SpotOn:

A BATCH COMPUTING SERVICE FOR THE SPOT MARKET

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David Irwin, Prashant Shenoy

University of Massachusetts Amherst

INFRASTRUCTURE CLOUD

On-demand

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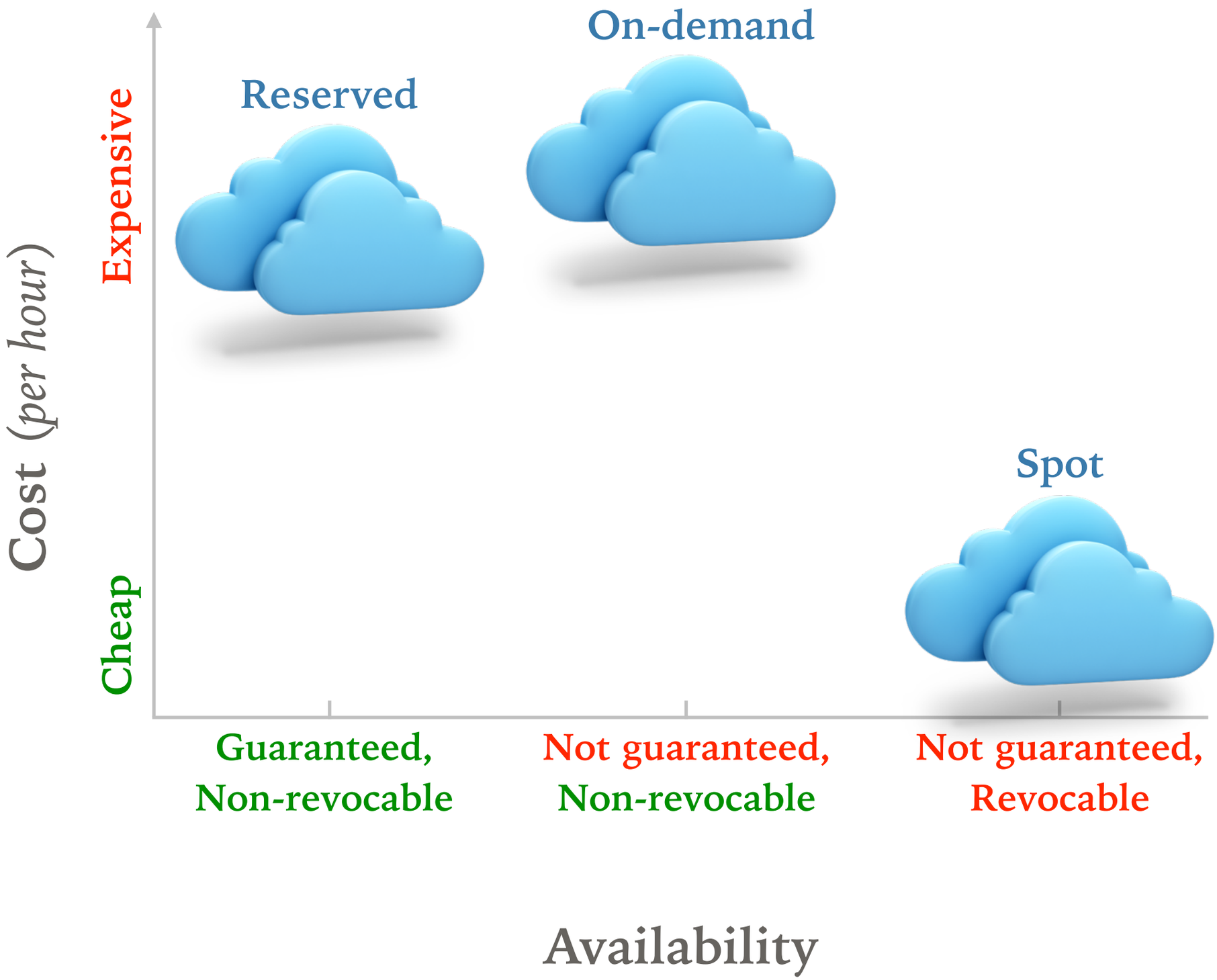
Cost vs. Availability Tradeoff in IaaS Clouds



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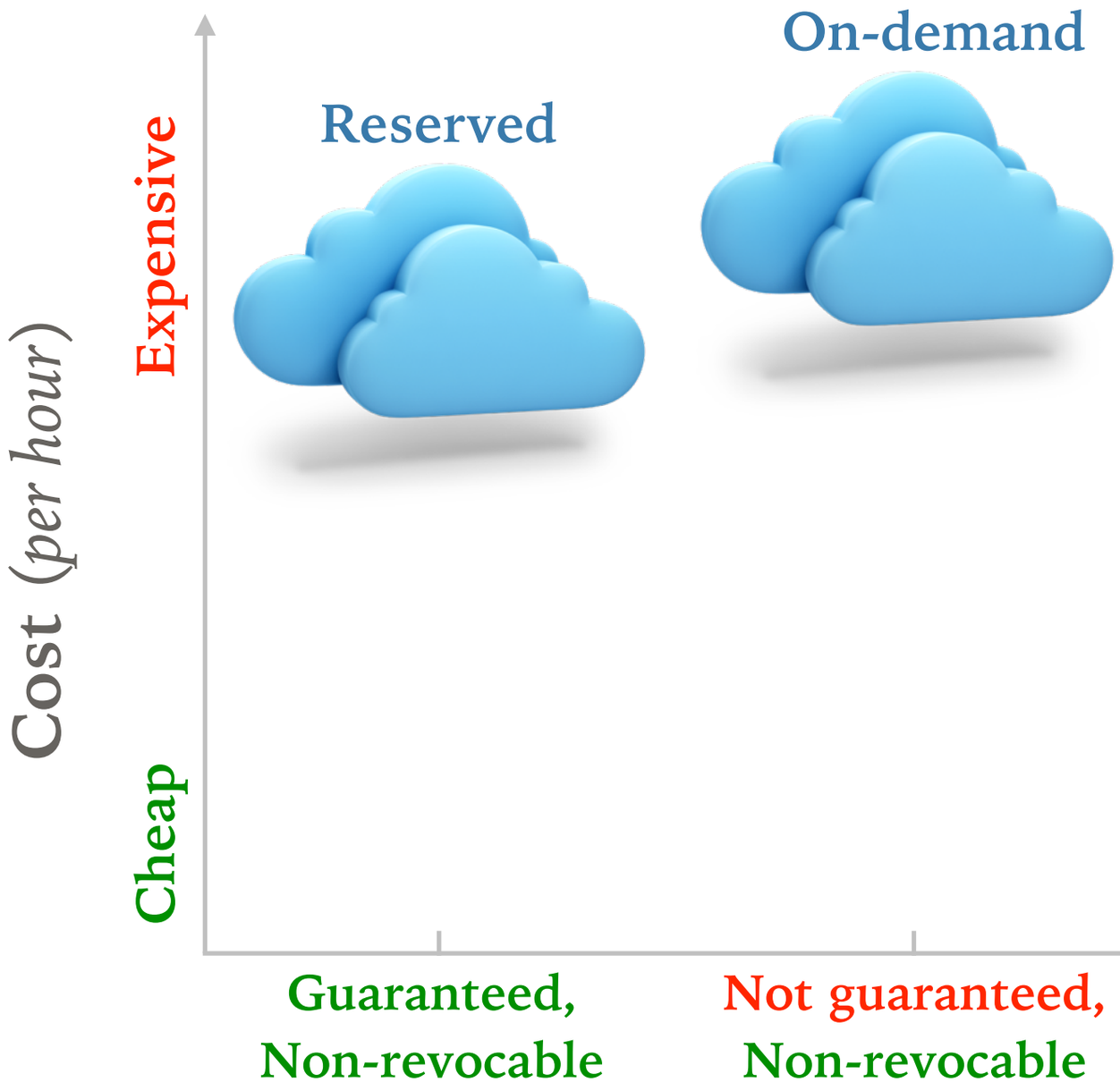


Spot Instances

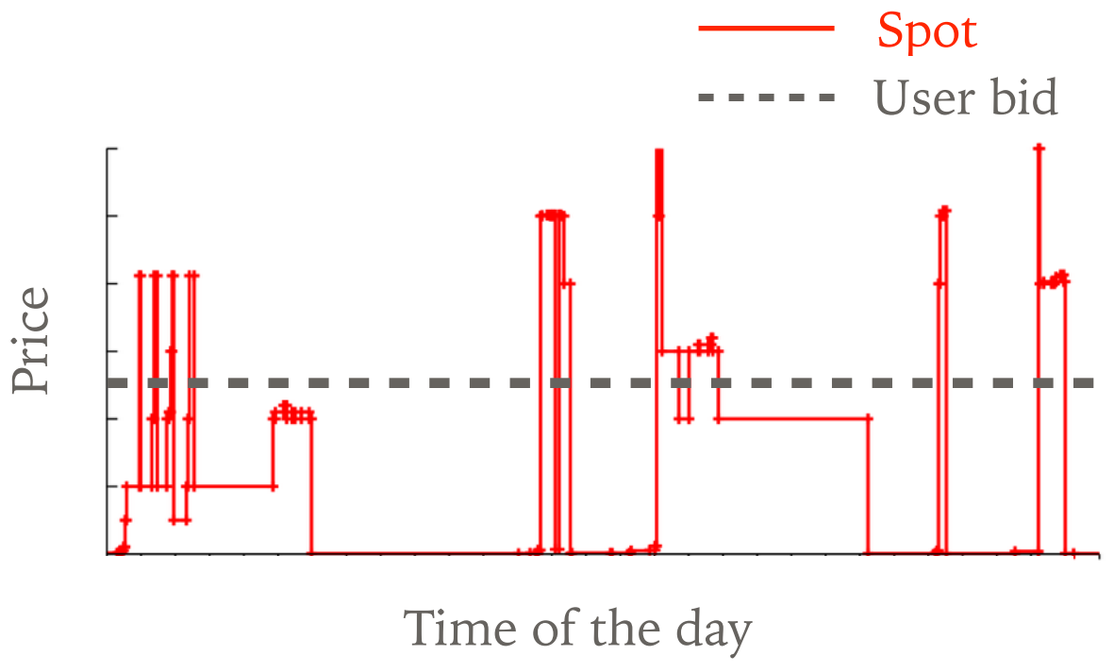
amazon web services™ | EC2

Google Cloud Platform
Preemptible VM

SPOT MARKETS

Amazon EC2

- ***Bid*** in a 2nd price auction
- ***Acquire*** when bid > spot price
- ***Terminate*** when spot price > bid



