NUMA-Friendly Stack (using Delegation and Elimination)

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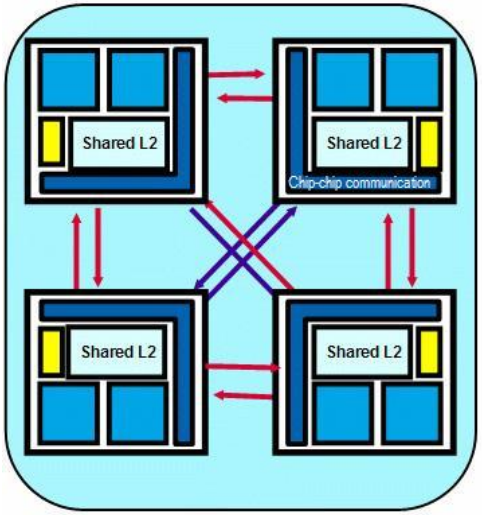
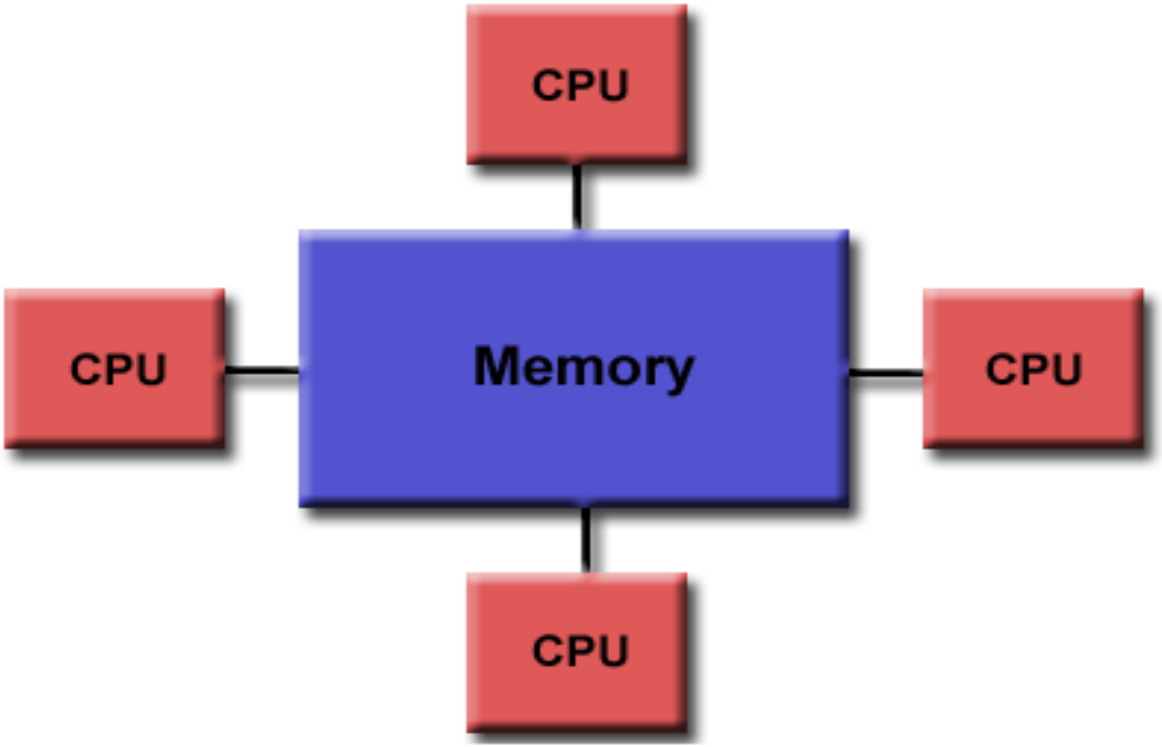
HotPar '13

Trends for Future Architectures



Uniform Memory Access (UMA)



Non-Uniform Memory Access (NUMA)

NUMA NODE (multiple cores, shared Last Level Cache)

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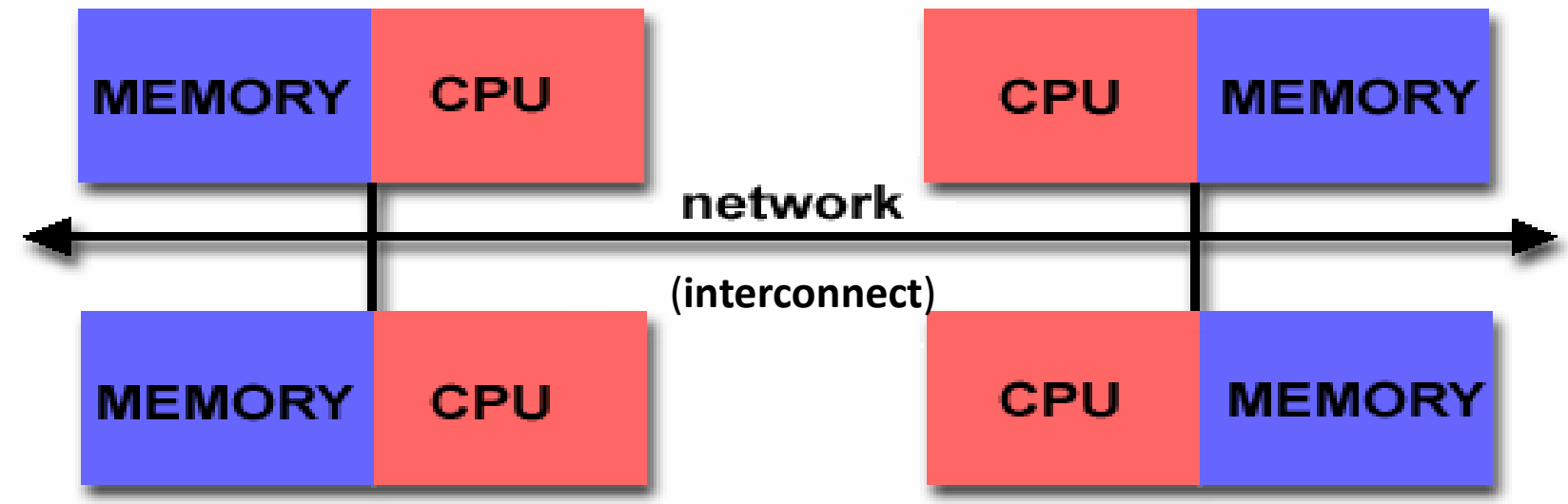

NUMA NODE (multiple cores, shared Last Level Cache)

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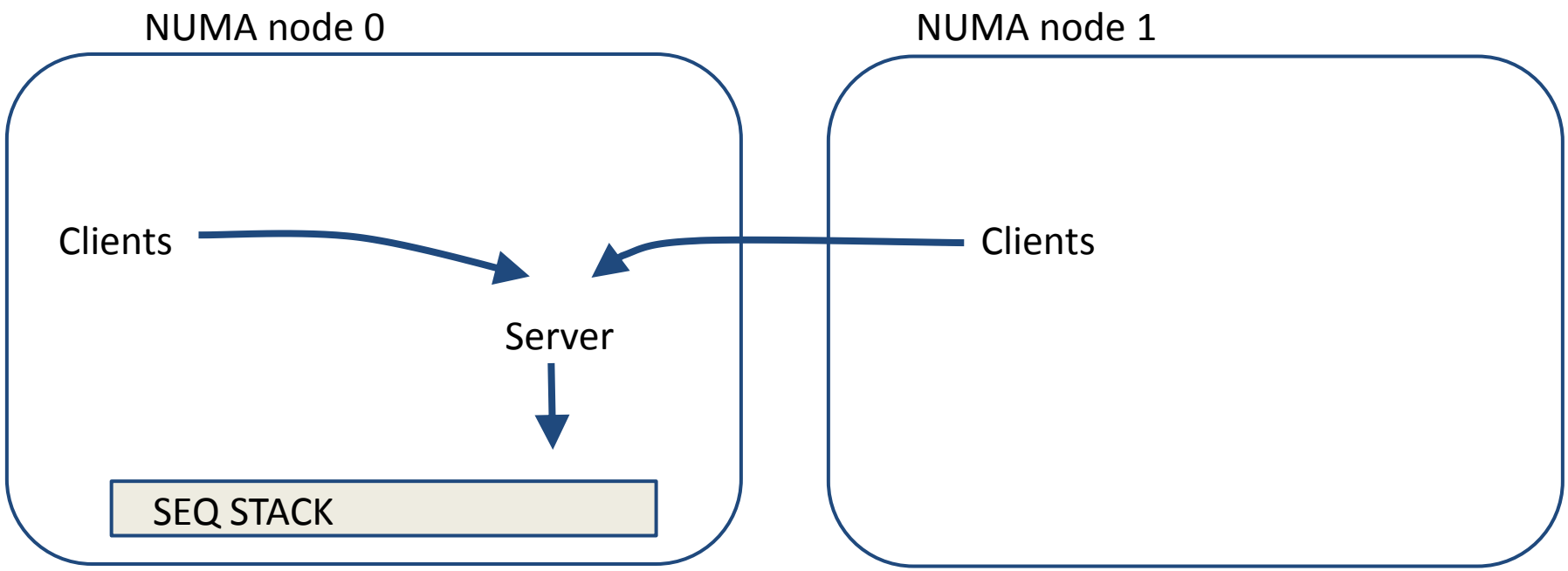
Cache coherency maintained between caches on different NUMA nodes

