RAS: Continuously Optimized Region-Wide Datacenter Resource Allocation

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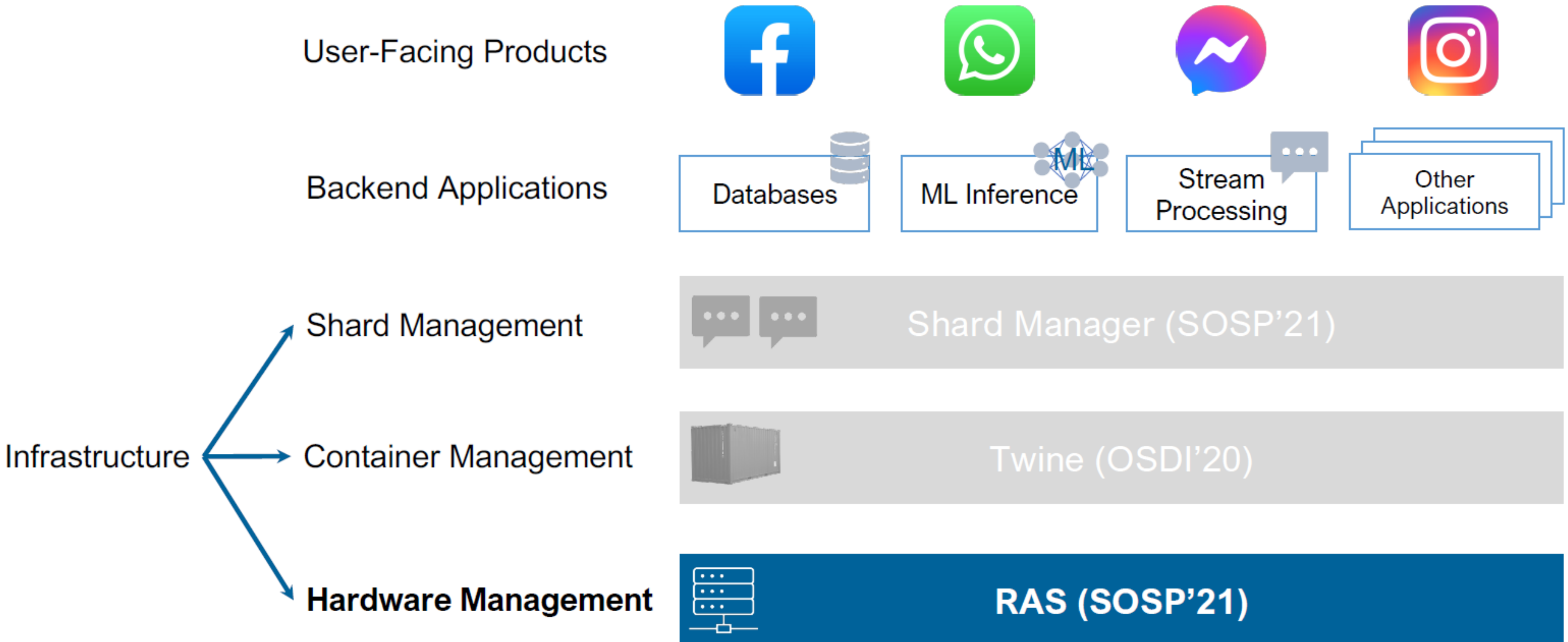
RAS 是什么