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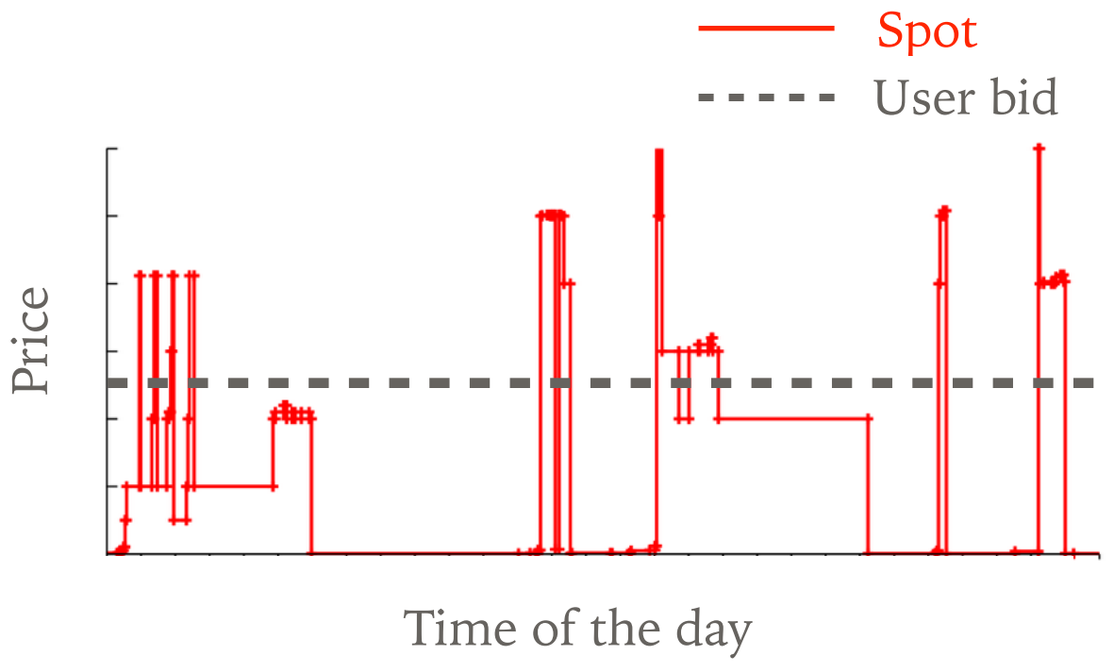

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1. Raise the bid
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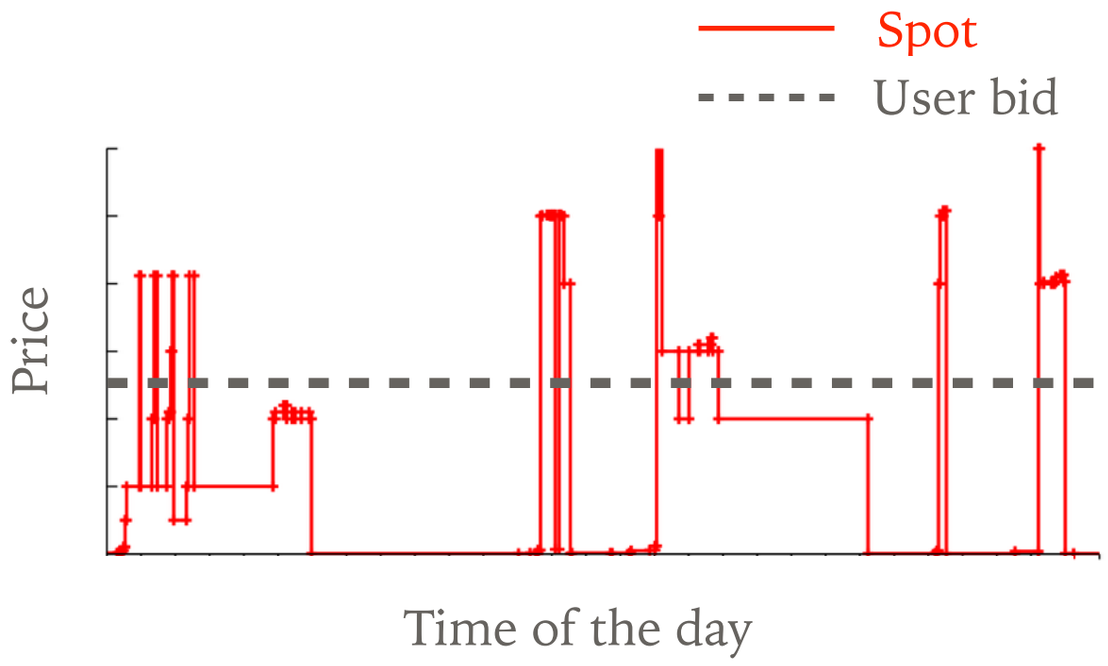

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CHALLENGES — SPOT MARKET COMPLEXITY

Amazon EC2 operates ***~4000*** spot markets

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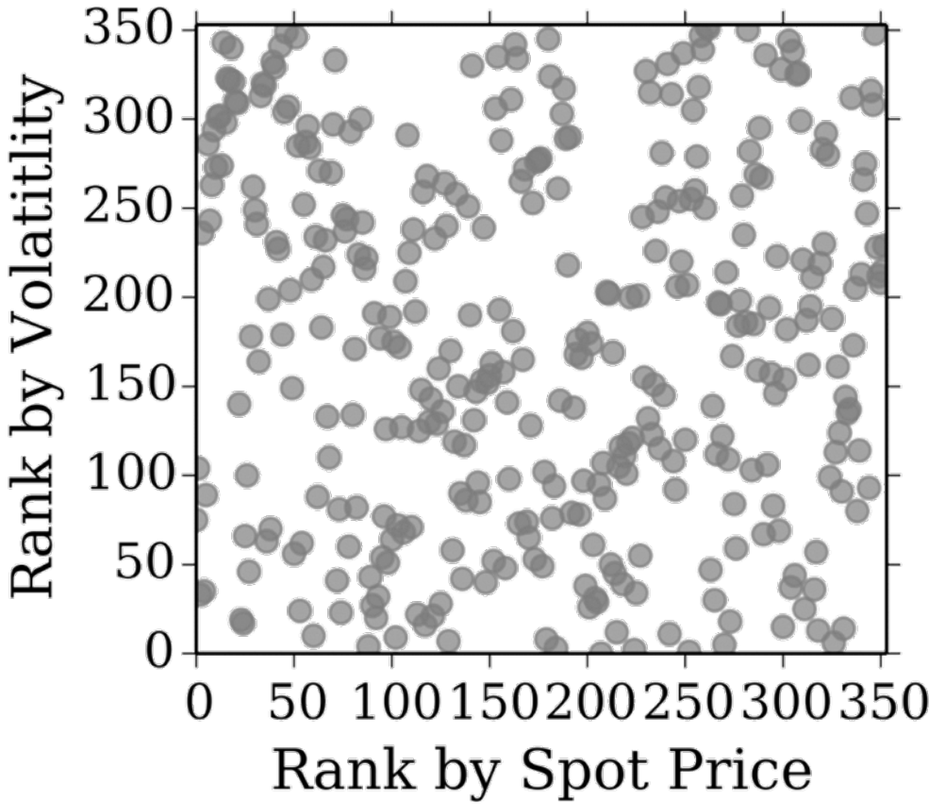

Scatterplot of ranks for EC2 spot markets

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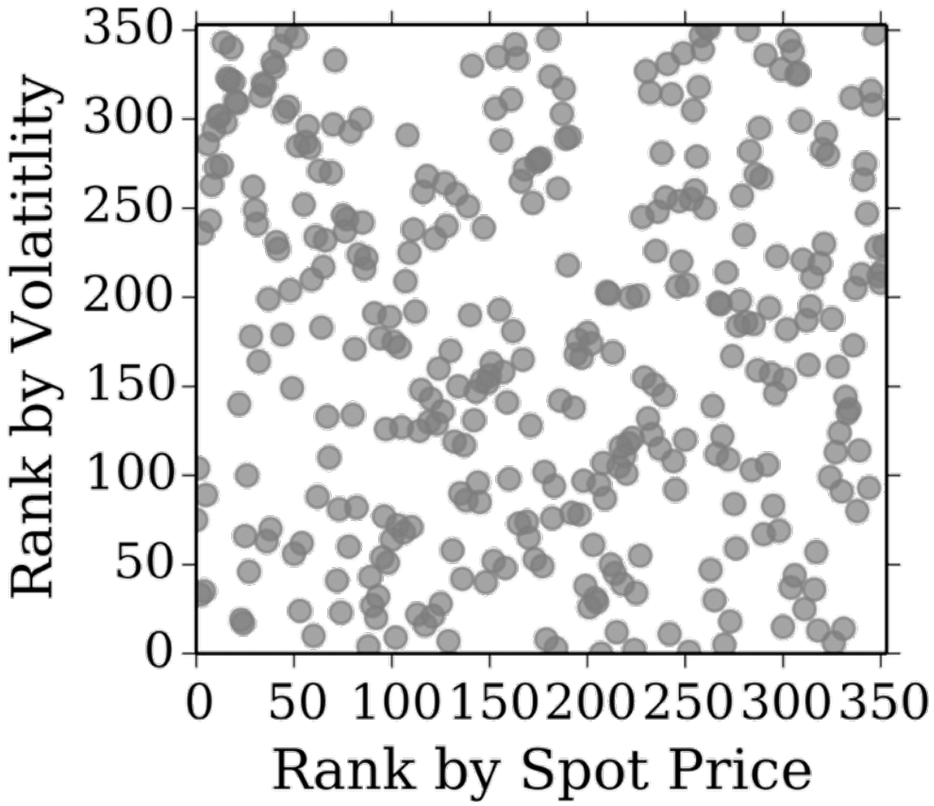

Scatterplot of ranks for EC2 spot markets

Selecting an instance that yields

lowest cost per unit of computation

while also considering the

probability of revocation is complex

CHALLENGES — APPLICATION COMPLEXITY

Resource Vector

CPU : IO	Working Set	Disk Type	Running Time
1:1	8GB	Remote	1 hour

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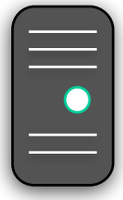

Spot VM

Cost	Revocation Rate	Fault-tolerance Mechanism
20% On-demand	2.4 per day	Checkpoint (every 900s)

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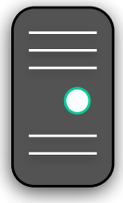

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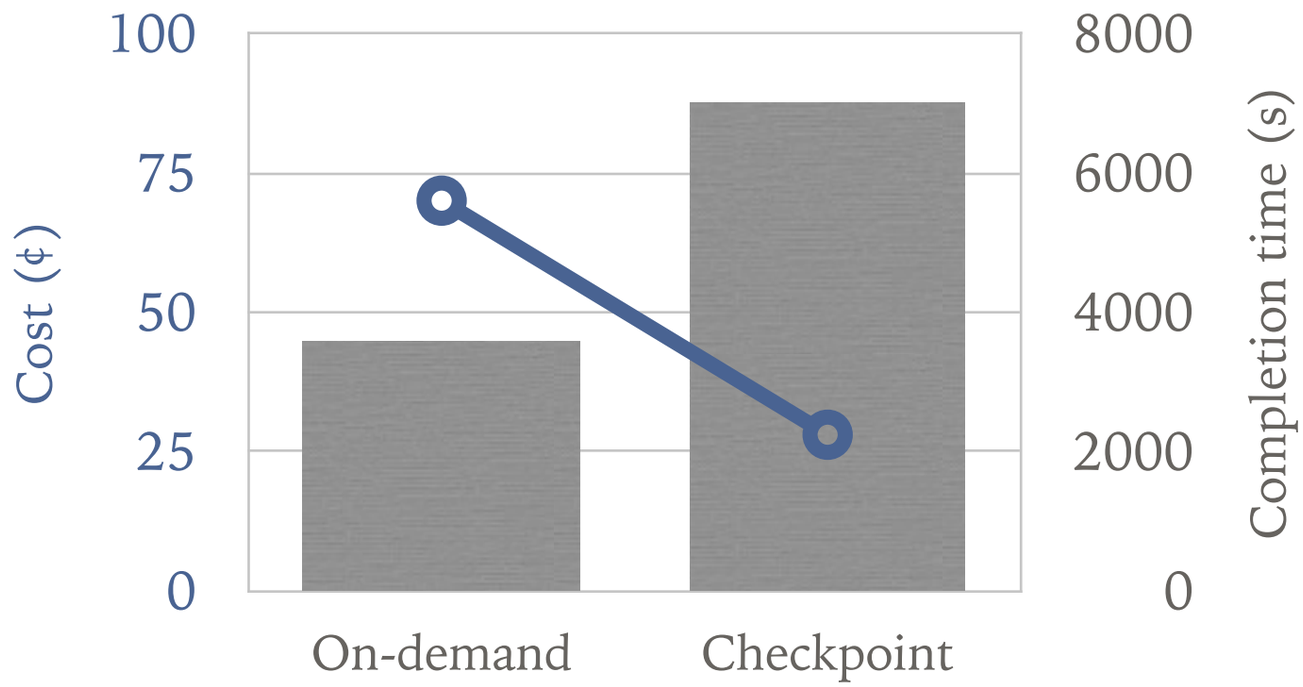

