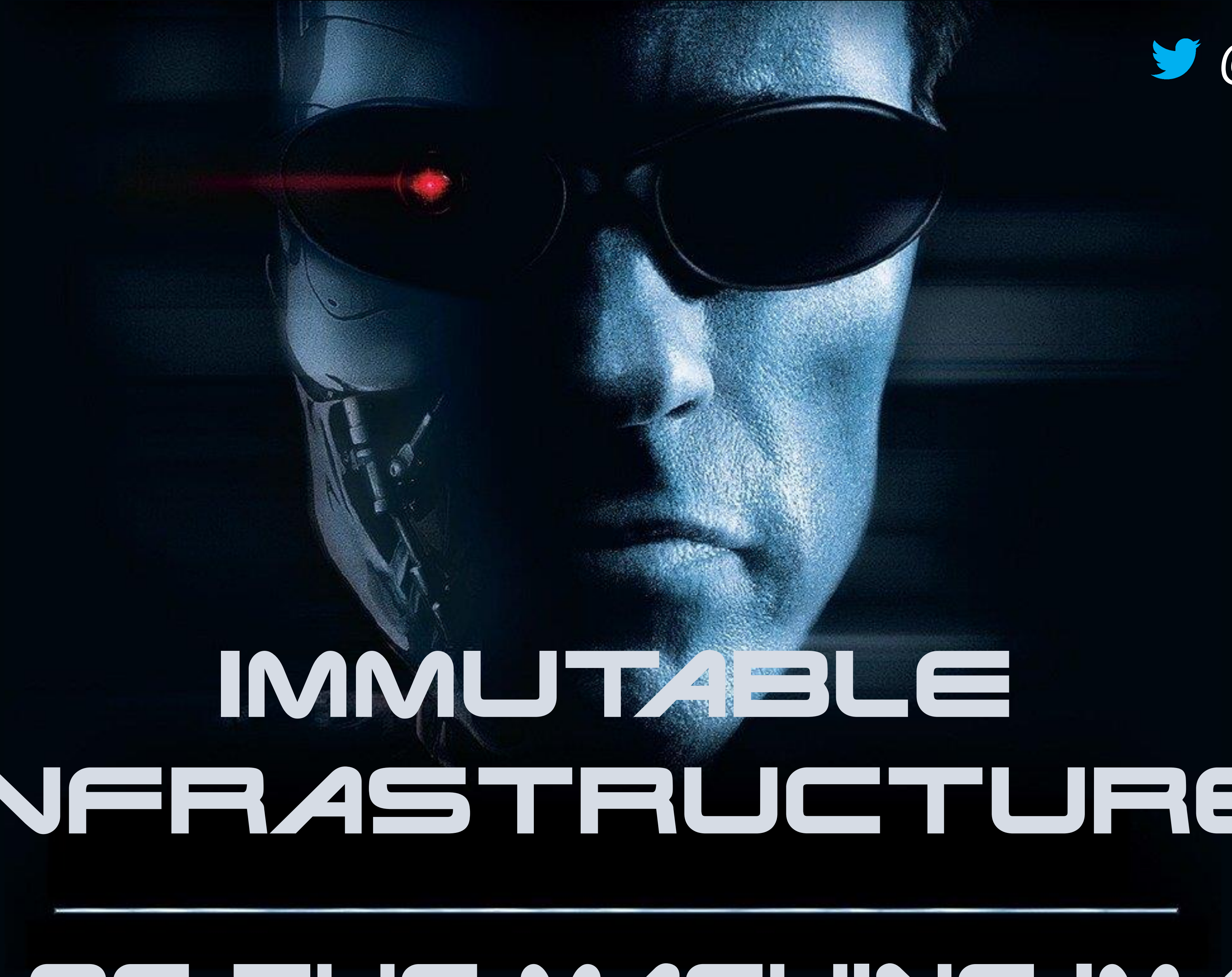
@axelfontaine



IMMUTABLE INFRASTRUCTURE

RISE OF THE MACHINE IMAGES

About Axel Fontaine

- Founder and CEO of Boxfuse
- Over 15 years industry experience
- Continuous Delivery expert
- Regular speaker at tech conferences
- JavaOne RockStar