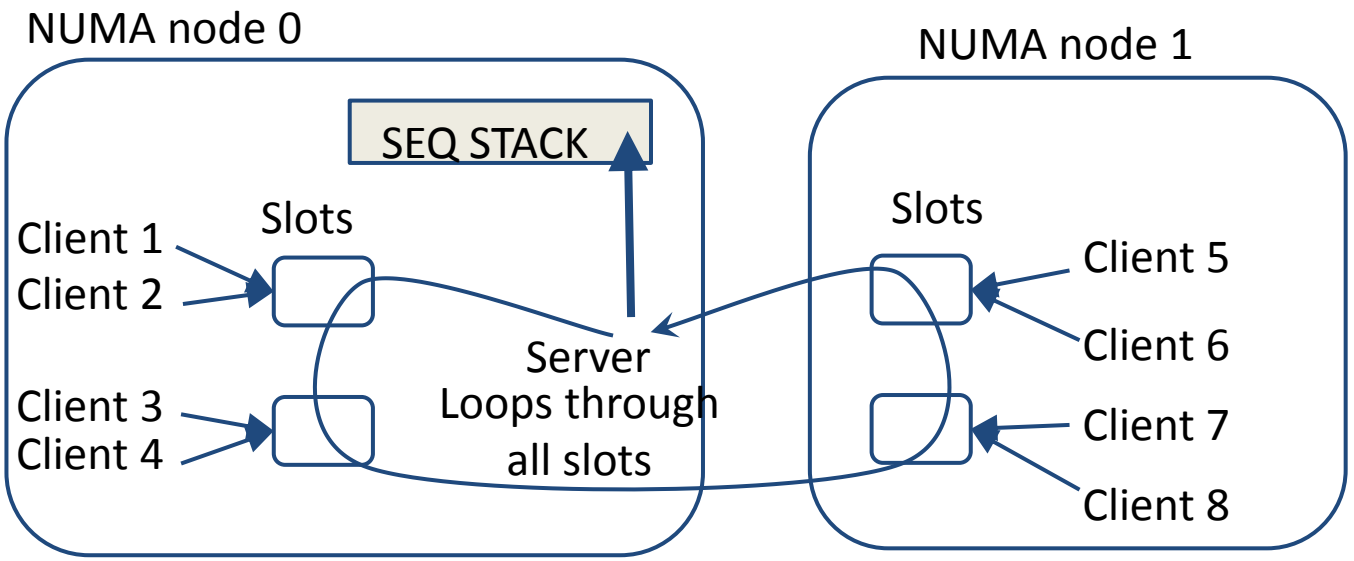
Overview

- Motivation
- Algorithms
- Results
- Conclusions

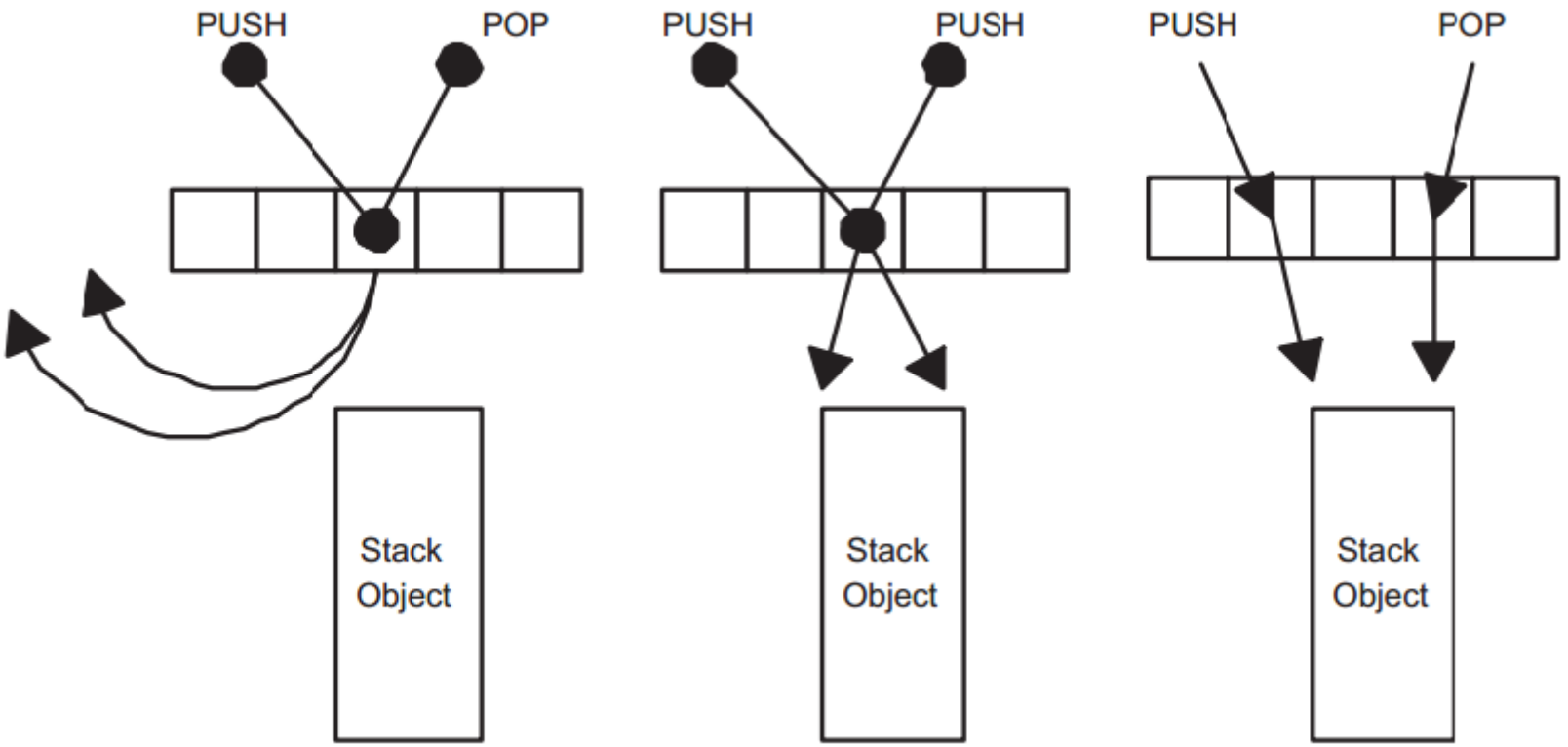
Delegation



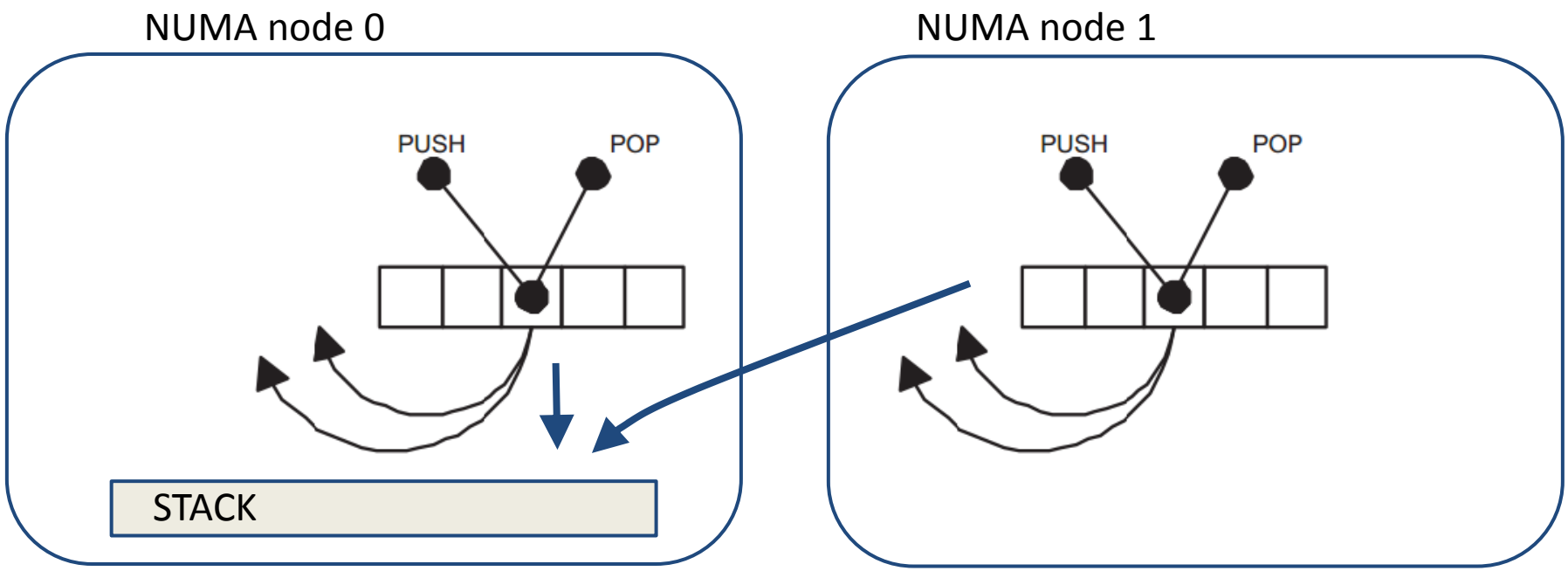
Delegation


NUMA node 0
NUMA node 1
SEQ STACK
Slots
Slots
Client 1
Client 2
Client 3
Client 4
Server
Loops through
all slots
Client 5
Client 6
Client 7
Client 8