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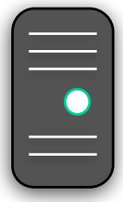

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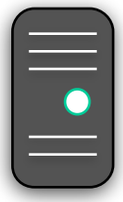

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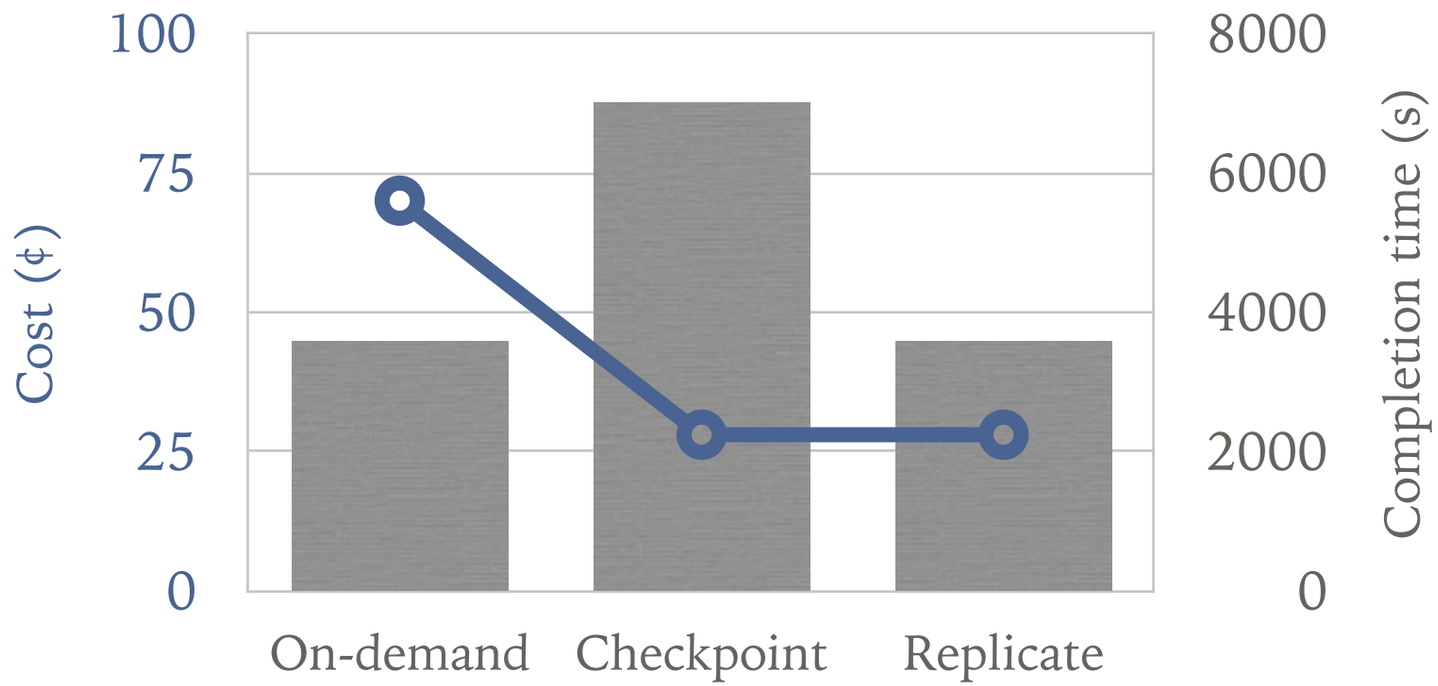

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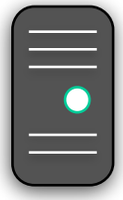

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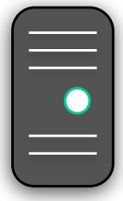

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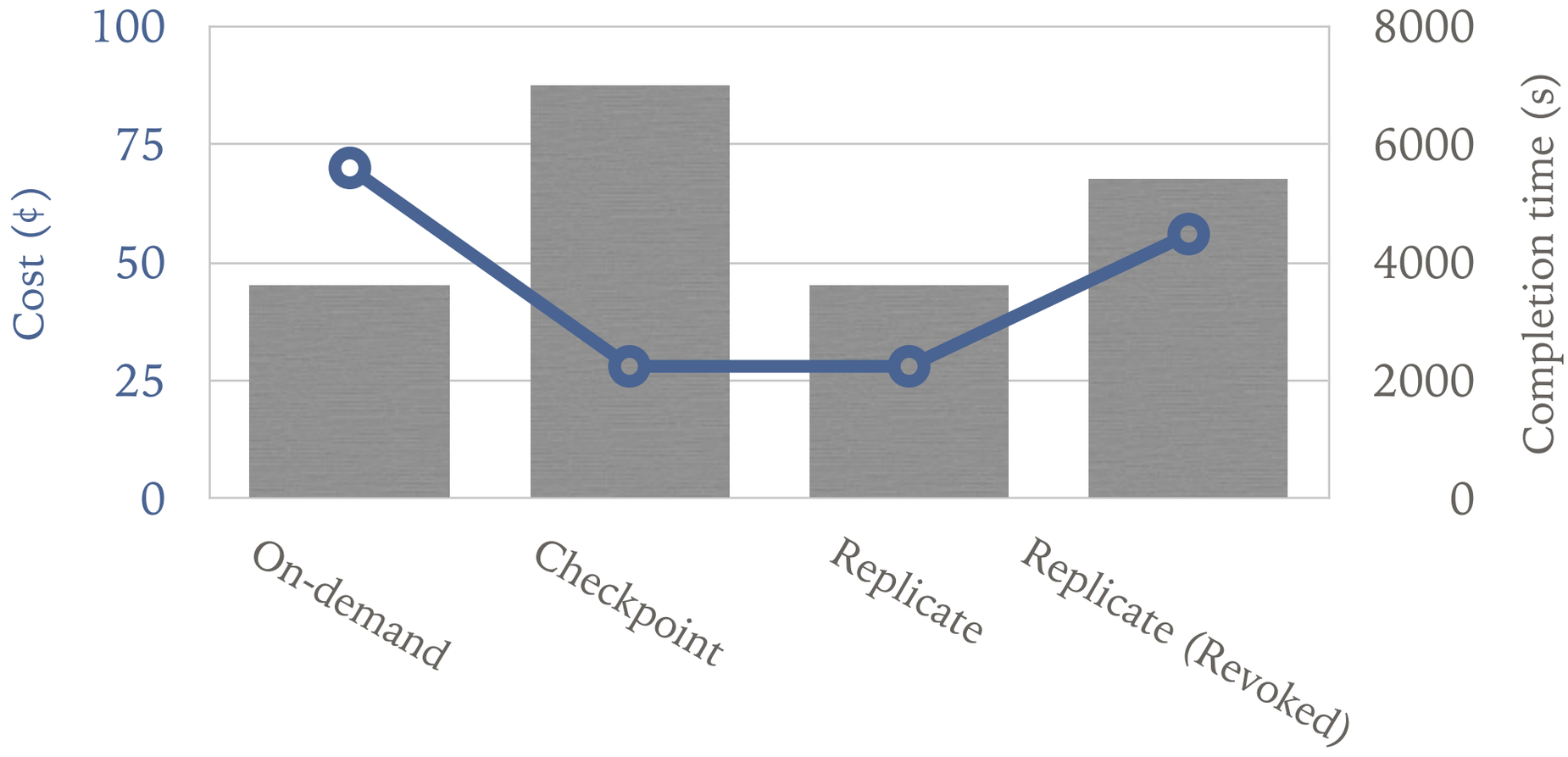

SpotOn: a batch computing service

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Service that accepts batch jobs from users and runs them on spot instances

Manages application and spot market complexity transparently

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Run batch jobs at ***on-demand performance***
but paying ***spot market price***

GREEDY SELECTION ALGORITHM

Selecting the best spot market and fault-tolerance mechanism

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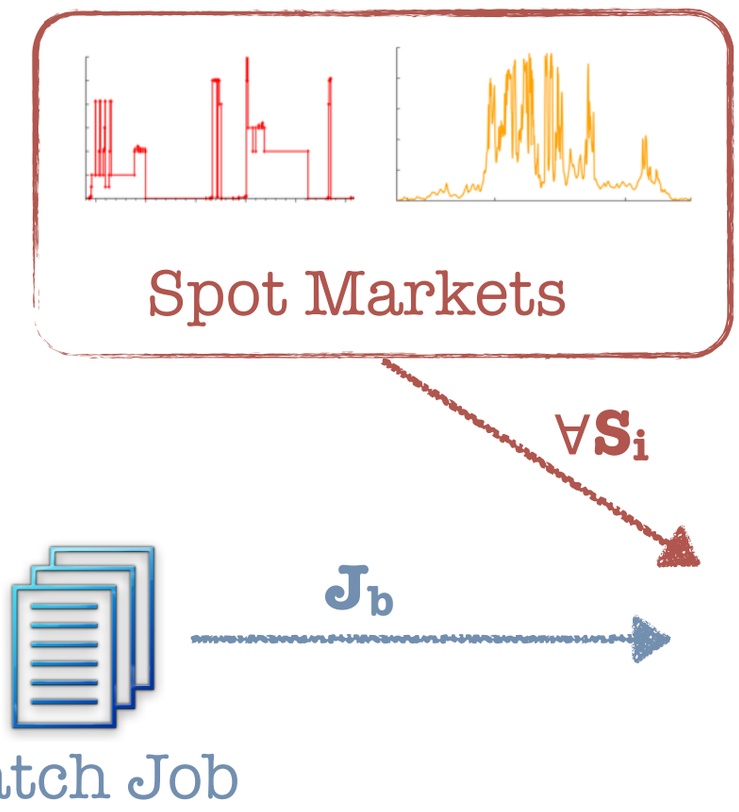