User-Facing Products
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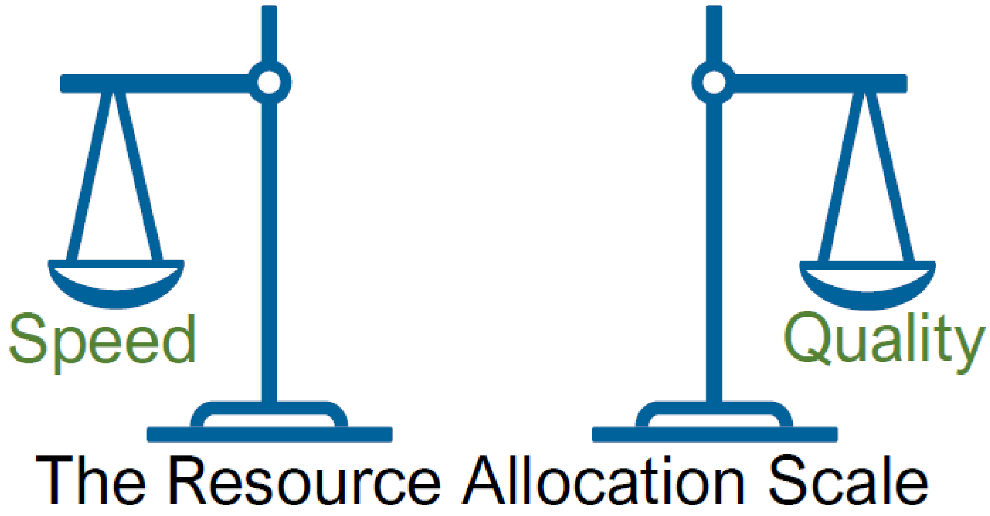
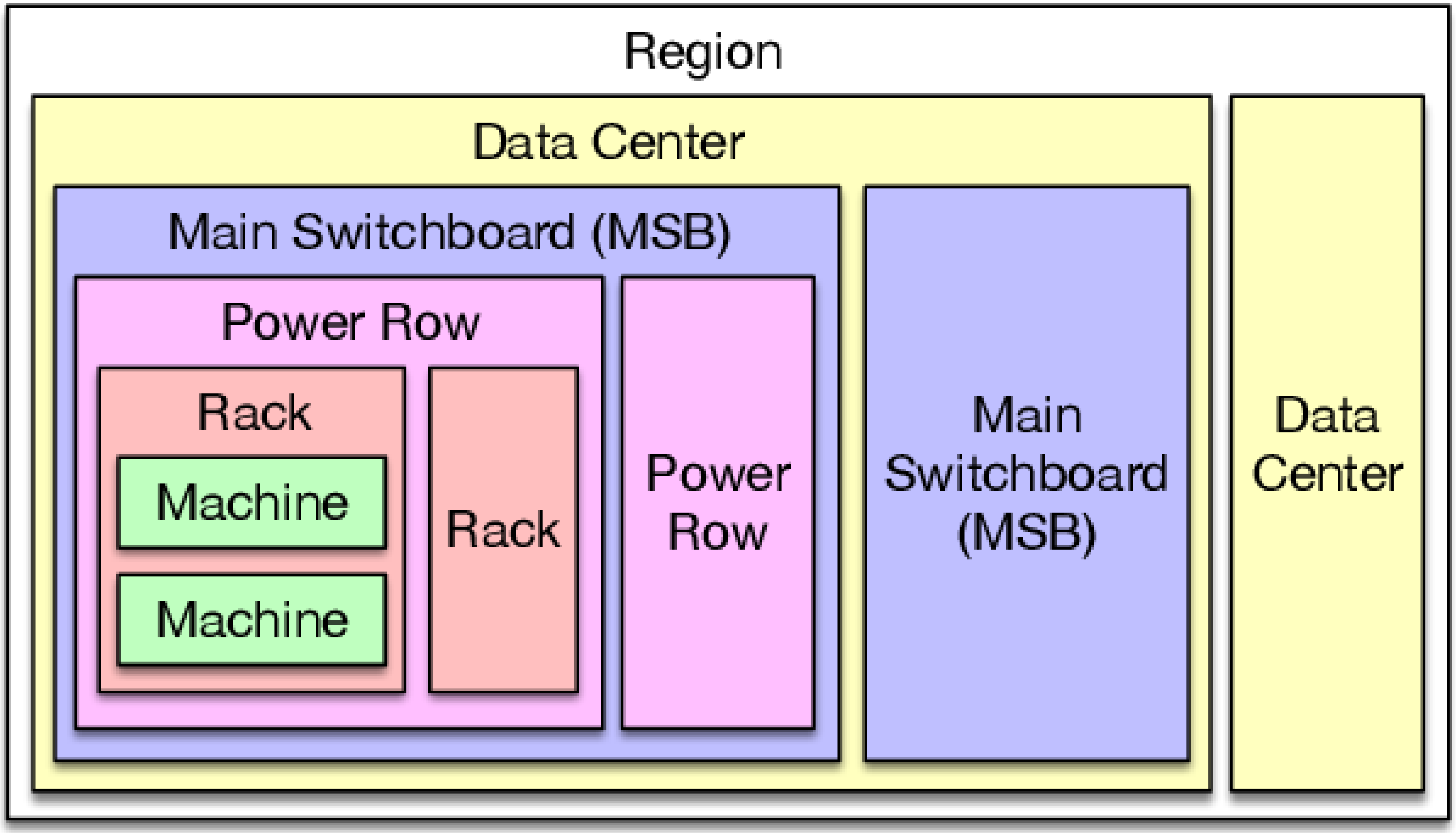
Shard Manager (SOSP’21)
Twine (OSDI’20)
RAS (SOSP’21)

