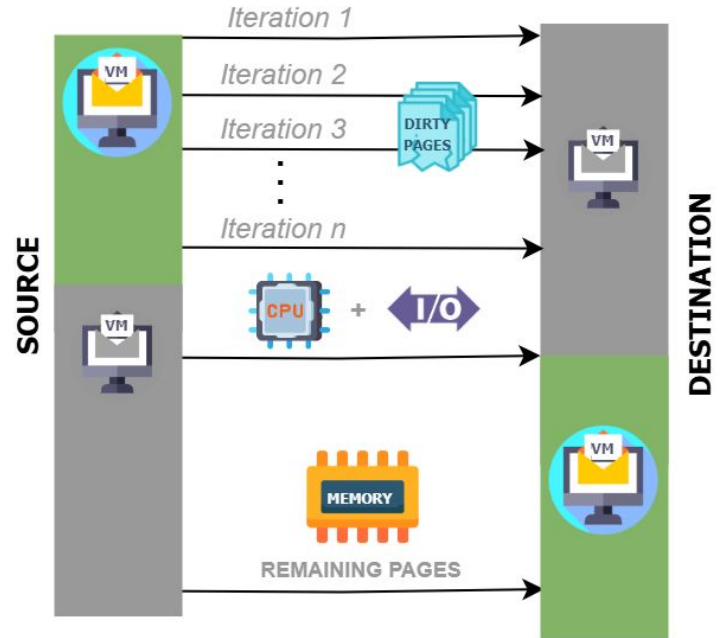
Live Migration Techniques

Hybrid Migration

Pre-copy: copies dirty pages from source to destination.

Stop-and-copy.

Post-copy.



Source: Sahni, Shashank and Vasudeva Varma (2012). "A hybrid approach to live migration of virtual machines". In: 2012 IEEE international conference on cloud computing in emerging markets (CCEM). IEEE, pp. 1-5.

Live Migration

Multiple VM Migration

Serial Migration

One VM after the other.

Full migration bandwidth can be used.

Gang Migration

Concurrently.

Migration bandwidth is shared among VMs.

Trade-off

Lower migration time.

Greater total downtime.

Greater migration time.

Lower total downtime.

Sources: Sun, Gang, et al. "A new technique for efficient live migration of multiple virtual machines." *Future Generation Computer Systems* 55 (2016): 74-86, 5] F. Callegati, W. Cerroni, *Live migration of virtualized edge networks: analytical modeling and performance evaluation*, in: *2013 IEEE SDN4FNS*, 2013, pp. 1-6.

Live Migration

Priority (Urgency) Level

- How quickly the VMs need to be migrated.
- Priority level can be specified by system administrators or assigned considering Service Level Agreements (SLAs) and migration time violations.

For example,

Breakdown - migration need to occur as fast as possible.

Routine server maintenance - not as urgent, but less service disruption expected.

Traffic Contention Problem

Traffic

Migration Traffic

Pre-copy has **predominantly outgoing** traffic at the **source**.

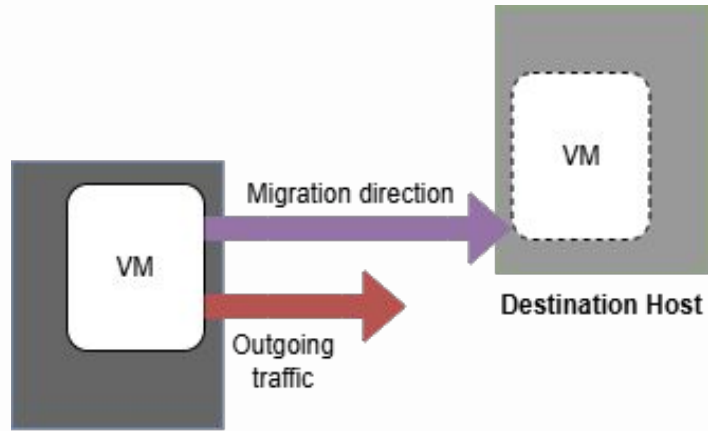
Post-copy has **predominantly incoming** traffic at the **destination**.