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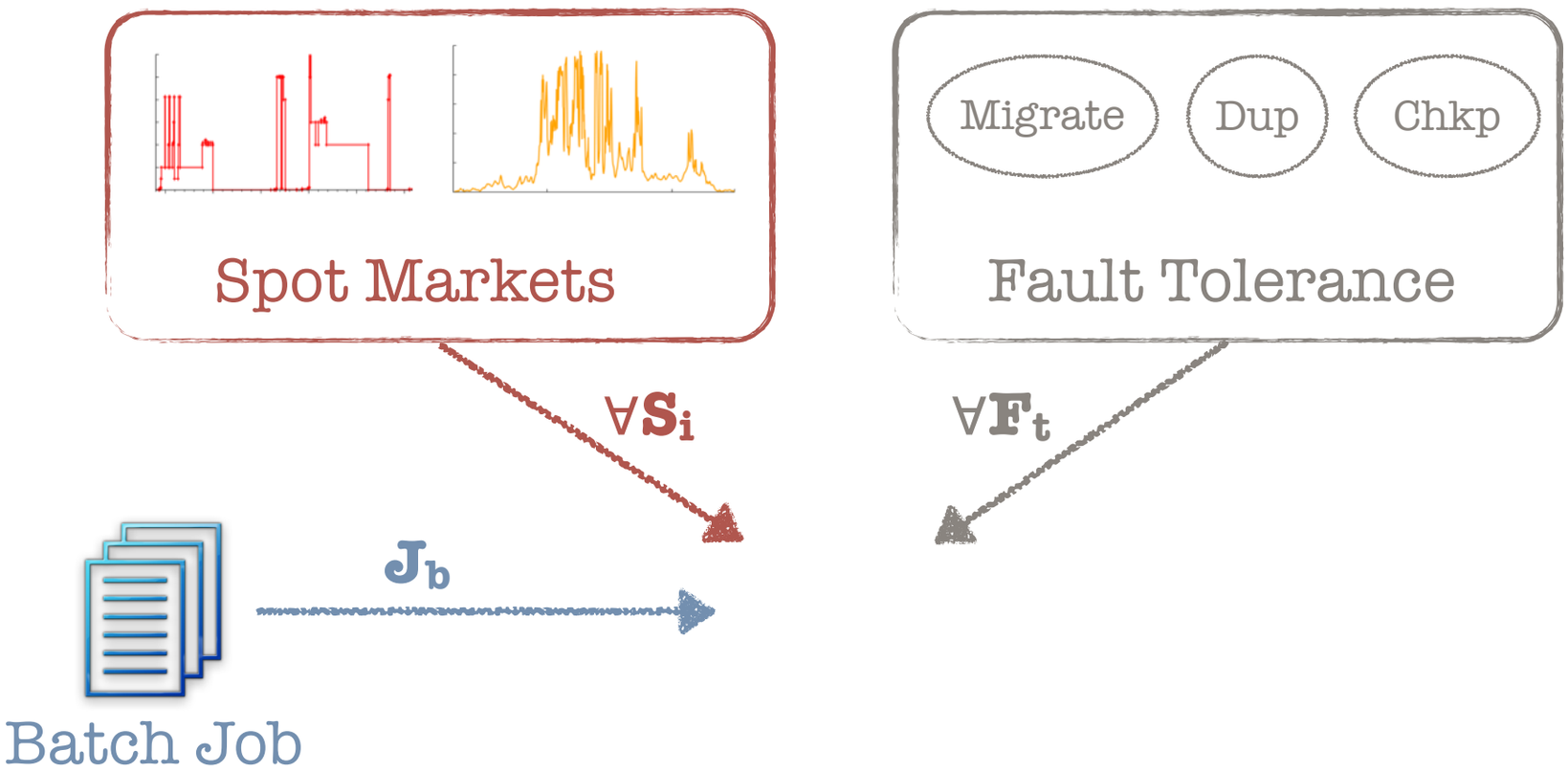

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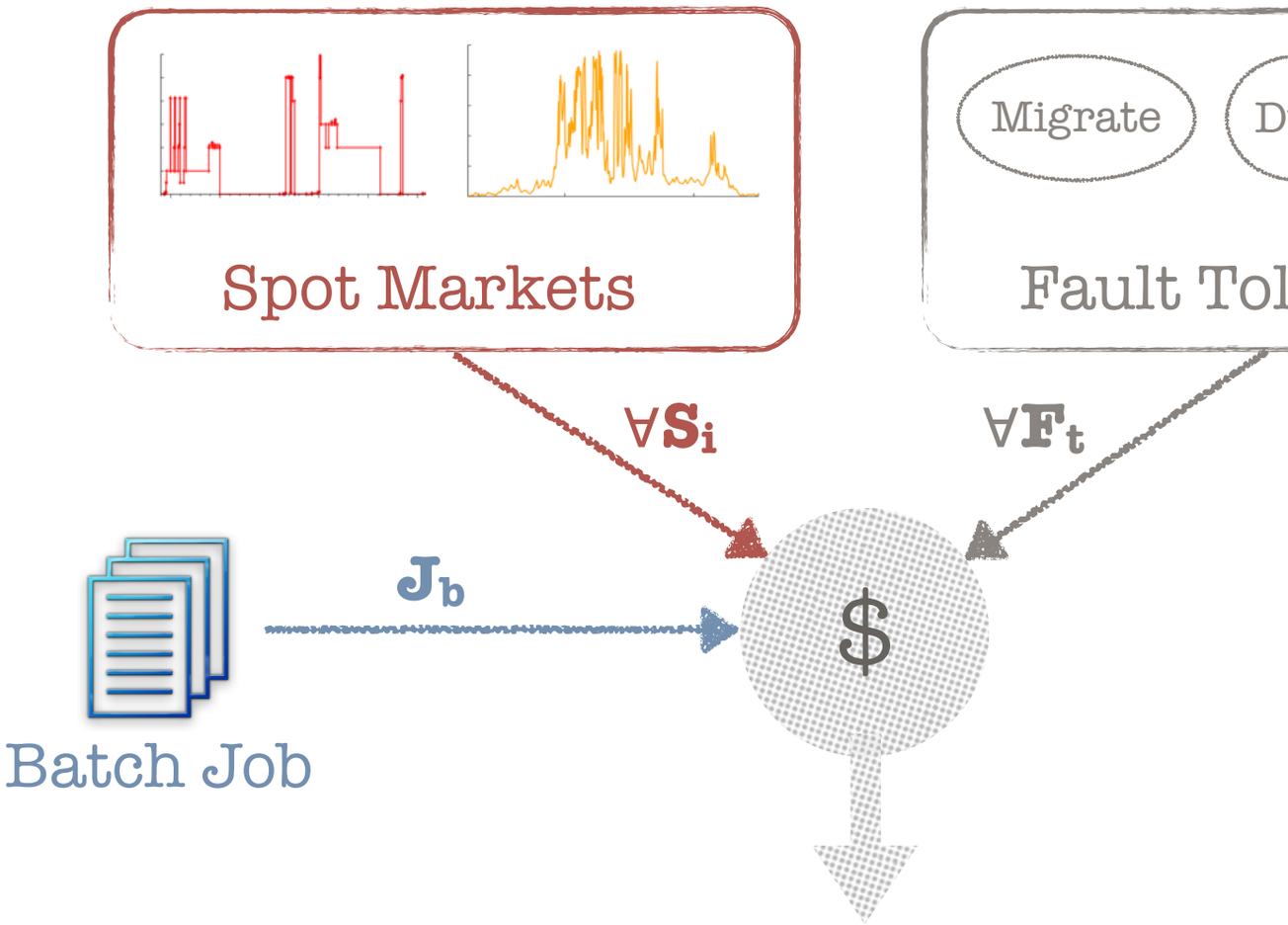

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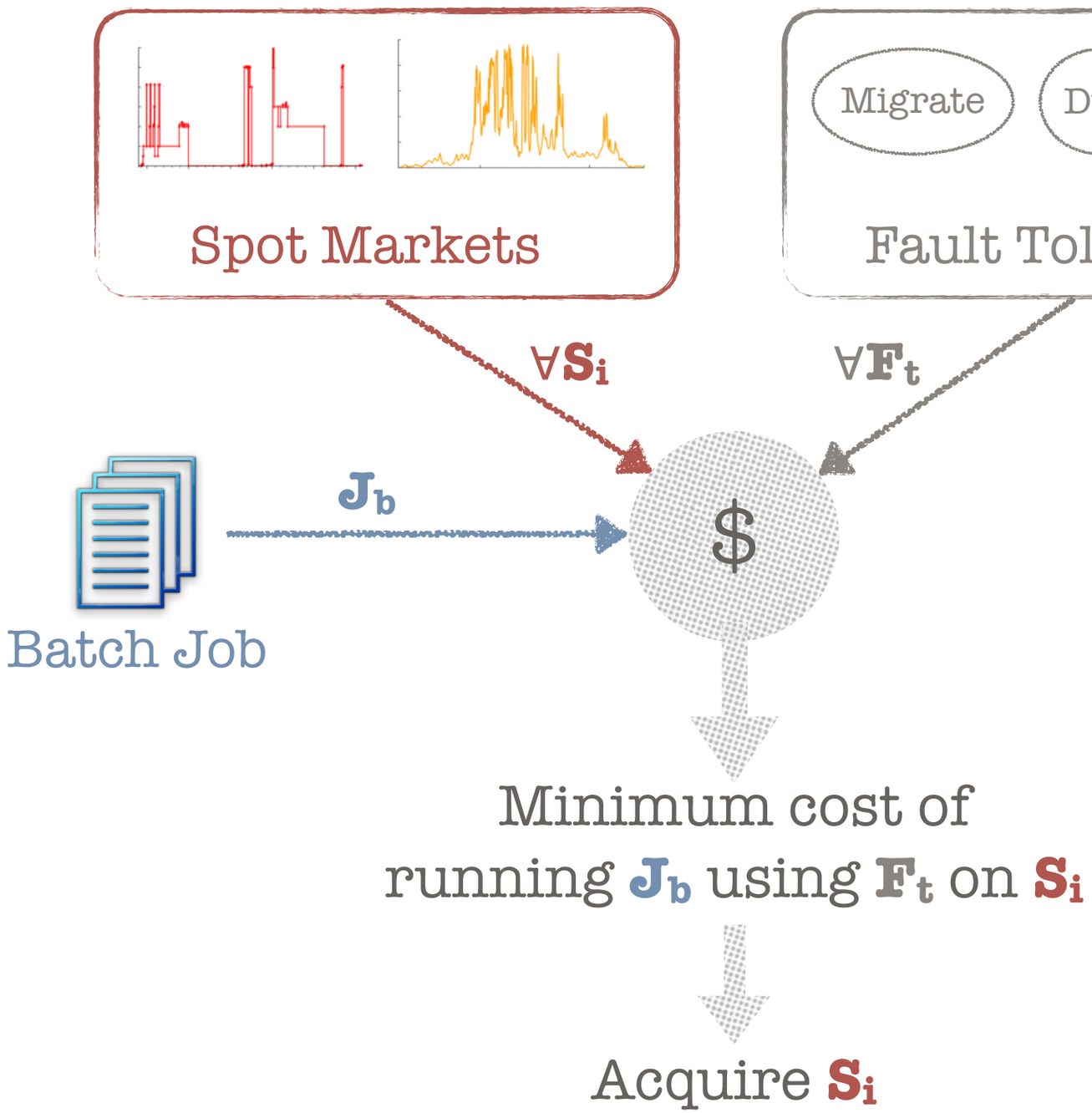

