
Software Scalability

CS480 Software Engineering

<http://cs480.yusun.io>

February 23, 2015

Yu Sun, Ph.D.

<http://yusun.io>

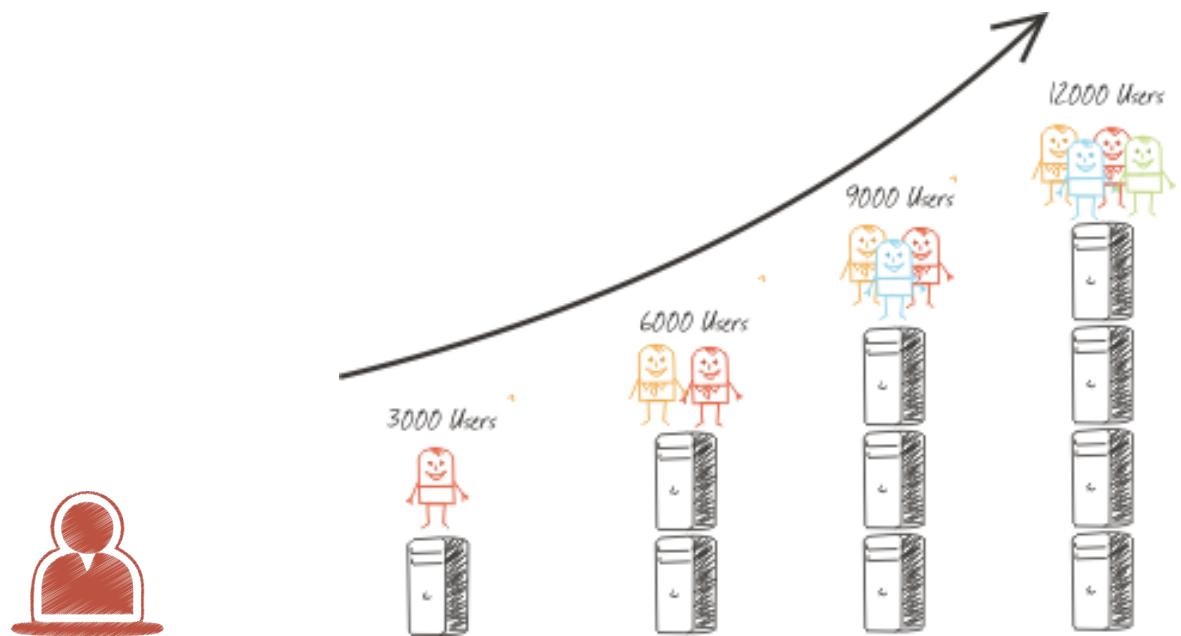
yusun@cpp.edu



CAL POLY POMONA

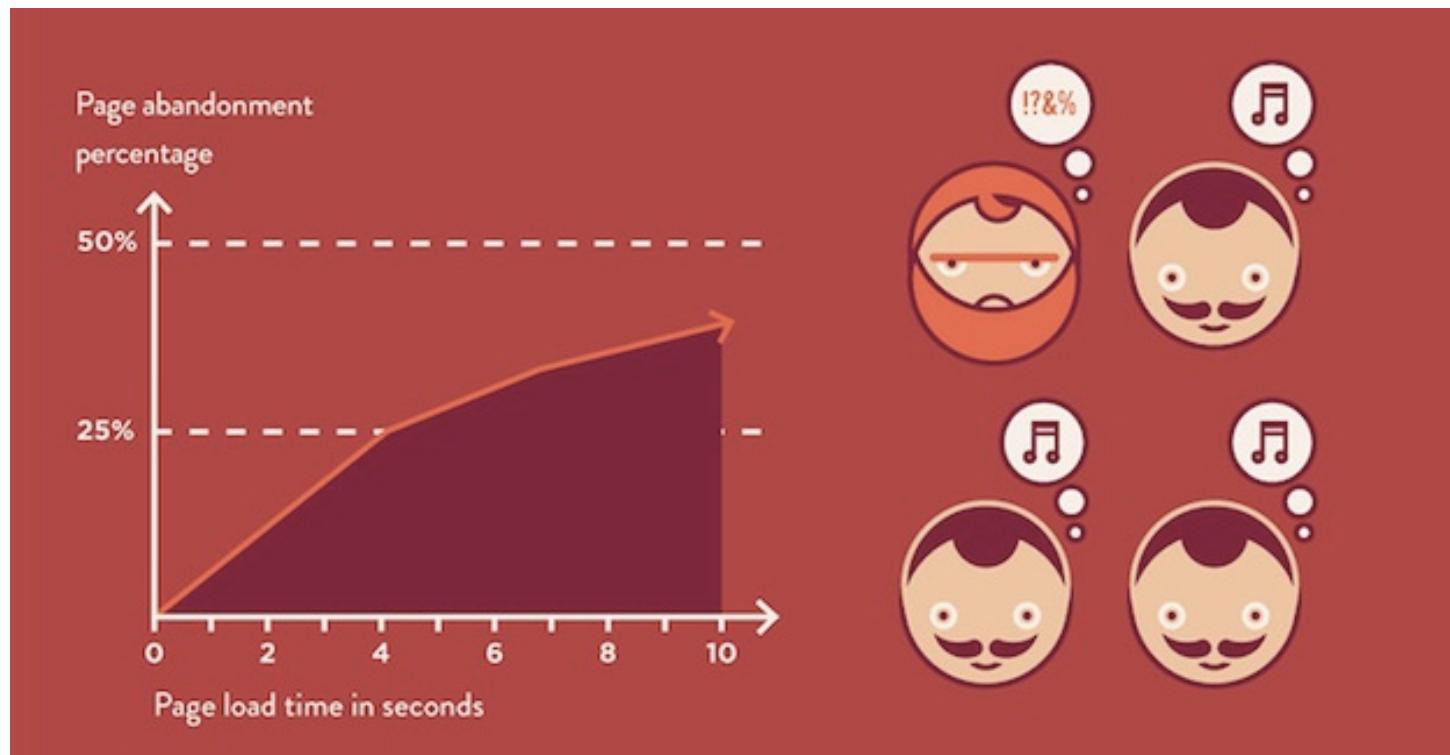
Software Scalability

- ◆ *Scalability* is the ability of a system to handle a growing amount of work in a capable manner or its ability to be enlarged to accommodate that growth



Amazon.com

- ◆ 426 items were sold per second during Christmas
- ◆ A page load slowdown of just one second could cost it \$1.6 billion in sales each year



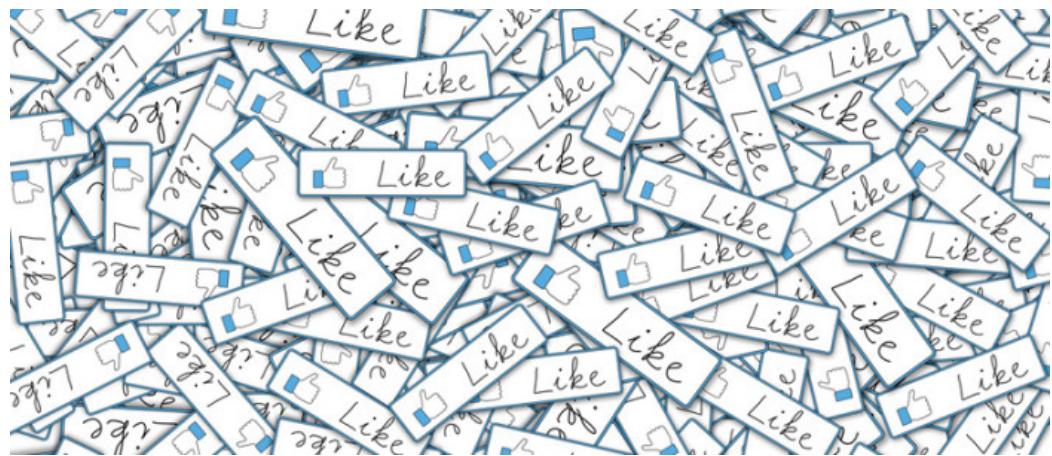
Google

- ◆ 3.5 billion searches / day
- ◆ 1.2 trillion searches / year
- ◆ “by slowing its search results by just 4/10 of a second they could lose 8 million searches per day”



Facebook

- ◆ People spend over 700 billion minutes per month on Facebook
- ◆ In 20 minutes 10.2 million comments are posted
- ◆ 750 million photos were uploaded to Facebook over New Year's weekend

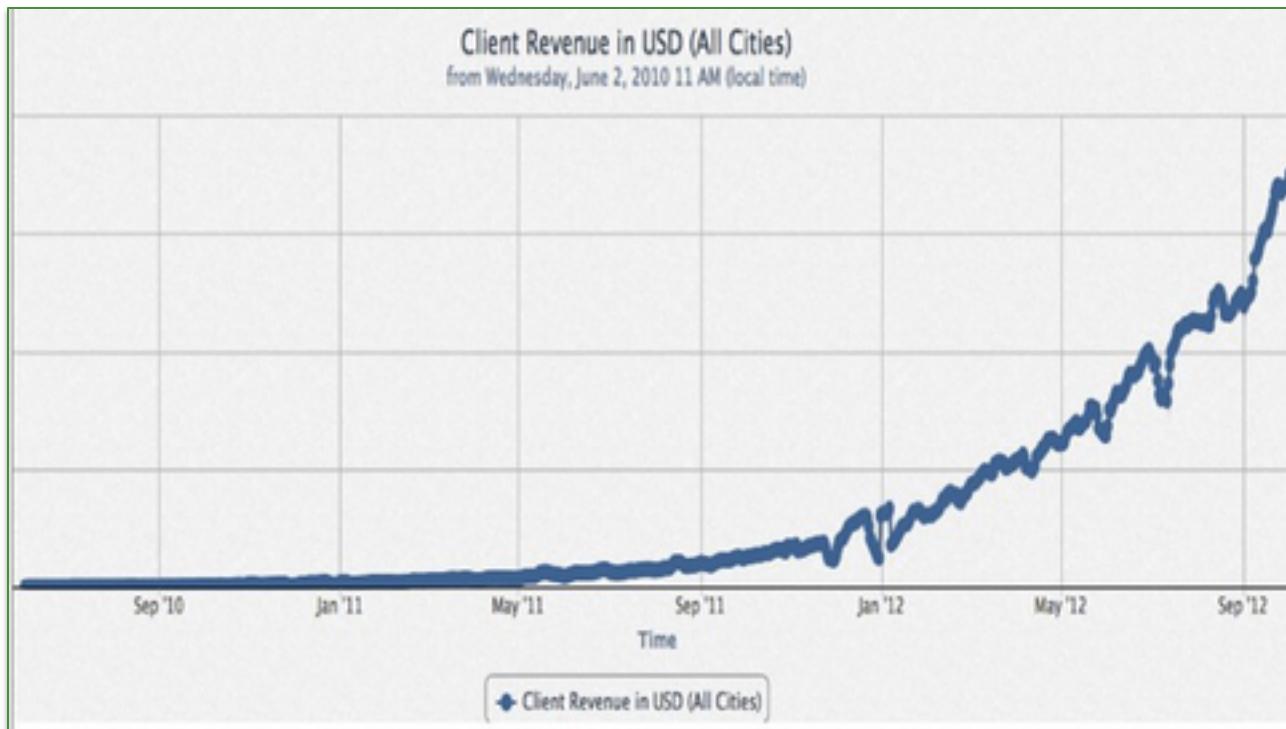


Amazon S3

- ◆ 1.3 trillion objects stored
- ◆ 1.1 million requests / second



Uber Growth



BroncoDirect



Cal Poly Pomona

February 10 at 11:47am ·

Broncos, if you're trying to register for classes right now, you've probably noticed that BroncoDirect is having some serious issues right now.