Workload Traffic

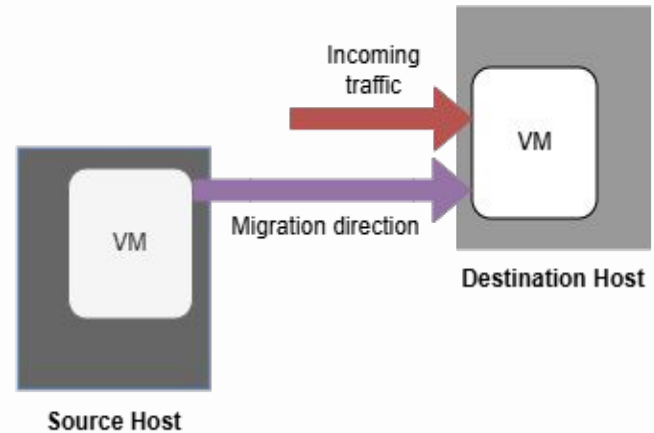
Incoming traffic - data packets received by a system or network interface.

Outgoing traffic - data packets transmitted from a network interface.

Traffic Contention Problem



Pre-Copy

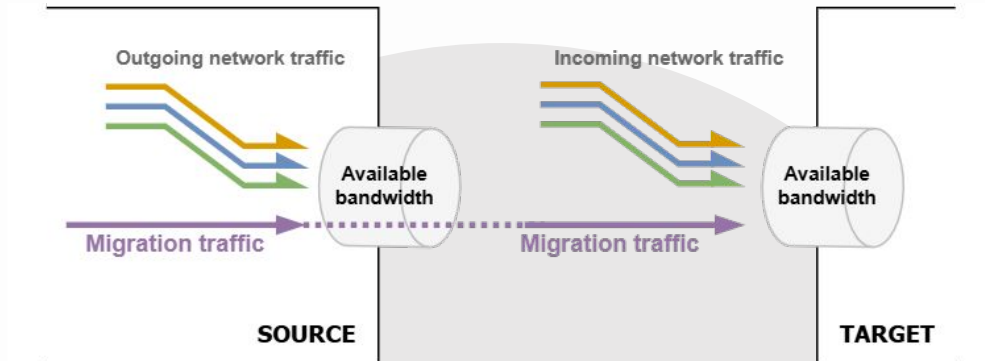


Post-Copy

Traffic

Traffic Contention Problem

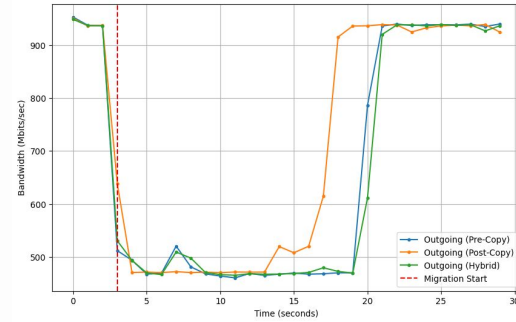
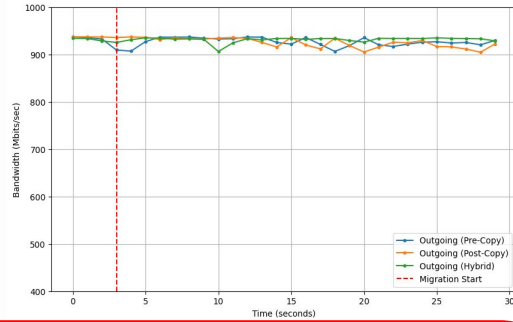
Migration traffic and workload traffic **share** the same **network bandwidth**.
When they occur simultaneously, they **compete** for the limited network resources.