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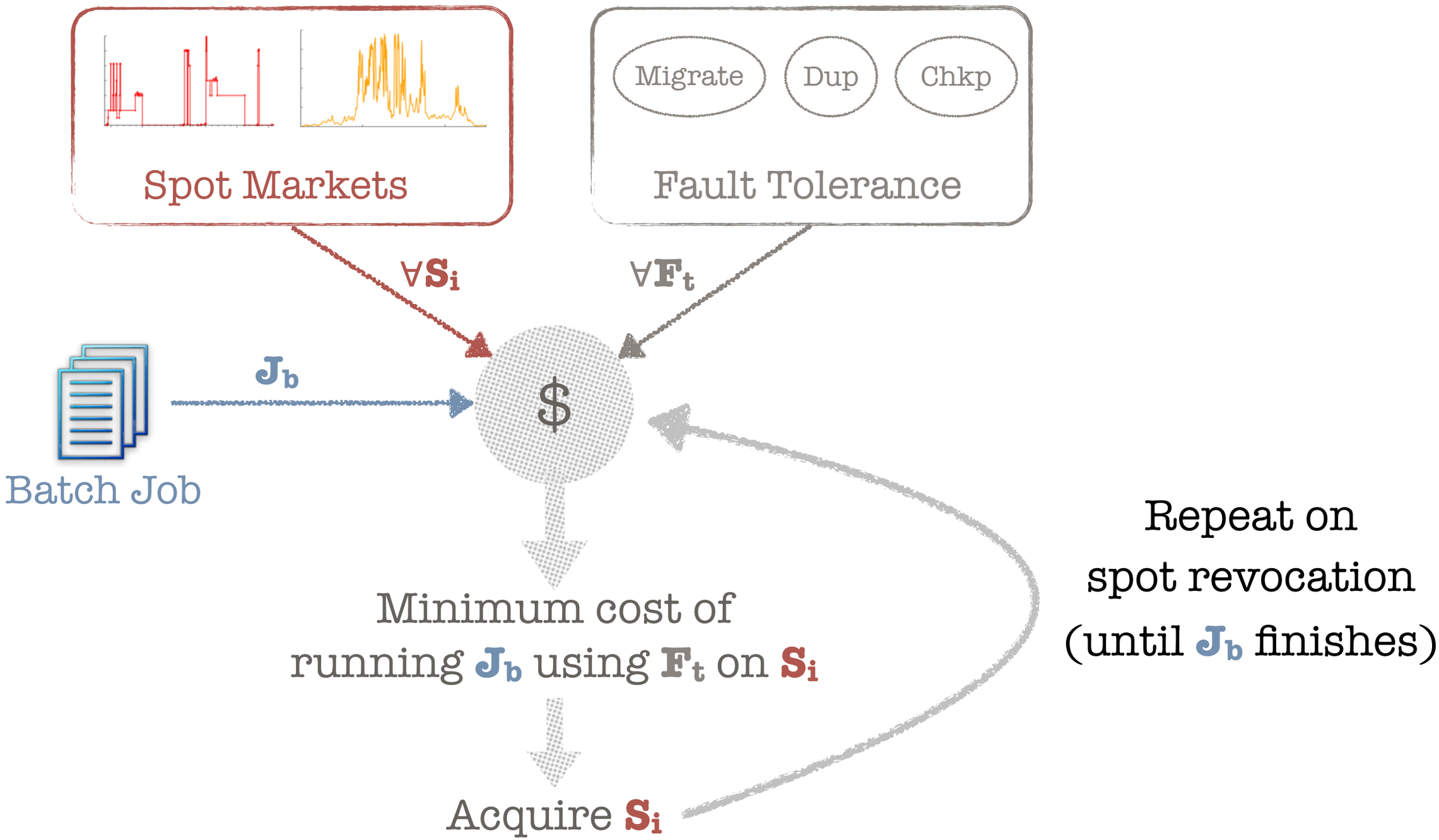
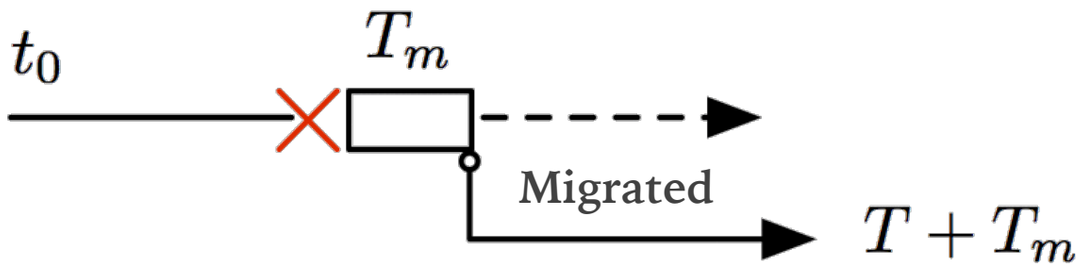


FAULT TOLERANCE (1/3)

Reactive Migration



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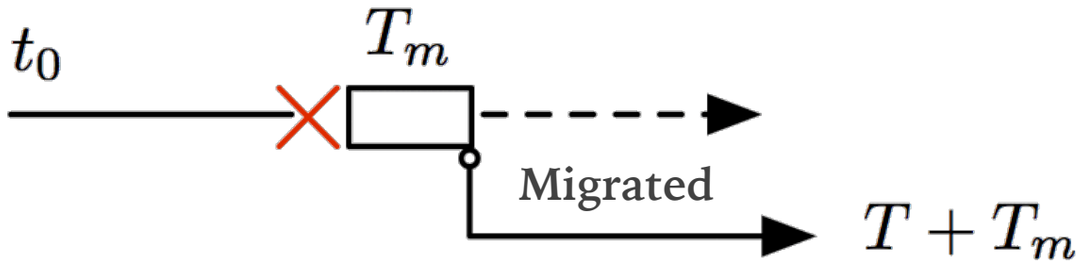

$$T_M \propto \frac{\text{size of memory + local disk}}{\text{remote disk bandwidth}}$$

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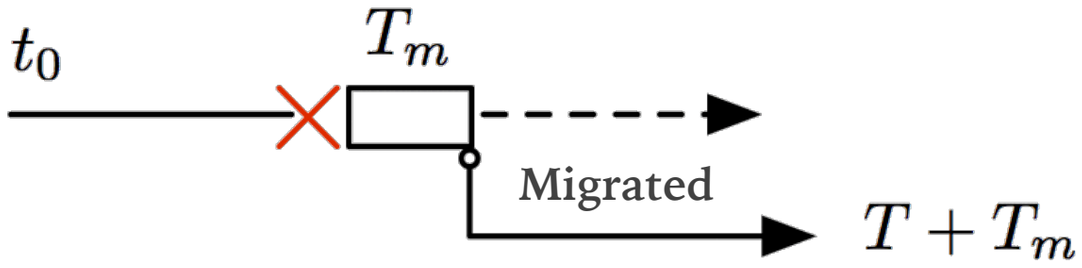

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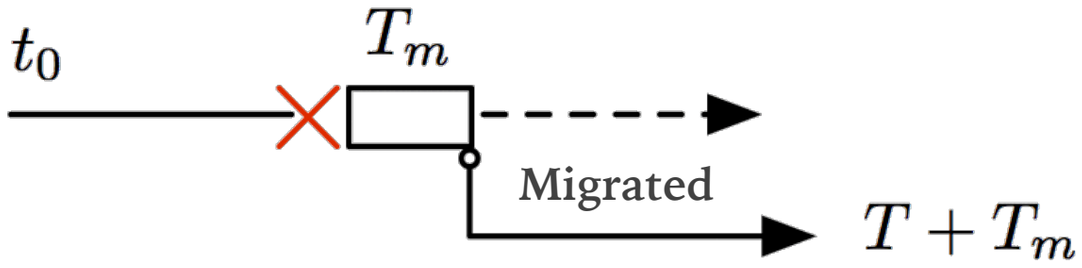

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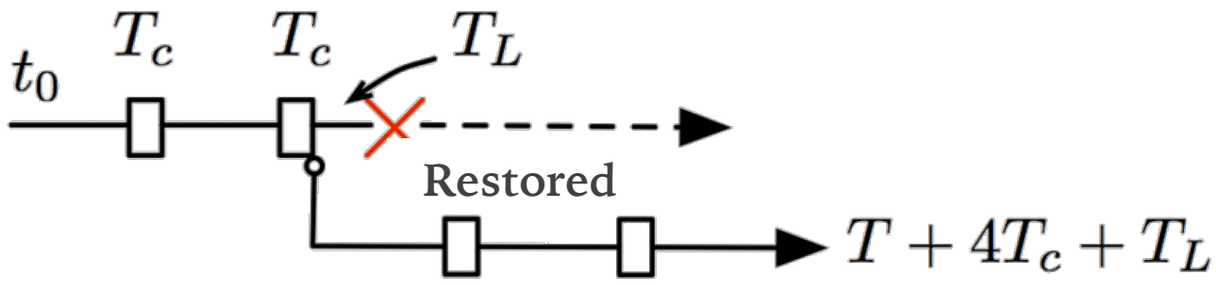
$$\text{Cost} = \frac{E[\text{Price}_k]}{E[\text{Time}_k]} = \frac{[(1 - P_k) * T \quad + \quad P_k * (E(Z_k) + T_M)] * \text{spot-price}}{(1 - P_k) * T \quad + \quad P_k * E(Z_k)}$$

FAULT TOLERANCE (2/3)

Proactive Checkpoint



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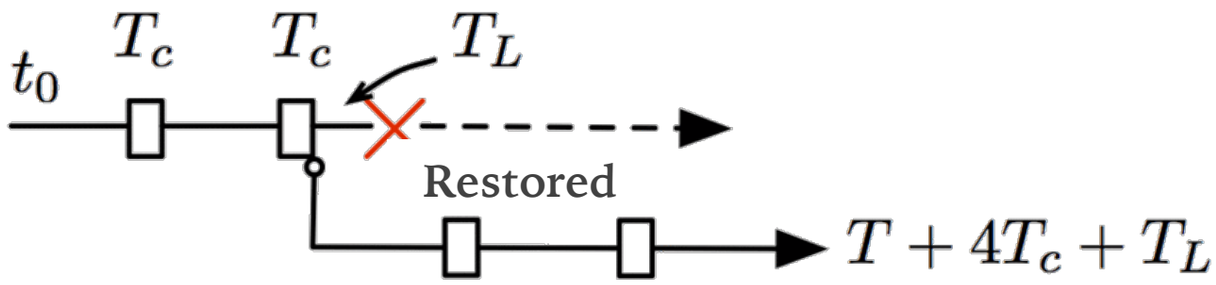

$$T_C \propto \frac{\text{size of memory + local disk}}{\text{remote disk bandwidth}}$$

$$T_L \propto (\tau/2)$$

τ: checkpoint frequency

FAULT TOLERANCE (2/3)