We apologize for this. Really, we do. We know that you don't need this extra aggravation while you're trying to get your classes for next quarter.

We are working as quickly as we can to fix the situation. We will keep you updated as much as possible.

Again, our sincere apologies.



Ian I pray Lord for this matter to be resolved...Amen.

· February 11 at 11:56am

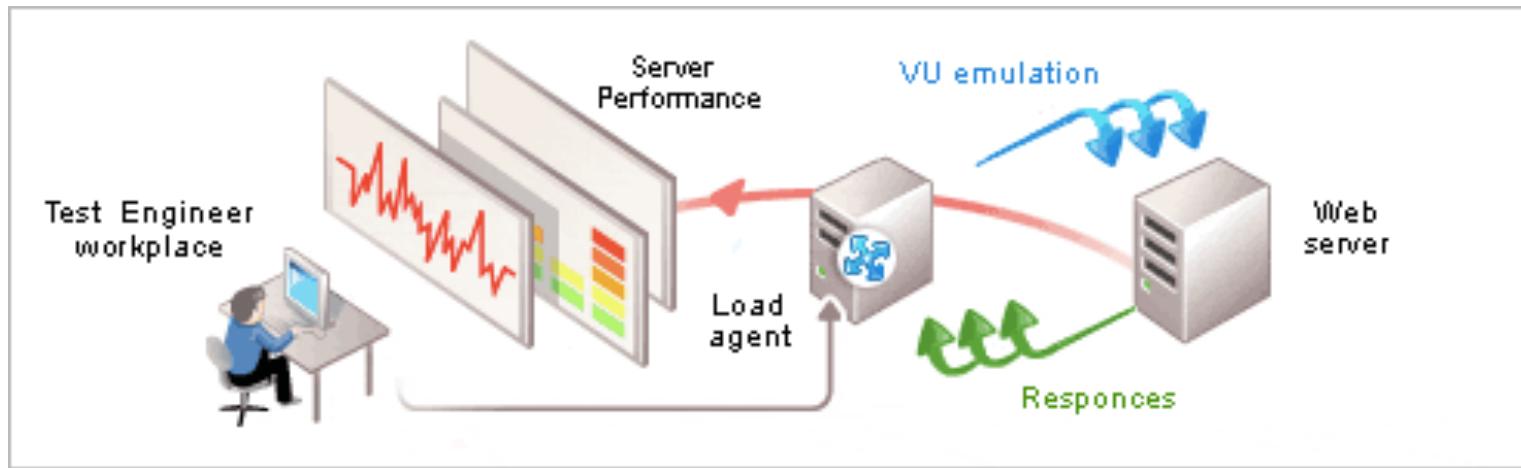
LOL Broncodirect... the worst thing about Cal Poly Pomona.

February 10 at 1:17pm

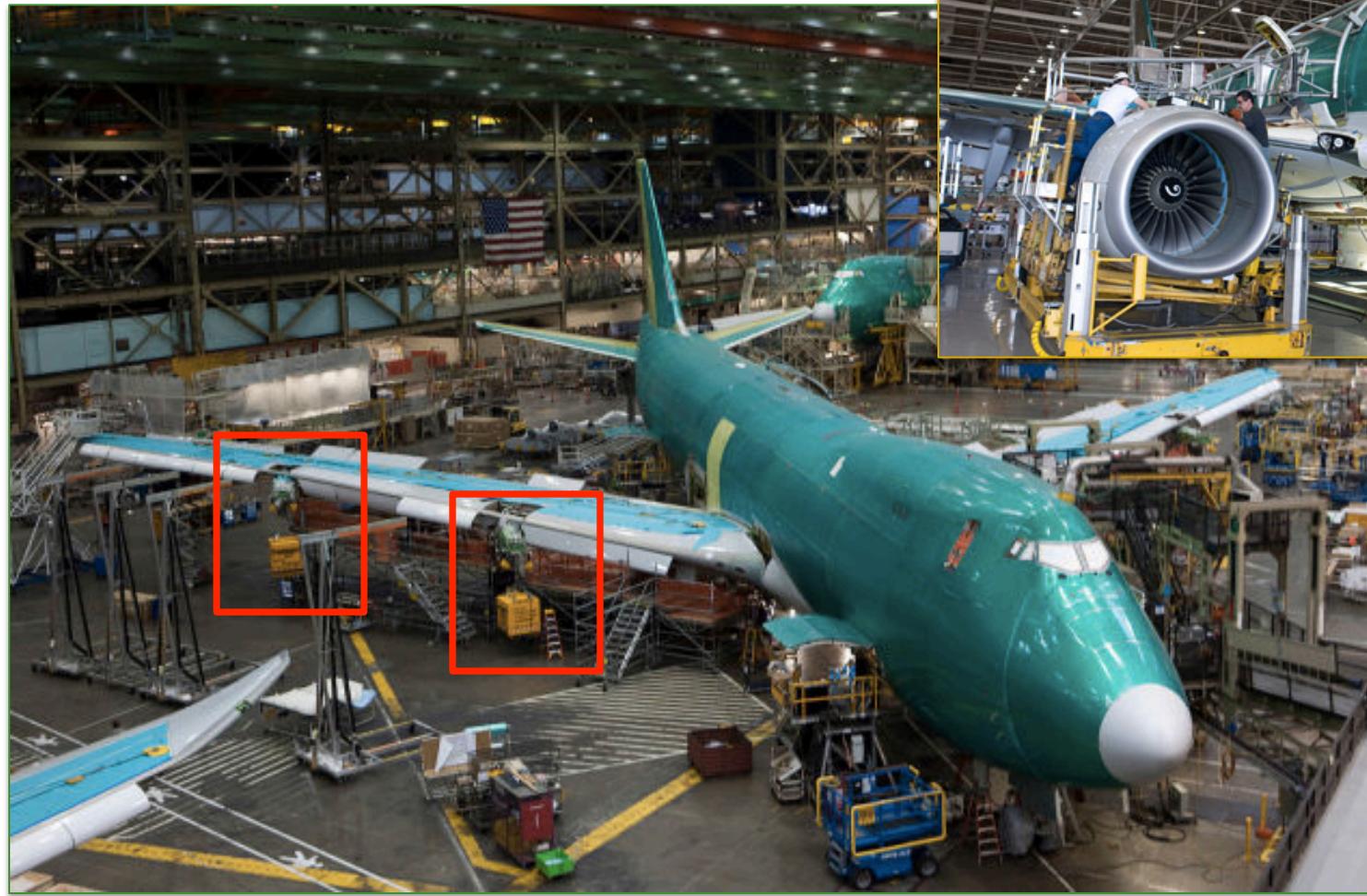
Gabriel Horowitz Lol one of the most stressful parts about going to school at CPP

Michelle Cassidy Every college has these problems during registration, I don't blame cpp, hope it's resolved soon though!

