

JEFF DURHAM

INTRO TO AWS LAMBDA

"I'm not conceited. Conceit is a fault and I have no faults." - David Lee Roth

WHO AM I?

- ▶ I'm a developer at Princeton TMX
 - ▶ We are a Transportation Management System (TMS) SaaS provider
 - ▶ Everything we build runs in AWS
- ▶ I went to AWS re:Invent once so I know what I'm talking about
- ▶ Most importantly, I'm the guy who got the pizza

“Get your facts first, then you can distort them as you please” - Mark Twain

WHY “INTRO”?

- ▶ It's all for which I'm qualified
- ▶ Lambda is too big of a topic to cover in one presentation
- ▶ There's actually a lot to cover before we even get to Lambda

"Later equals never." - Le Blanc's law

AGENDA

- ▶ The history of cloud computing that lead to AWS Lambda
- ▶ What is "serverless" and where does Lambda fit into the picture?
- ▶ Details of AWS Lambda
- ▶ Demo

"The most important single aspect of software development is to be clear about what you are trying to build." - Bjarne Stroustrup

WHAT COMES TO MIND WHEN YOU HEAR "AWS LAMBDA"?

- ▶ Serverless
- ▶ Function as a Service
- ▶ Pay only for what you use
- ▶ Zero Management
- ▶ Automatic Scaling



THE HISTORY OF

CLOUD
COMPUTING

"There are two ways to write error-free programs; only the third one works." - Alan Perlis

ON PREMISES DATA CENTERS

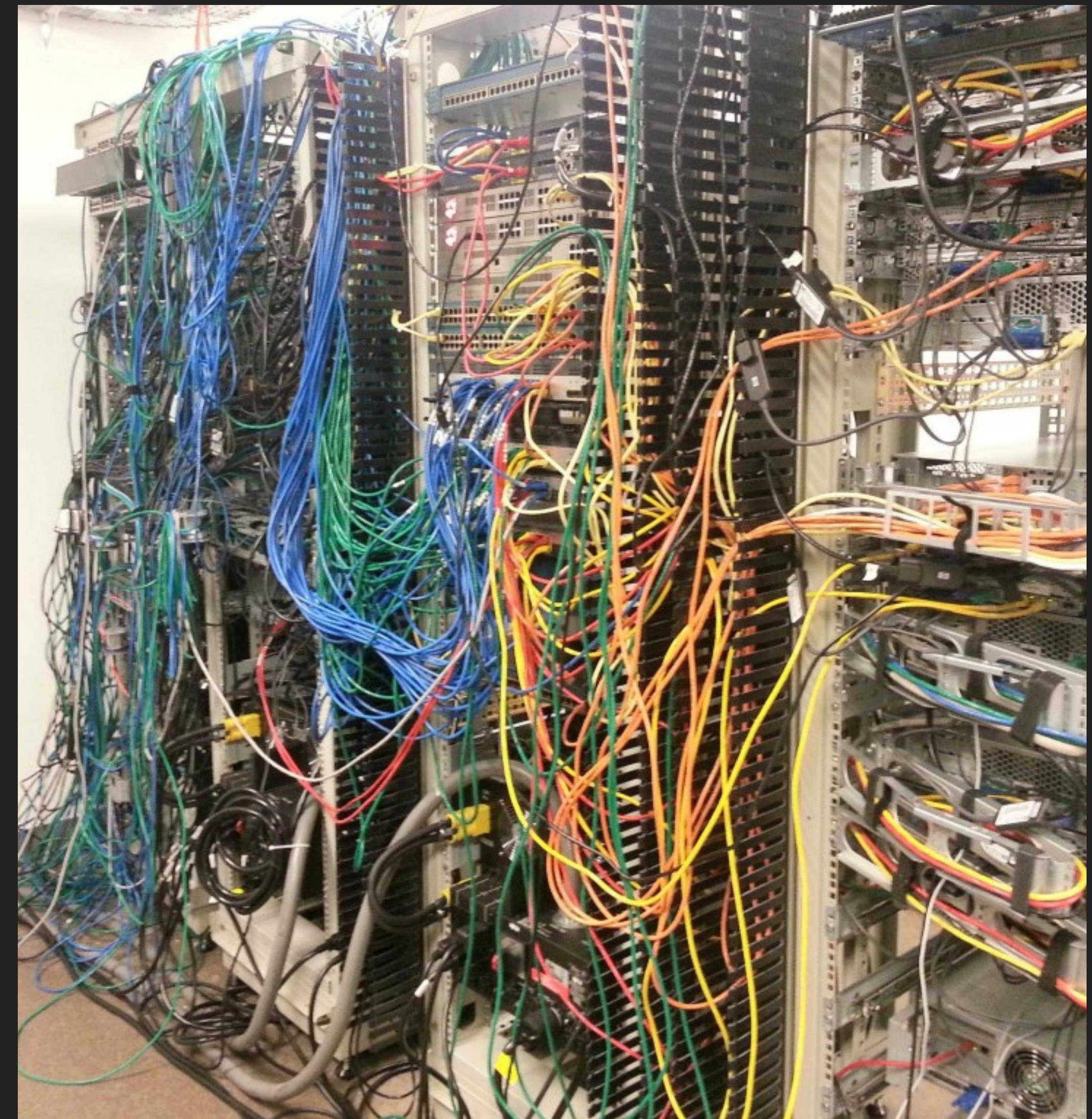
- ▶ Get Real! Nobody has a data center like this!!!



"We build our computer (systems) the way we build our cities: over time, without a plan, on top of ruins." - Ellen Ullman

ON PREMISES DATA CENTERS

- ▶ Requires a lot of up-front knowledge
 - ▶ What types of servers are needed?
 - ▶ How much CPU and memory do the servers need?
 - ▶ How many servers are needed?
 - ▶ What to do if a server fails?
 - ▶ How big does the room need to be?
 - ▶ Do we need UPS?
 - ▶ Do we need air conditioning?
 - ▶ How much network bandwidth do we need?
 - ▶ Who should have physical access to the server room?



