High Throughput Computing with EC2 Spot Instances

HTCondor Week @ The University of Wisconsin, Madison

19 May 2016

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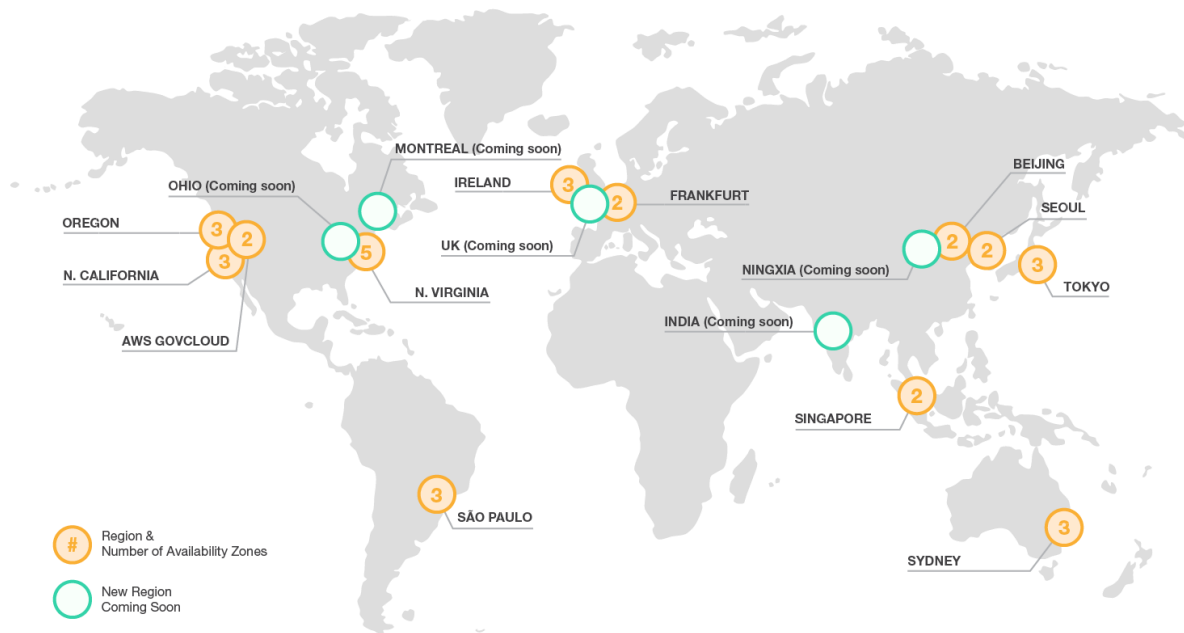
Solutions Architect
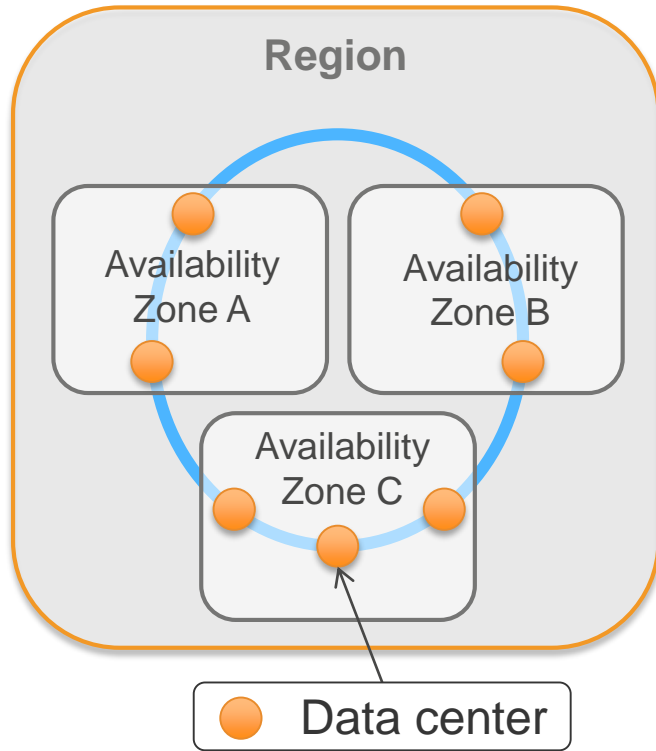
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AWS Global Infrastructure

33 Availability Zones in 12 geographic Regions around the world

11 more Availability Zones in 5 new Regions coming online in the next year

MONTREAL (Coming soon)

OHIO (Coming soon)

IRELAND

FRANKFURT

BEIJING

SEOUL

OREGON

UK (Coming soon)