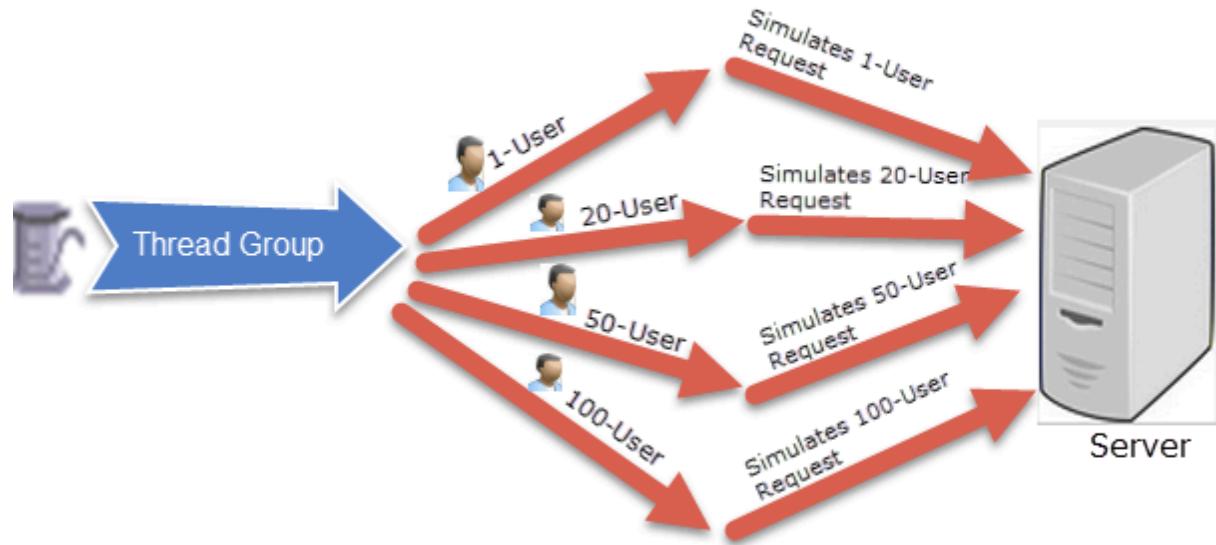
Scalability Verification – Load Test



Scalability Verification – Load Test



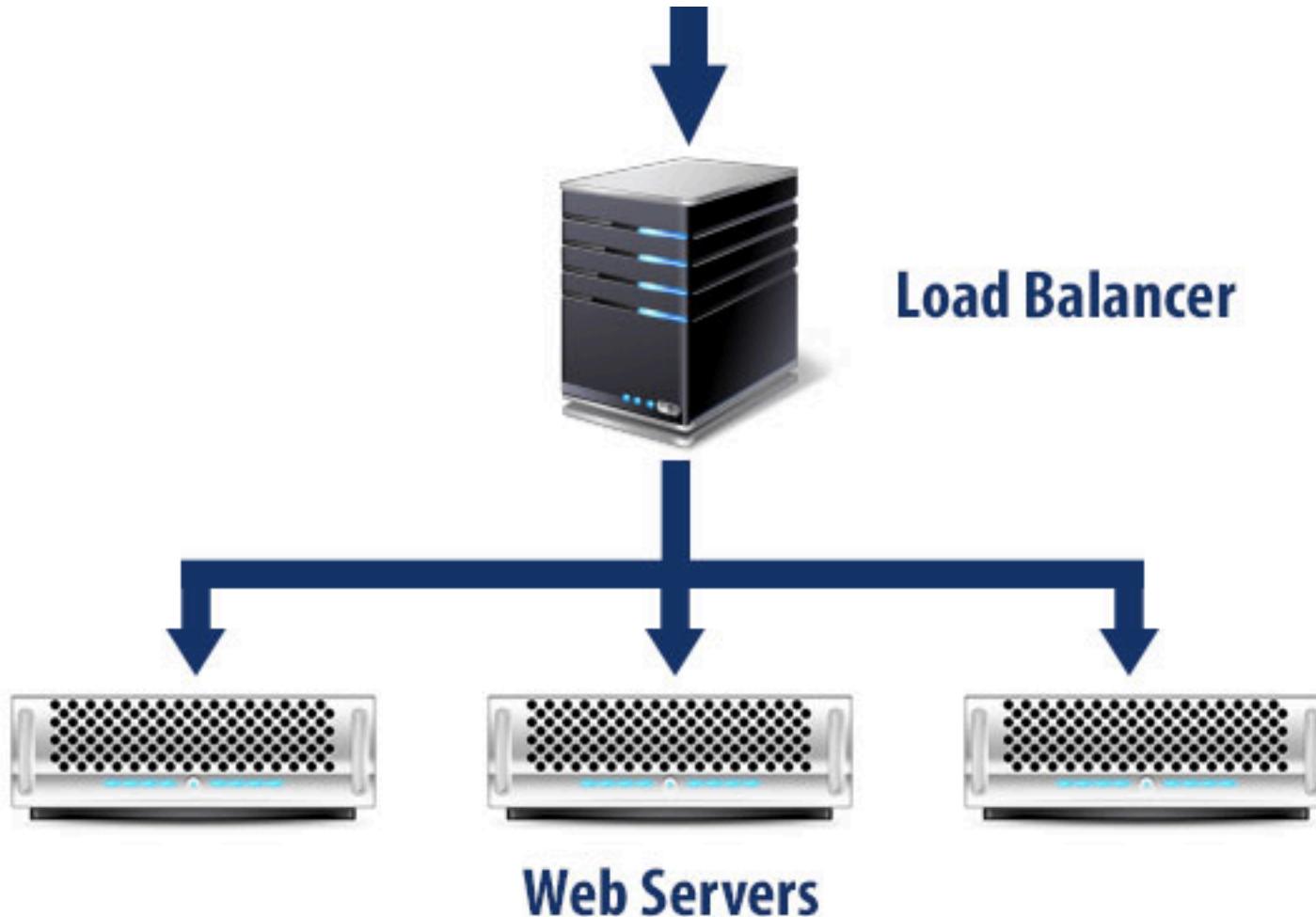
JMeter Demo



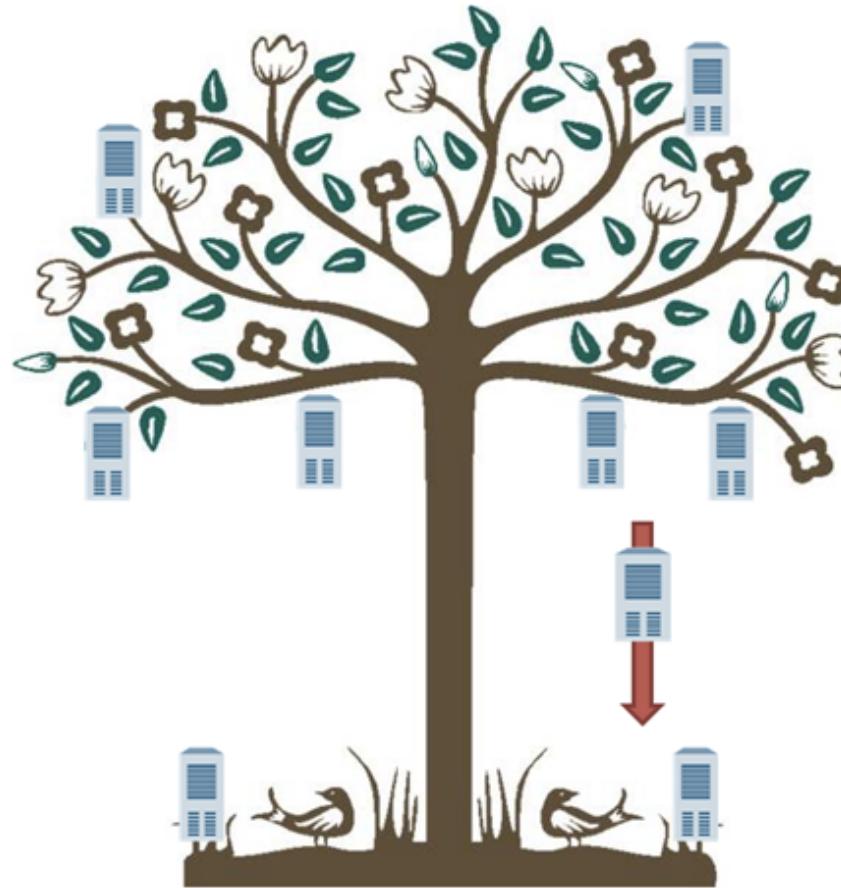
How to Improve Scalability?



How to Improve Scalability?



How to Make Scalability Easy?



Cloud Computing

- ◆ Cloud computing shifts computing from local dedicated resources to distributed, virtual, elastic, multi-tenant resources
 - ◆ On-demand access to computing, storage, and software services
 - ◆ Based on a utility cost model



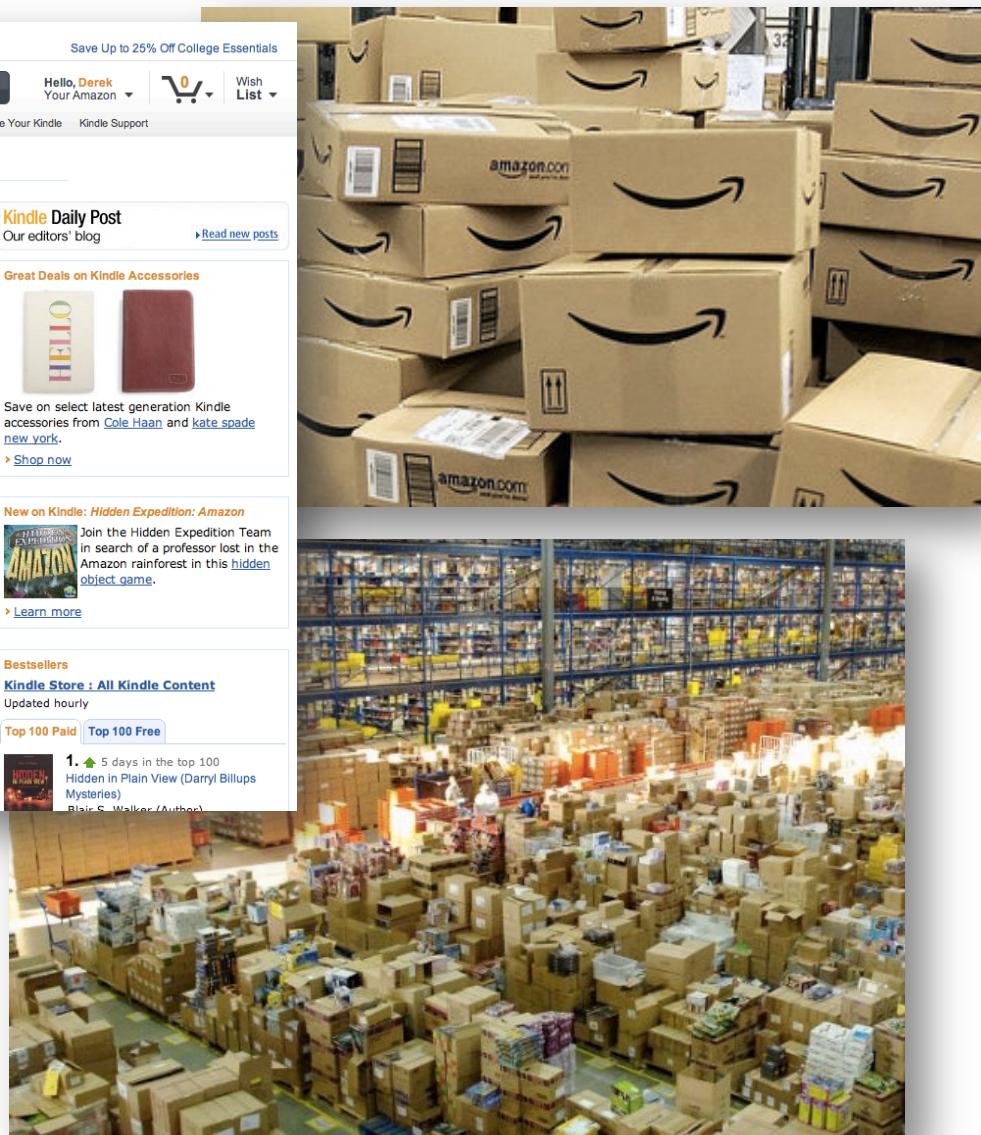
Cloud Computing & Amazon

- ◆ The popularization of the term can be traced to 2006 when Amazon.com introduced the Elastic Compute Cloud (EC2)