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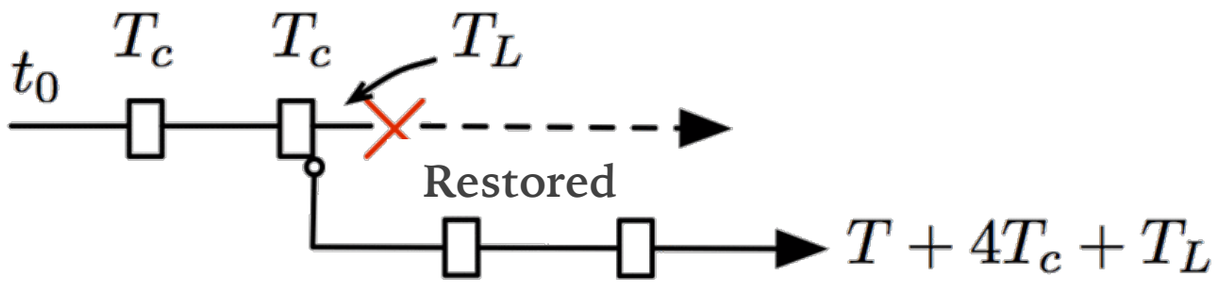

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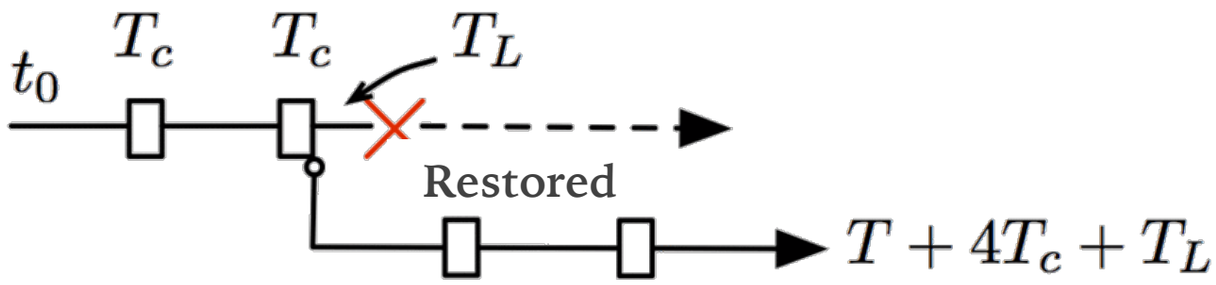

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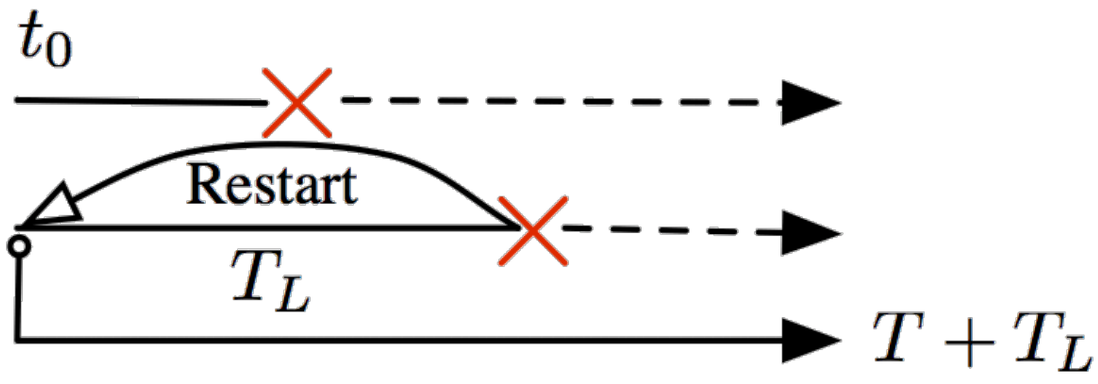
Cost overhead is primarily a function of job's resource usage

FAULT TOLERANCE (3/3)

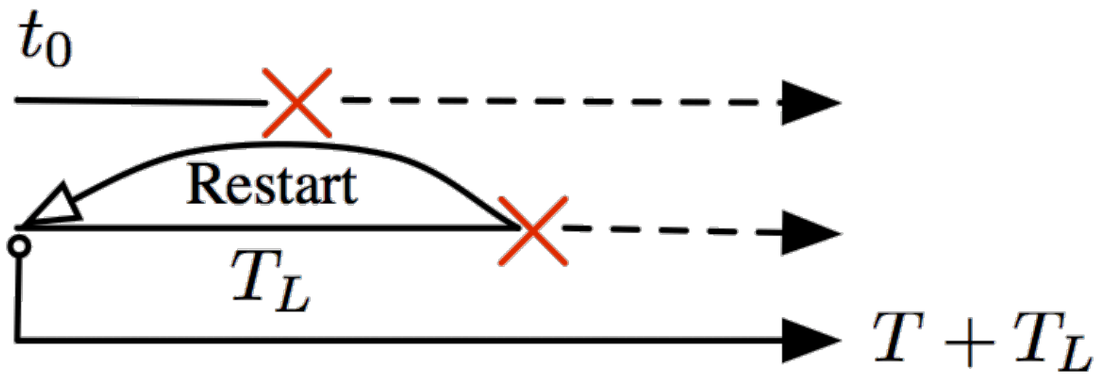
Spot Replication



$T_L \propto$ market volatility

FAULT TOLERANCE (3/3)

Spot Replication



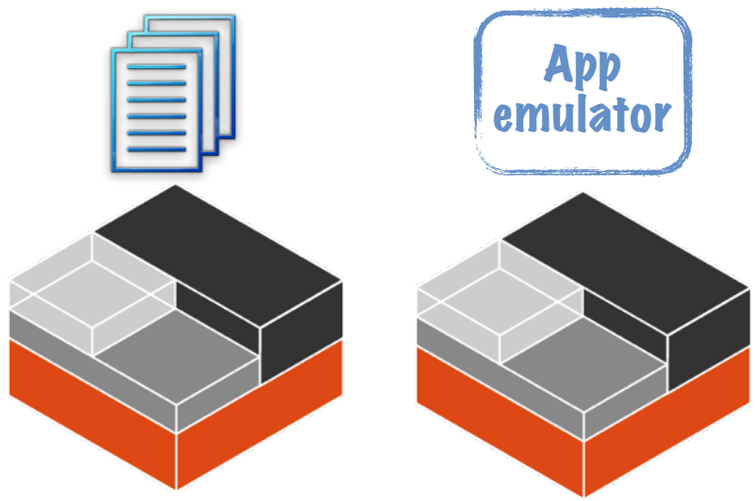
$T_L \propto$ market volatility

Total Overhead $\propto$ (Replication factor, T_L)

Cost overhead is primarily a function of market characteristics

EVALUATION (1/3)

SpotOn Prototype



- Built on ***Linux Containers*** for efficient checkpointing / migration
- ***App Emulator*** to create synthetic jobs with varying resource usage

EVALUATION (2/3)

Effect of Application and Spot Market Characteristics

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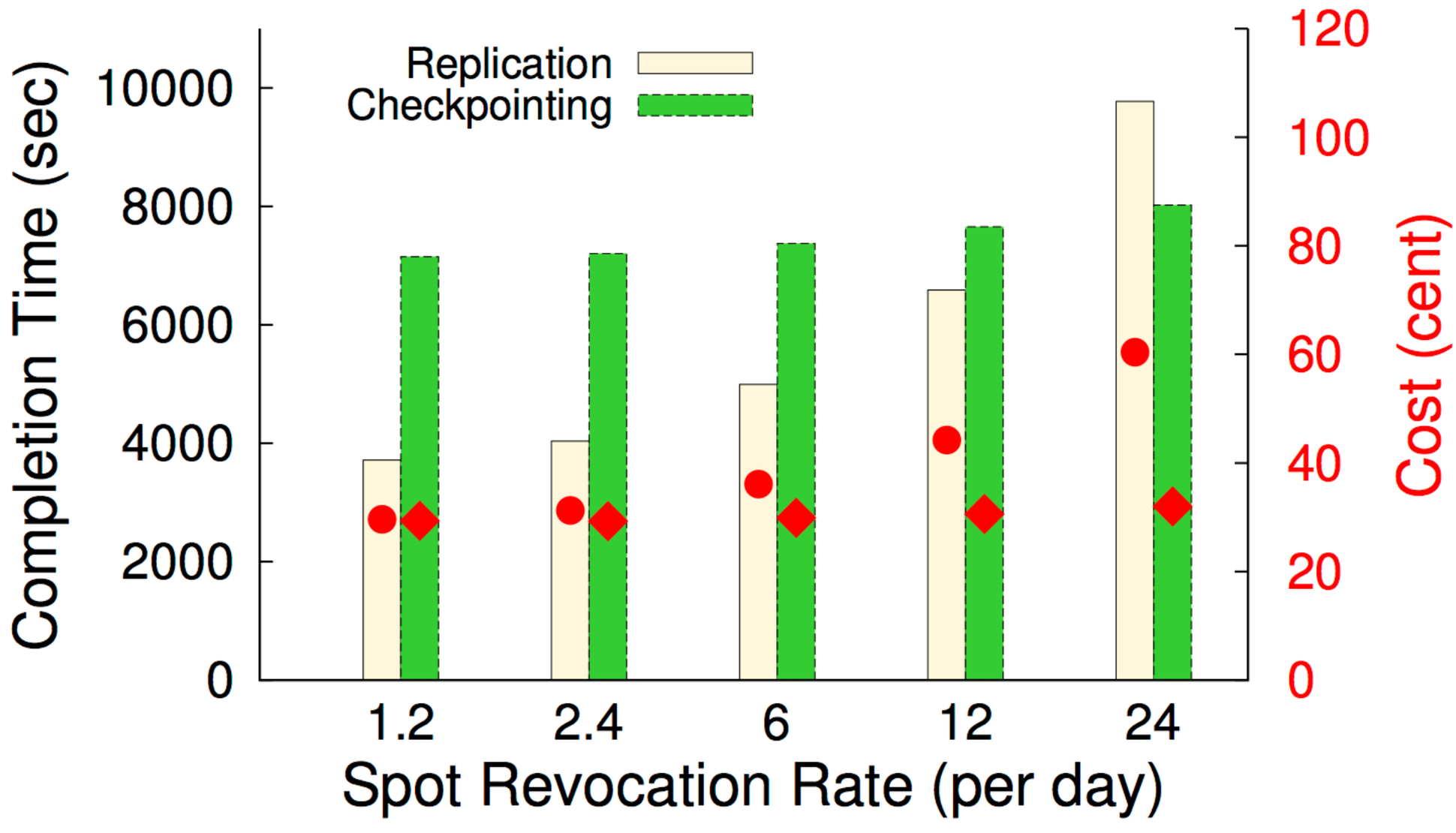