NINGXIA (Coming soon)

N. CALIFORNIA

N. VIRGINIA

TOKYO

AWS GOVCLOUD

INDIA (Coming soon)

SINGAPORE

SÃO PAULO

SYDNEY

Region & Number of Availability Zones

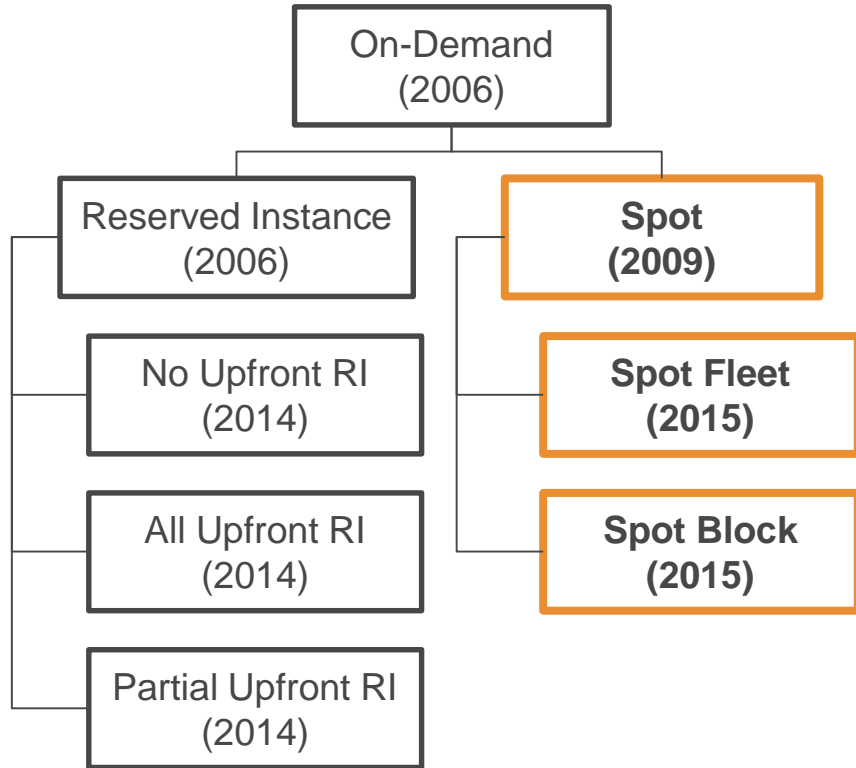New Region Coming Soon

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Regions and Availability Zones

A Region is a physical location in the world where we have multiple Availability Zones.

Availability Zones consist of one or more discrete data centers, each with redundant power, networking and connectivity, housed in separate facilities.

EC2 Pricing

```
                    ┌─────────────────┐
                    │   On-Demand     │
                    │    (2006)       │
                    └─────────────────┘
            ┌──────────────┴──────────────┐
┌─────────────────────┐          ┌─────────────────┐
│  Reserved Instance  │          │     Spot        │
│      (2006)         │          │    (2009)       │
└─────────────────────┘          └─────────────────┘
  ┌─────────────────────┐          ┌─────────────────┐
  │  No Upfront RI      │          │   Spot Fleet    │
  │     (2014)          │          │    (2015)       │
  └─────────────────────┘          └─────────────────┘
  ┌─────────────────────┐          ┌─────────────────┐
  │  All Upfront RI     │          │   Spot Block    │
  │     (2014)          │          │    (2015)       │
  └─────────────────────┘          └─────────────────┘
  ┌─────────────────────┐
  │ Partial Upfront RI  │
  │      (2014)         │
  └─────────────────────┘
```

- On-Demand
  - Pay a fixed price per hour with no commitments or upfront payments
- Reserved Instances
  - Save up to 70% compared to On-Demand with a 1- or 3-year commitment
  - Your capacity will always be available for the type and zone purchased
- Spot Instances
  - Specify the maximum hourly price you are willing to pay, with the risk of interruption
  - Savings as high as 80-90% compared to On-Demand