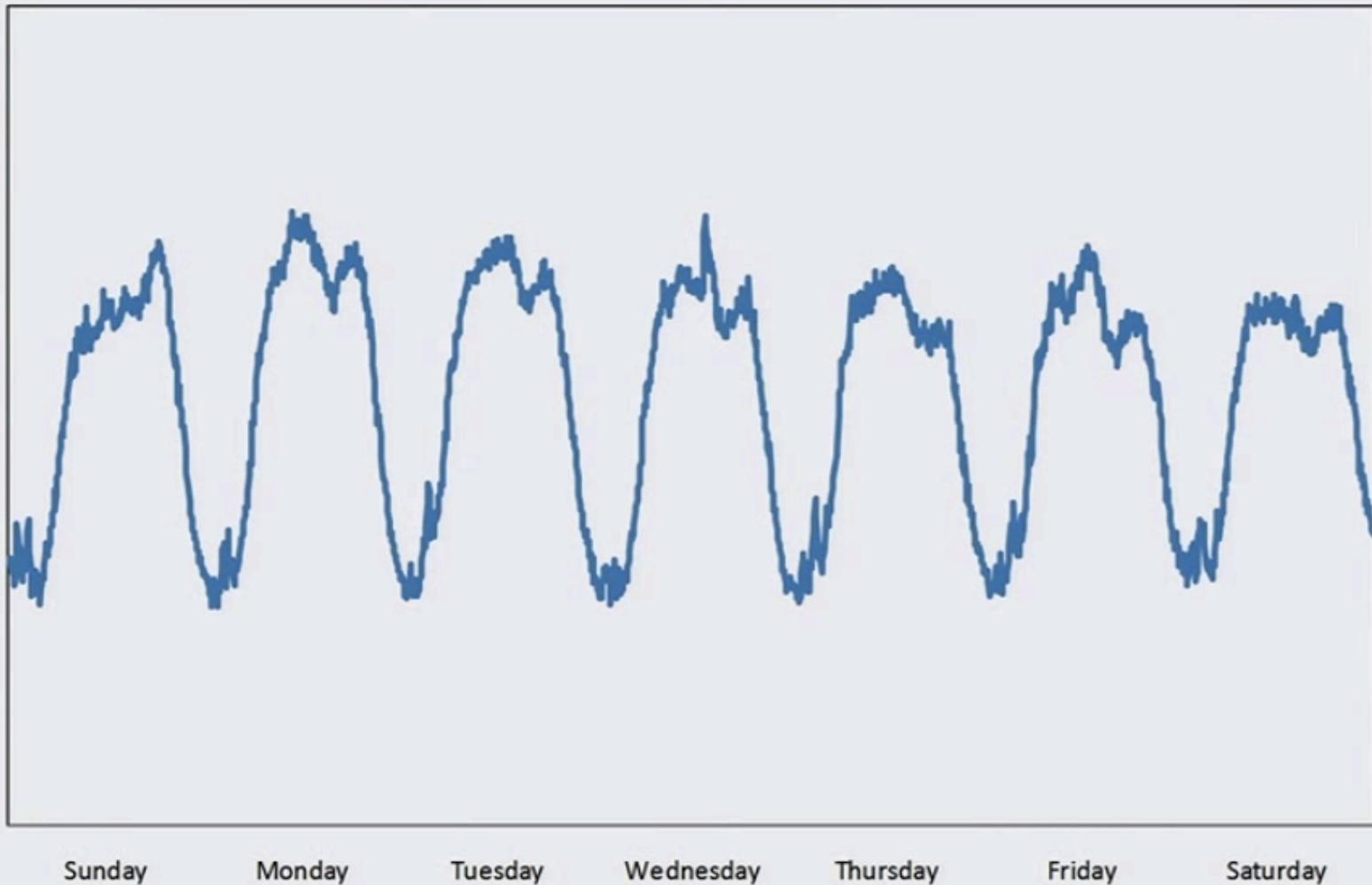
Case Study: Amazon Retail Website

The screenshot shows the Kindle Store page on the Amazon website. At the top, there's a navigation bar with links for 'Today's Deals', 'Gift Cards', and 'Help'. Below that is a search bar and a user profile for 'Hello, Derek' with a cart icon showing '0' items and a 'Wish List' dropdown. A banner at the top says 'Save Up to 25% Off College Essentials'. The main headline is 'Best Books of 2011 So Far' with a 'See all our editors' picks' link. On the left, there's a sidebar for 'Your Country or Region' set to 'United States'. Under 'Browse', there are sections for 'Buy a Kindle' (listing Kindle (Wi-Fi, 6"), Kindle 3G (Free 3G + Wi-Fi, 6"), Kindle DX (Free 3G, 9.7", Graphite), Kindle DX (Free 3G, 9.7", White - 2nd Generation)), 'Kindle Reading Apps' (listing Kindle Cloud Reader, Kindle for iPad, Kindle for iPhone, Kindle for PC, Kindle for Mac, Kindle for Android, Kindle for BlackBerry, Kindle for Windows Phone 7), and 'Give Kindle Gifts' (listing Give Kindle Books, Give a Kindle Gift Card, Redeem a Kindle Gift Card). A 'Need Help?' section includes 'Getting Started', 'Manage Your Kindle', 'Kindle Support', and 'Around the Store'. The main content area features a large image of a Kindle device with the text 'Kindle The #1 Bestseller on Amazon'. It lists three Kindle models with their prices: Kindle (\$139), Kindle 3G with Special Offers (\$139), and Kindle 3G (\$189). Below this, there's a section titled 'More Items to Consider' showing book covers for 'THE INNOVATOR'S DNA', 'BASIC ECONOMICS', 'The Innovator's Dilemma', and 'venture deals'. To the right, there's a 'Kindle Daily Post' section with a link to 'Read new posts', a 'Great Deals on Kindle Accessories' section showing a grey Kindle case and a brown Kindle cover, and a 'New on Kindle: Hidden Expedition: Amazon' section with a link to 'Learn more'. At the bottom, there's a 'Bestsellers' section for 'Kindle Store : All Kindle Content'.