"If at first you don't succeed, call it version 1.0." — Unknown

ON PREMISES DATA CENTERS

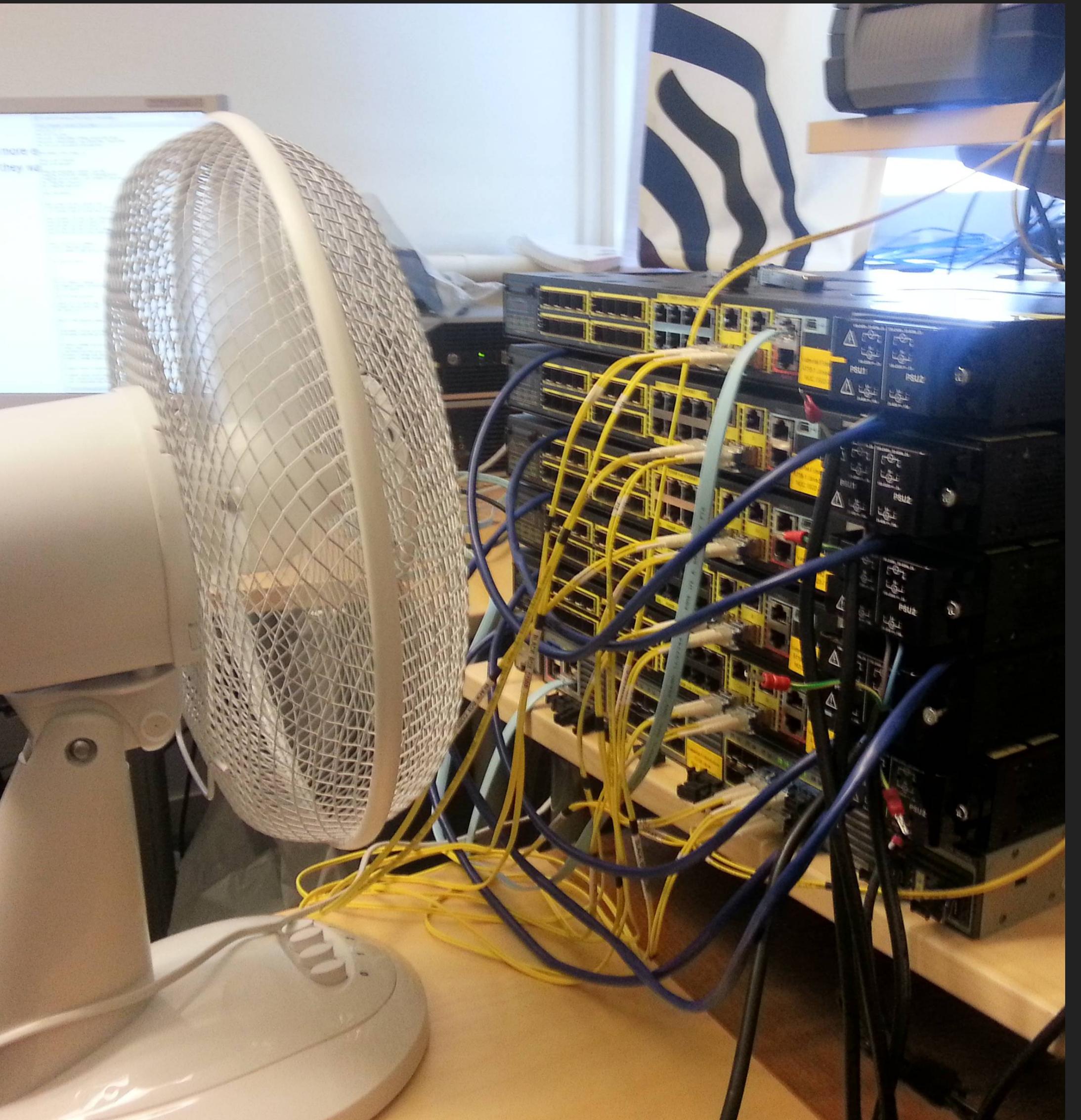
- ▶ Need purchase approval
- ▶ An order must be placed
- ▶ There is a delay before it arrives
- ▶ Then someone has to set it up
- ▶ Finally someone has to support it



"Don't patch bugs out, rewrite them out." - Anonymous

ON PREMISES DATA CENTERS

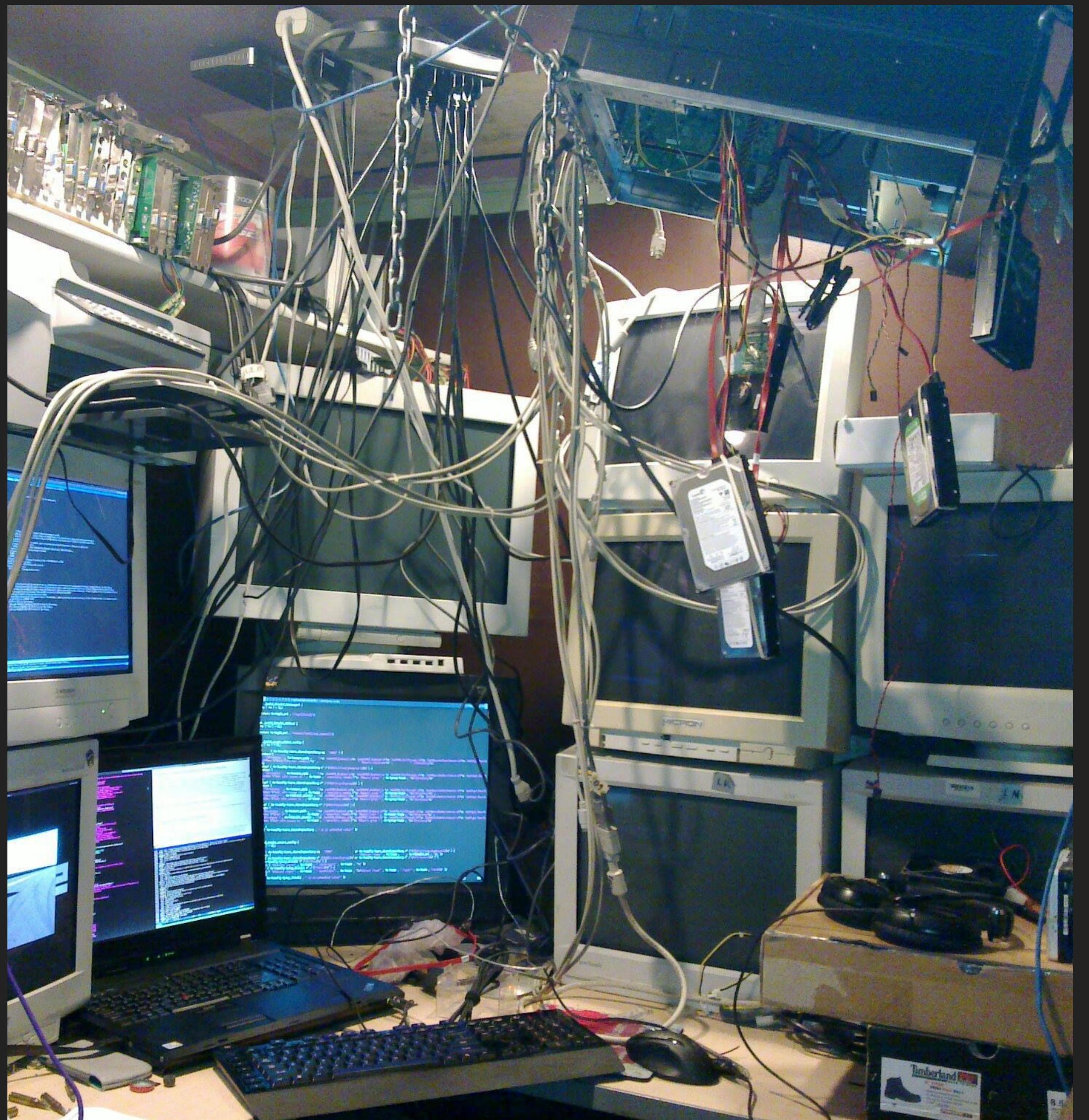
- ▶ This process could take months



"The sooner you start to code, the longer the program will take." - Roy Carlson

ON PREMISES DATA CENTERS

- ▶ Must over-provision to handle volume spikes
- ▶ This means there is a lot of idle, wasted resources