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What is Amazon EC2 Spot?
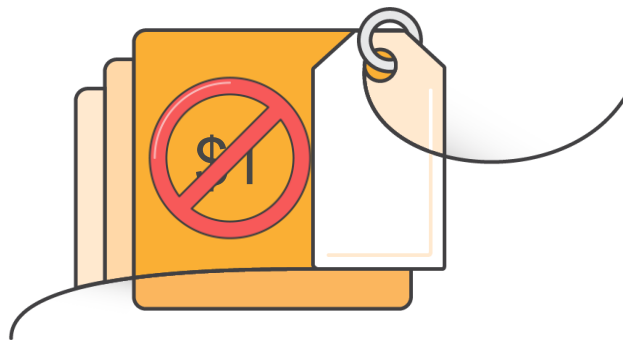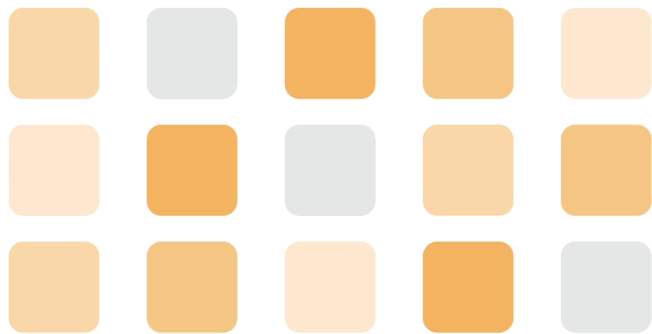
Amazon EC2 Spot instances are spare EC2 instances that you can bid on to run your cloud computing applications. Spot instances are available at lower prices than On-Demand, so you can significantly reduce the cost of running your applications, grow your application's compute capacity and throughput for the same budget, and enable new types of cloud computing applications.

Spare capacity at scale

- AWS has more than a million active customers every month in 190 countries.

- On average, every week, AWS customers are using more compute capacity on Amazon EC2 Spot instances than customers in 2012 were running across all of Amazon EC2.
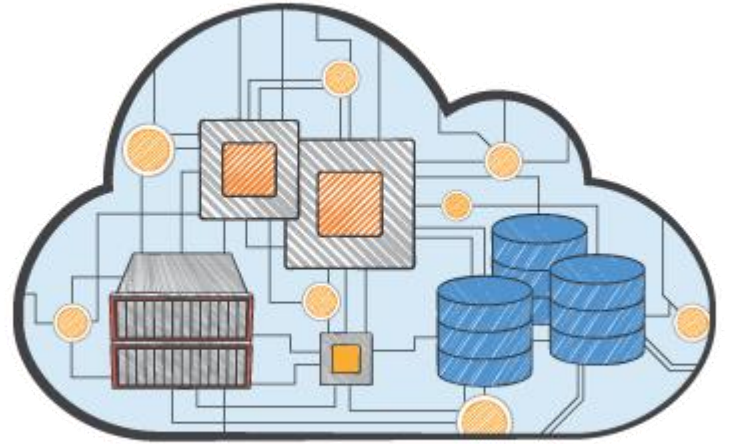
The Spot market

- Each instance type and Availability Zone combination is its own market

- As long as your bid price exceeds the market price, your instances run at the market (not bid) price

- 2-minute warning prior to shutdown if outbid
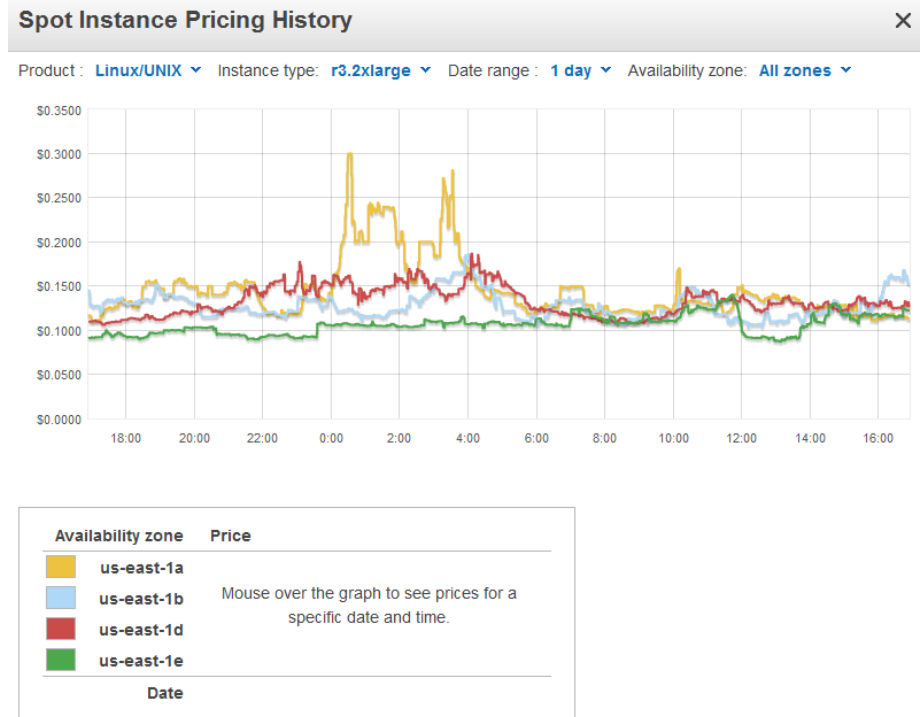
View pricing history for Spot Instances in the EC2 Console