RAS —— 资源分配系统

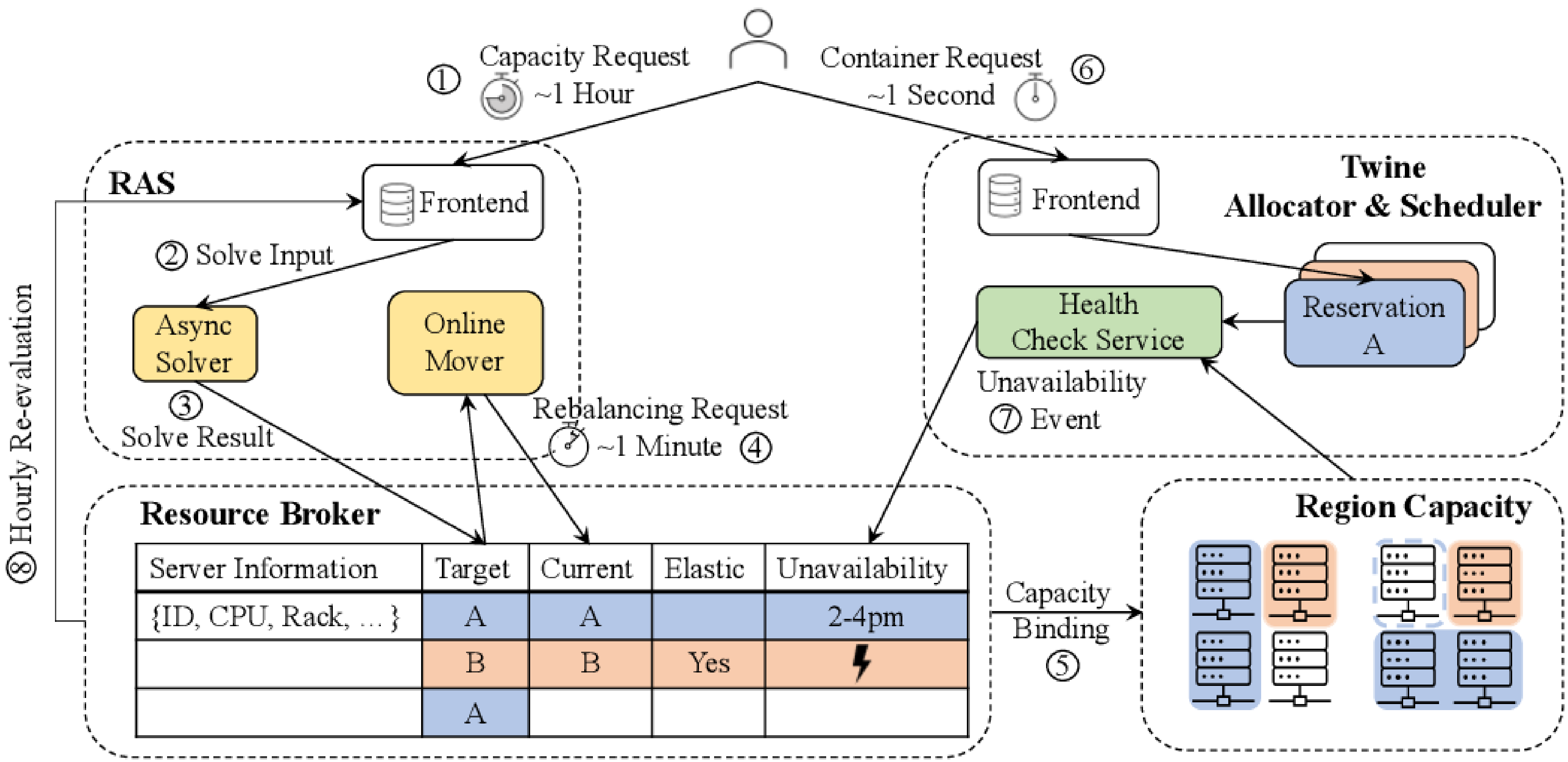
基于 Twine 的新的服务器分配组件



Facebook 的 datacenter 拓扑图



RAS 工作原理


① Capacity Request
~1 Hour
Container Request ⑥
~1 Second
RAS
Frontend
② Solve Input
Async Solver
Online Mover
③ Solve Result
Rebalancing Request
~1 Minute ④
Twine
Allocator & Scheduler
Frontend
Health Check Service
Reservation A
Unavailability
⑦ Event
⑧ Hourly Re-evaluation
Resource Broker
Server Information
Target
Current
Elastic
Unavailability
{ID, CPU, Rack, … }
A
A
2-4pm
B
B
Yes
A
Capacity Binding
⑤
Region Capacity

Failure Buffers

Random Failure：

Failure Buffers

Random Failure:

Correlated Failure:

Failure Buffers

Random Failure: Shared buffer

Correlated Failure:

Failure Buffers

Random Failure:　　Shared buffer —> Online Mover

Correlated Failure:

Failure Buffers

Random Failure:　　Shared buffer —> Online Mover

Correlated Failure: Embedded buffer

Failure Buffers

Random Failure： Shared buffer —> Online Mover

Correlated Failure： Embedded buffer —> Twine Allocator

Async Solver

Two-phase solving:

1. Solve without any rack-related goals
2. Solve with all goals in phase 1 plus rack goals

Async Solver

Constraints:

1. Capacity
2. Server availability
3. Network
4. Correlated failure

Objectives:

1. move unused servers
2. spreads reservations across MSBs
3. reduce hotspots that may overload rack switch uplinks

Async Solver

Minimize:

$$\sum_{s \in S, r \in R} M_s * \max(0, X_{s,r} - x_{s,r}) \qquad (1)$$

$$+\beta * \sum_{r \in R, G \in \Psi^K} \max\left(0, \sum_{s \in G} (V_{s,r} * x_{s,r}) - \alpha^K * C_r\right) \qquad (2)$$

$$+\beta * \sum_{r \in R, G \in \Psi^F} \max\left(0, \sum_{s \in G} (V_{s,r} * x_{s,r}) - \alpha^F * C_r\right) \qquad (3)$$

$$+\tau * \sum_{r \in R} \max_{G \in \Psi^F} \left(\sum_{s \in G} V_{s,r} * x_{s,r}\right) \qquad (4)$$

Subject to:

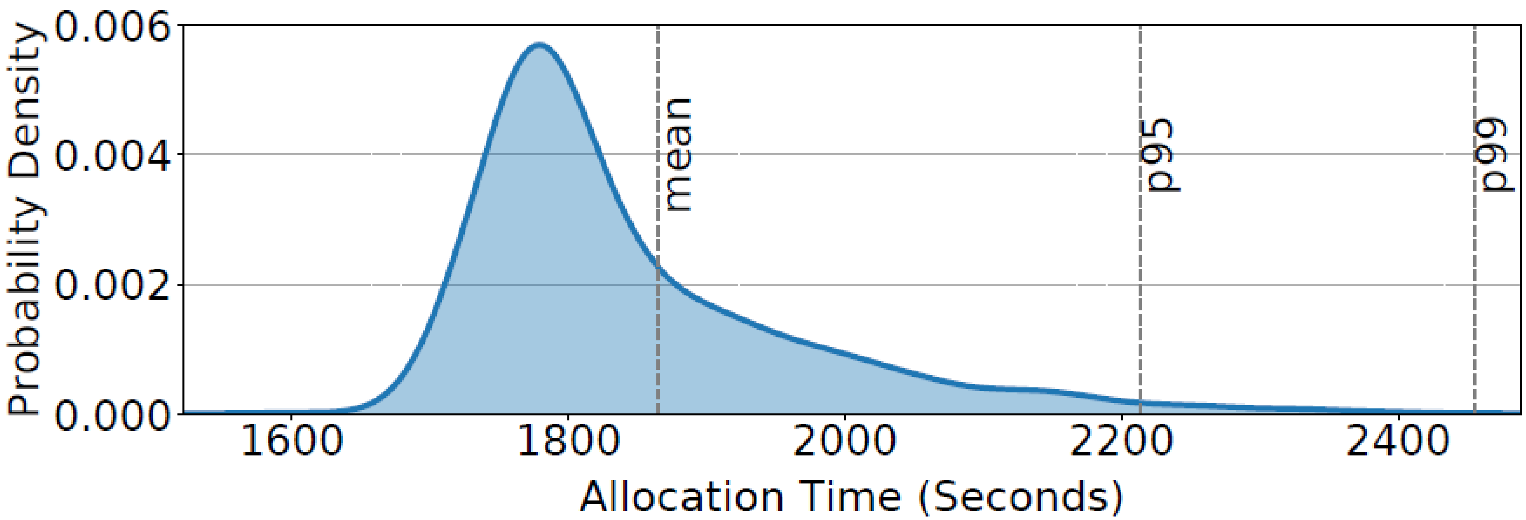
$$\sum_{r \in R} x_{s,r} \le 1, \qquad \forall s \in S \qquad (5)$$

$$\sum_{s \in S} (V_{s,r} * x_{s,r}) - \max_{G \in \Psi^F} \left(\sum_{s \in G} V_{s,r} * x_{s,r}\right) \ge C_r, \qquad \forall r \in R \qquad (6)$$

$$\left| \frac{\sum_{s \in G} (V_{s,r} * x_{s,r})}{C_r} - A_{r,G} \right| \le \theta, \qquad \forall r \in R, G \in \Psi^D \qquad (7)$$