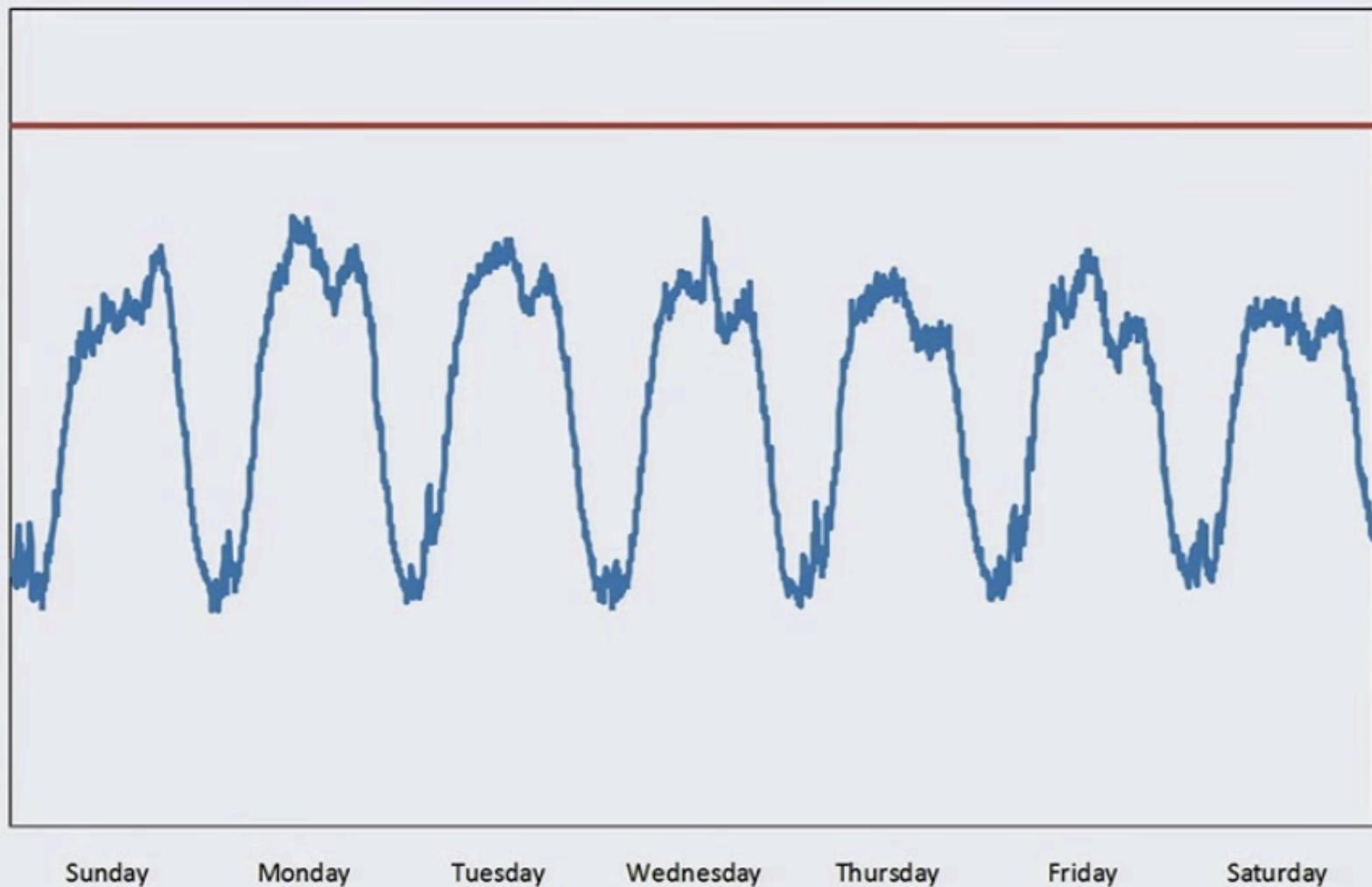
Case Study: Amazon Retail Website

Typical Weekly Traffic to amazon.com



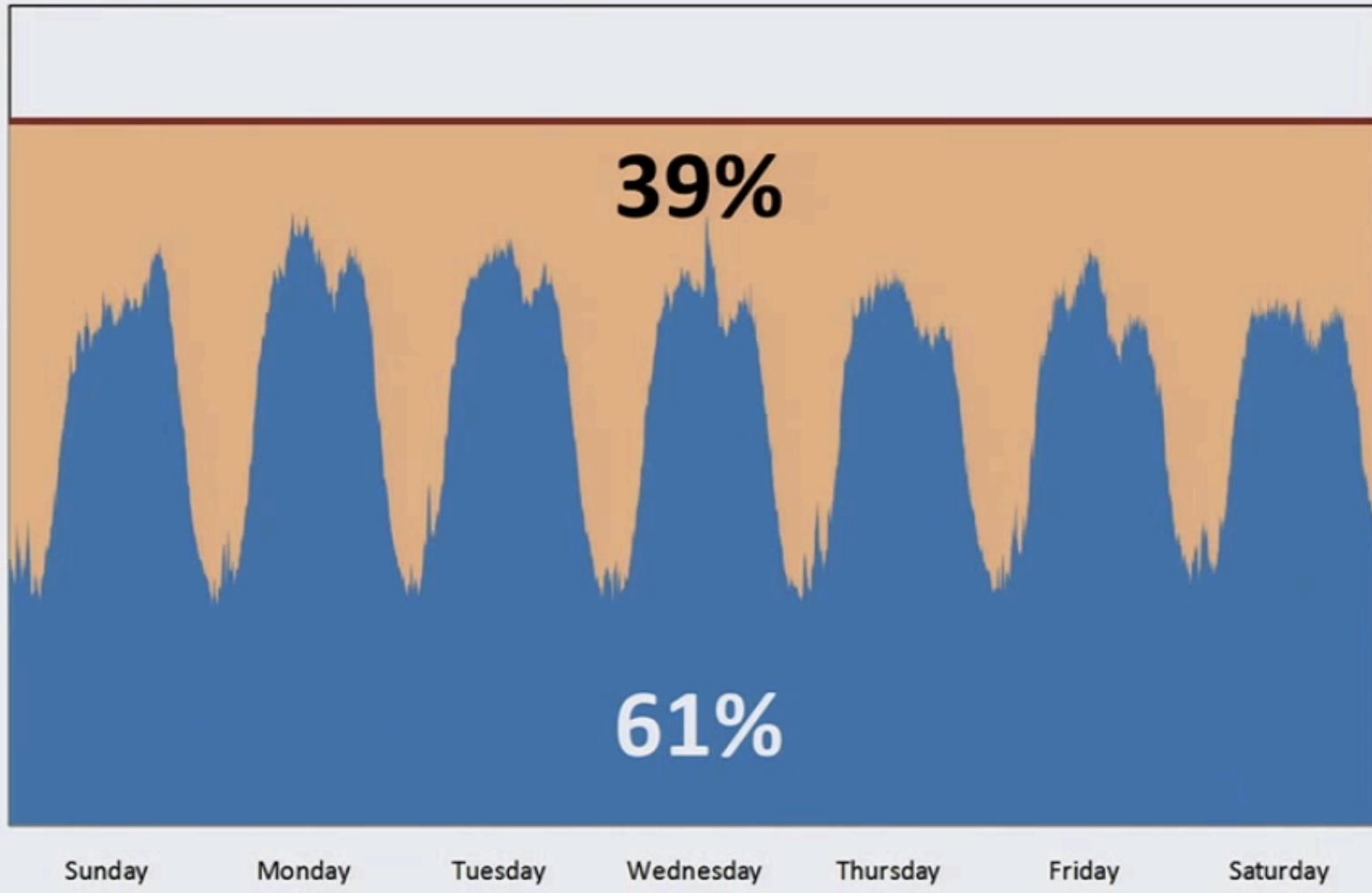
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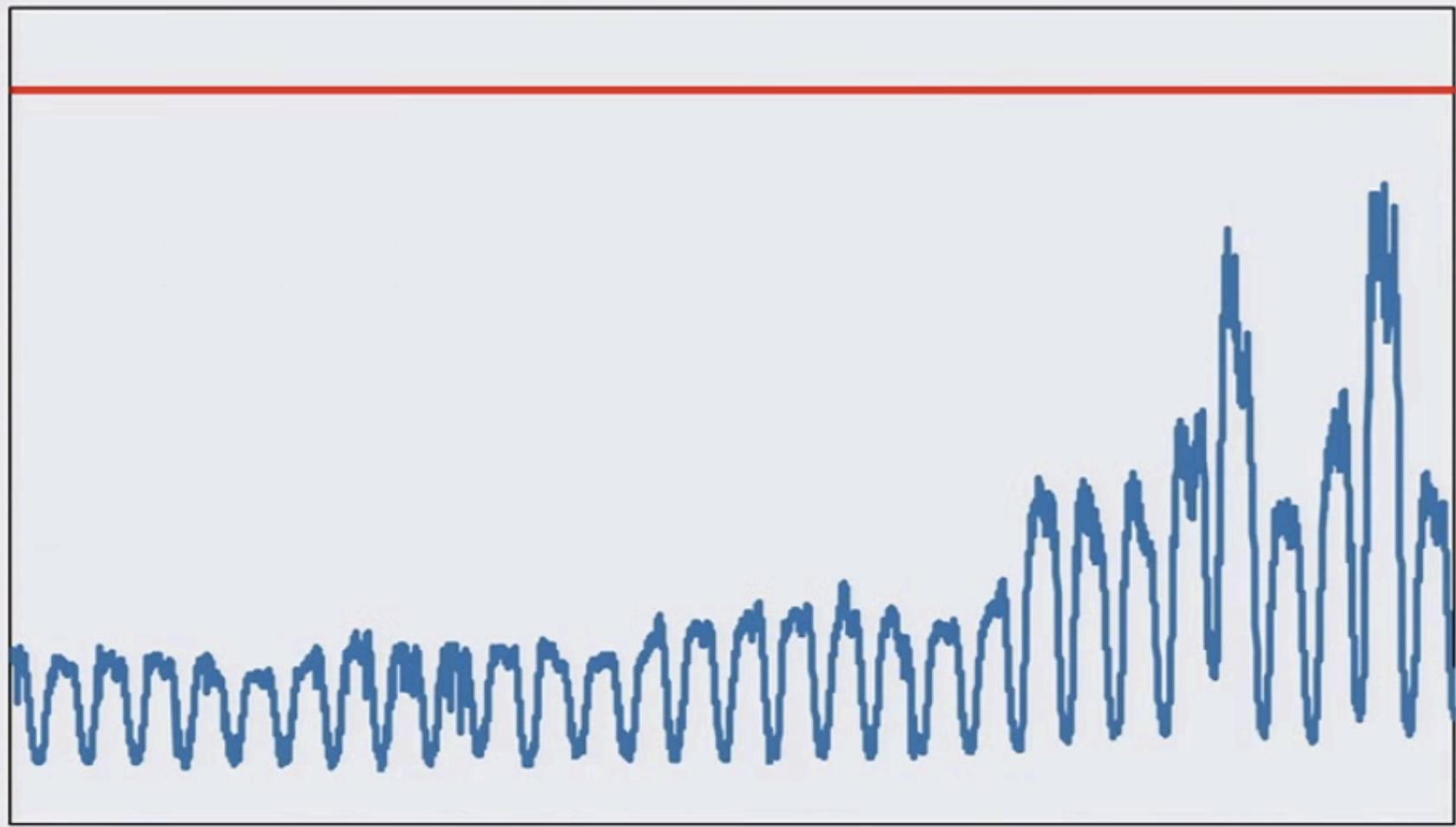
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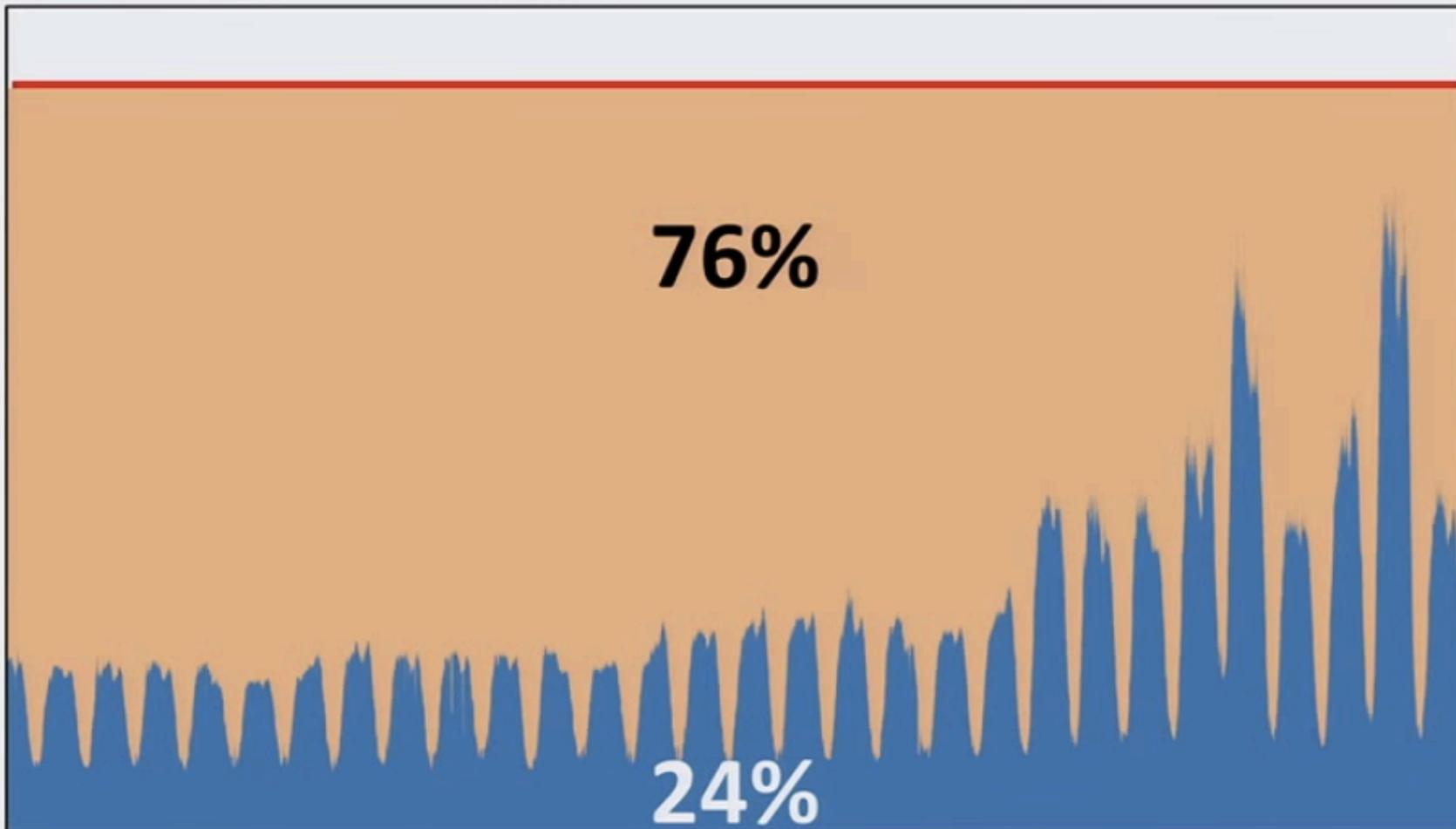
Case Study: Amazon Retail Website

November Traffic for amazon.com



Case Study: Amazon Retail Website

November Traffic for amazon.com



76%

24%

Motivation of Cloud Computing (I)

November Traffic for amazon.com



Capacity Planning = Spending Money

Capacity Optimization = Saving Money



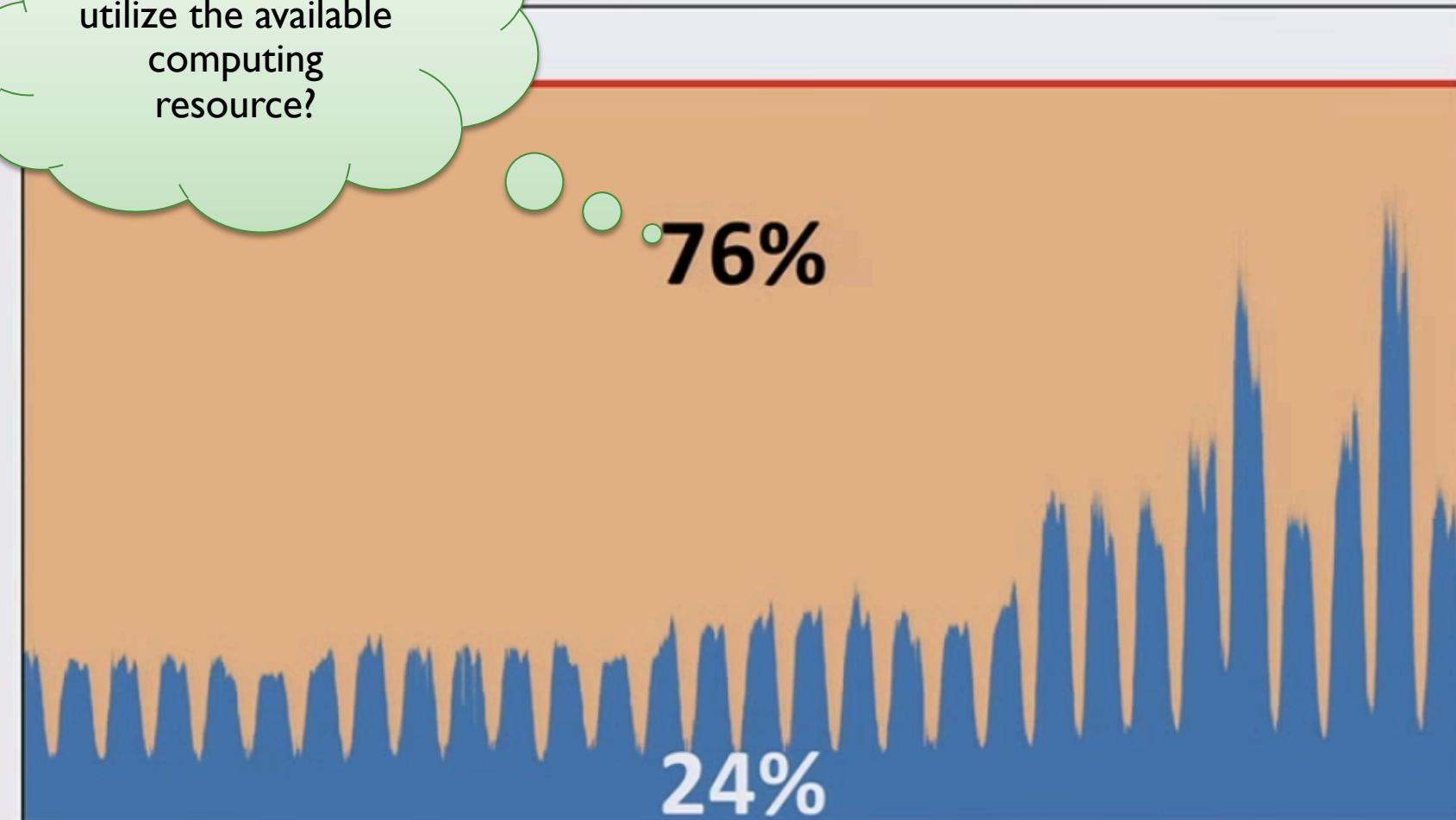
Motivation of Cloud Computing (2)

How can we better utilize the available computing resource?