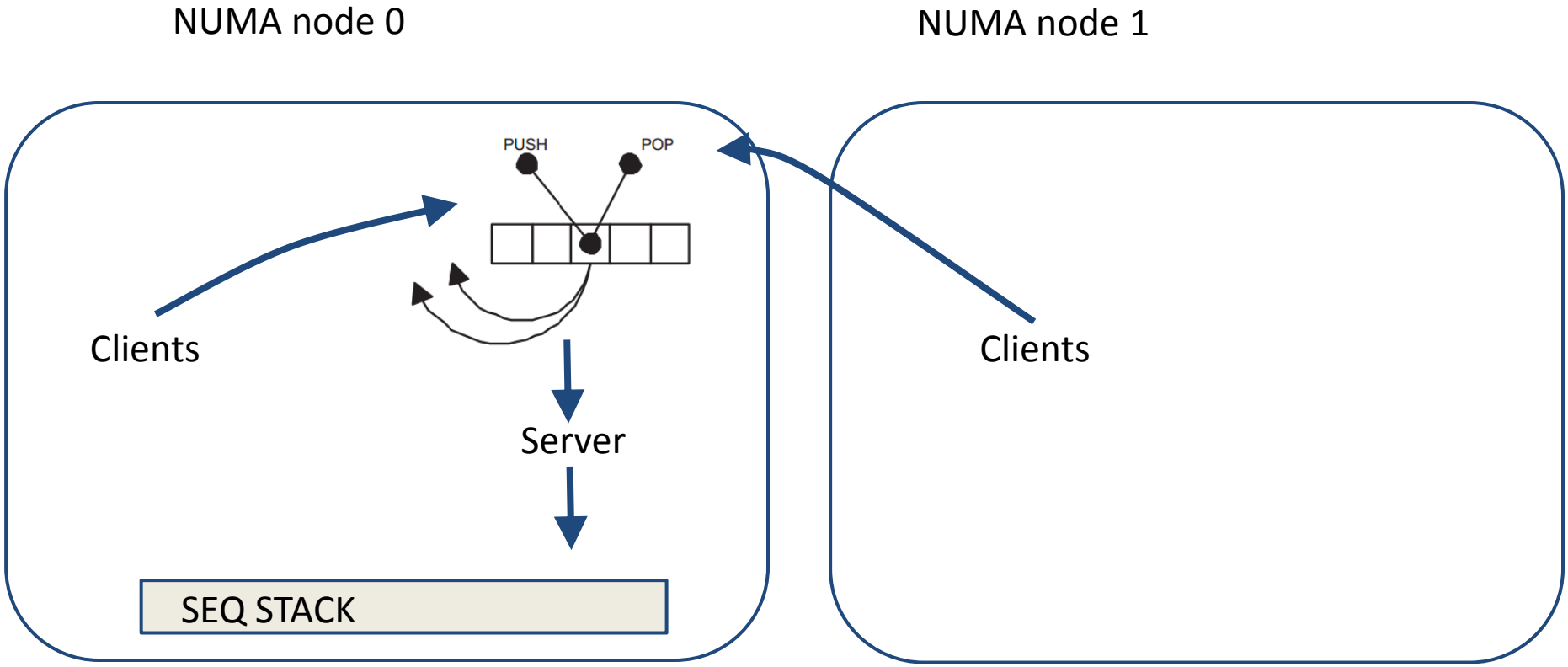
Elimination, Rendezvous



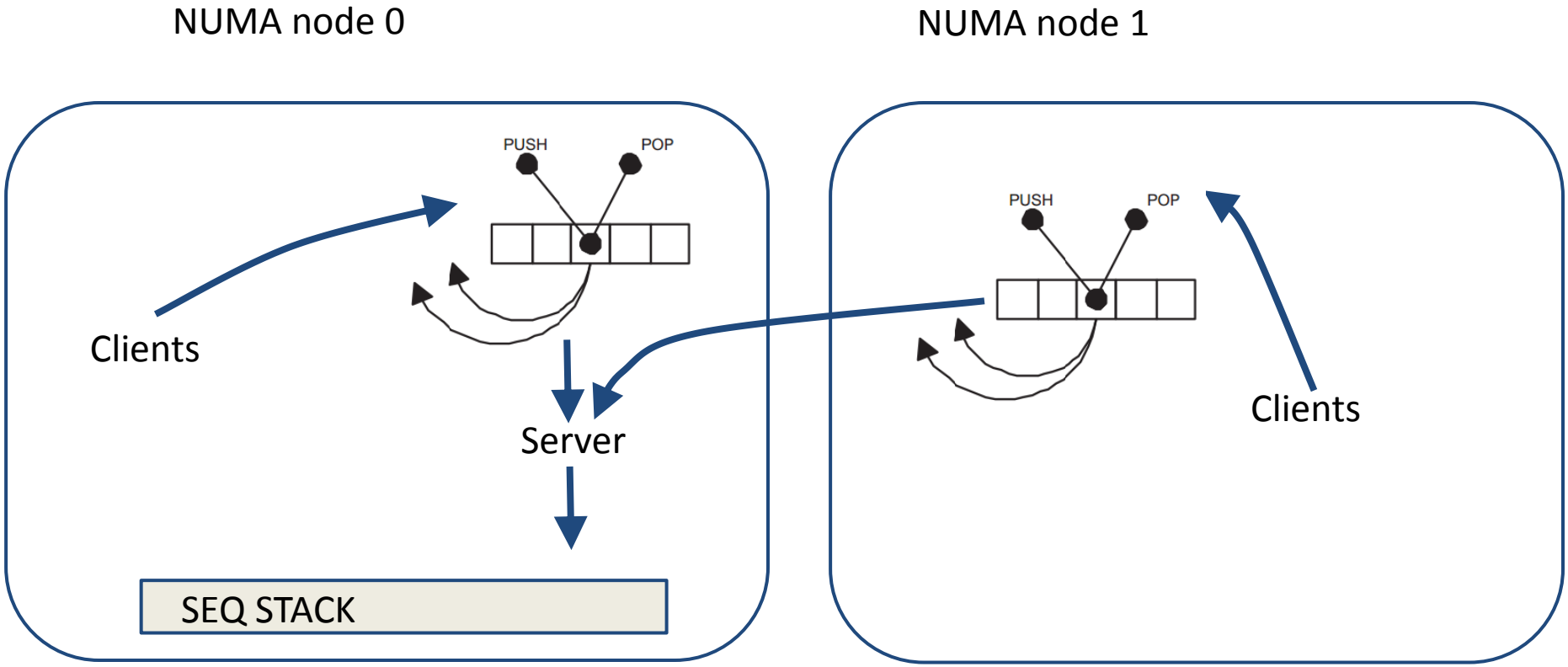
Local Rendezvous



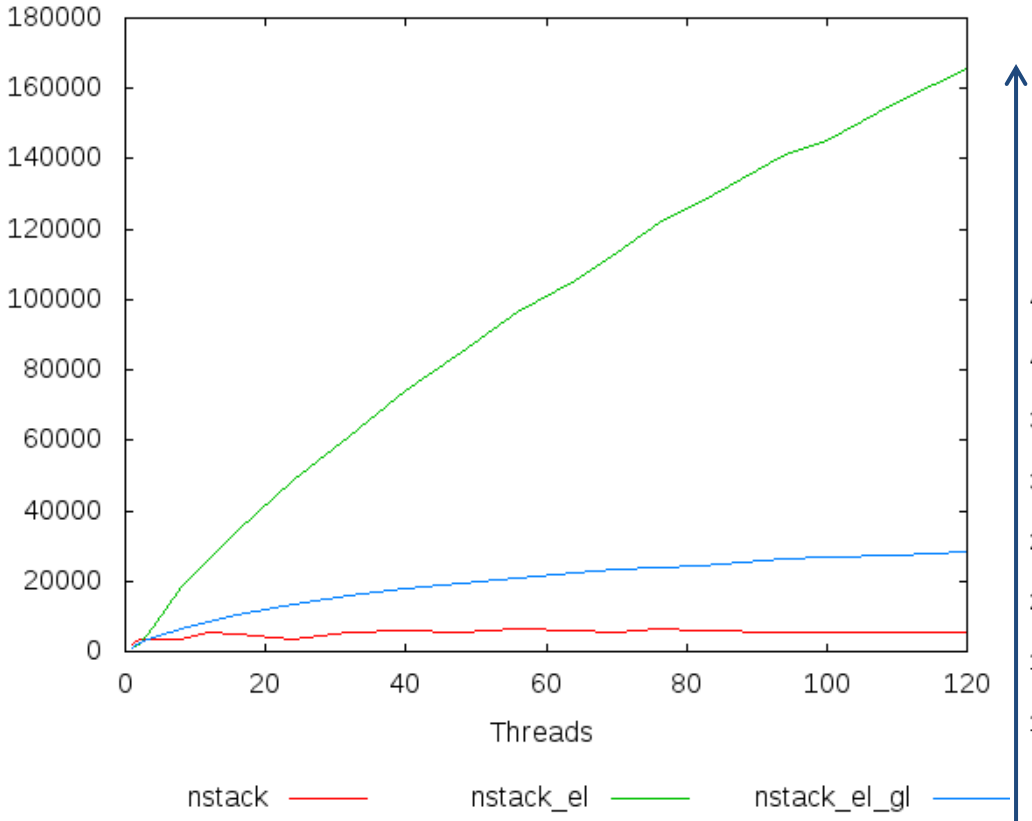
Delegation + Elimination