Bid vs. Market Price

Spot Instance Pricing History   ✕

Product : **Linux/UNIX (Amazon VPC)** ⌄   Instance type: **r3.4xlarge** ⌄   Date range : **1 week** ⌄   Availability zone: **us-east-1d** ⌄

75% Bid

50% Bid

25% Bid

You pay the market price

Availability zone	Price
🟩 us-east-1d	$0.1788
Date	September 17, 2015 at 10:33:37 PM UTC-7

Handling the 2-minute warning (example)

```
 $ if curl -s http://169.254.169.254/latest/meta-
data/spot/termination-time | \
 grep -q .*T.*Z; then instance_id=$(curl -s
http://169.254.169.254/latest/meta-data/instance-id); \
/opt/bin/checkpoint.sh; fi
```

1. Check instance metadata service (169.254.169.254)
   for 2-minute warning
2. If present, run checkpoint.sh

Amazon EC2 Spot Bid Advisor

https://aws.amazon.com/ec2/spot/bid-advisor/

- Analyzes Spot price history to help you determine a bid price that suits your needs
- The lower your frequency of being outbid, the longer your Spot instances are likely to run without interruption

Optimizing your bidding strategy

- Relying on a single instance type means more impact from price movements and instance terminations

- Calcuating bid strategy for a given $/core (or $/GB) is undifferentiated heavy lifting

- Solution? Use **Spot Fleet**
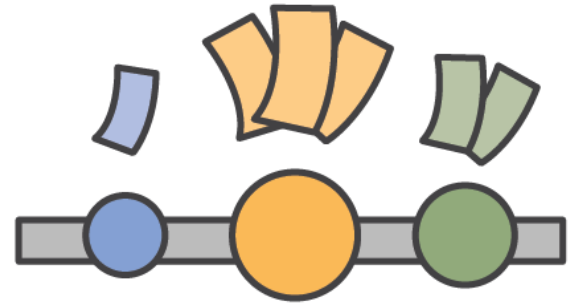
Spot Fleet

- Make a single request for a target amount of resources drawing from multiple pools of resources
- Spot Fleet attempts to maintain its target capacity fleet if your Spot instances are interrupted
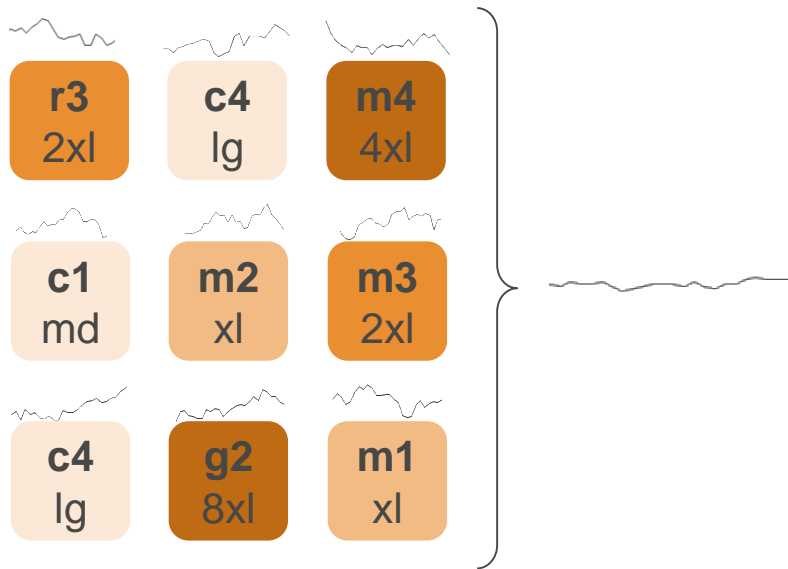
Bid based on custom units

- Optimize for the best price or the most instance type diversity to increase availability

- Bid based on your desired $/vCPU, or $/vCPU+RAM

- Eliminates the undifferentiated heavy lifting of bid planning

Find instance types

AMI ⓘ	Amazon Linux AMI 2015.03.1 (HVM), ▼
Capacity unit ⓘ	Customize your unit... ▼