ember Traffic for amazon.com

76%

24%



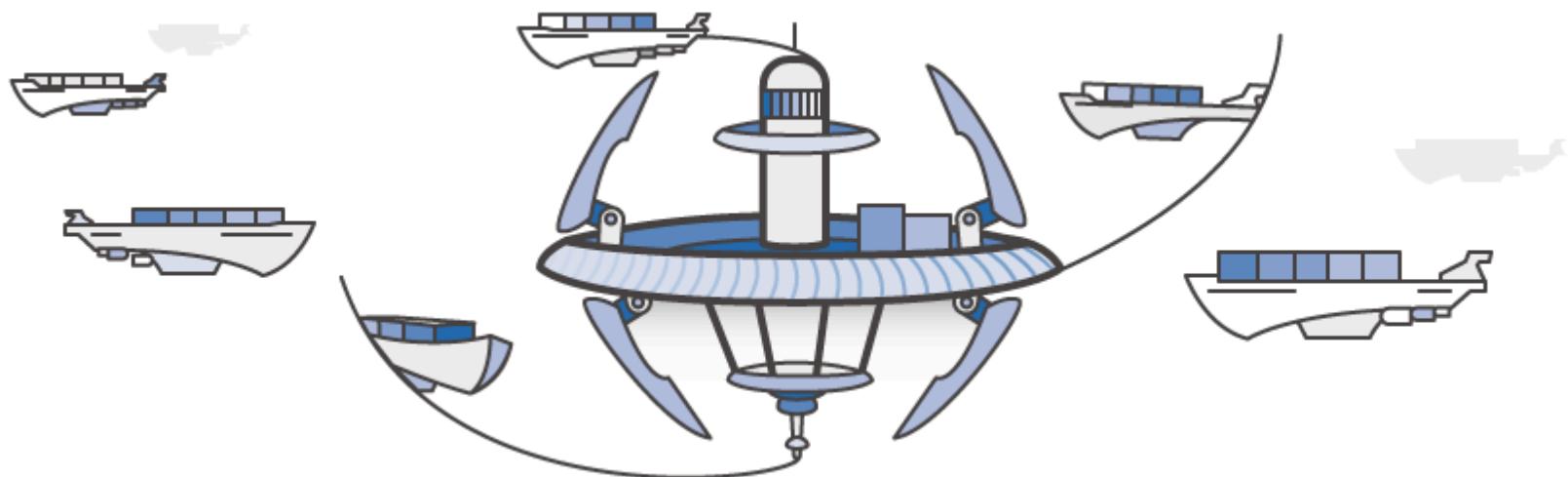
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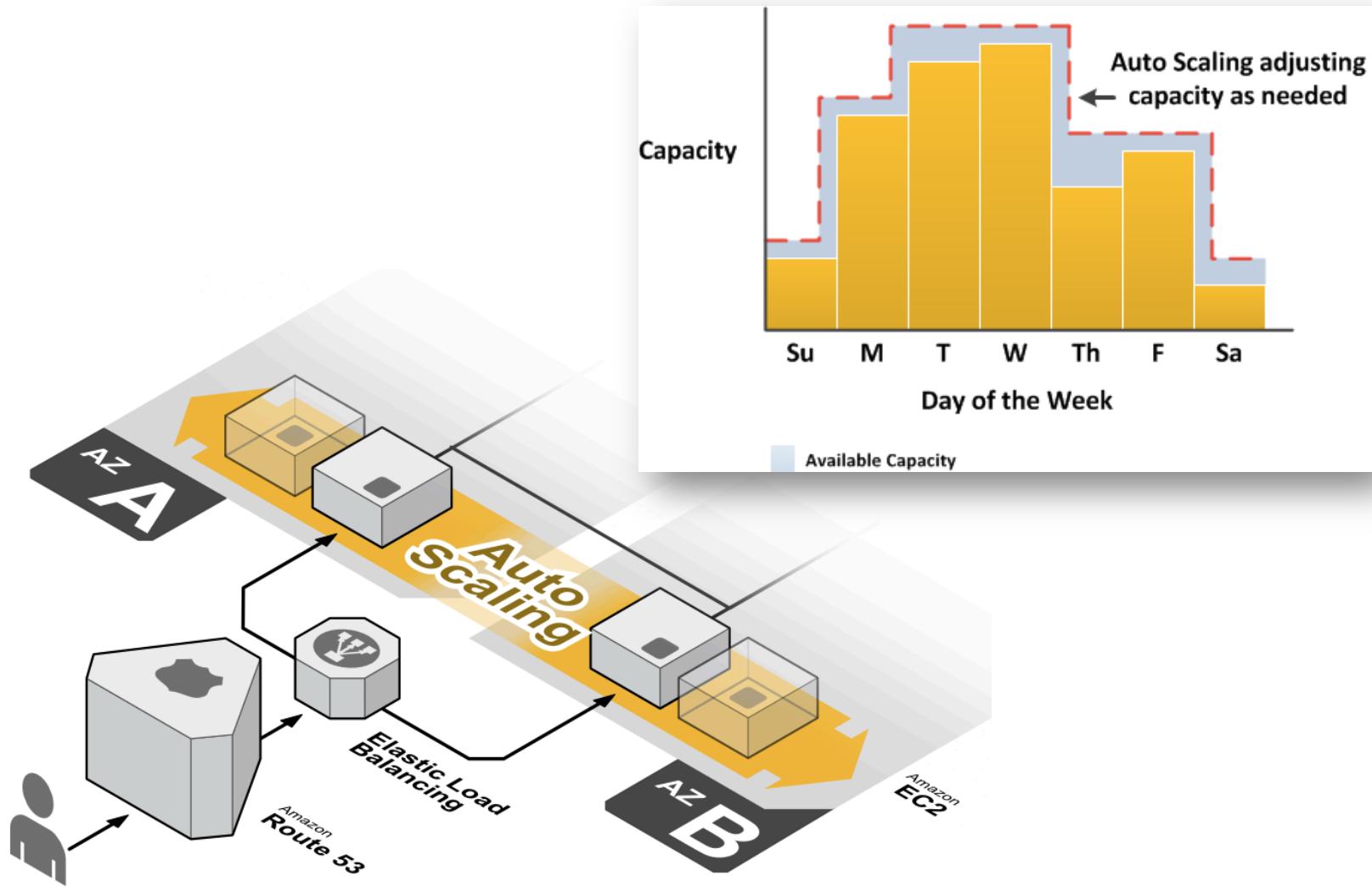


Amazon EC2 On-Demand Pricing

United States	Europe	
Standard On-Demand Instances	Linux/UNIX Usage	Windows Usage
Small (Default)	\$0.10 per hour	\$0.125 per hour
Large	\$0.40 per hour	\$0.50 per hour
Extra Large	\$0.80 per hour	\$1.00 per hour
High CPU On-Demand Instances	Linux/UNIX Usage	Windows Usage
Medium	\$0.20 per hour	\$0.30 per hour
Extra Large	\$0.80 per hour	\$1.20 per hour



Auto Scaling with Cloud Computing



Auto-Scaling Demo

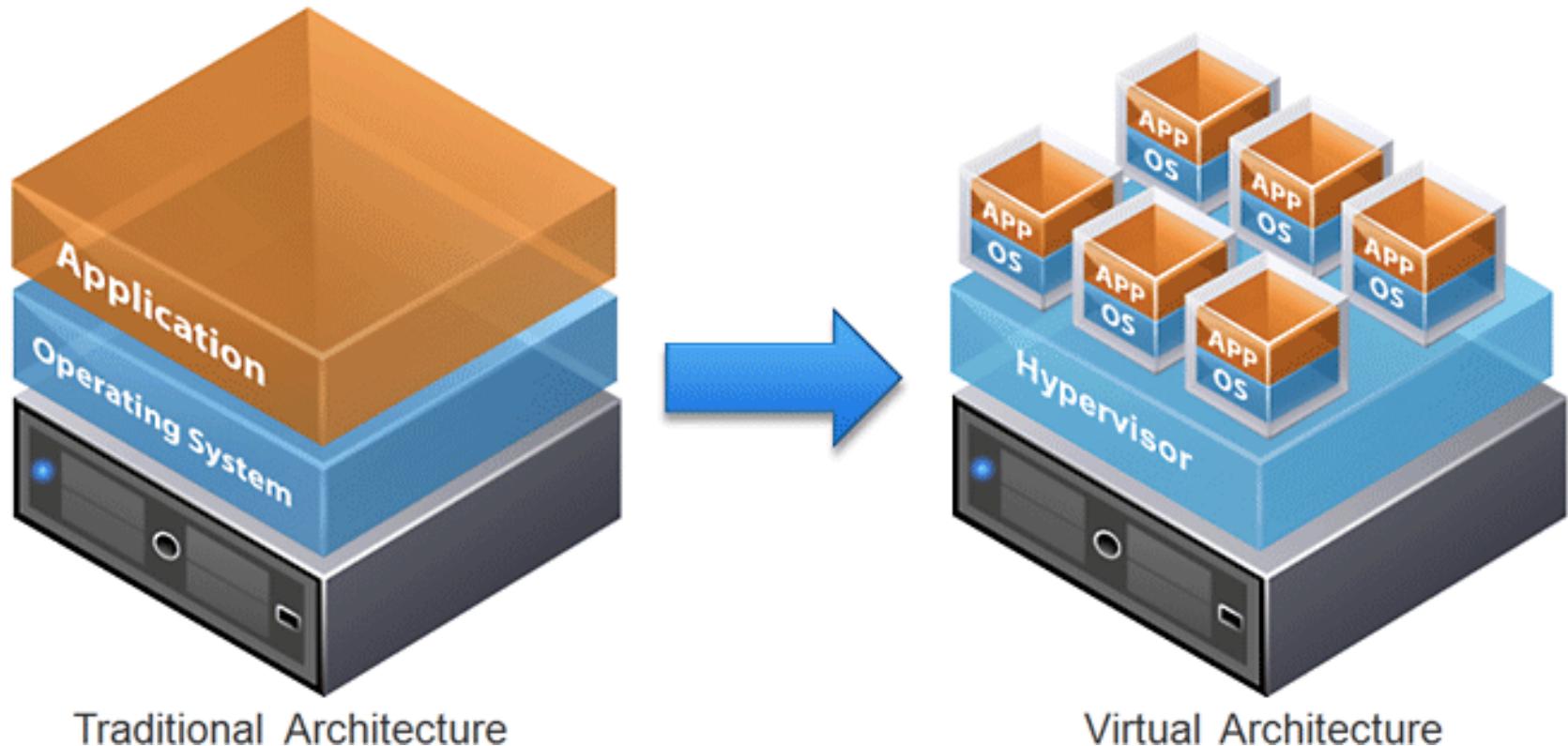


Amazon.com is Fully Served by EC2

- ◆ Reduced spending on server capacity
- ◆ Fleet scales dynamically in increments as small as a single host
- ◆ Traffic spikes can be handled with ease
- ◆ Cultural change