@axelfontaine

boxfuse

flywaydb.org

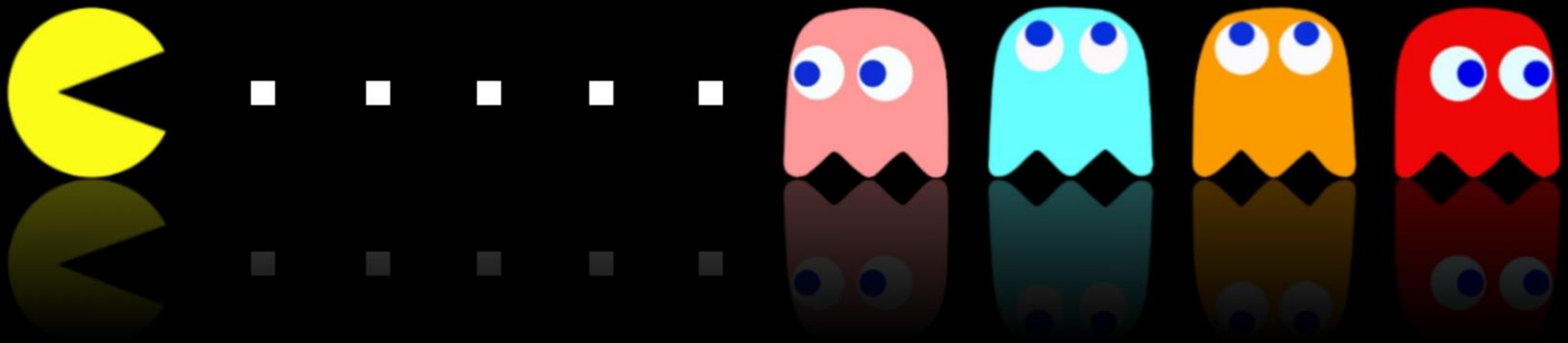
boxfuse

boxfuse.com

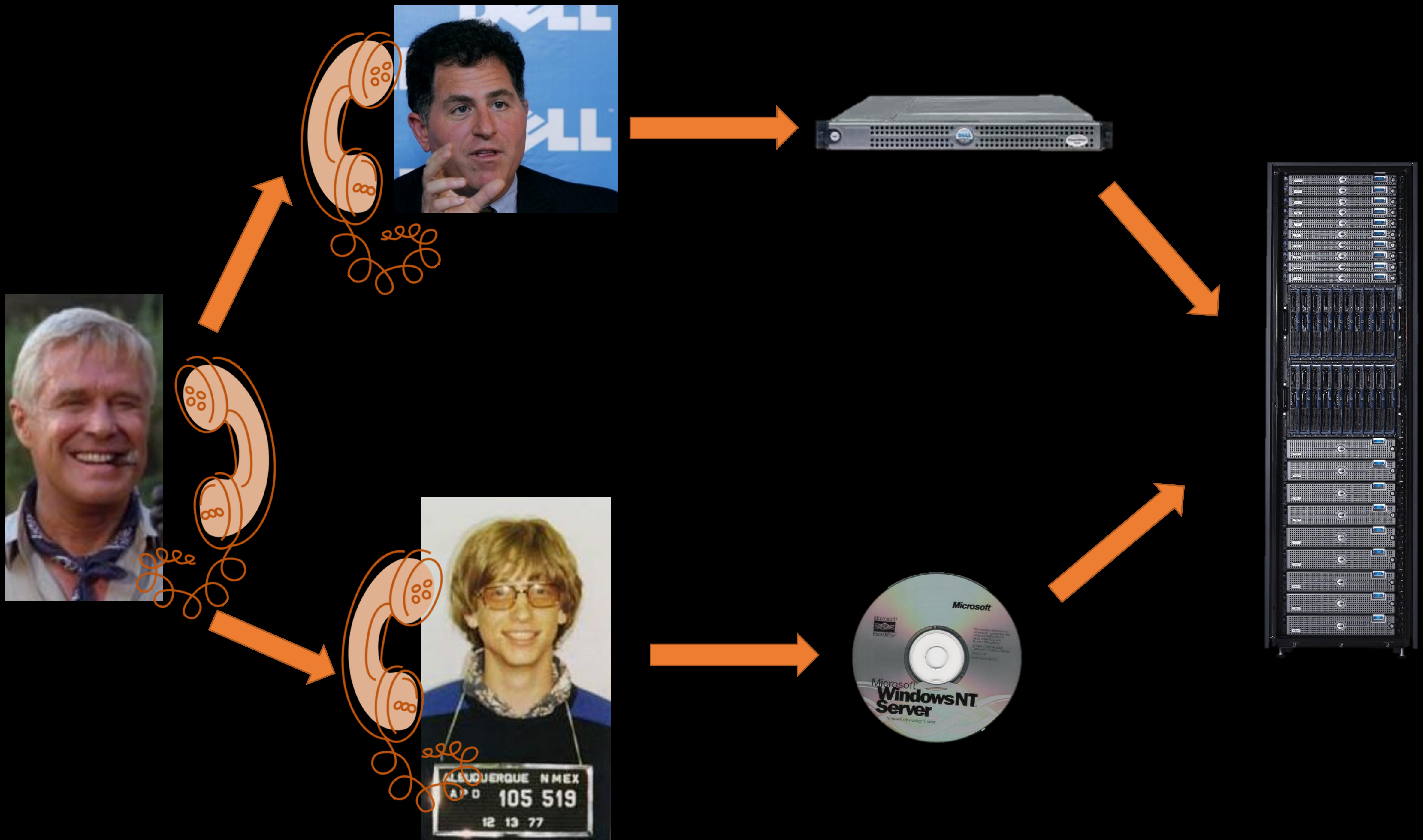
about

questions

sometime in the 20th century …



http://en.wikipedia.org/wiki/File:Tdkc60cassette.jpg


DELL
Microsoft
Microsoft Windows NT Server
ALBUQUERQUE N MEX
A P D 105 519
12 13 77

Challenges

ON PREM =

+

+

- ✓ OS Install
- ✓ OS Patching
- ✓ App Install
- ✓ App Updates

- ✓ Procurement
- ✓ Vendor Mgmt
- ✓ Capacity Plan.
- ✓ Financing

- ✓ Power
- ✓ Network
- ✓ Cooling
- ✓ Phys. Security
- ✓ Phys. Space

Challenges

ON PREM =

+

- ✓ OS In
- ✓

tor Mgmt

Capacity Plan.