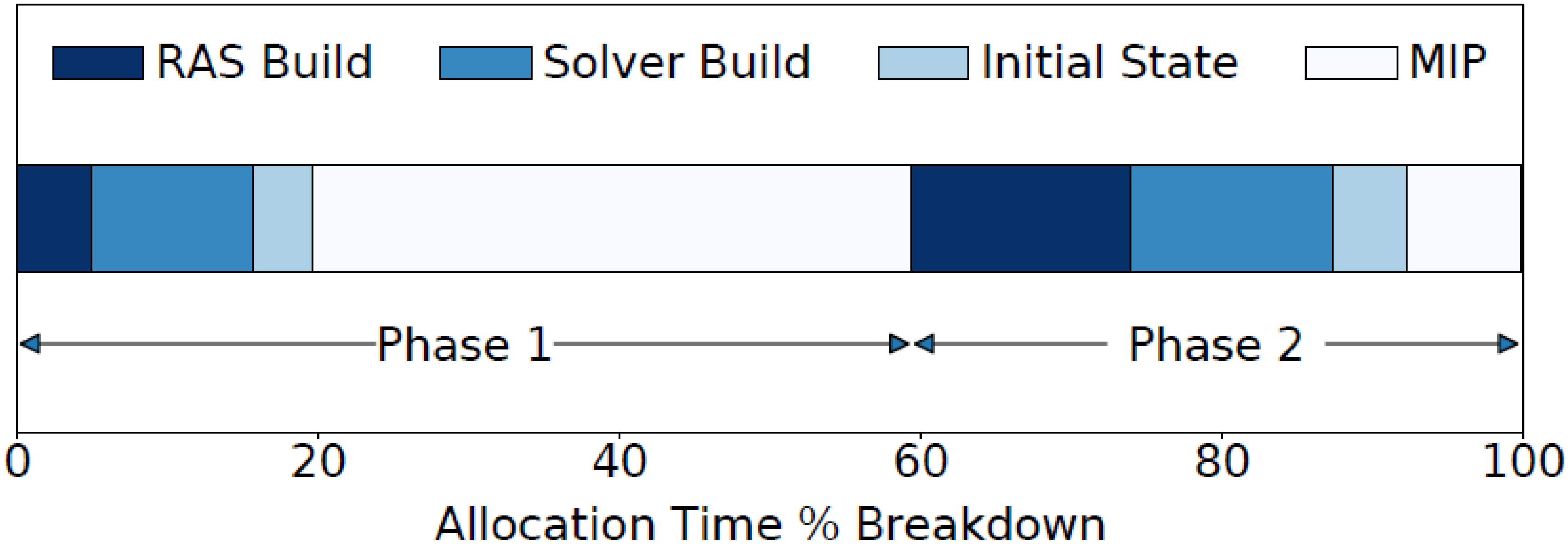
Notation	Description
S	Set of all servers
R	Set of all reservations
$x_{s,r}$	Assignment variable which is 1 if server s is assigned to reservation r and 0 otherwise
$X_{s,r}$	Constant initial assignment value
M_s	Movement cost of server s
τ	Cost of each correlated-failure-buffer server
β	Cost of each server outside spread goals