Delegation + LOCAL Elimination



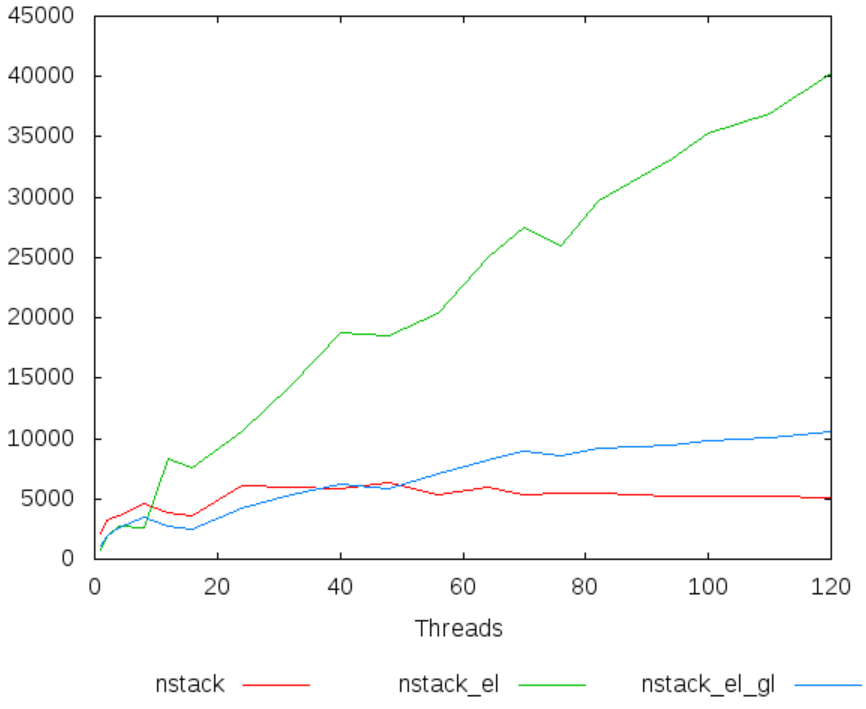
Effect of Elimination



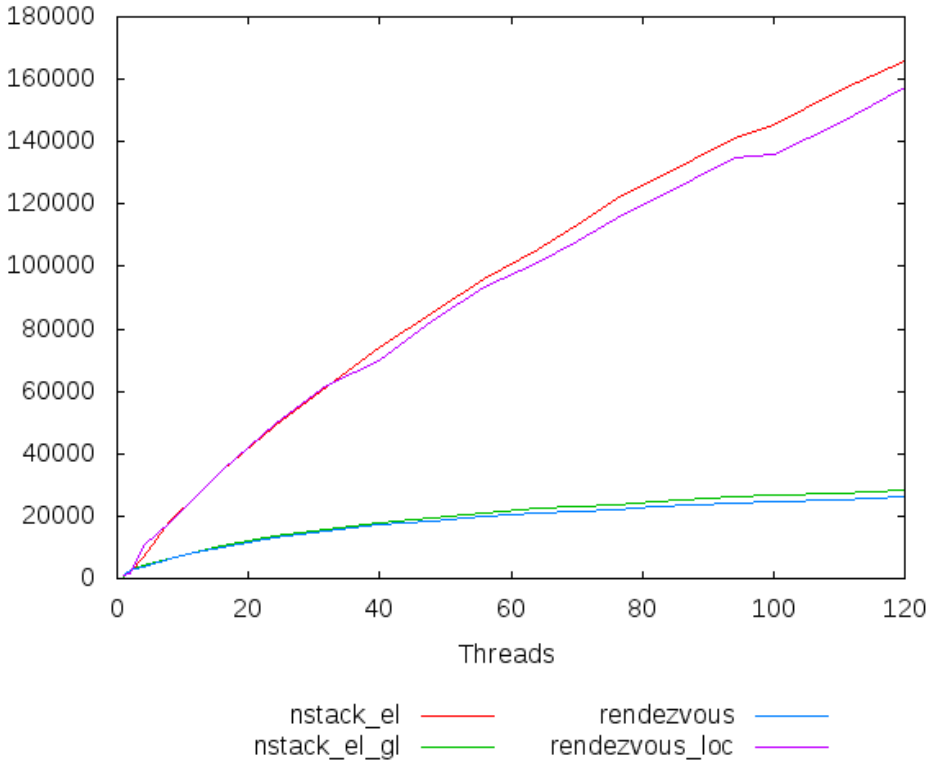
50% push 50% pop

Throughput (Better)