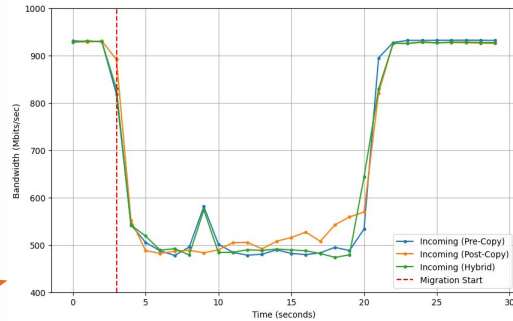
Preliminary Experimental Study

Bandwidth Fluctuation During Migrations with iPerf Traffic

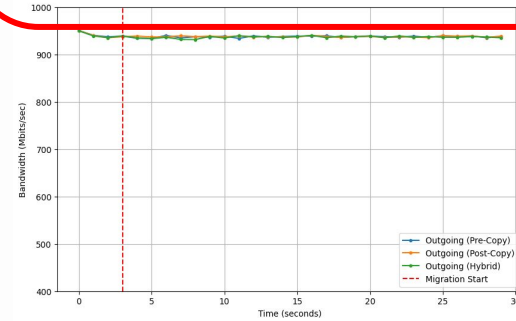
Source



Destination



Incoming traffic



Outgoing traffic

This traffic contention problem,



**Increases migration
time**



**Degrades application
performance**

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Related Work

Related Work

Choosing where to migrate to:

1. **AppAware** (Shrivastava et al., IEEE INFOCOM, 2011) - optimizes migration destinations based on traffic volume, network topology, and server resource constraints.
2. **S-CORE** (Tso et al., IEEE ICDCS, 2014) - minimizes overall communication between VMs by treating VM communication as an optimization problem and using a distributed migration technique that adapts to traffic changes.
3. **ShareOn** (Maheshwari et al., IEEE Access, 2018) - selects target nodes for migration based on current traffic conditions to minimize network traffic.

Related Work

Choosing which VM to migrate:

4. **ST-LVM-LB** (Kanniga Devi, Murugaboopathi, and Muthukannan, Cluster Computing, 2018) - migrates the least loaded VMs, considering network bandwidth and current flow.
5. **NTVMM** (Fu et al., ITNEC, 2019) - reduces traffic and network load through algorithms for VM selection and placement.

Related Work

Dynamically adapting based on traffic:

6. **Traffic-aware algorithm** (Deshpande and Keahey, Future Generation Computer Systems, 2017) - Monitors application and migration traffic to decide between pre-copy or post-copy migration techniques.
7. **Adaptive migration algorithm selection framework** (Cui, Zhu, et al., IJPE, 2020) - Uses fuzzy clustering to categorize VMs based on business traffic and select the most appropriate migration algorithm.

Related Work

Urgency level:

8. **SOLive** (Fernando, P. Yang, and Lu, IEEE INFOCOM, 2020) - Approach that considers migration urgency in reserving bandwidth.
9. VM selection based on priority (Nadeem, Elazhary, and Fadel, IJACSA, 2018).

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Research Gap

Research Gap

Need for a live VM migration algorithm that considers both, traffic contention and migration urgency.

Lacking research on the decision-making process for performing serial vs parallel migrations **in the context of network contention**.

Less focus on hybrid live migration to address the traffic contention problem in live gang migration.

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Research Questions

Research Questions

- 01 What is the optimal migration strategy to reduce the migration time and minimize network contention, considering how quickly the VM needs to be migrated?
- 02 How can we efficiently migrate VMs in gang migration or serial migration by considering network contention and the migration priority to reduce migration time, downtime, and application performance degradation?
- 03 Can the integration of the hybrid copy technique enhance the efficiency of live multiple VM migration when considering traffic contention?

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Objectives

Objectives

1. Identify key network metrics that affect VM migration performance.
2. Create an adaptive decision-making algorithm that uses network metrics and migration priority to optimize live multiple VM migration.
3. Investigate the impact of the hybrid-copy approach on the adaptability of live gang migration techniques to different traffic conditions.