Virtualization

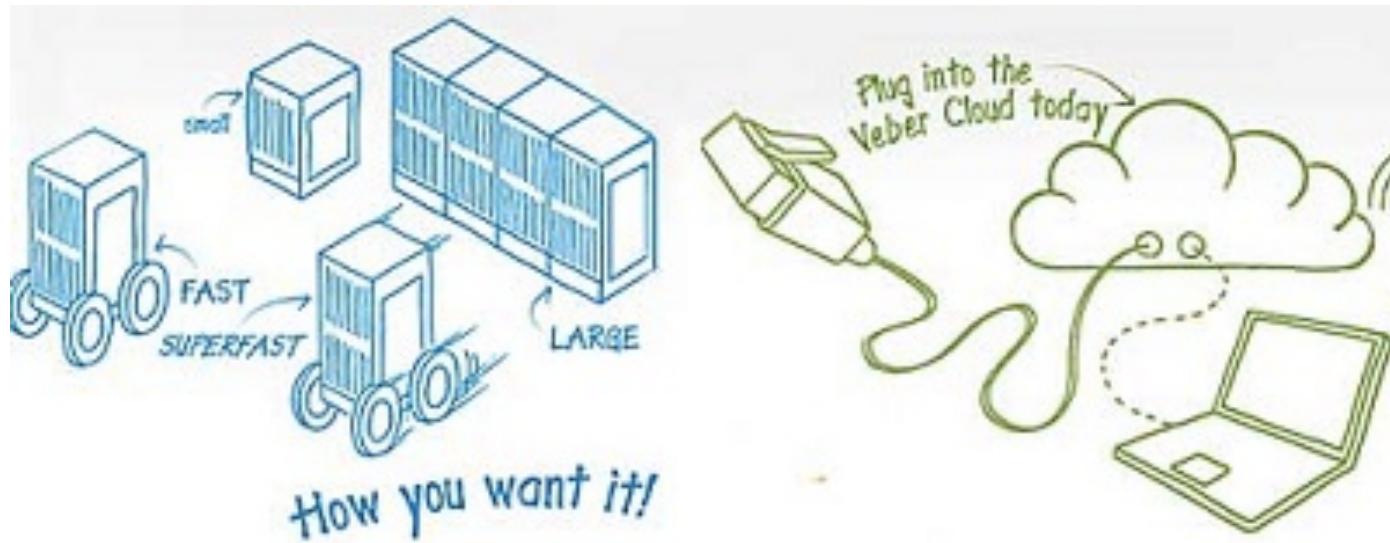


Flexible Options

Google vs. AWS On-Demand Pricing

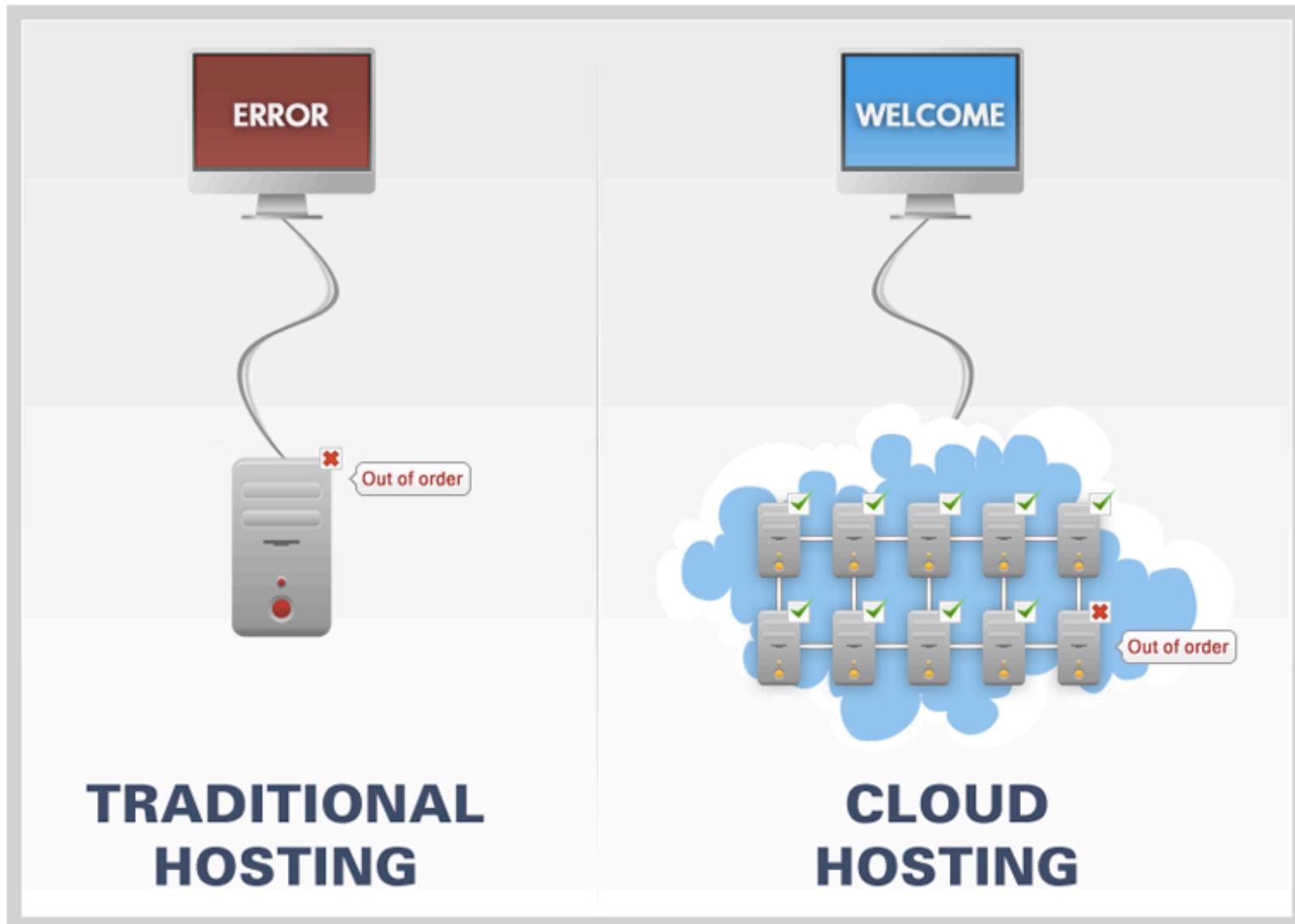
Google Instance Type	CPU Cores	RAM	AWS Instance Type	CPU Cores	RAM	Google New On-Demand (per hour)	AWS On-Demand (per hour)	New Google Price vs. AWS
n1-standard-1	1	3.75	m3.medium	1	3.75	\$ 0.070	\$ 0.113	-38.05%
n1-standard-2	2	7.5	m3.large	2	7.5	\$ 0.140	\$ 0.225	-37.78%
n1-standard-4	4	15	m3.xlarge	4	15	\$ 0.280	\$ 0.450	-37.78%
n1-standard-8	8	30	m3.2xlarge	8	30	\$ 0.560	\$ 0.900	-37.78%
n1-higmem-2	2	13	m2.xlarge	2	17.1	\$ 0.164	\$ 0.410	-60.00%
n1-higmem-4	4	26	m2.2xlarge	4	34.2	\$ 0.328	\$ 0.820	-60.00%
n1-higmem-8	8	52	m2.4xlarge	8	68.4	\$ 0.656	\$ 1.640	-60.00%
n1-highcpu-2	2	1.8	c3.large	2	3.75	\$ 0.088	\$ 0.150	-41.33%
n1-highcpu-4	4	3.6	c3.xlarge	4	7.5	\$ 0.176	\$ 0.300	-41.33%
n1-highcpu-8	8	7.2	c3.2xlarge	8	15	\$ 0.352	\$ 0.600	-41.33%
n1-highcpu-16	16	14.4	c3.4xlarge	16	30	\$ 0.704	\$ 1.200	-41.33%

Rapid Resource Allocation

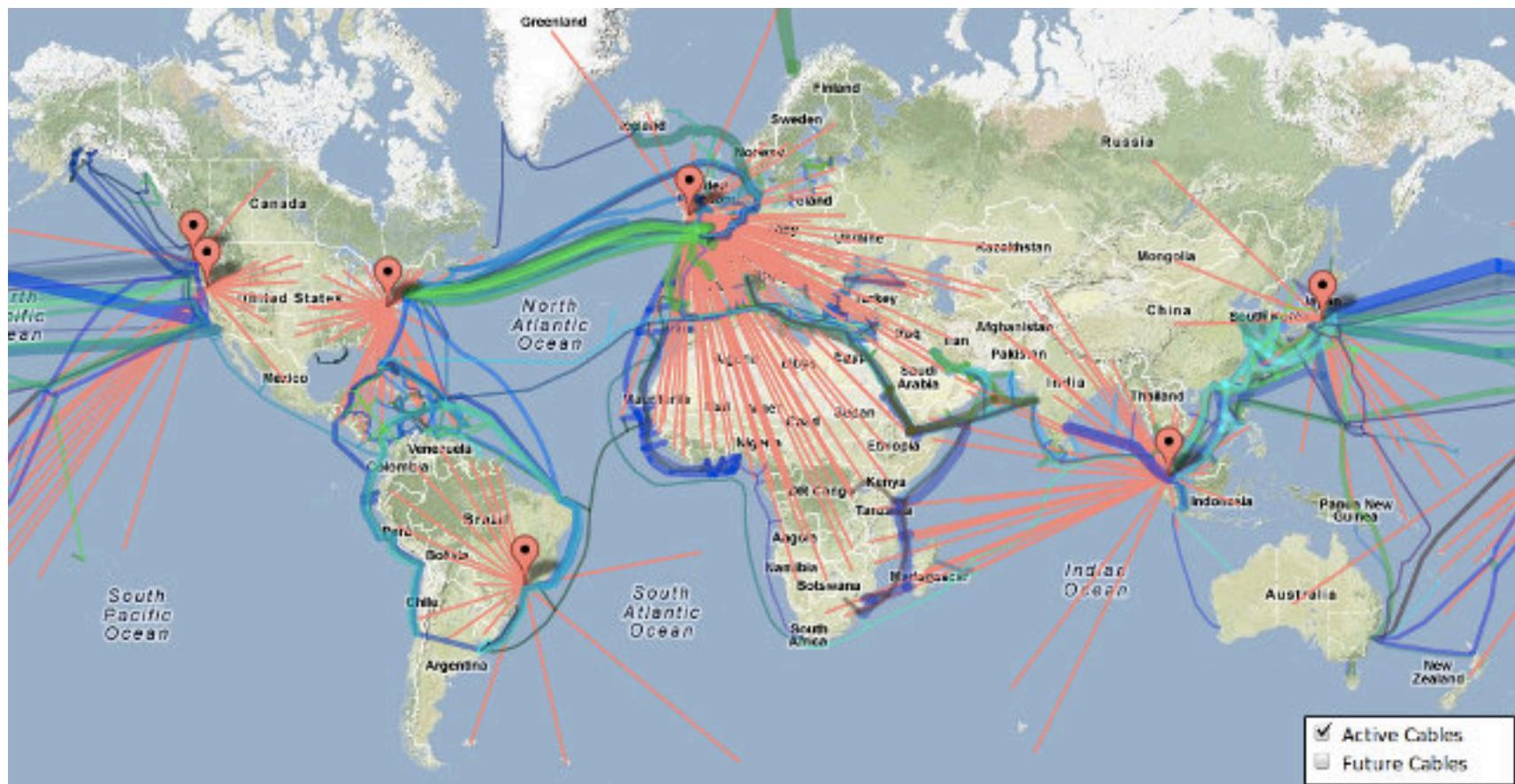


Dedicated Vs Cloud

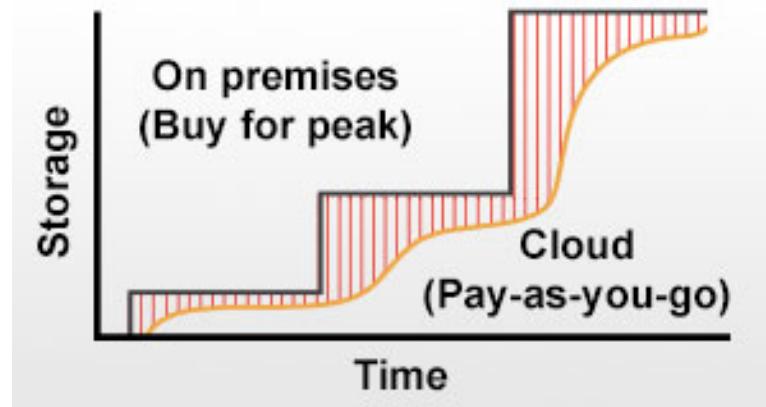
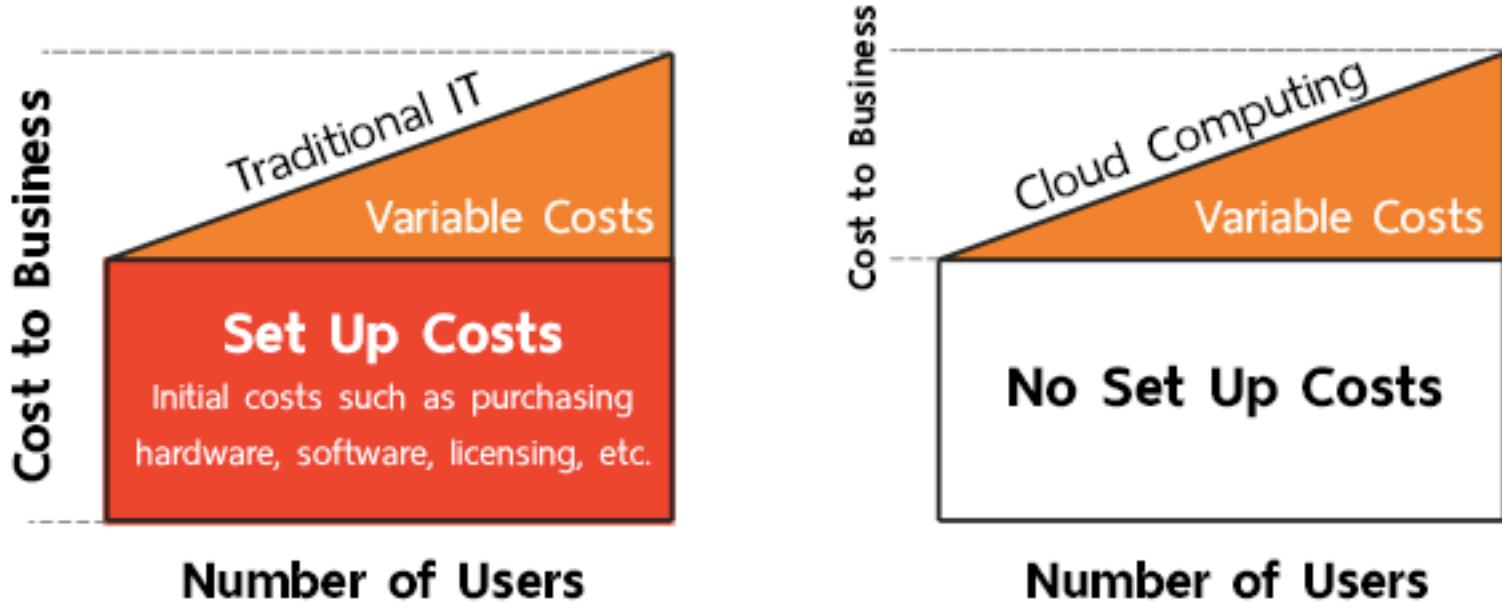
High Availability