Minimum unit requirements

vCPUs:	Memory:
4 ▼	32 ▲▼ GiB

☑ Current generation required

Target capacity ⓘ	100 ▲▼ units
Bid price ⓘ	⦿ per unit/hour $ 0.25 ▲▼
	○ % of on-demand ▲▼ %

Best practices for HTC
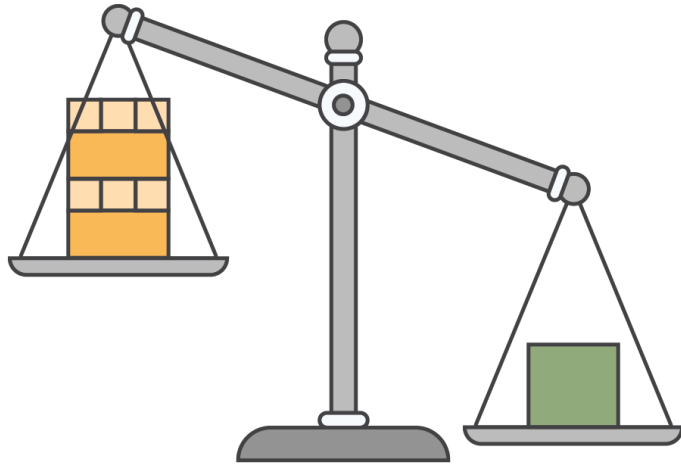
- To maximize goodput, jobs must be broken up into tasks small enough to largely avoid preemption
- Spot market conditions are generally good, but an aggressive bidding strategy can backfire if jobs are interrupted too often

Spot Blocks

- Request guaranteed execution from 1-6 hours
- Up to 50% off On-Demand pricing
  - Regular spot can be as high as 90%
- Use for:
  - Web/app servers
  - Master/coordinator nodes
  - Shared filesystem hosts
  - Stop-loss strategy for outlier jobs

```
$ aws ec2 request-spot-instances \
    --block-duration-minutes 360 \
    --instance-count 2 \
    --spot-price "0.25" ...
```
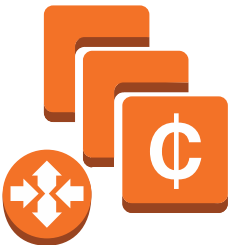
Recap

Spot Fleet

Launch 10s, 100s, or 1000s of instances across multiple instance types to meet the target capacity you define

+

Spot Instances

Save on EC2 pricing by bidding on unused capacity

Spot Block

Launch Spot Instances with guaranteed execution time of up to 6 hours

A quick word on storage

Amazon Simple Storage Service (S3)
Highly scalable object storage
(data presented as buckets of immutable objects)

Amazon Glacier
Low-cost archival storage
(data presented as vaults of immutable archives)

Amazon Elastic Block Store (EBS)
Block storage for individual hosts
(data presented as disk volumes; analogous to SAN)

Amazon Elastic File System (EFS)
Network file storage
PREVIEW
(data presented as a shared file system; analogous to NAS)

Introducing Elastic File System

- Fully managed shared NFSv4 file system
  - Standard file system semantics
  - Works with standard OS file system APIs
- Highly scalable
  - Reach petabyte scale with 1000s of concurrent connections
  - Throughput and IOPS scale automatically as file systems grow
- Pay only for the storage space you use, with no minimum fee
- Currently in preview in us-west-2 (Oregon)

New magnetic Elastic Block Store (EBS) volumes

	Solid-State Drives (SSD)		Hard disk Drives (HDD)	
Volume Type	General Purpose SSD (gp2)*	Provisioned IOPS SSD (io1)	Throughput Optimized HDD (st1)	Cold HDD (sc1)
Max. IOPS/ Volume	10,000	20,000	500	250
Max. Throughput/ Volume	160 MiB/s	320 MiB/s	500 MiB/s	250 MiB/s
Max. IOPS/ Instance	48,000	48,000	48,000	48,000
Max. Throughput/ Instance	800 MiB/s	800 MiB/s	800 MiB/s	800 MiB/s
Dominant Performance Attribute	IOPS	IOPS	MiB/s	MiB/s

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The AWS High Throughput toolbox

Spot Fleet
Automatically manage heterogeneous pools of spare EC2 capacity

Throughput-optimized (st1) EBS volumes
High throughput, low-cost storage for sequential I/O

Spot Block
Launch Spot Instances with guaranteed execution time of up to 6 hours

Elastic File System
Petabyte scale managed NFS service

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Thank you

https://aws.amazon.com/ec2/spot/

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