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Scope

In Scope

- Live VM migration.
 - LAN migrations.
 - KVM/QEMU virtualization environment.
 - Single NIC supported server with a single port for migration and application traffic.
 - Linux host OS.
 - Single and multiple VM migration.
- Analyzing the effect of traffic on live VM migration.
- Developing an optimized algorithm for **traffic-sensitive** live migration of multiple **co-located** VMs considering the **priority** of the migration.
- Evaluating migration performance for migration time, downtime and application performance degradation.

07

Research Approach

Research Approach

Testbed setup

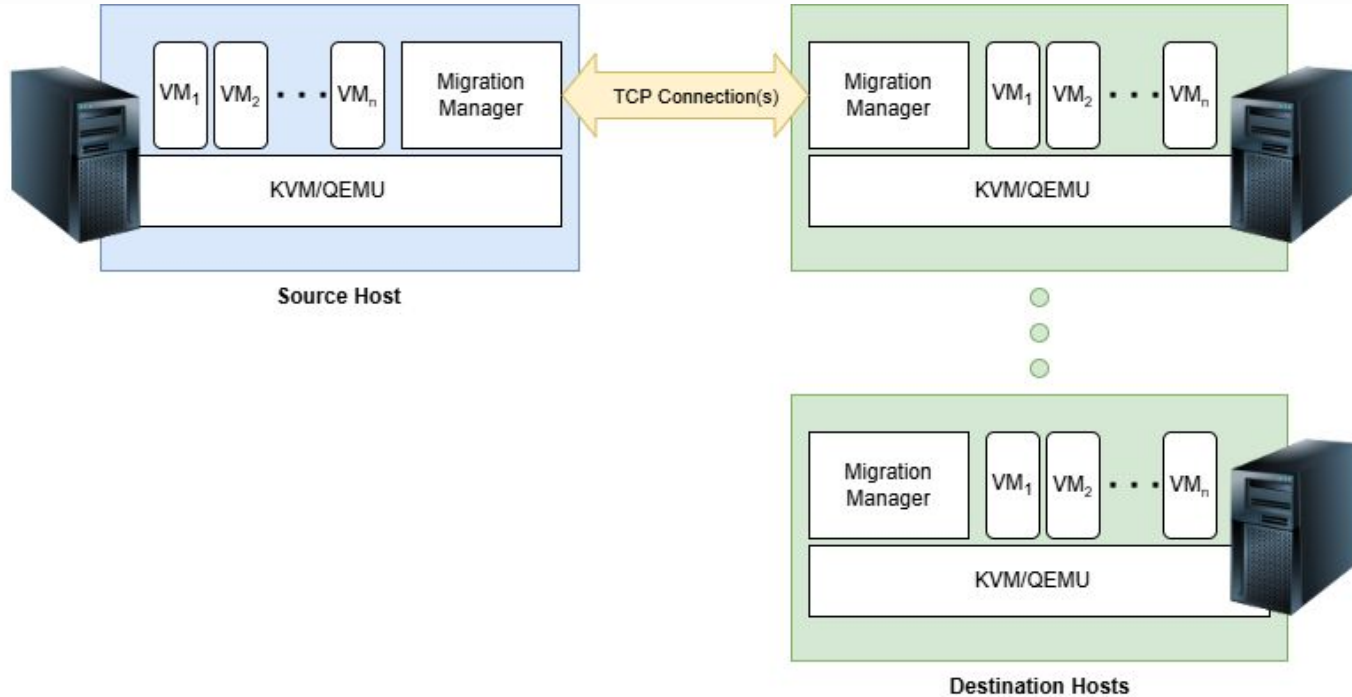