$\alpha^{K,F}$	Proportional limit of reservation for spread in K (rack) or F (MSB fault domain)
$V_{s,r}$	RRU value of server s for reservation r
C_r	Capacity desired for reservation r
$\Psi^{K,F,D}$	Partition of servers based on K (rack), D (datacenter), or F (MSB fault domain)
$A_{r,G}$	Affinity of reservation r to a partition group G

RAS Performance



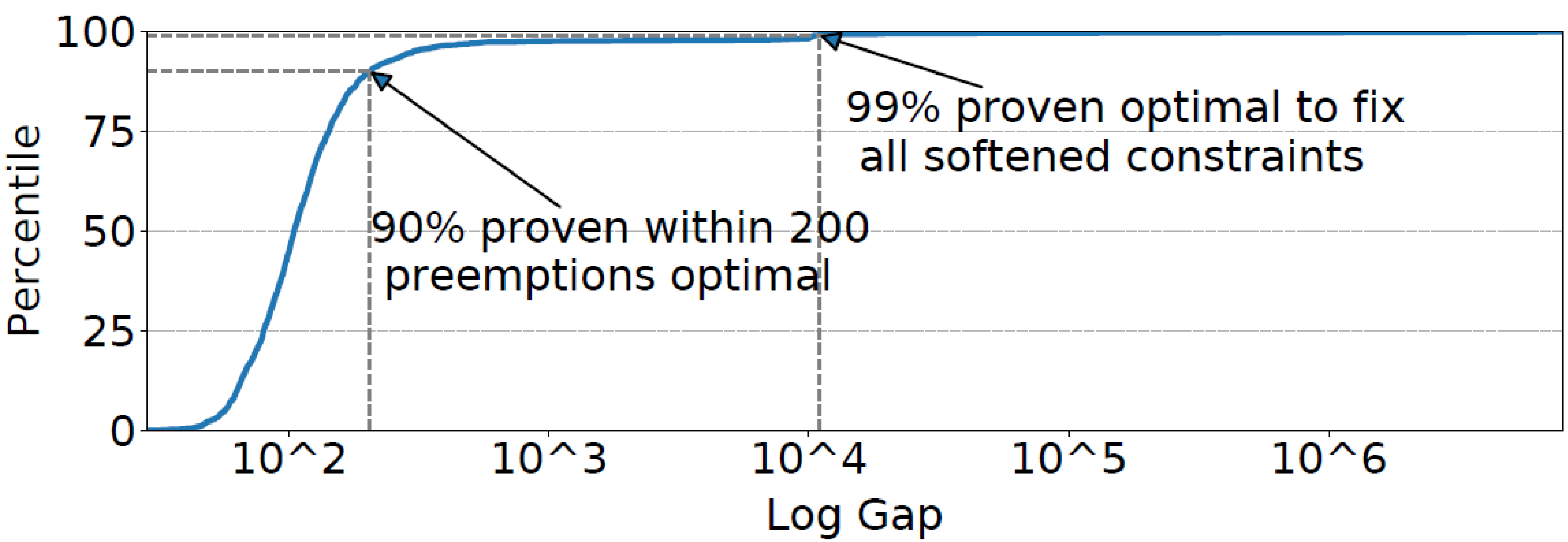
RAS regional allocation time distribution