90% push 10% pop



Effect of Delegation



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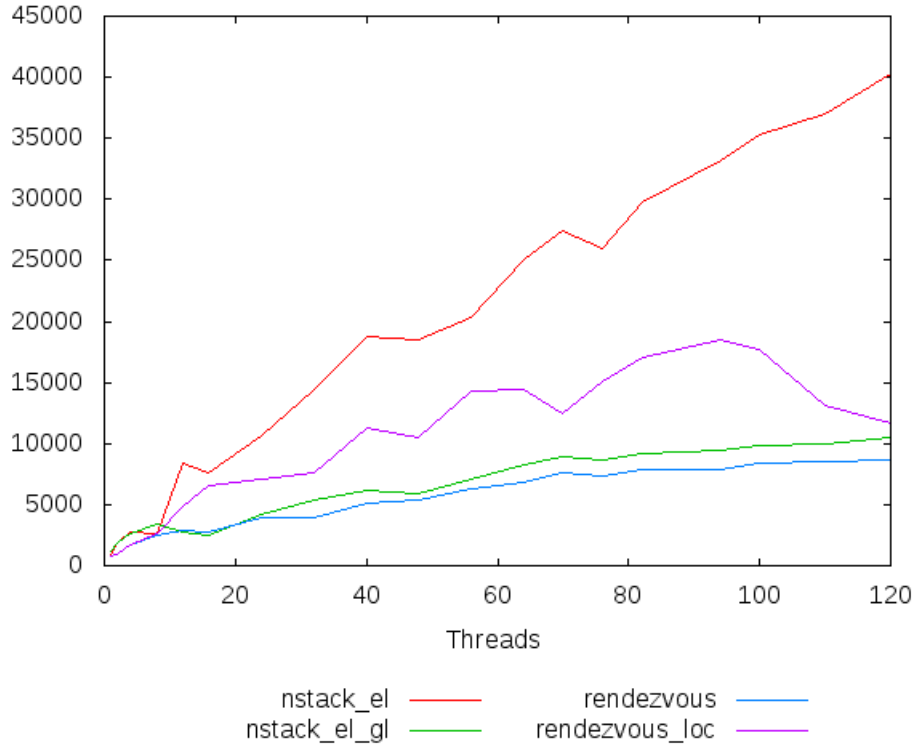
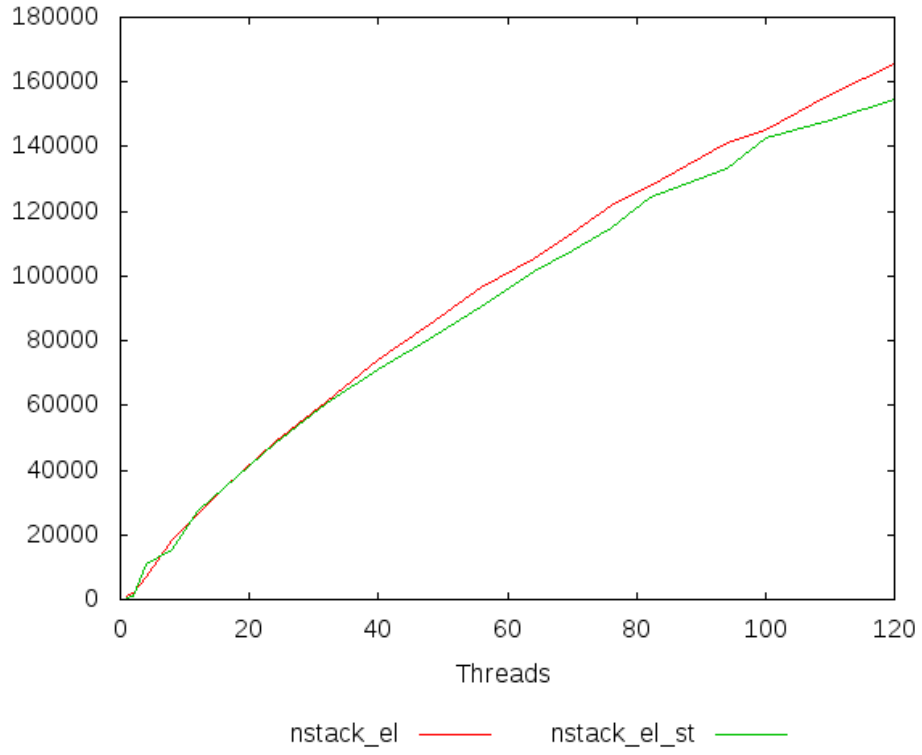


Number of Slots



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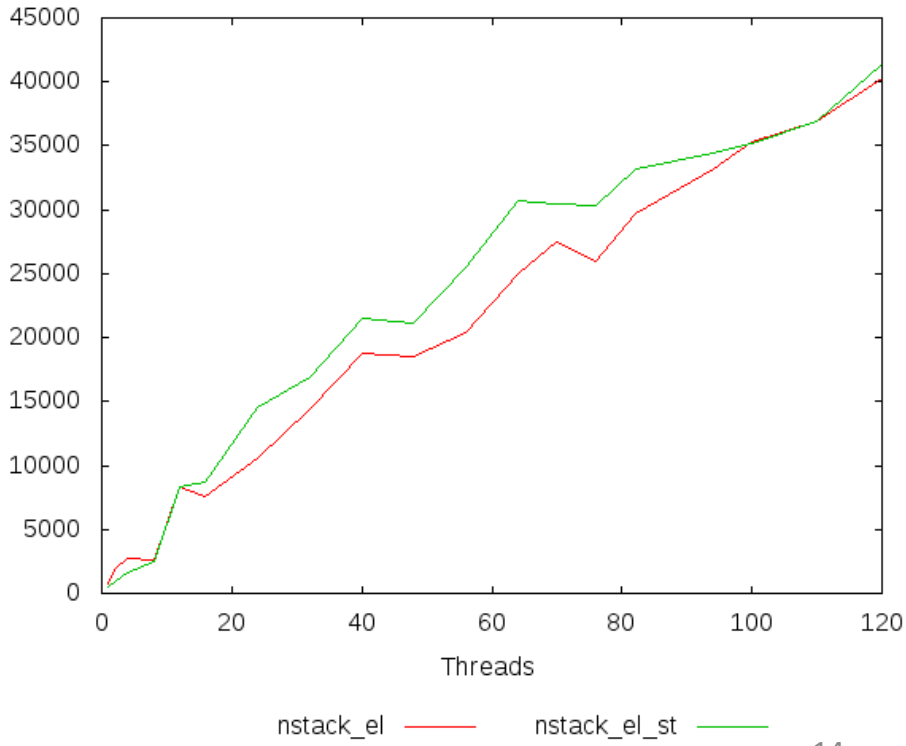
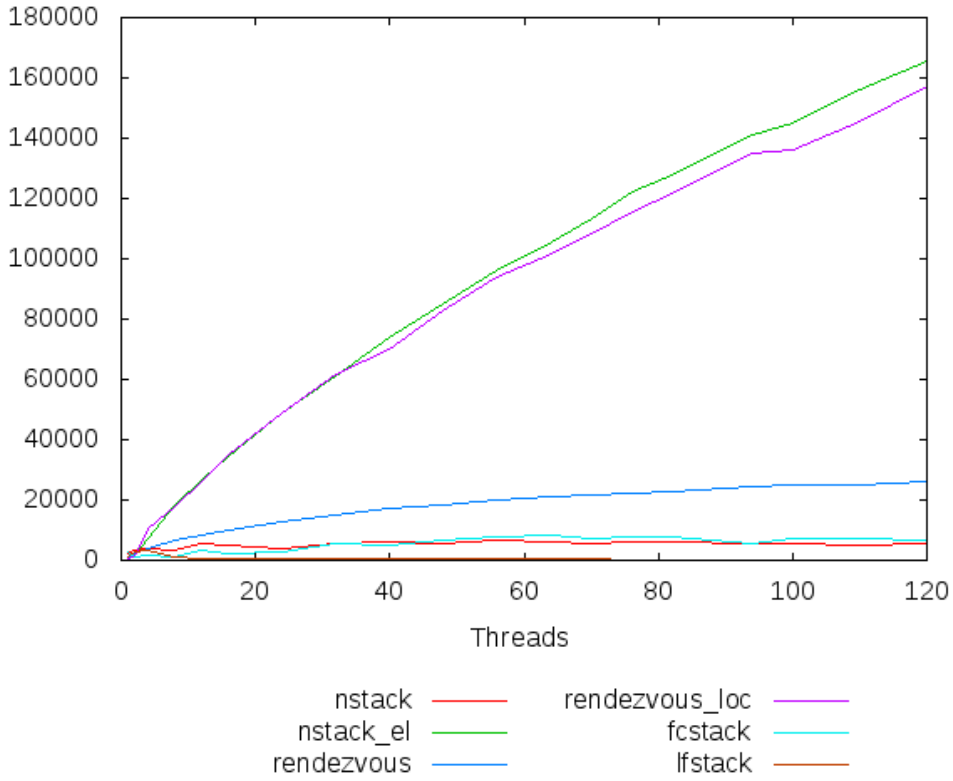