"There are 2 hard problems in computer science: cache invalidation, naming things, and off-by-1 errors." - Unknown

ON PREMISES DATA CENTERS

- ▶ Do not discount the challenges of the physical world
- ▶ During an office move someone knocked over a server and broke the key off in the cage lock
- ▶ We had a hornet's nest fall into an air conditioning fan
- ▶ We found people making s'mores over a fire in our outdoor generator



“Any fool can write code that a computer can understand. Good programmers write code that humans can understand.” – Martin Fowler

RESPONSIBILITY SPLIT

On Premises					
Functions					
Program					
Runtime					
Containers					
OS/VMs					
Servers/Network/Storage					
Physical World					

Cloud Vendor's Responsibility

"Sometimes it pays to stay in bed on Monday, rather than spending the rest of the week debugging Monday's code." - Christopher Thompson

DATA CENTERS

- ▶ We can now use this image
- ▶ Abstracts the physical hosting environment
- ▶ Costs can be shared with other customers
 - ▶ Air Conditioning
 - ▶ UPS
 - ▶ Physical Security
- ▶ They probably have more experience running a data center than your team does
- ▶ You still have to do things like over provisioning and order & waiting
- ▶ Hardware as the unit of scale



"In programming, the hard part isn't solving problems, but deciding what problems to solve." - Paul Graham

RESPONSIBILITY SPLIT

On Premises	Data Center				
Functions	Functions				
Program	Program				
Runtime	Runtime				
Containers	Containers				
OS/VMs	OS/VMs				
Servers/Network/Storage	Servers/Network/Storage				
Physical World	Physical World				

Cloud Vendor's Responsibility

"Beware of bugs in the above code; I have only proved it correct, not tried it." - Donald Knuth

Infrastructure as a Service (IaaS)

- ▶ All the hardware is abstracted away from you allowing you to focus on the other layers
- ▶ You control everything from the Operating System / Virtual Machine up
- ▶ You use API calls to provision infrastructure
 - ▶ No longer ordering & waiting
 - ▶ Operating system as the unit of scale



"When debugging, novices insert corrective code; experts remove defective code." - Richard Pattis

Infrastructure as a Service (IaaS)

- ▶ You still have to:
 - ▶ Install, configure and maintain the OS/VM
 - ▶ Manage Middleware
 - ▶ Tools like Chef, Puppet and Ansible made this a little bit more manageable
 - ▶ AWS OpsWorks is a service to run Chef or Puppet recipes in AWS
 - ▶ Operating system as the unit of scale



"If software cannot be maintained, then it will be rewritten" – Dave Cheney

Infrastructure as a Service (IaaS)

- ▶ AWS EC2
 - ▶ August 25, 2006 - Limited Public Beta
- ▶ Azure VMs
- ▶ GCP Compute Engine
- ▶ Rackspace
- ▶ Digital Ocean



"You should not have a favorite ~~weapon~~ programming language. To become over-familiar with one ~~weapon~~ programming language is as much a fault as not knowing it sufficiently well" – Miyamoto Musashi

RESPONSIBILITY SPLIT

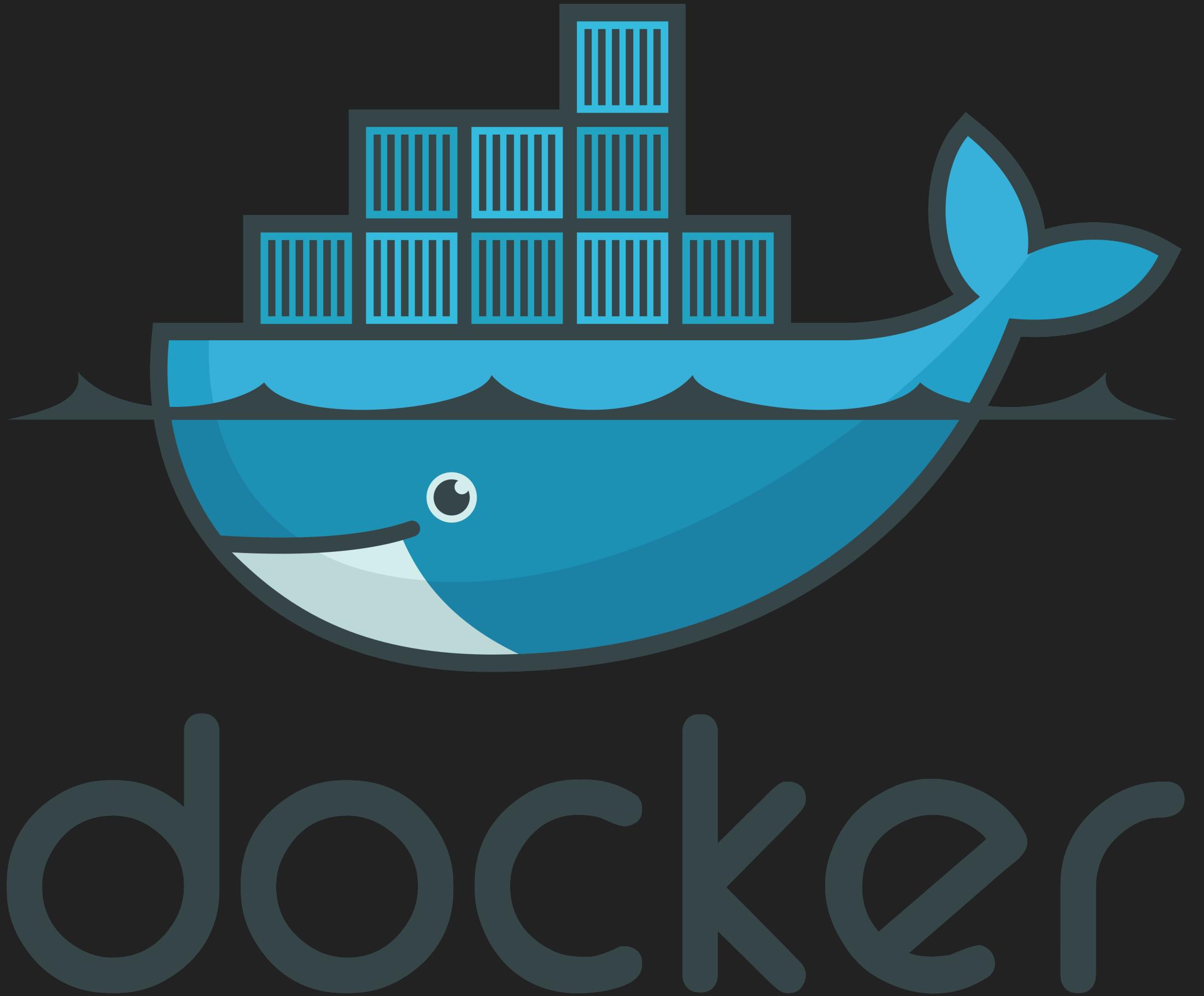
On Premises	Data Center	IaaS			
Functions	Functions	Functions			
Program	Program	Program			
Runtime	Runtime	Runtime			
Containers	Containers	Containers			
OS/VMs	OS/VMs	OS/VMs			
Servers/Network/Storage	Servers/Network/Storage	Servers/Network/Storage			
Physical World	Physical World	Physical World			