- ✓ Financing

- ✓ Power
- ✓ Network
- ✓ Cooling
- ✓ Phys. Security
- ✓ Phys. Space

Lots of undifferentiated heavy lifting

FNB
GOLD Credit Card
4000 1234 5678 9010
4127
EXPIRES END 05/84
SARAH CONNOR
VISA

Challenges

ON PREM =

+

+

- ✓ OS Install
- ✓ OS Patching
- ✓ App Install
- ✓ App Updates

🕘 Hours

- ✓ Procurement
- ✓ Vendor Mgmt
- ✓ Capacity Plan.
- ✓ Financing

🕘 Days or Weeks

- ✓ Power
- ✓ Network
- ✓ Cooling
- ✓ Phys. Security
- ✓ Phys. Space

🕘 Months

boxfuse

Challenges

COLO =

+

+

- ✓ OS Install
- ✓ OS Patching
- ✓ App Install
- ✓ App Updates

◷ Hours

- ✓ Procurement
- ✓ Vendor Mgmt
- ✓ Capacity Plan.
- ✓ Financing

◷ Days or Weeks

- ✓ Power
- ✓ Network
- ✓ Cooling
- ✓ Phys. Security
- ✓ Phys. Space

◷ Months

Challenges

ROOT SERVER =

+

+

- ✓ OS Install
- ✓ OS Patching
- ✓ App Install
- ✓ App Updates

- ✓ Procurement
- ✓ Vendor Mgmt
- ✓ Capacity Plan.
- ✓ Financing

🕘 Hours

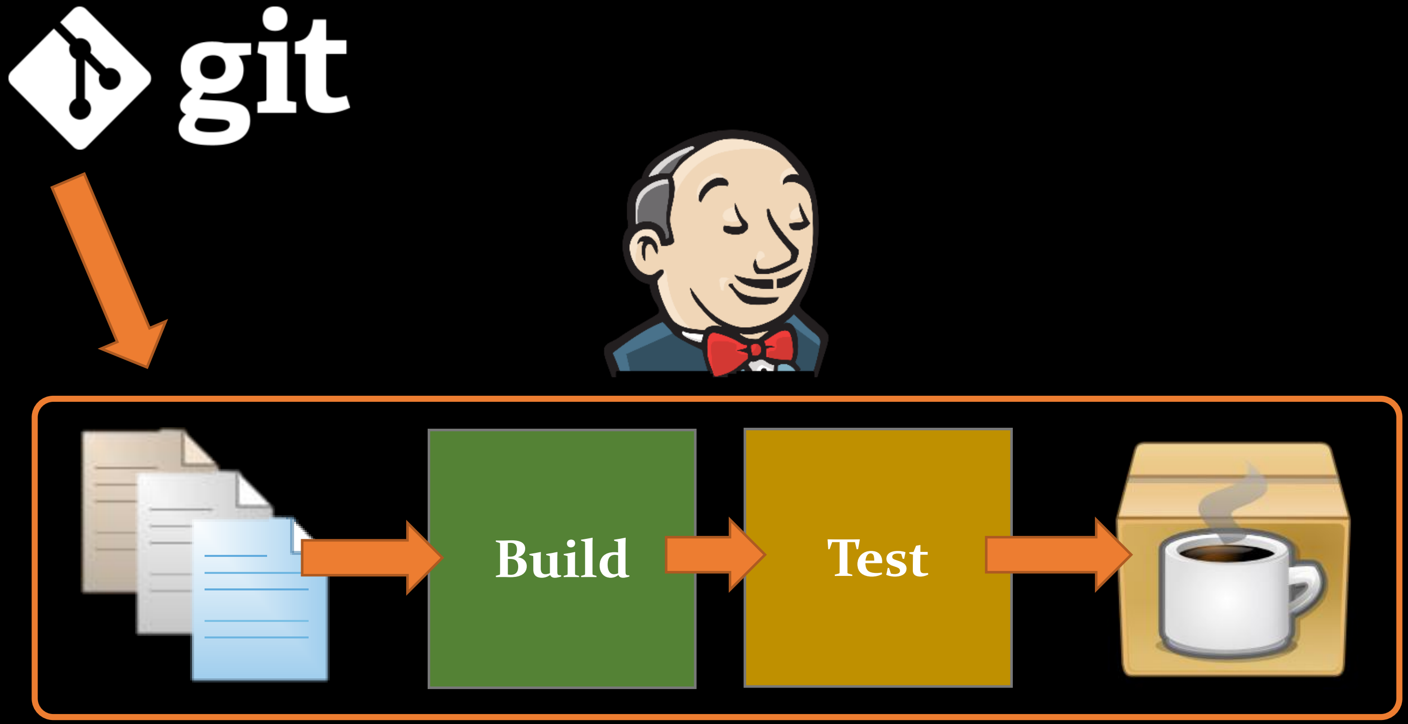
🕘 Days or Weeks

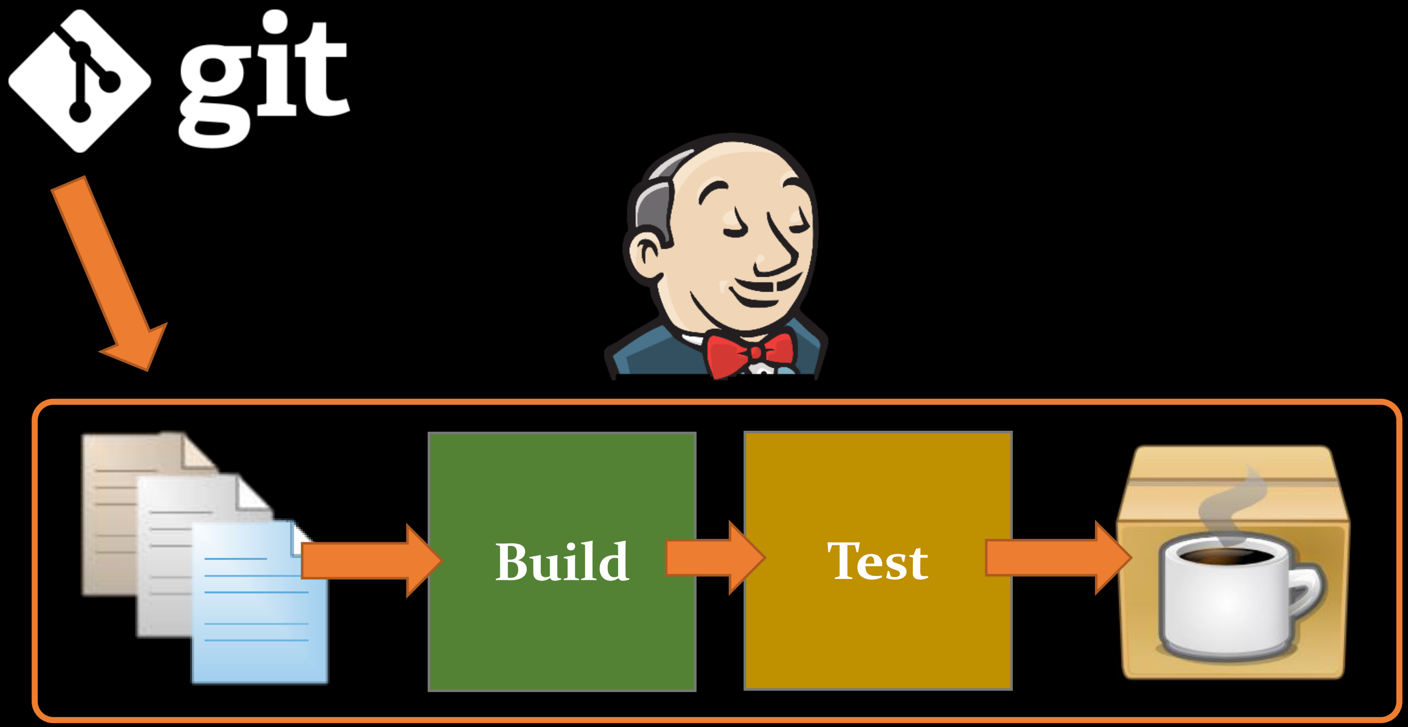
Let’s talk about software

- ✓ OS Install
- ✓ OS Patching
- ✓ App Install
- ✓ App Updates

POLL:
which level of automation are you at?