Preliminary study

Evaluation of migration methodologies against traffic

Develop a traffic-sensitive VM migration algorithm

Performance evaluation

High-level Architecture of the Testbed



Preliminary Study

Measurements

- Available bandwidth
- Total migration time
- Downtime

Traffic types

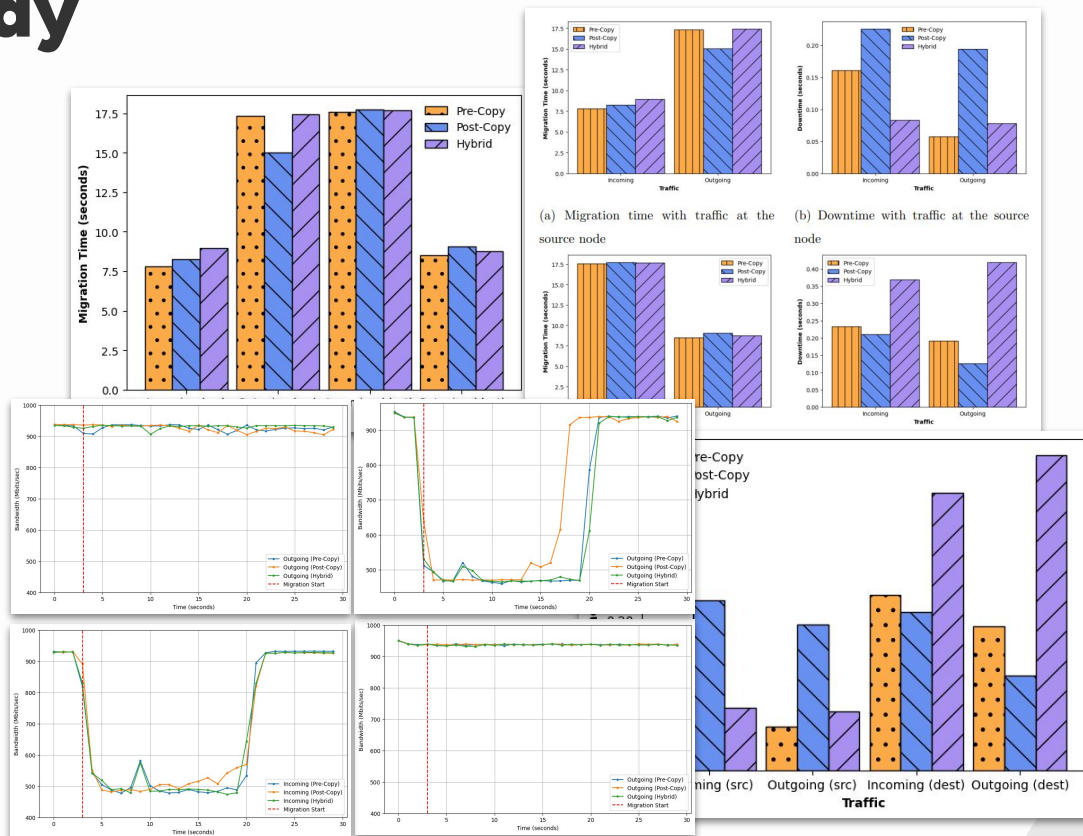