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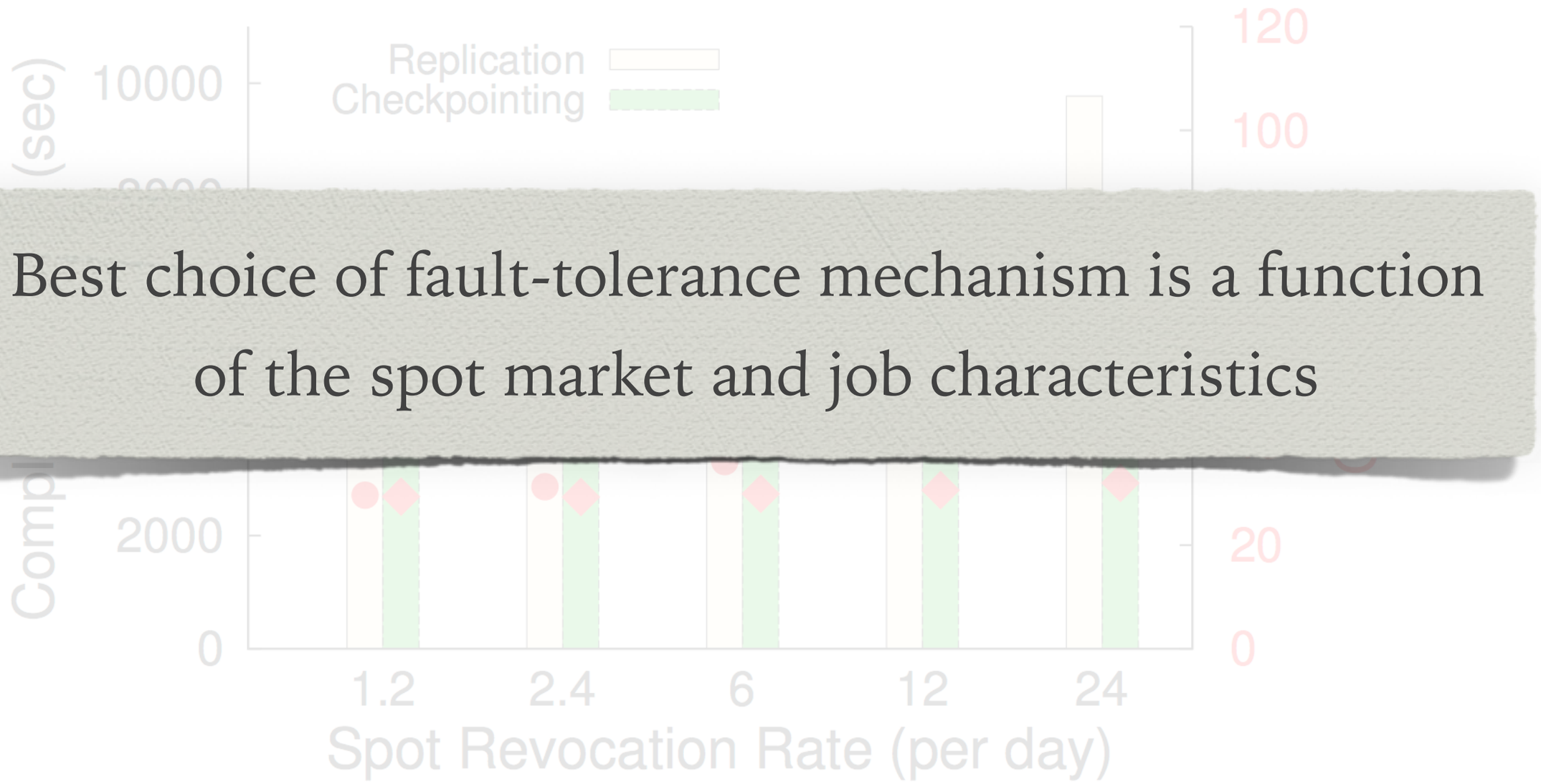

Best choice of fault-tolerance mechanism is a function of the spot market and job characteristics

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Effect of Cost-aware Selection

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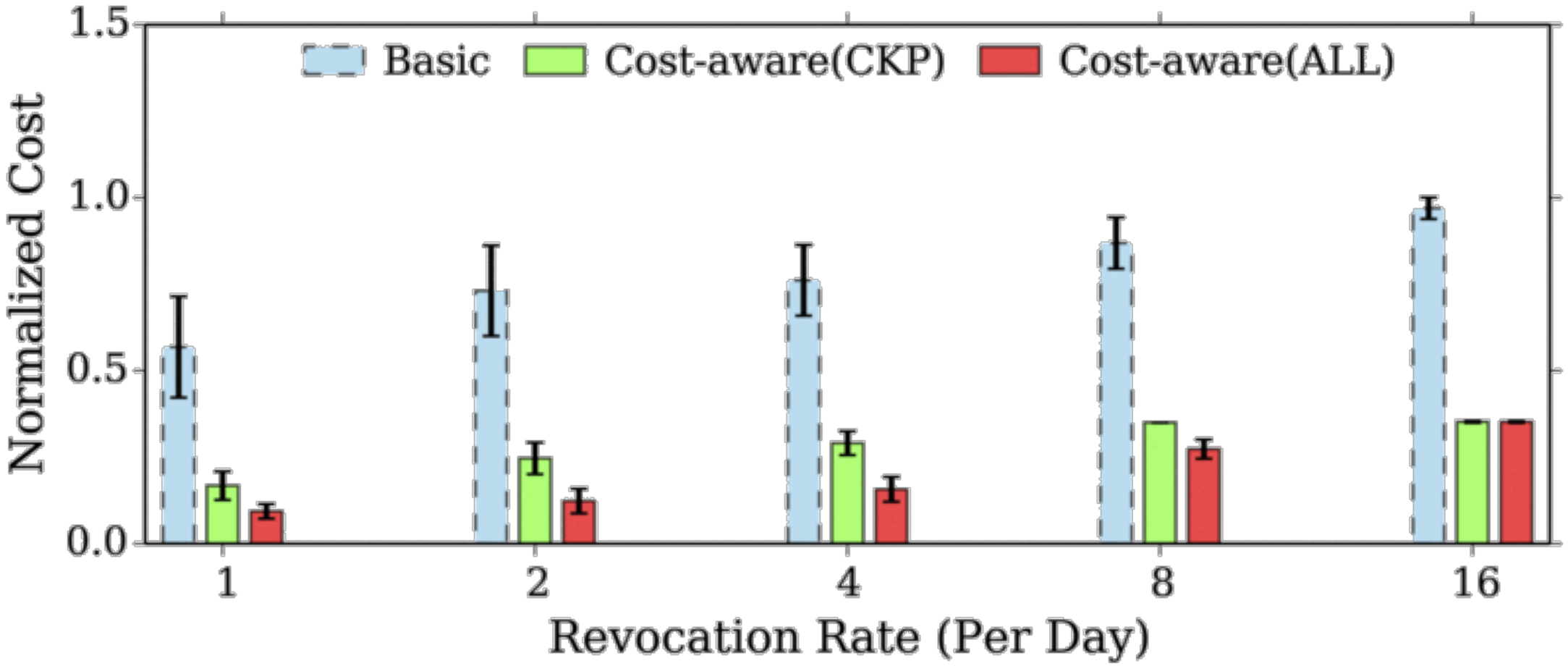

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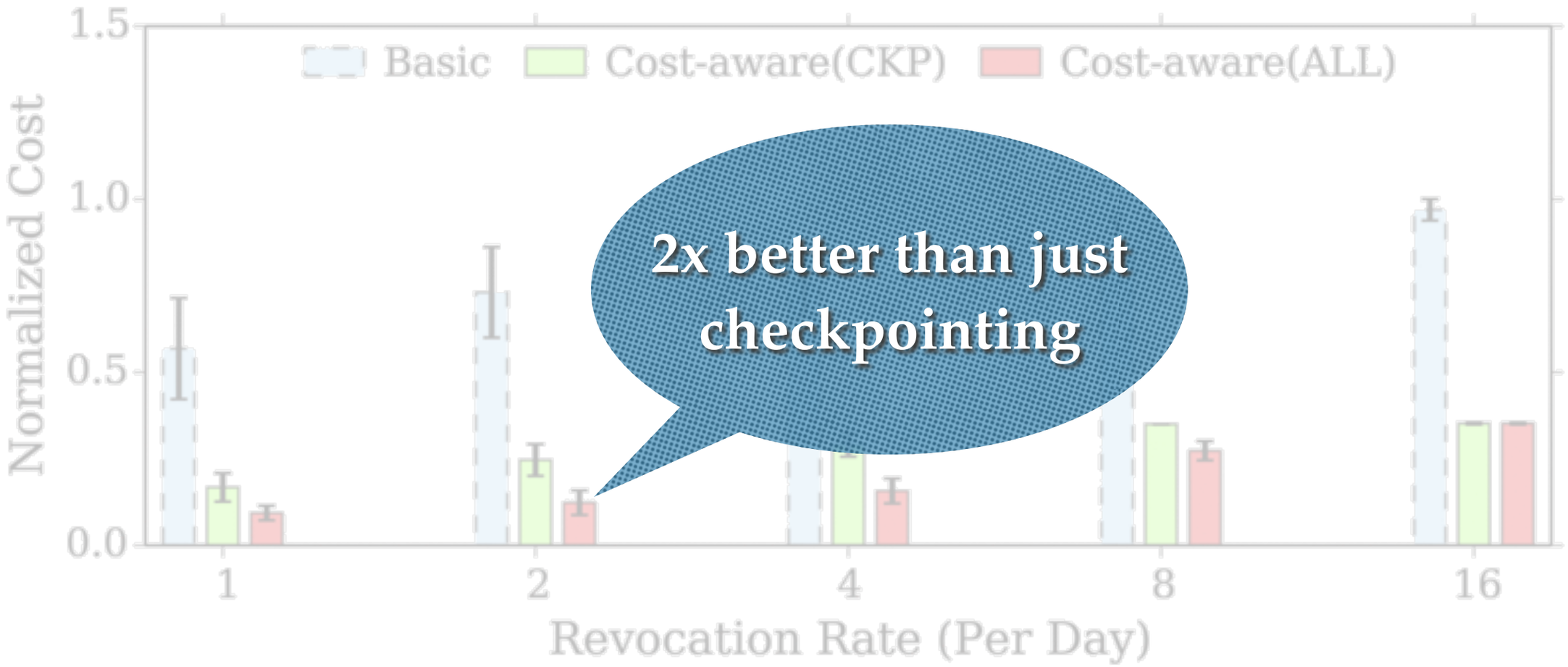

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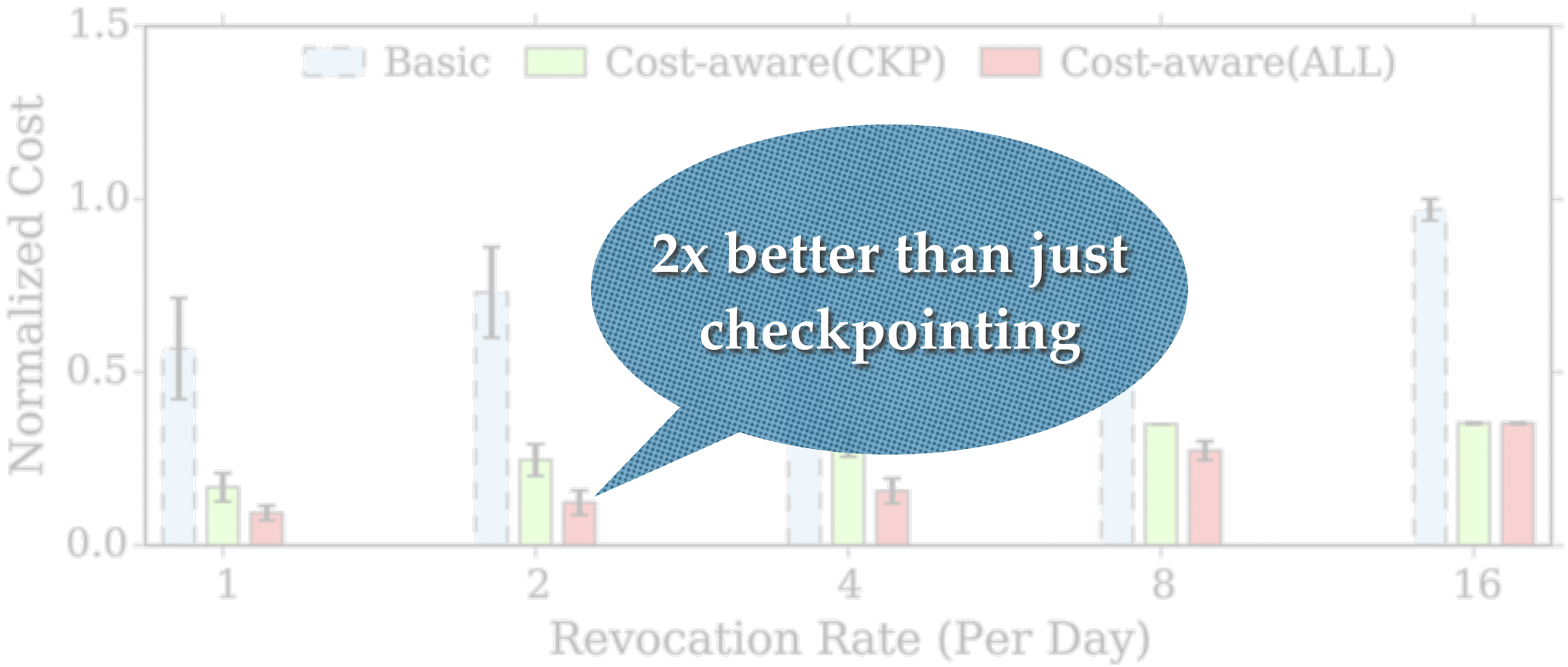