Cloud Vendor's Responsibility

"In theory, there is no difference between theory and practice. But, in practice, there is."
- Jan L. A. van de Snepscheut

Containers as a Service (CaaS)

- ▶ You are able to build, run and test your applications on your local machine
- ▶ Once you have a workable solution you can ship it to your cloud vendor and it will work as expected
- ▶ We got bit by time zone differences
- ▶ You no longer needed to manage the operating system
- ▶ Container deployment managed by the cloud vendor
- ▶ Container as the unit of scale



"Software being 'Done' is like lawn being 'Mowed'." - Jim Benson

Containers as a Service (CaaS)

- ▶ AWS Elastic Container Services (ECS)
 - ▶ April 9, 2015
- ▶ AWS Elastic Kubernetes Service (EKS)
 - ▶ June 5, 2018
- ▶ Google Kubernetes Engine (GKE)
- ▶ Azure Container Services (ACS)



kubernetes

“From a programmer’s point of view, the user is a peripheral that types when you issue a read request.” – P. Williams

RESPONSIBILITY SPLIT

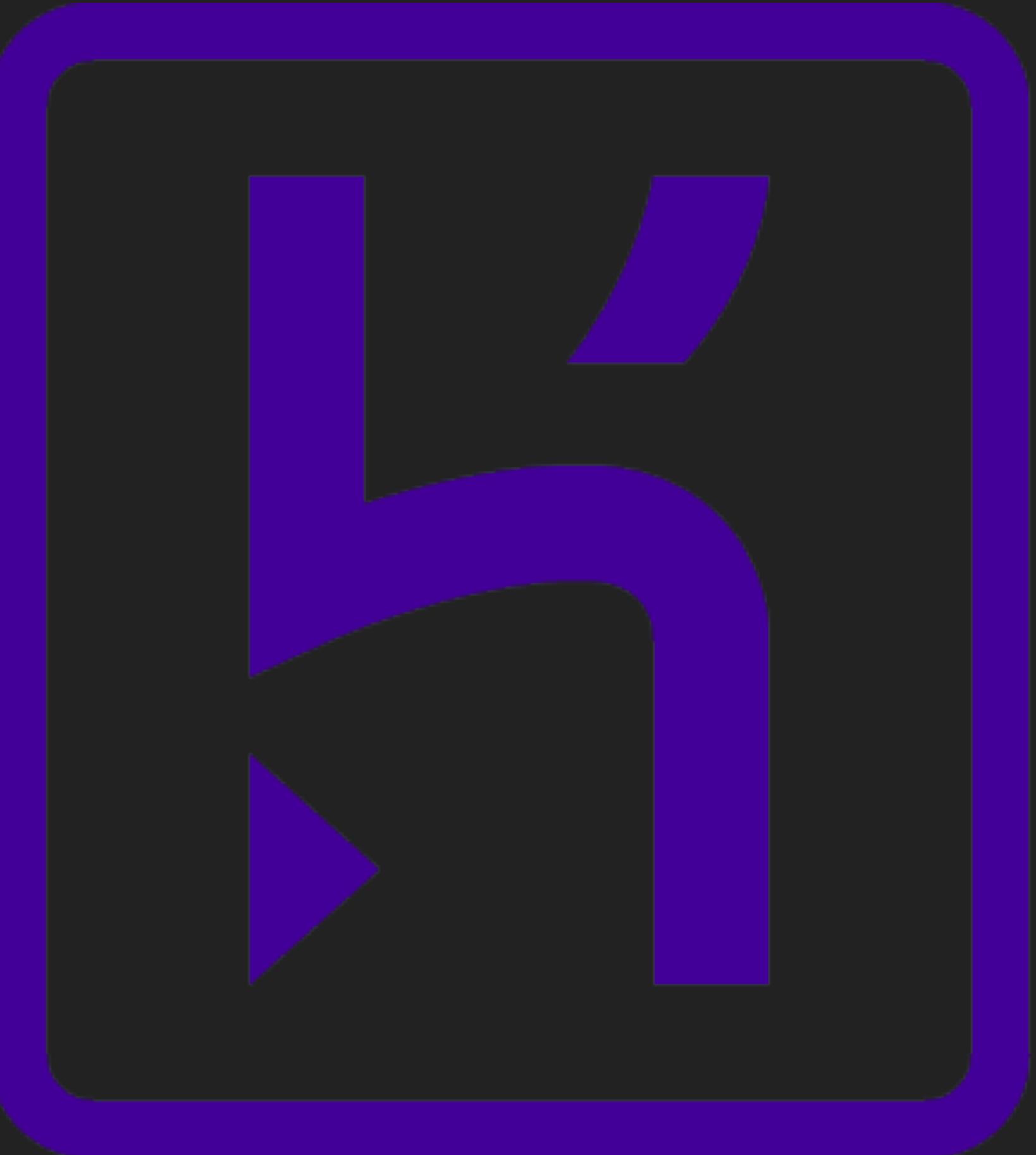
On Premises	Data Center	IaaS	CaaS	
Functions	Functions	Functions	Functions	
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Cloud Vendor's Responsibility

"Weeks of coding can save you hours of planning." - Unknown

Platform as a Service (PaaS)

- ▶ Provides you a platform on top of which to build
- ▶ This includes managing the:
 - ▶ Server
 - ▶ Network
 - ▶ Storage
 - ▶ OS
 - ▶ Virtualization
 - ▶ Runtimes
- ▶ You only pay for the resources your application creates