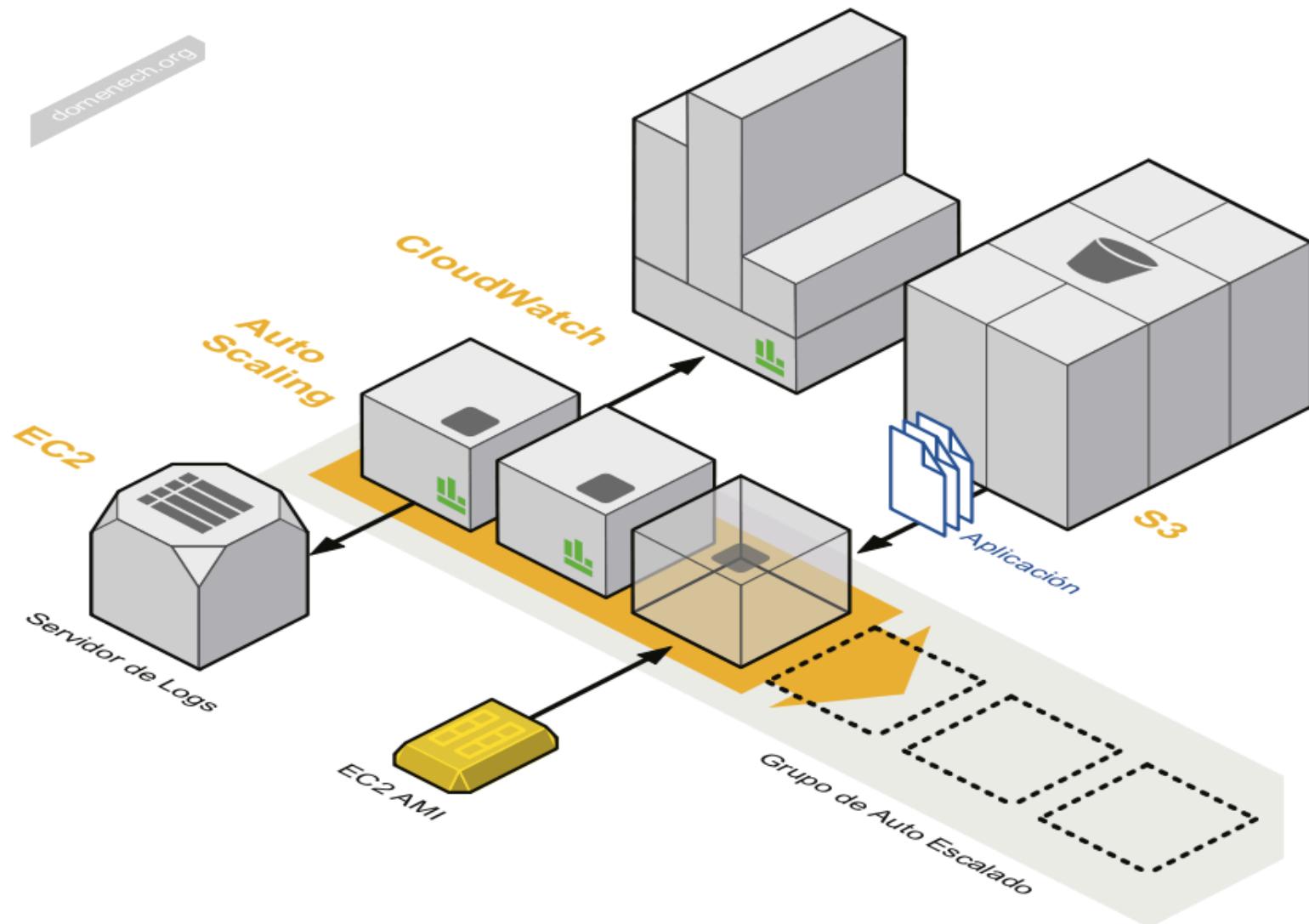
High Availability: AWS Data Centers



Cost-Effective



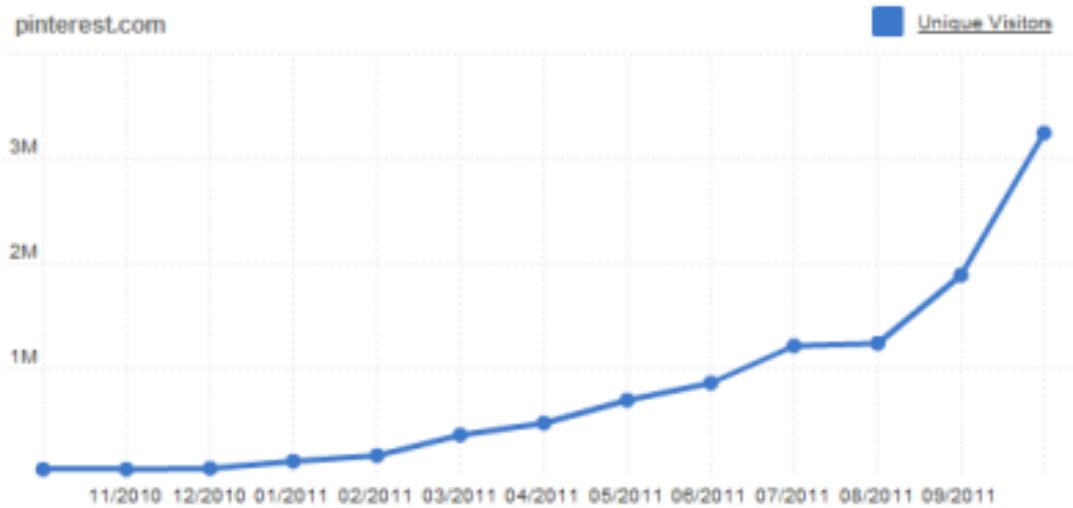
Scalability: Auto-Scaling



Focus on the Applications



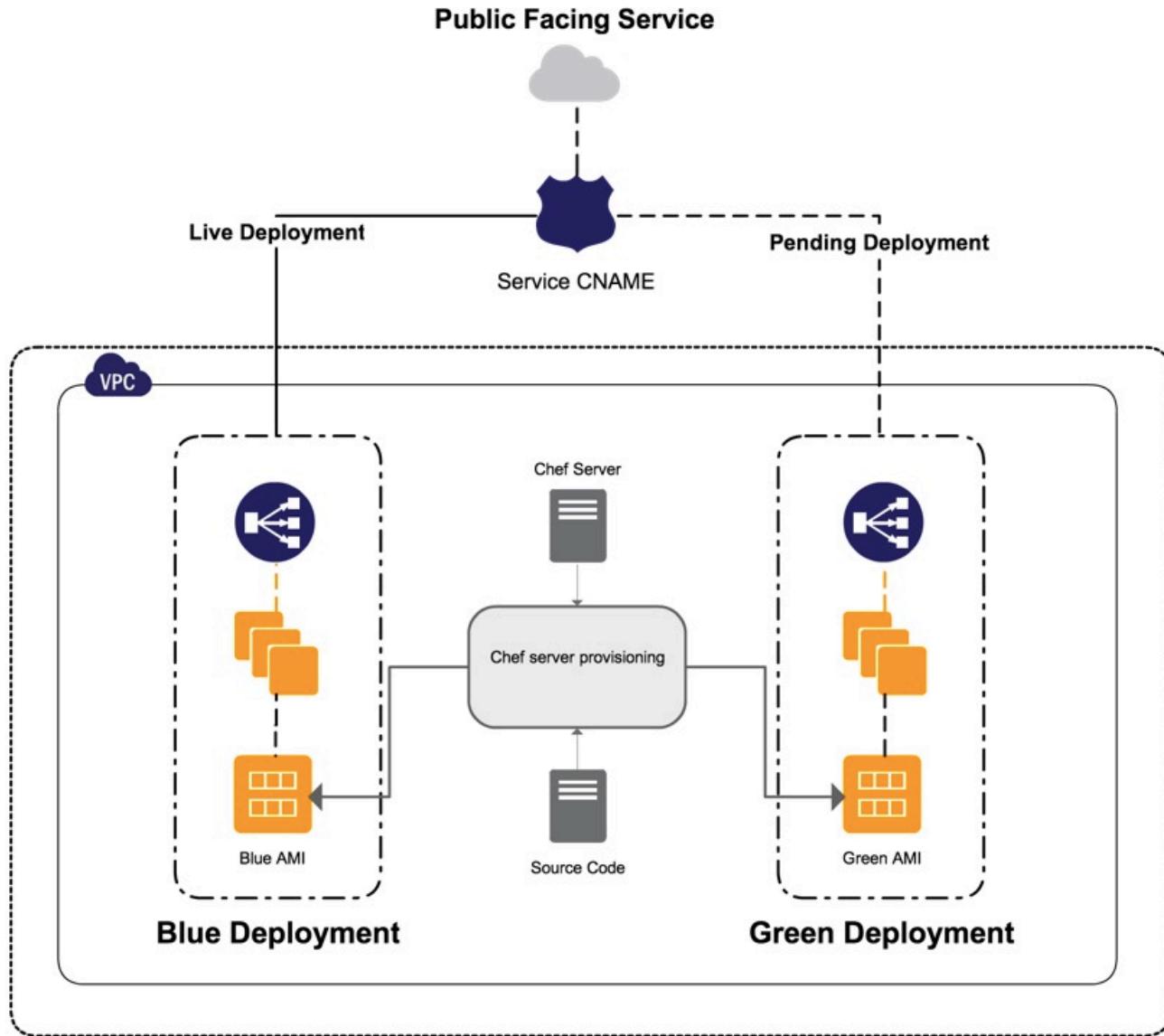
Startups Made Easy



Etsy



Deployment with Ease



Always Keep Scalability in Mind

- ◆ Minimizing work
- ◆ Paging through large datasets
- ◆ Avoiding datastore contention
- ◆ Sharding counters
- ◆ Effective memcache