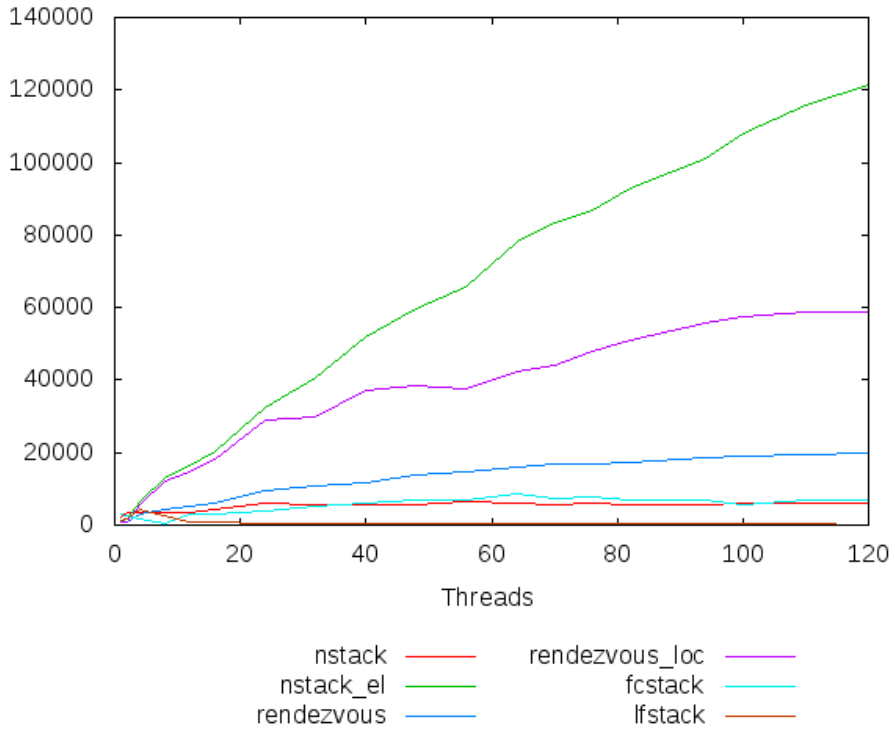
Workloads: Balanced vs. Unbalanced



50% push 50% pop

Throughput (Better)

70% push 30% pop



Advantages

- Memory and cache locality
- Reduced bus traffic
- Increased parallelism through elimination

Drawbacks

- Communication cost between clients and server thread
  - Insignificant compared to the benefits
- Serializing otherwise parallel data structures
  - Parallelism through elimination
- Elimination opportunities decrease as workload more unbalanced

Open Questions

- Are there other data structures where we can use delegation and elimination?
- Are there data structures where direct access is much better?
- What can we do for those data structures?

Thank you! Questions?

References

- A Scalable Lock-free Stack Algorithm

http://www.inf.ufsc.br/~dovicchi/pos-ed/pos/artigos/p206-hendler.pdf

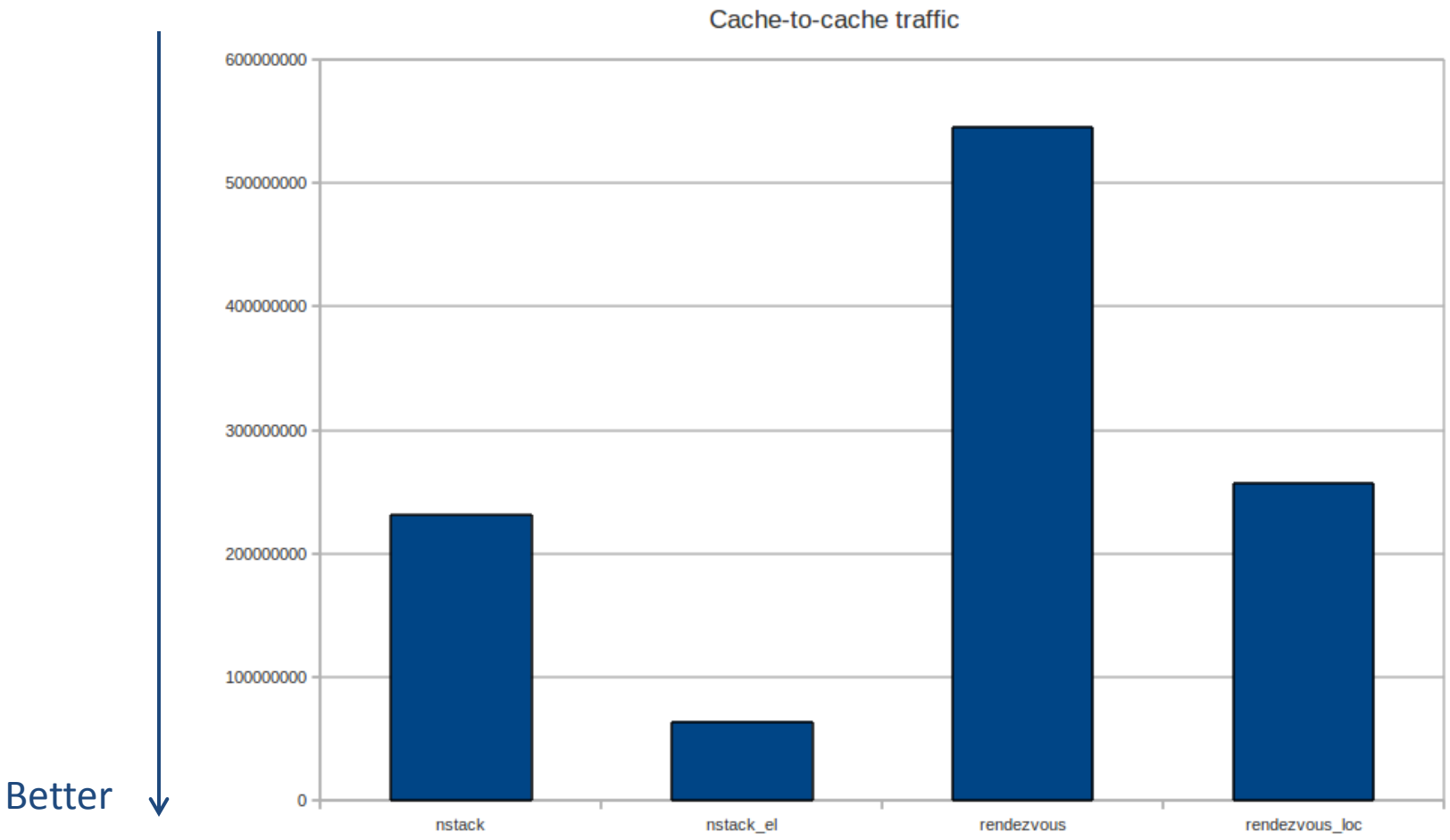
- Flat Combining and the Synchronization-Parallelism Tradeoff