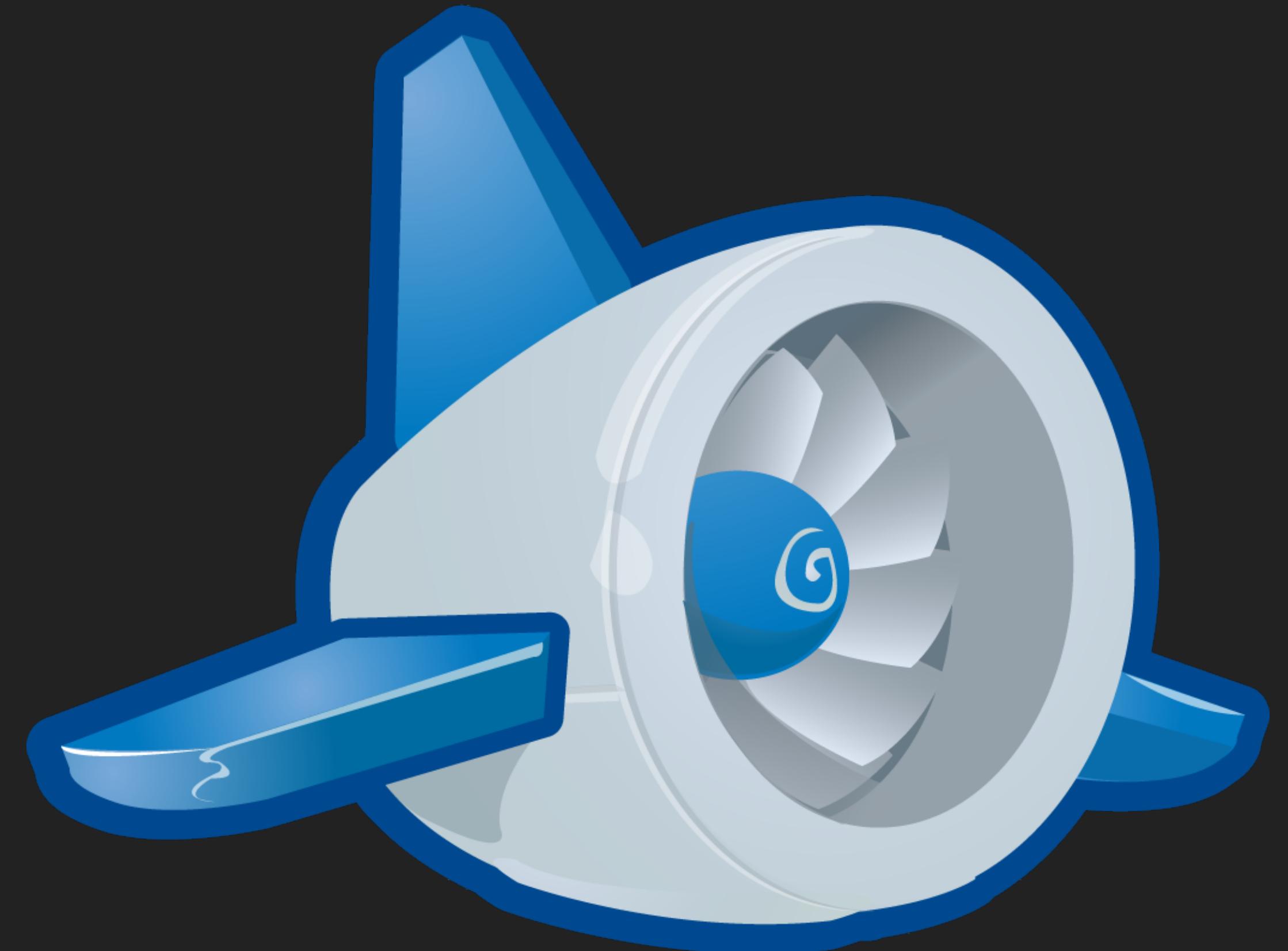


HEROKU

"A computer is like a mischievous genie. It will give you exactly what you ask for, but not always what you want." - Joe Sondow

Platform as a Service (PaaS)

- ▶ You get the hardware bundled up with the platform overlay to control the hardware
- ▶ You upload your code and the service will take care of deploying and running your application
- ▶ But there are still servers running your code and when the servers aren't doing anything you're still being charged



"The most secure code in the world is code which is never written." - Colin Percival

Platform as a Service (PaaS)

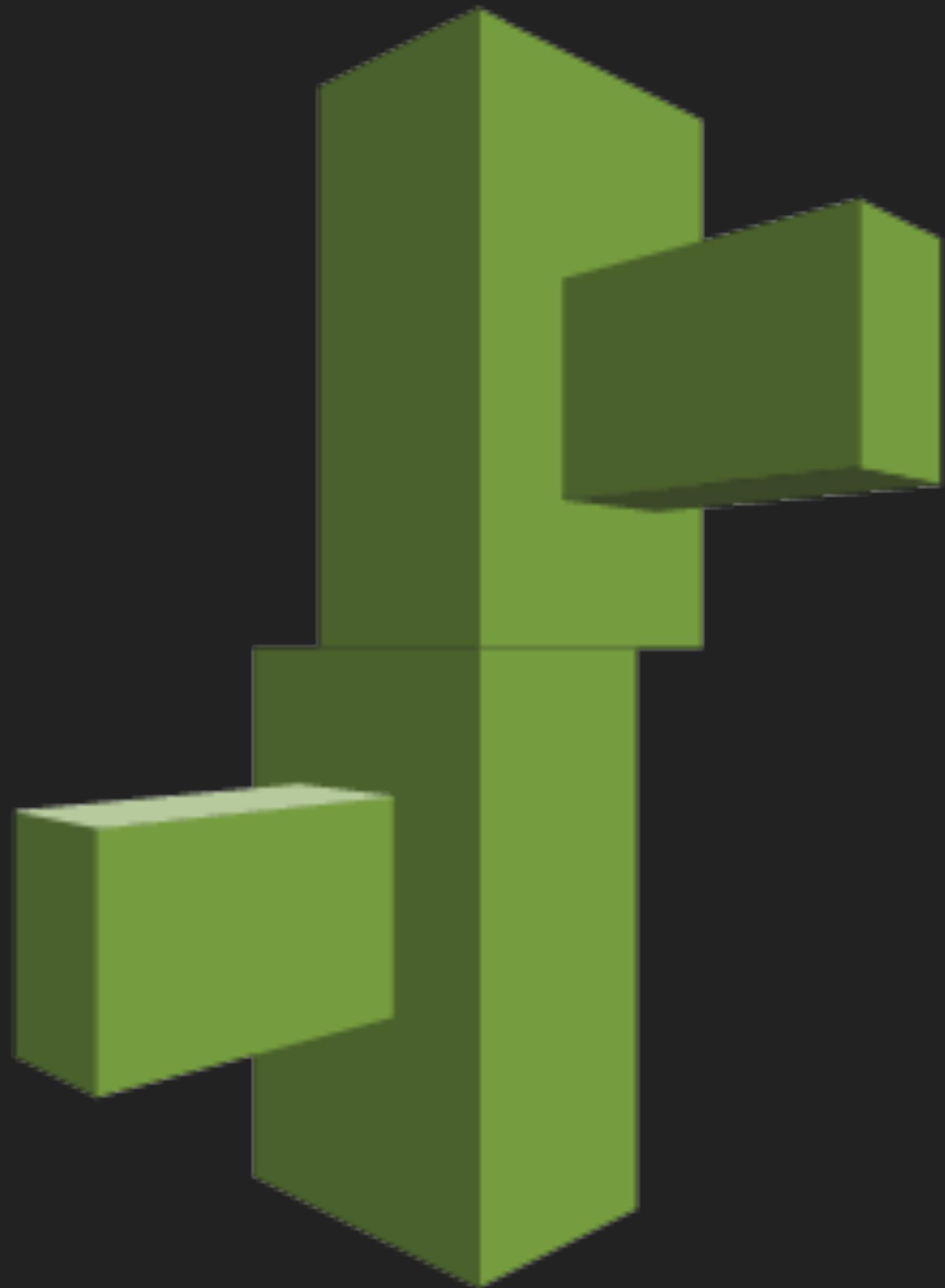
- ▶ You provide the application, they spin up a service and keep it running.
- ▶ There is still a dedicated VM to run your code
- ▶ To scale up, new VMs need to be provisioned which takes time and happens in large steps
- ▶ Application as the unit of scale