- ✓ Build
- ✓ Unit Tests
- ✓ Continuous Integration
- ✓ Acceptance Tests
- ✓ Continuous Deployment (Code)
- ✓ Continuous Deployment (Code + DB + Configuration)
- ✓ Infrastructure


git
Build
Test



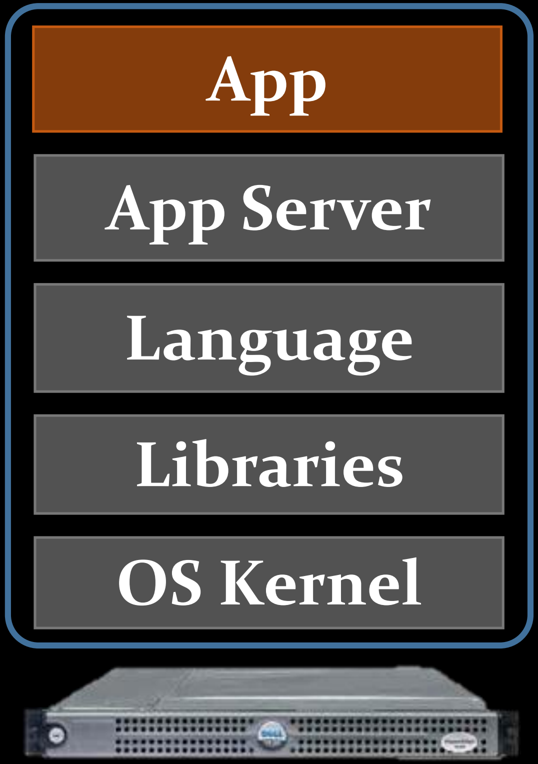
git

Build

Test

- One immutable unit
- Regenerated after every change
- Promoted from Environment to Environment