- Incoming
- Outgoing

At

- Source (src) node
- Destination (dest) node

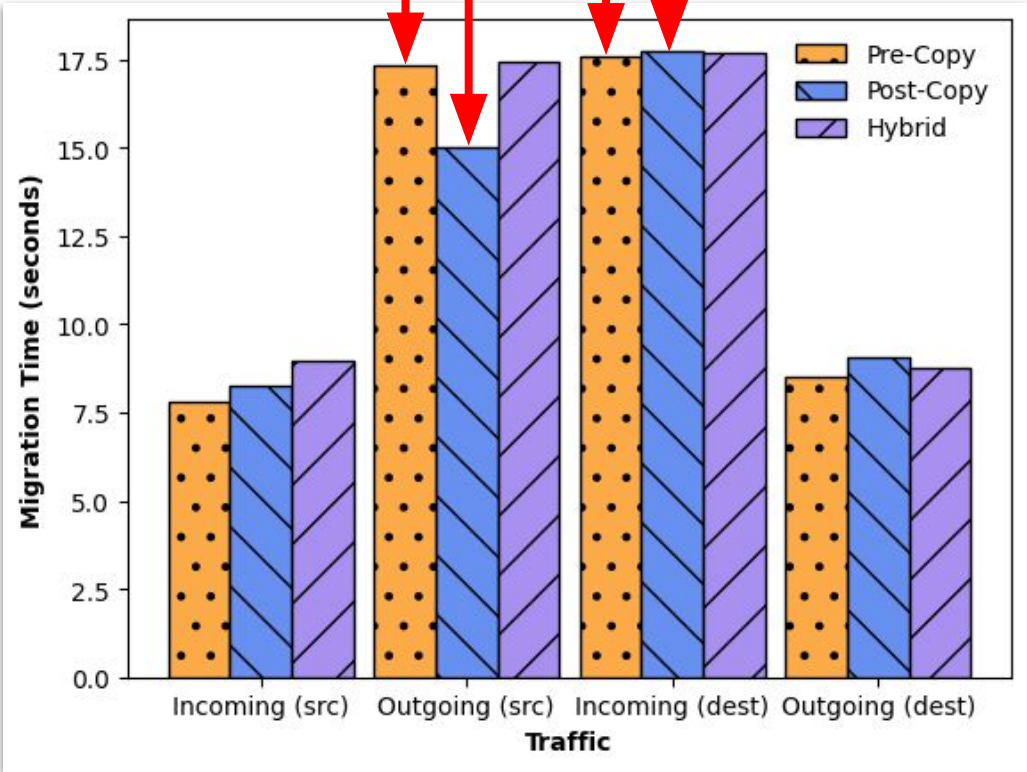
Tools used

- iPerf3
- Memcached



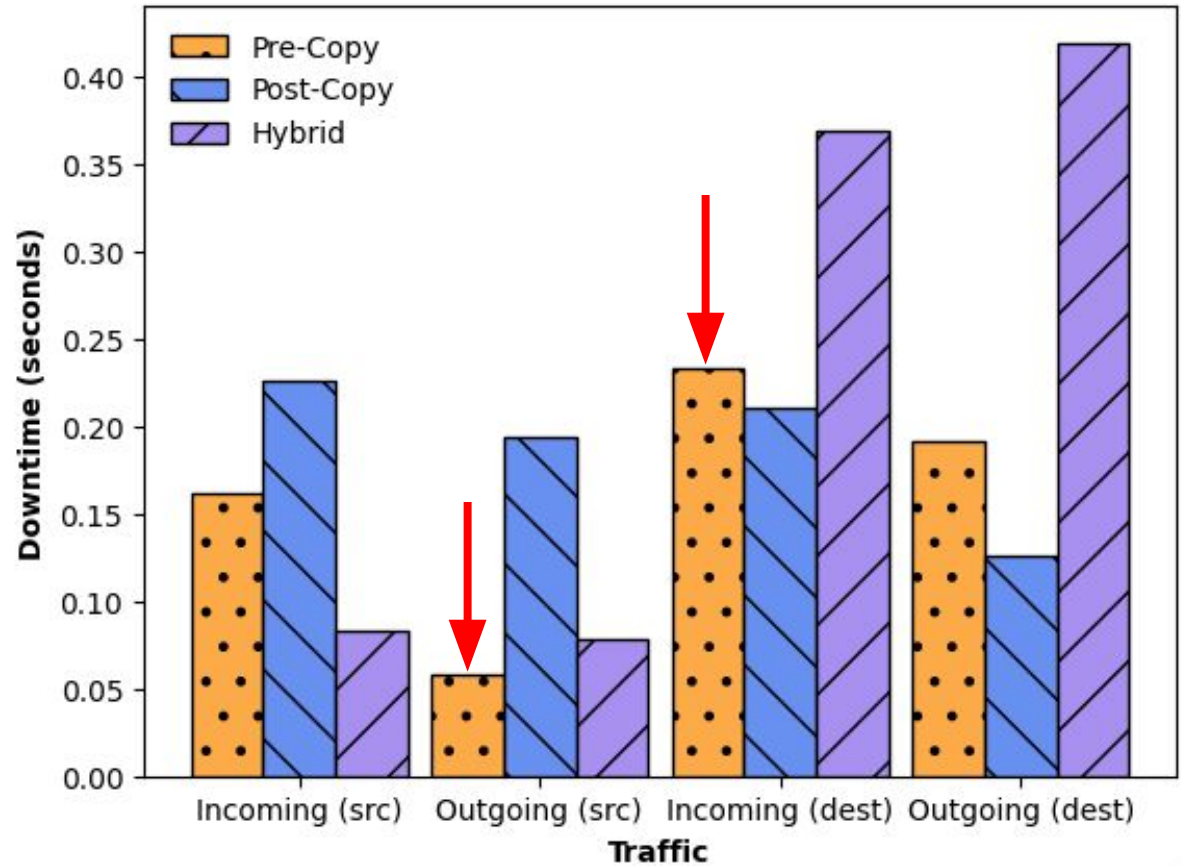
Preliminary Study

Migration Time
iPerf



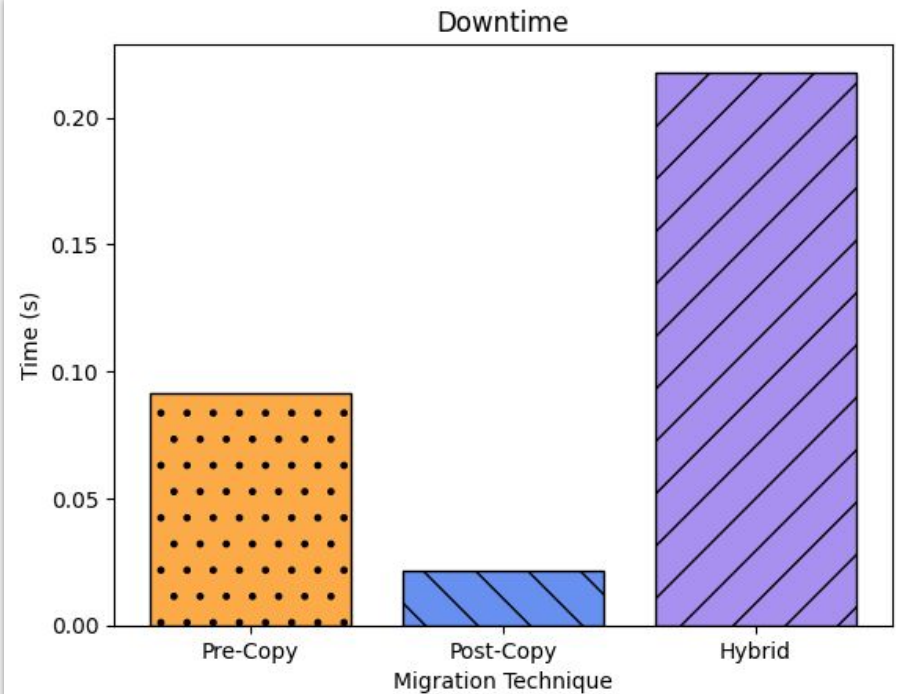
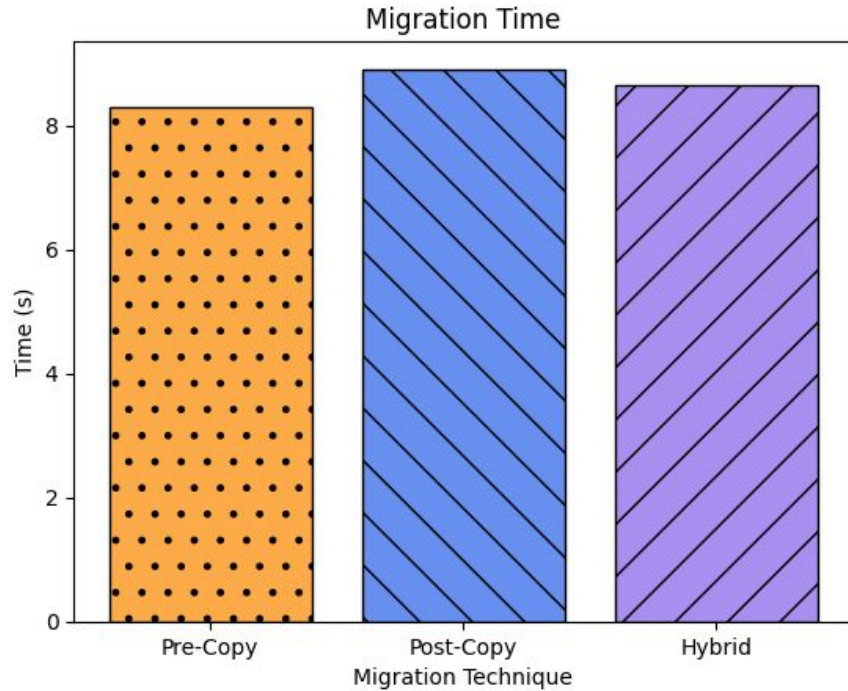
Preliminary Study