"Always implement things when you actually need them, never when you just foresee that you need them." - Ron Jeffries

Platform as a Service (PaaS)

- ▶ AWS Elastic Beanstalk
 - ▶ January 19, 2011
- ▶ Heroku
- ▶ Google App Engine
- ▶ AppHarbor



"One of the best programming skills you can have is knowing when to walk away for awhile." - Oscar Godson

RESPONSIBILITY SPLIT

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Physical World					

Cloud Vendor's Responsibility

"In carpentry you measure twice and cut once. In software development you never measure and make cuts until you run out of time." - Adam Morse

Function as a Services (FaaS)

- ▶ We just supply a function rather than an entire application to be executed.
- ▶ These functions:
 - ▶ Have small, targeted responsibilities
 - ▶ Are completely stateless which makes them scale effortlessly
 - ▶ Only run when needed
 - ▶ Function is executed in response to an event
 - ▶ The function is the unit of scale



"So much complexity in software comes from trying to make one thing do two things." - Ryan Singer

Function as a Services (FaaS)

- ▶ AWS Lambda
 - ▶ November 13, 2014 - Preview
- ▶ Azure Functions
- ▶ Google Cloud Functions



"The trouble with programmers is that you can never tell what a programmer is doing until it's too late." - Seymour Cray

RESPONSIBILITY SPLIT

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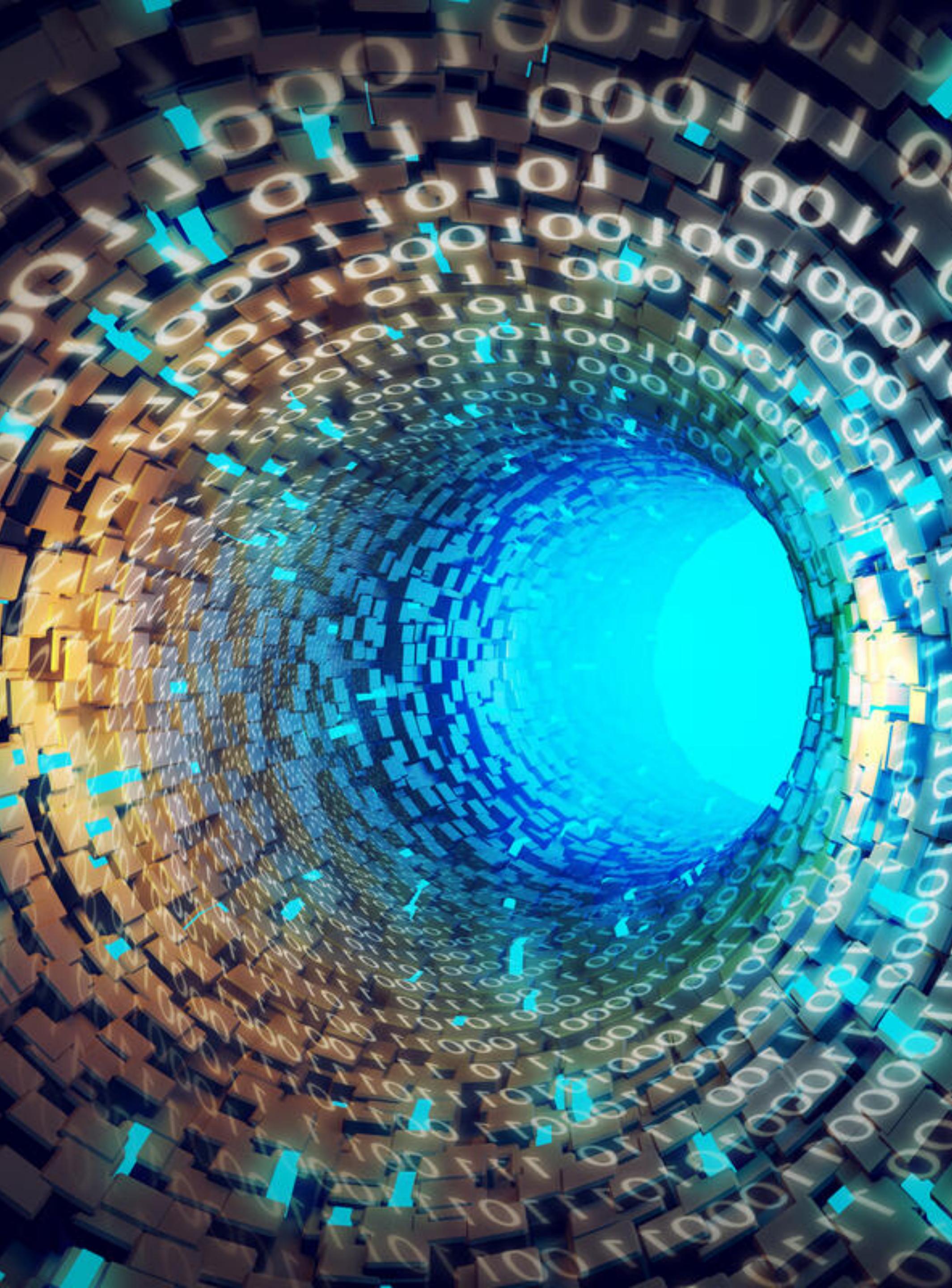
Cloud Vendor's Responsibility

"Programming is like pinball. The reward for doing it is the opportunity of doing it again." - Unknown

Other -aaSes

- ▶ BaaS - Backend as a Services (a.k.a MBaaS - Mobile Backend as a Service)
 - ▶ Platform containing all the services needed to create a backend
 - ▶ Examples: Firebase, PubNub, Backendless
- ▶ SaaS - Software as a Service
 - ▶ Business logic is created for you. You just need to sign up and use the service.
 - ▶ Examples: Gmail, Facebook, Princeton TMX





WHAT IS

SERVERLESS



Werner Vogels, CTO, Amazon

"No server is easier to manage than no server at all."