Classic Mistake: Build per Environment



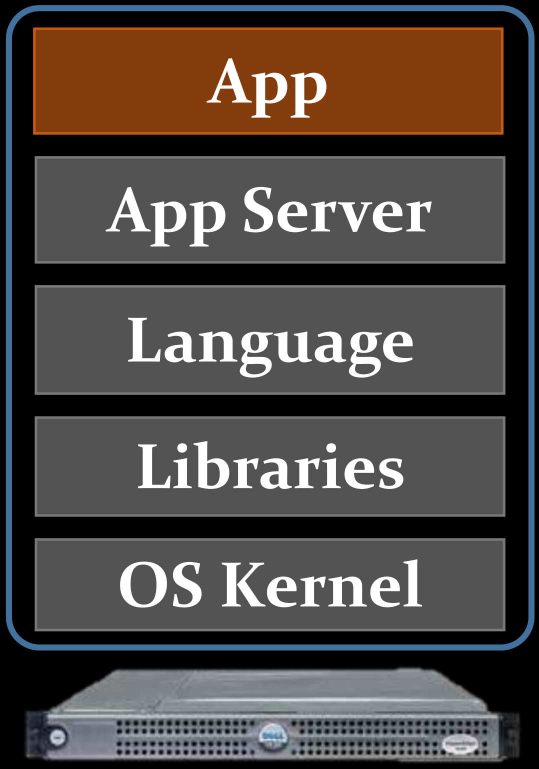
App

App Server

Language

Libraries

OS Kernel



App

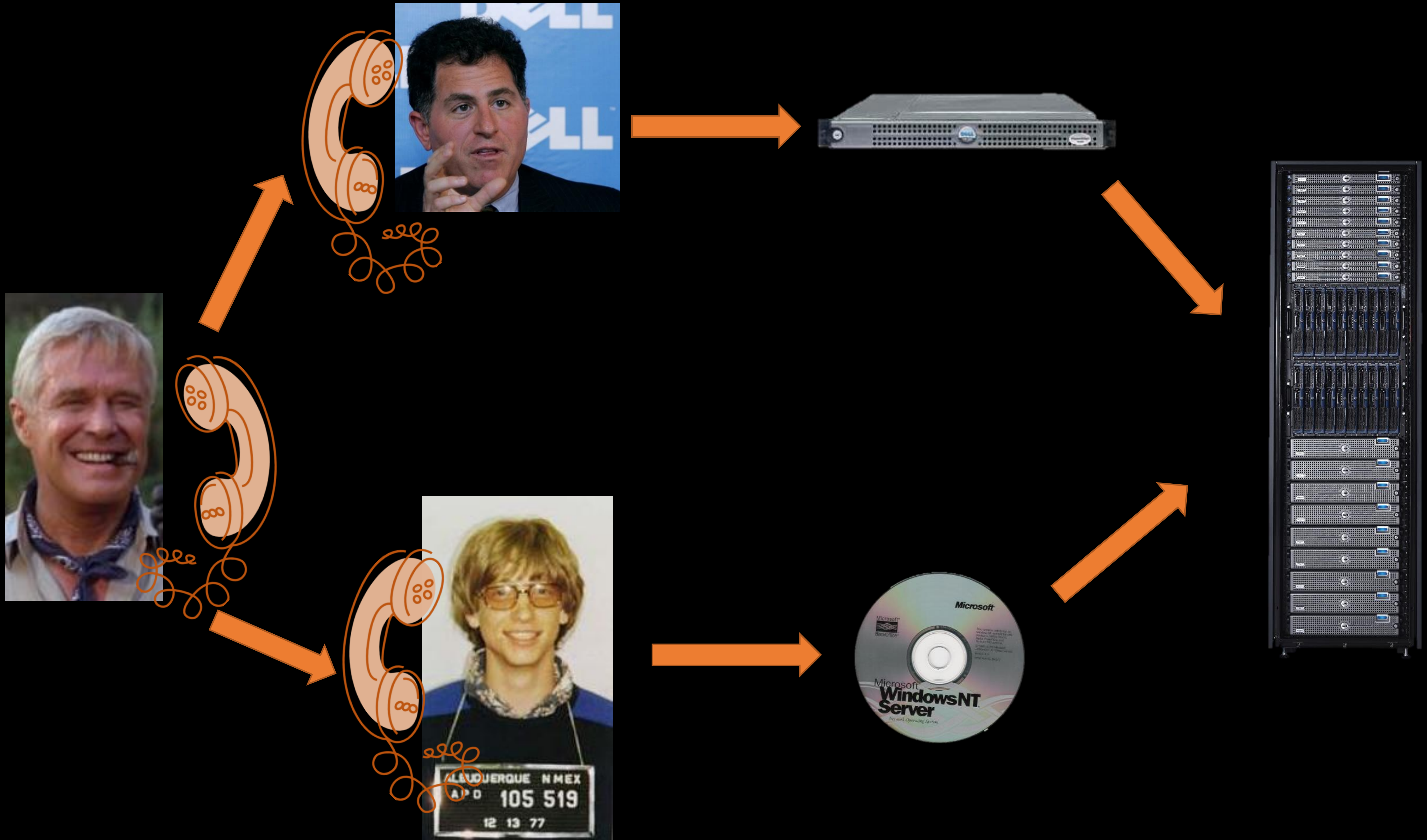
App Server

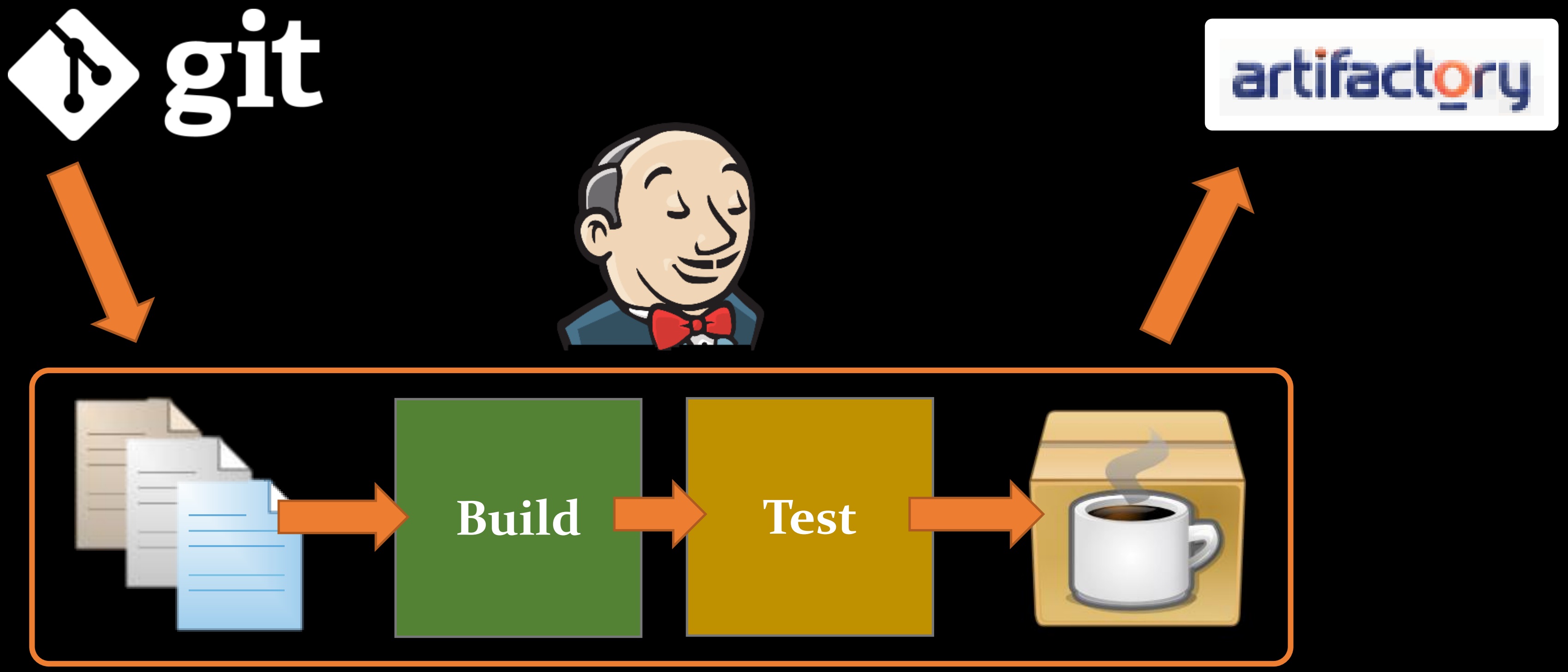
Language