Downtime
iPerf

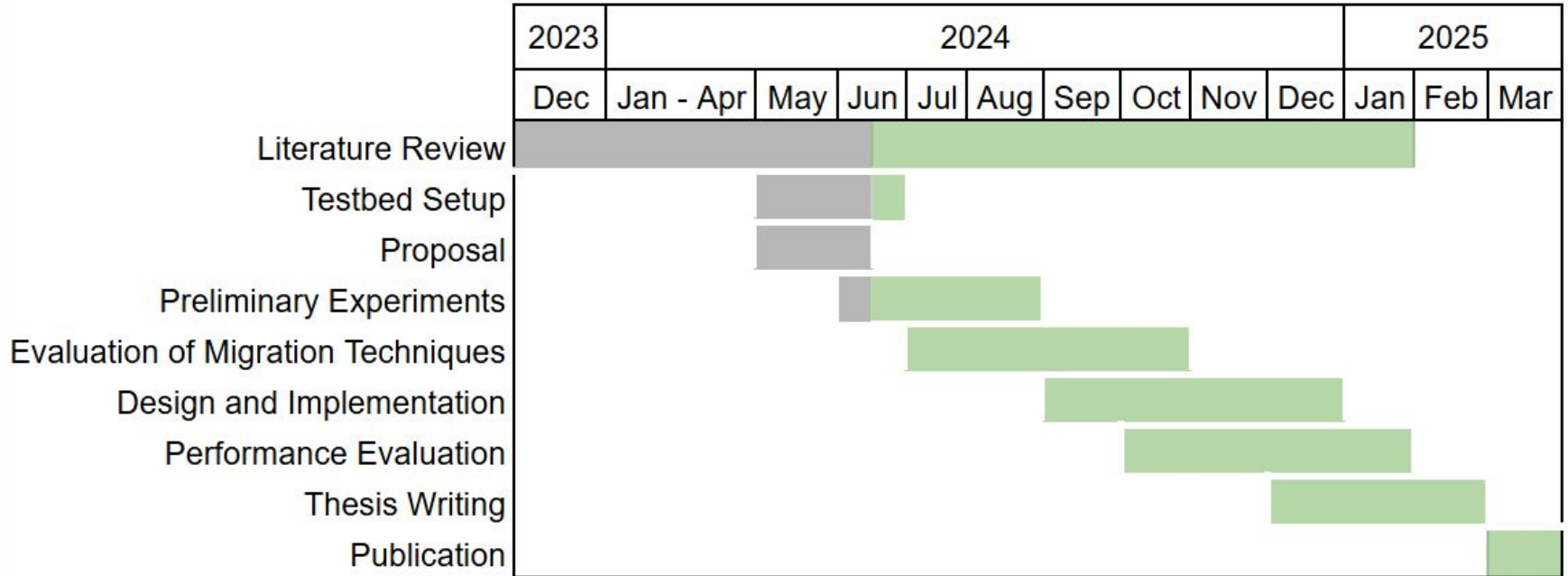


Preliminary Study

Memcached



Timeline



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In summary

- Develop a **traffic sensitive, adaptive decision making** algorithm
 - Addressing the **traffic contention problem**
 - Considering **migration urgency**
- Investigate the impact of the **hybrid-copy** approach on the adaptability to traffic of **live gang migration** techniques.



Thank you!