WERNER VOGELS
CTO, AMAZON.COM

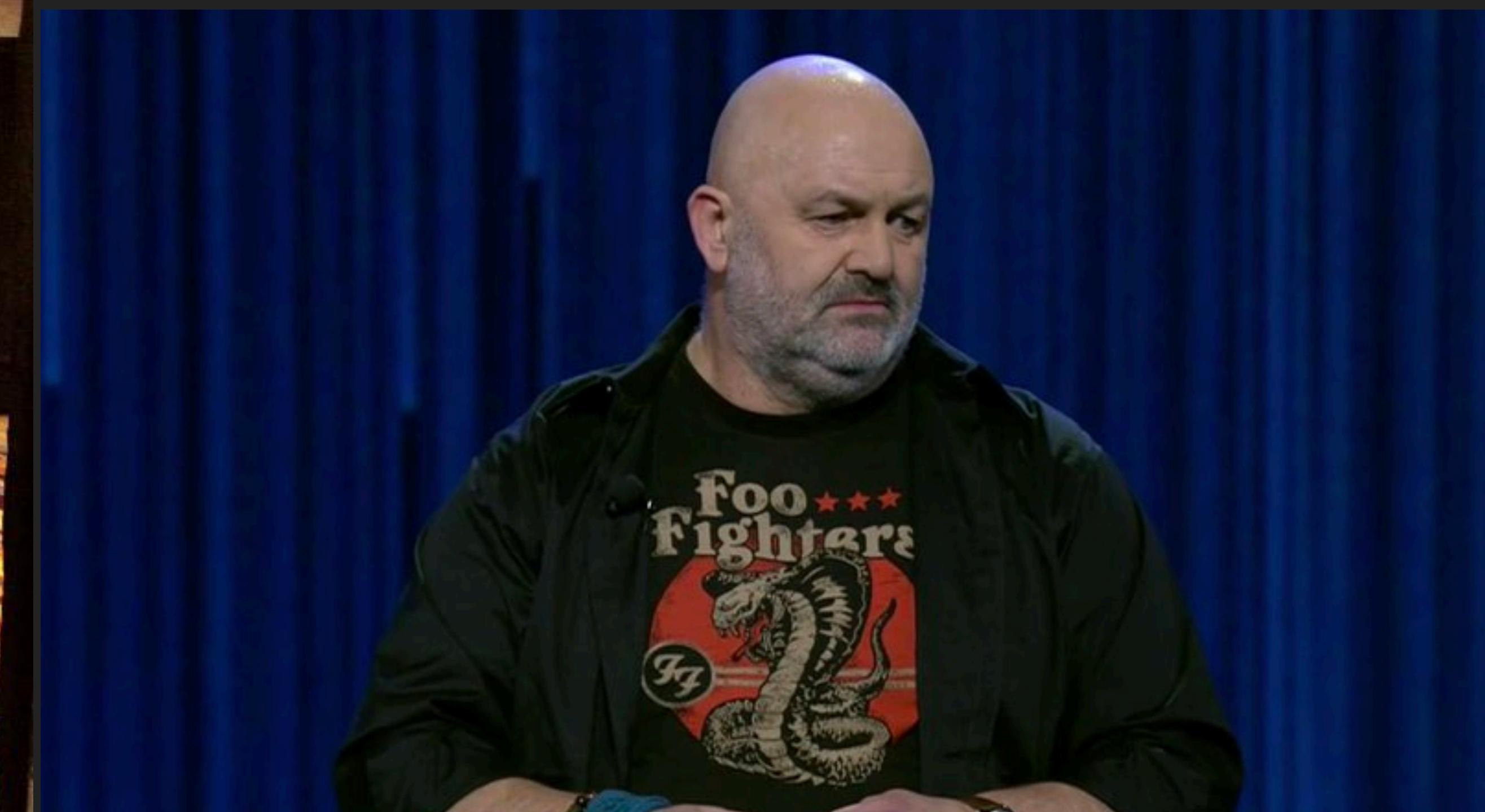
Werner Vogels, CTO, Amazon

**“Dance like no one is watching.
Encrypt like EVERYONE is.”**



Werner Vogels, CTO, Amazon

**“Dance like no one is watching.
Encrypt like EVERYONE is.”**





Werner Vogels, CTO, Amazon

"No server is easier to manage than no server at all."

"A program is never less than 90% complete, and never more than 95% complete." – Terry Baker

WHAT IS SERVERLESS?

- ▶ There are still servers
- ▶ But you don't manage them
- ▶ Pricing is based on the amount of resources consumed
 - ▶ Memory Allocated
 - ▶ Execution Time



<https://aws.amazon.com/serverless/>

What is serverless?

- ▶ Serverless is the native architecture of the cloud that enables you to shift more of your operational responsibilities to AWS, increasing your agility and innovation.
- ▶ Serverless allows you to build and run applications and services without thinking about servers. It eliminates infrastructure management tasks such as server or cluster provisioning, patching, operating system maintenance, and capacity provisioning.



AWS Serverless Architectures with AWS Lambda Whitepaper

- ▶ No Server Management
 - ▶ You don't have to provision or maintain any servers
 - ▶ There is no software or runtime to install, maintain or administer



AWS Serverless Architectures with AWS Lambda Whitepaper

- ▶ Flexible Scaling
 - ▶ You can scale your application automatically or by adjusting its capacity through toggling the units of consumptions (for example throughput or memory) rather than units of individual servers



AWS Serverless Architectures with AWS Lambda Whitepaper

- ▶ High Availability
 - ▶ Serverless applications have built-in availability and fault tolerance
 - ▶ You don't need to architect for these capabilities because the services running the application provide them by default



AWS Serverless Architectures with AWS Lambda Whitepaper

- ▶ No idle capacity
 - ▶ You don't have to pay for idle capacity
 - ▶ There is no need to pre-provision or over-provision capacity for things like compute and storage
 - ▶ There is no charge when your code isn't running



"The cleaner and nicer the program, the faster it's going to run. And if it doesn't, it'll be easy to make it fast." - Joshua Bloch

SERVERLESS BENEFITS

- ▶ It's serverless!
 - ▶ No servers to maintain
- ▶ Scalable
- ▶ Low Cost
- ▶ Less Code



"The best programs are the ones written when the programmer is supposed to be working on something else." - Melinda Varian

SERVERLESS BENEFITS

- ▶ You don't have to manage any servers, VMs or containers
- ▶ Highly available by default
- ▶ Fault tolerant by default
- ▶ You only pay for what you use
- ▶ Faster time to market because you're no longer working on the infrastructure



"Programming: when the ideas turn into the real things." - Maciej Kaczmarek

SERVERLESS DRAWBACKS

- ▶ Education
- ▶ Serverless is still pretty new so it's hard to learn from other's experiences
- ▶ It requires a complete mental shift from traditional systems
- ▶ No control of the underlying systems



"One of my most productive days was throwing away 1000 lines of code." - Ken Thompson

SERVERLESS DRAWBACKS

- ▶ Reliant on Cloud Provider
- ▶ If the services goes down you are at the mercy of the provider to fix the issue
- ▶ Tools & Best Practices are still being developed



AWS SERVERLESS OFFERINGS

- ▶ Compute
 - ▶ Lambda, ECS Fargate (EKS Fargate coming?)
- ▶ Storage
 - ▶ S3, EFS
- ▶ Data Stores
 - ▶ DynamoDB, Aurora Serverless
- ▶ API Proxy
 - ▶ API Gateway
- ▶ Application Integration
 - ▶ SNS, SQS, AppSync, EventBridge
- ▶ Orchestration
 - ▶ Step Functions
- ▶ Analytics
 - ▶ Kinesis, Athena





HOW DOES IT WORK?