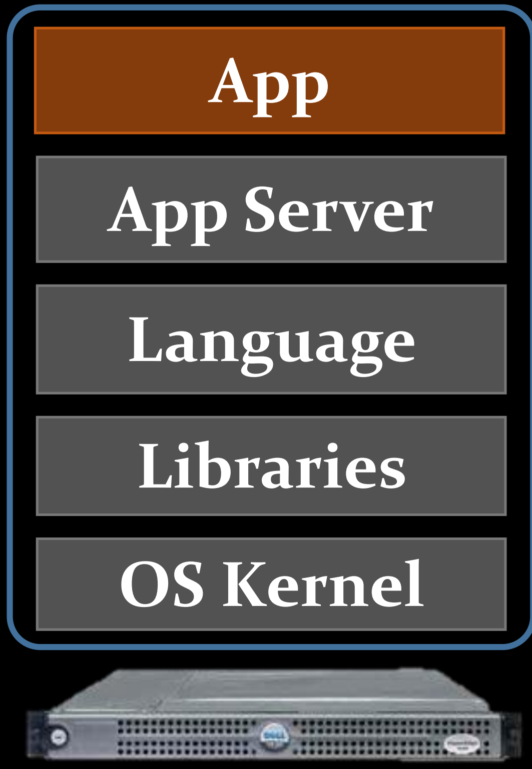
Libraries

OS Kernel

why aren’t we doing the same
for the layers this is running on ???


DELL
DELL
ALBUQUERQUE N MEX
APD 105 519
12 13 77
Microsoft
Microsoft BackOffice
Microsoft Windows NT Server
Network Operating System