http://www.cs.bgu.ac.il/~hendlerd/papers/flat-combining.pdf

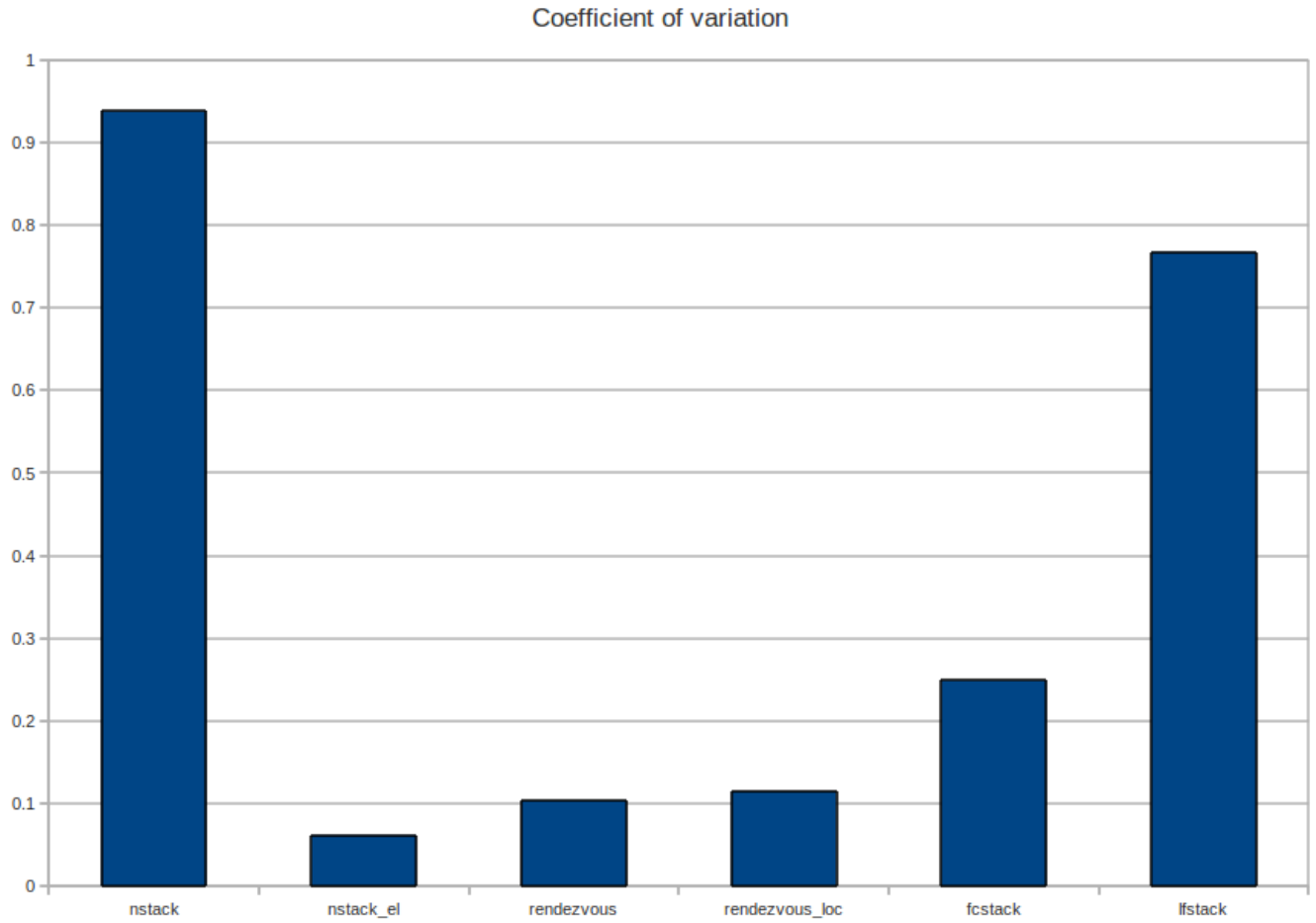
- Fast and Scalable Rendezvousing

http://www.cs.tau.ac.il/~afek/rendezvous.pdf

Cache to Cache Traffic

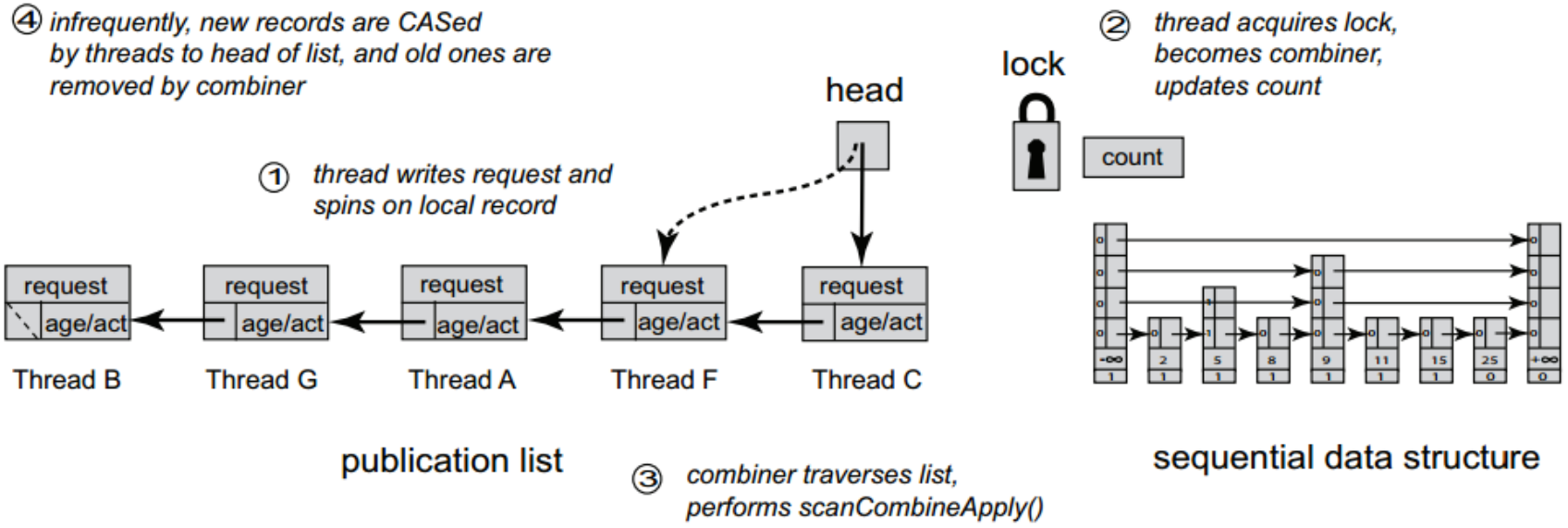


Coefficient of Variation

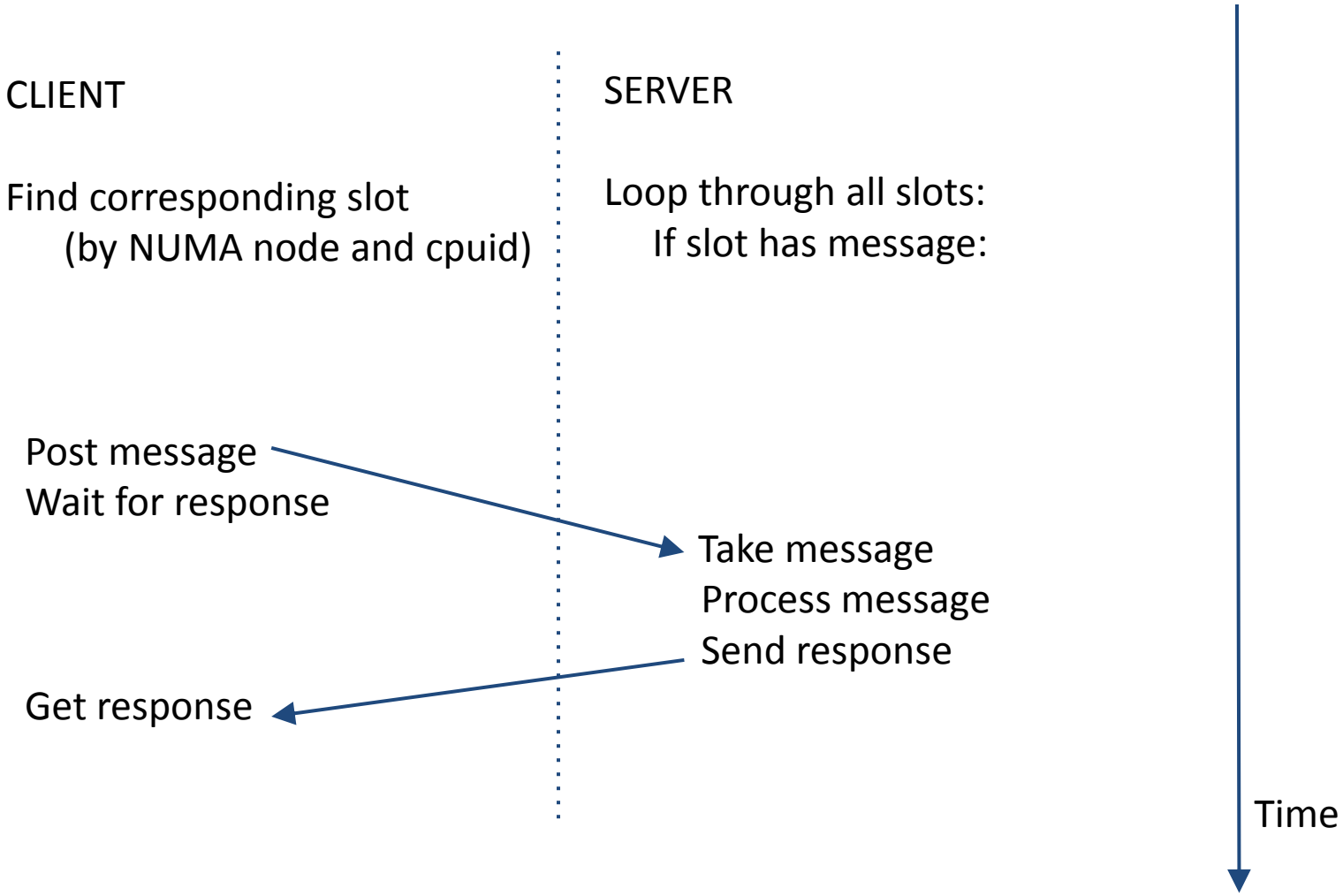


Better ↓

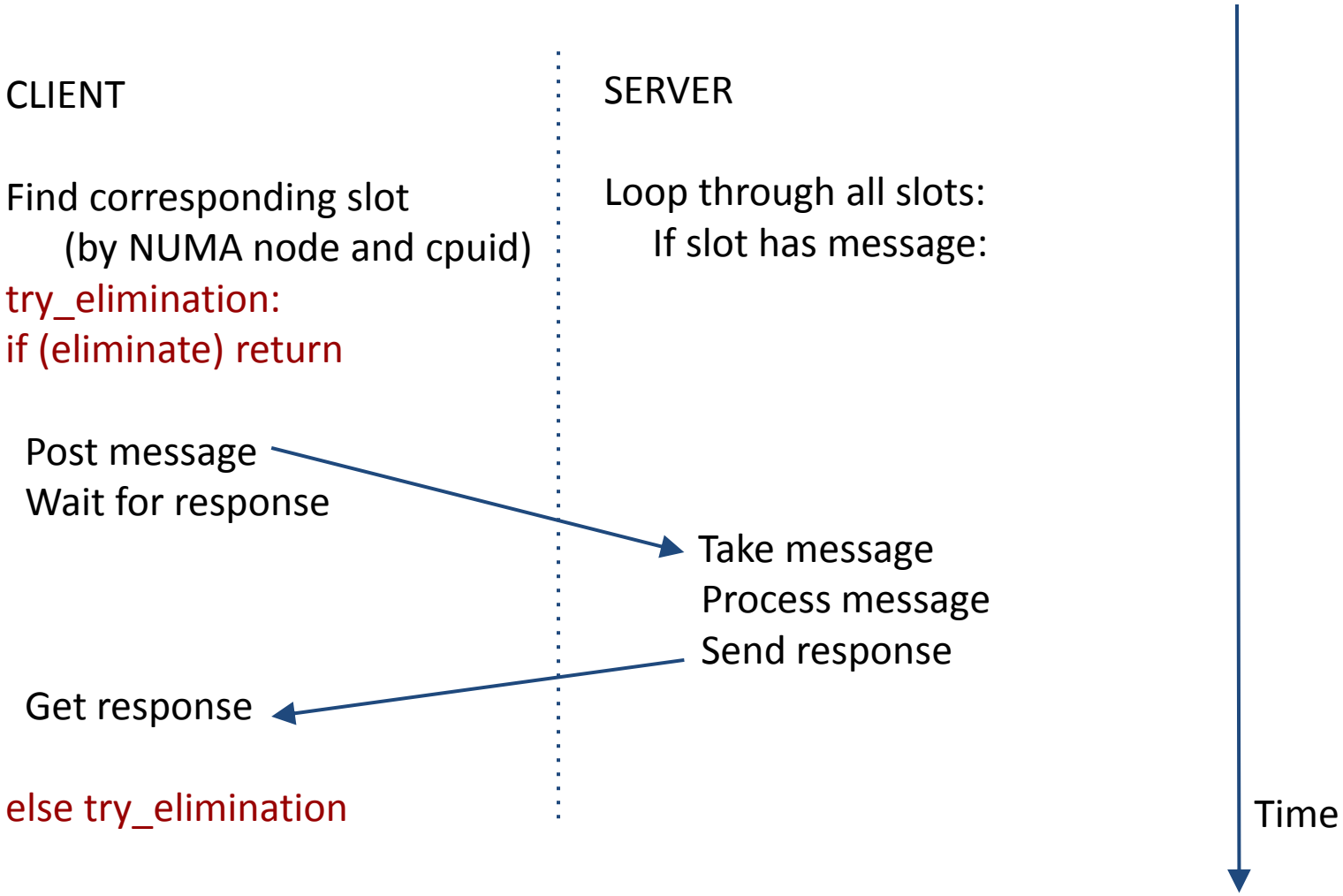
Flat Combining



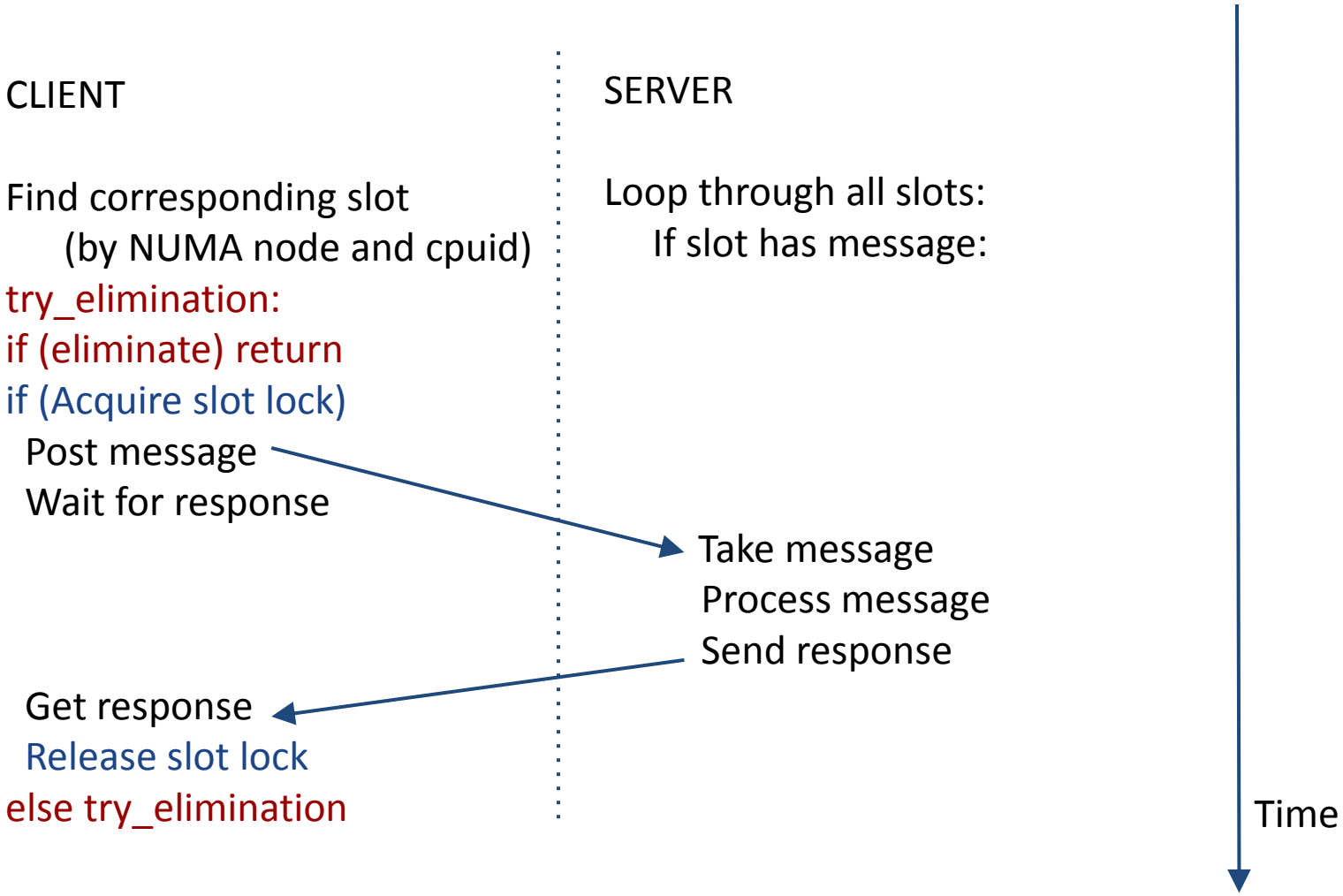
Delegation


CLIENT
Find corresponding slot
(by NUMA node and cpuid)
SERVER
Loop through all slots:
If slot has message:
Post message
Wait for response
Take message
Process message
Send response
Get response
Time

Delegation


CLIENT
Find corresponding slot
(by NUMA node and cpuid)
try_elimination:
if (eliminate) return
Post message
Wait for response
Get response
else try_elimination
SERVER
Loop through all slots:
If slot has message:
Take message
Process message
Send response
Time

Delegation


CLIENT
Find corresponding slot
(by NUMA node and cpuid)
try_elimination:
if (eliminate) return
if (Acquire slot lock)
Post message
Wait for response
Get response
Release slot lock
else try_elimination
SERVER
Loop through all slots:
If slot has message:
Take message
Process message
Send response
Time

Open Questions

- Performance
- Scalability
- Power