AWS LAMBDA

"Sometimes, the elegant implementation is just a function. Not a method. Not a class. Not a framework. Just a function." - John Carmack

THE BASICS

- ▶ Lambda is Amazon's FaaS offering
- ▶ You pay by the 100 ms and by how much memory you've configured
 - ▶ Charged in GB-Seconds
- ▶ You do not pay for idle resources
- ▶ You pay only when events come in



"Every great developer you know got there by solving problems they were unqualified to solve until they actually did it." - Patrick McKenzie

EVENT SOURCES

- ▶ Schedules
- ▶ S3 Events
- ▶ DynamoDB Streams
- ▶ Kinesis Streams
- ▶ SNS Topics
- ▶ API Gateway
- ▶ CloudTrail Logs
- ▶ EC2 Lifecycle Events
- ▶ SDK Invocation



"Debuggers don't remove bugs. They only show them in slow motion." - Unknown

UNDER THE HOOD

- ▶ Your code executes in a container
- ▶ The EC2 instance is not accessible by you and is shared with other AWS customers
- ▶ You can only use the amount of RAM you have configured
 - ▶ Configuring more RAM costs you more money
- ▶ 100ms Execution Measurement
- ▶ 15 Minute Max (Used to be 5 minutes)
 - ▶ You define an timeout per Lambda functions and if the timeout is reached AWS terminates execution of your Lambda function
 - ▶ Timeouts can help keep your costs down
- ▶ AWS SDK Built-In



"Functions should do one thing. They should do it well. They should do it only." - Robert C. Martin

HOW DO WE CREATE LAMBDA FUNCTIONS

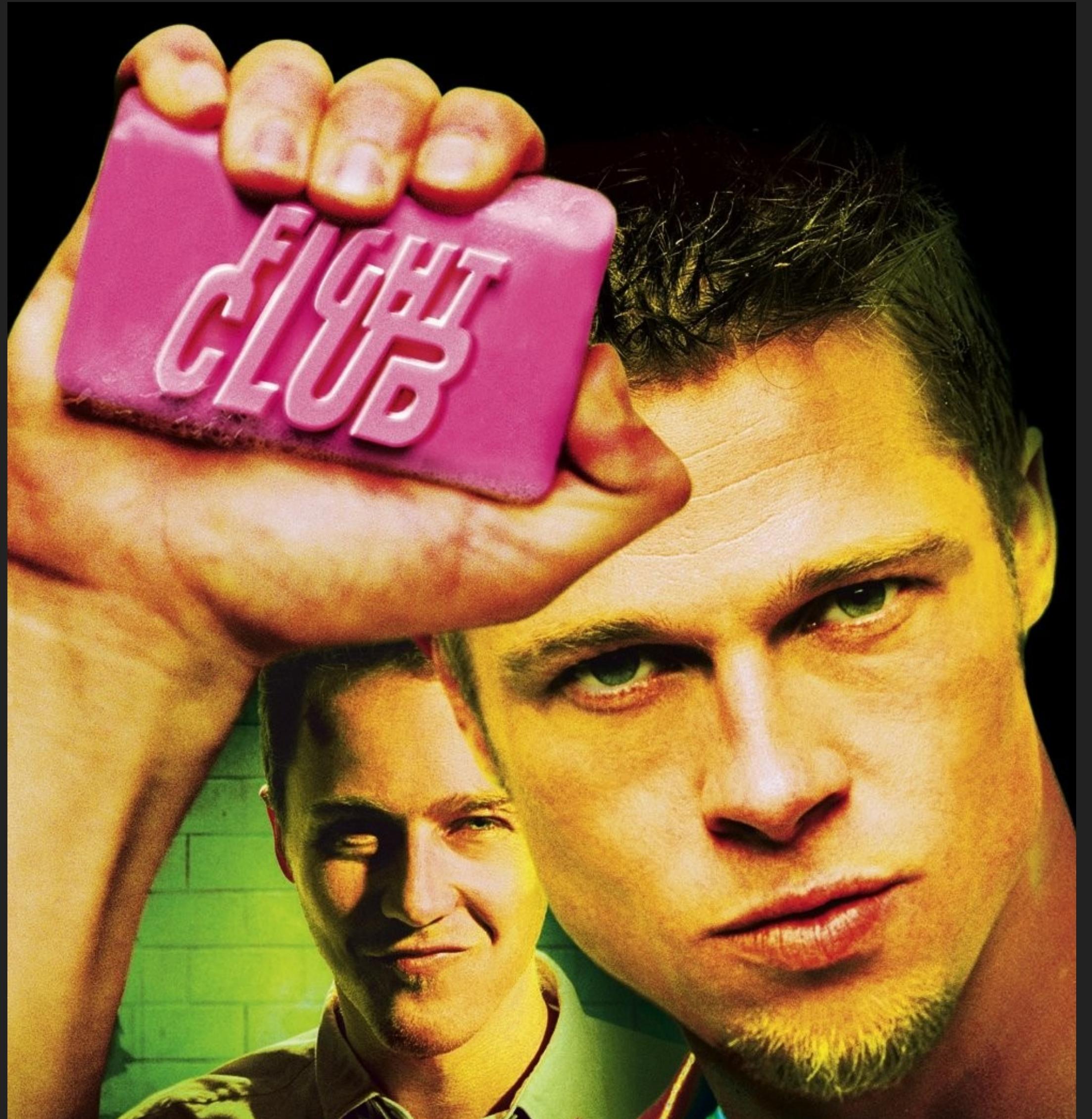
- ▶ AWS Console
 - ▶ Best suited for simple, one-off Lambdas
 - ▶ Good fit for AWS orchestration
 - ▶ We use this for starting and stopping our Test & QA environments
- ▶ AWS Serverless Application Model (SAM)
 - ▶ SAM templates leverage AWS CloudFormation to build out the infrastructure.
 - ▶ SAM CLI can be used to run Lambdas locally for development



The first rule of Fight Club is: You don't talk about Fight Club

RULES OF LAMBDA

- ▶ Follow the Single Responsibility Principle
- ▶ Make your functions stateless or AWS will do it for you
- ▶ Be aware of cold start impacts
- ▶ Be conscious of memory usage
 - ▶ You are charged in GB-Seconds
- ▶ Follow event driven design patterns





LINUS TORVALDS

**“TALK IS CHEAP.
SHOW ME THE CODE.”**