RAS Performance



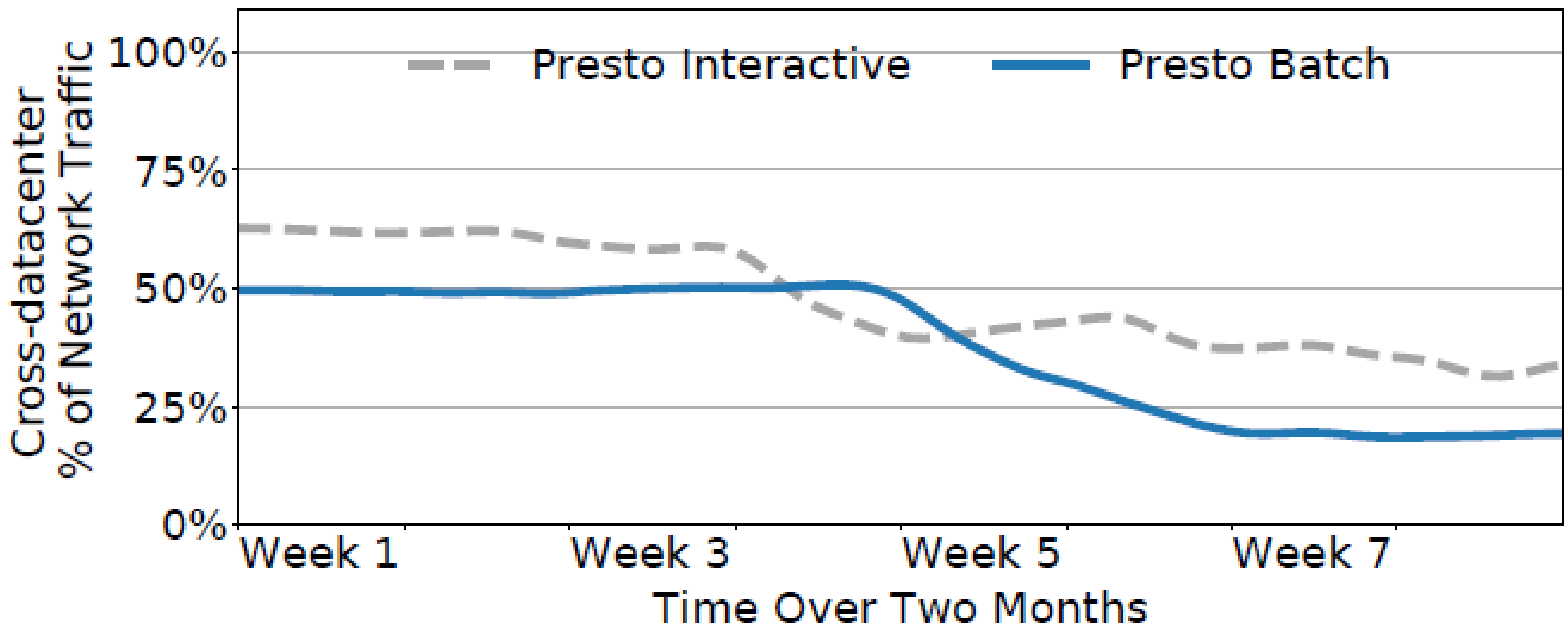
RAS allocation time breakdown

RAS Performance



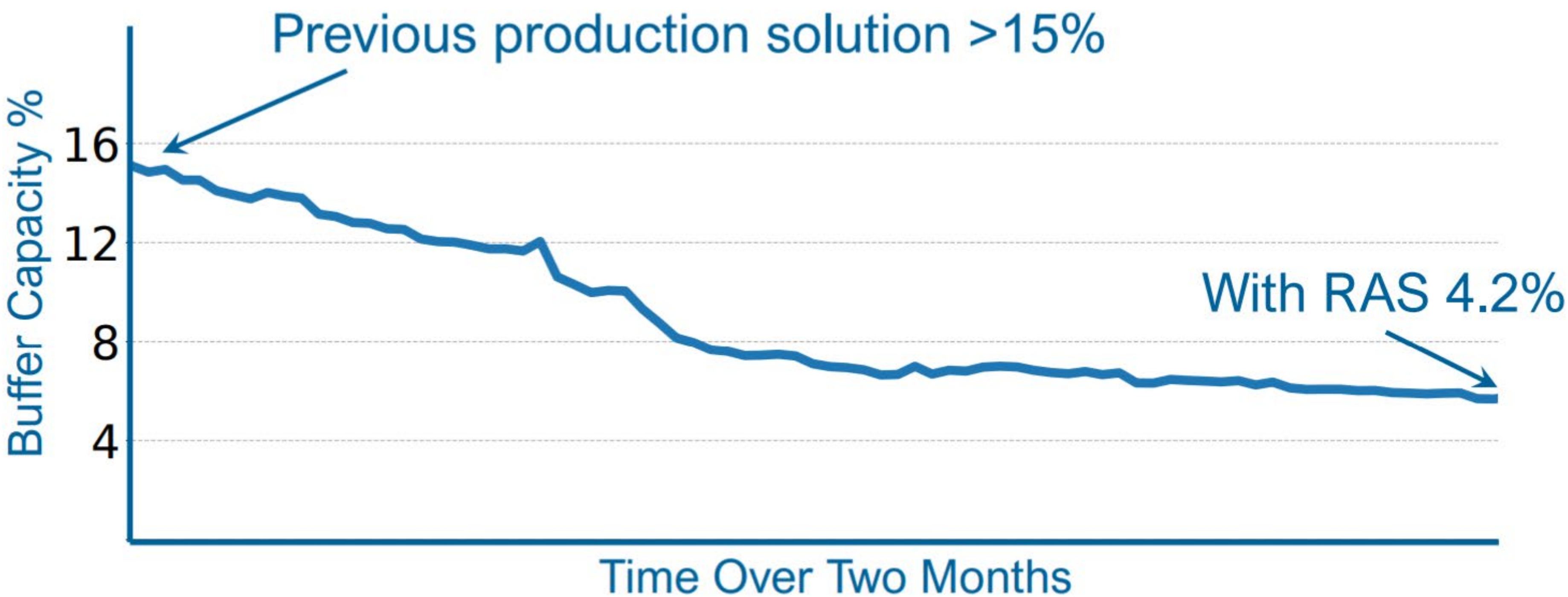
Allocation Quality: Phase 1 MIP quality gap

RAS Evaluation



RAS helps reduce cross-datacenter network traffic over a period of two months.

RAS Evaluation



RAS helps reduce correlated-failure buffers over a period of two months

Discussion

相信RAS的一些关键想法可以被其他系统考虑:

1. 给user介绍动态reservation而不是静态集群
2. 把服务器分配和容器放置解耦
3. 把服务器分配到reservation看成一个优化问题
4. …

Challenges

1. Capacity-request delays
2. Extra service preemption
3. …

谢谢！