On Google cluster trace, Cost-aware selection achieved 91.9% savings with little impact on performance

CONCLUSION

- Spot markets offer **arbitrage** opportunities
- SpotOn manages application and market complexities
- We model **fault tolerance** and propose a **selection algorithm**
- **Prototype** on Amazon EC2
- Achieves **~90%** cost savings

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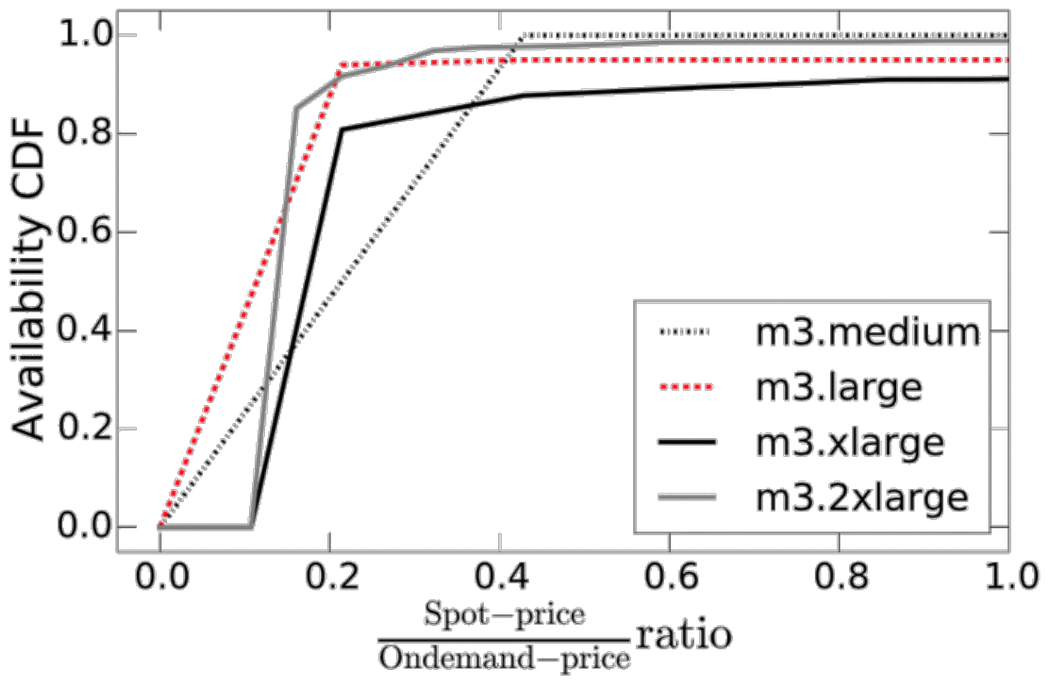
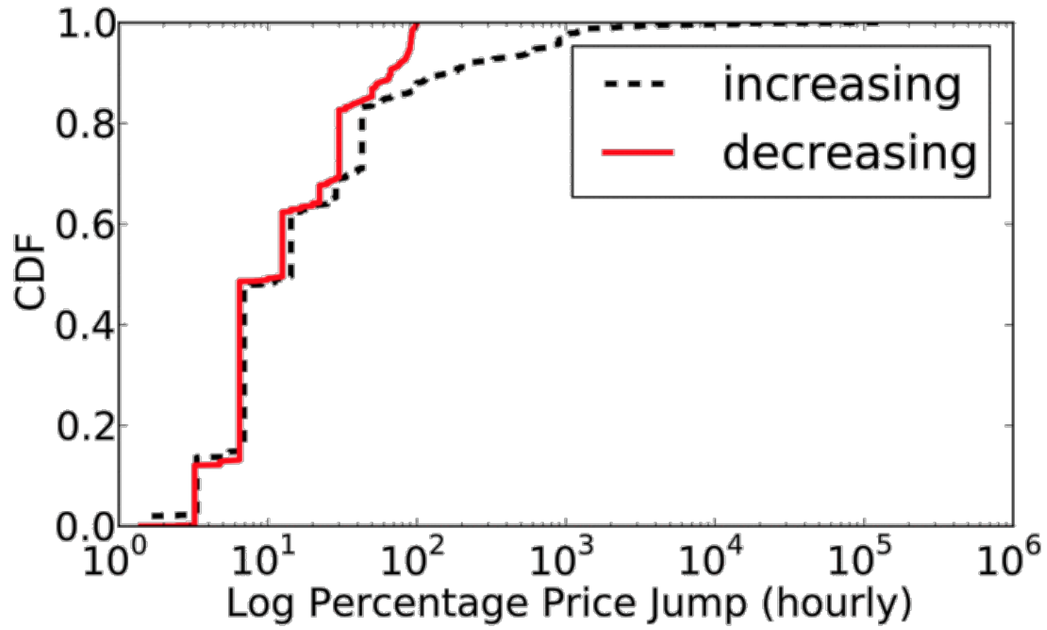
Thank you!

BACKUP SLIDES

BIDDING

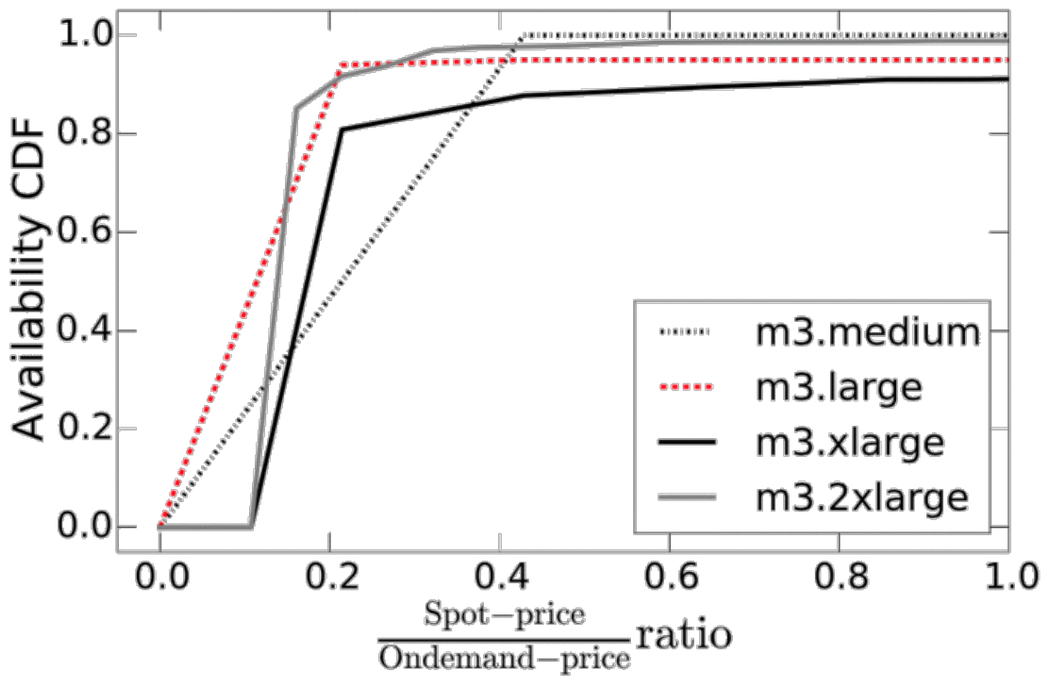


Spot price distribution has long tail

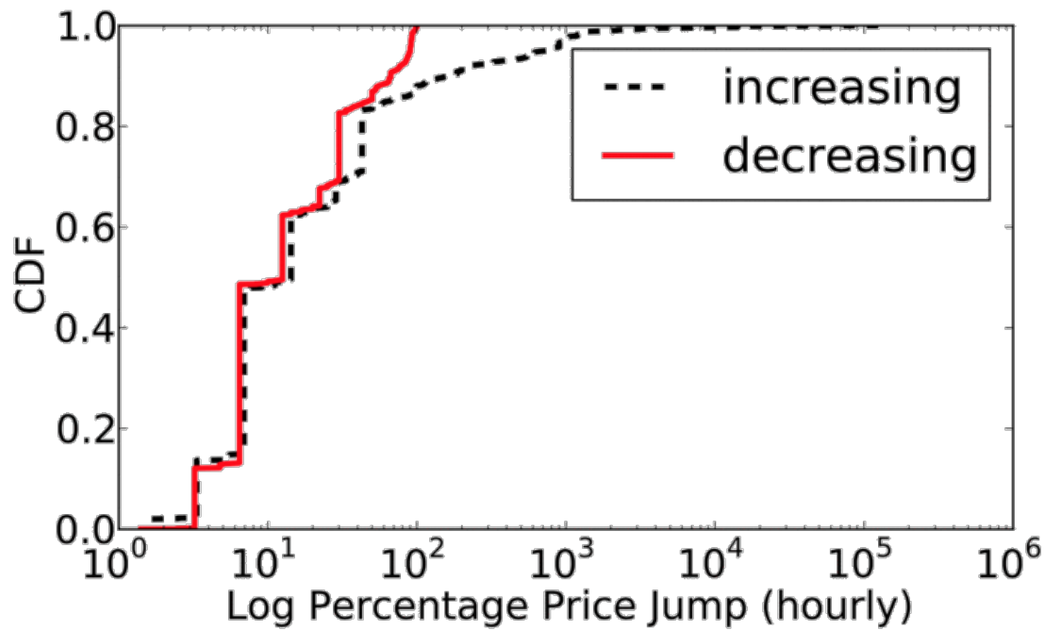


Spot price changes are peaky

BIDDING



Spot price distribution has long tail



Spot price changes are peaky

- Bidding does affect volatility but ***not drastically***

- SpotOn always bids at the on-demand price

  If spot price goes above on-demand, SpotOn would choose on-demand