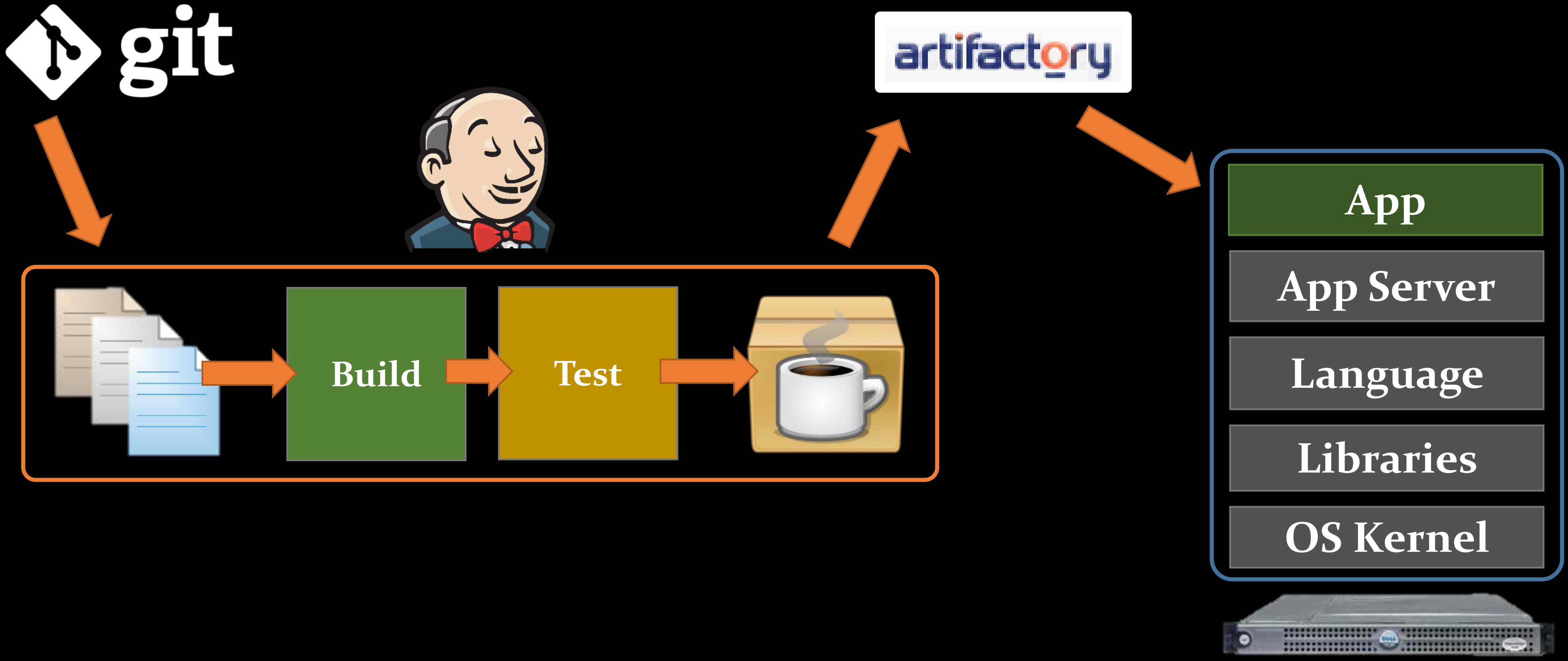
App

App Server

Language

Libraries

OS Kernel



Build

Test

App

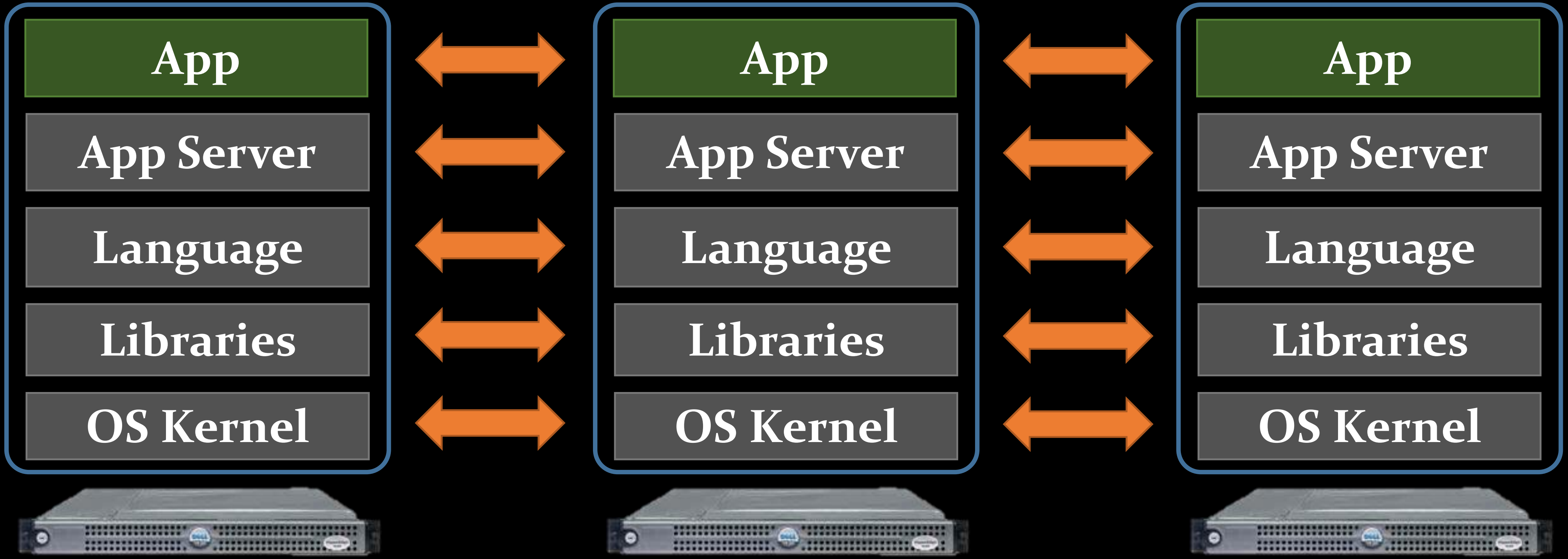
App Server

Language

Libraries

OS Kernel

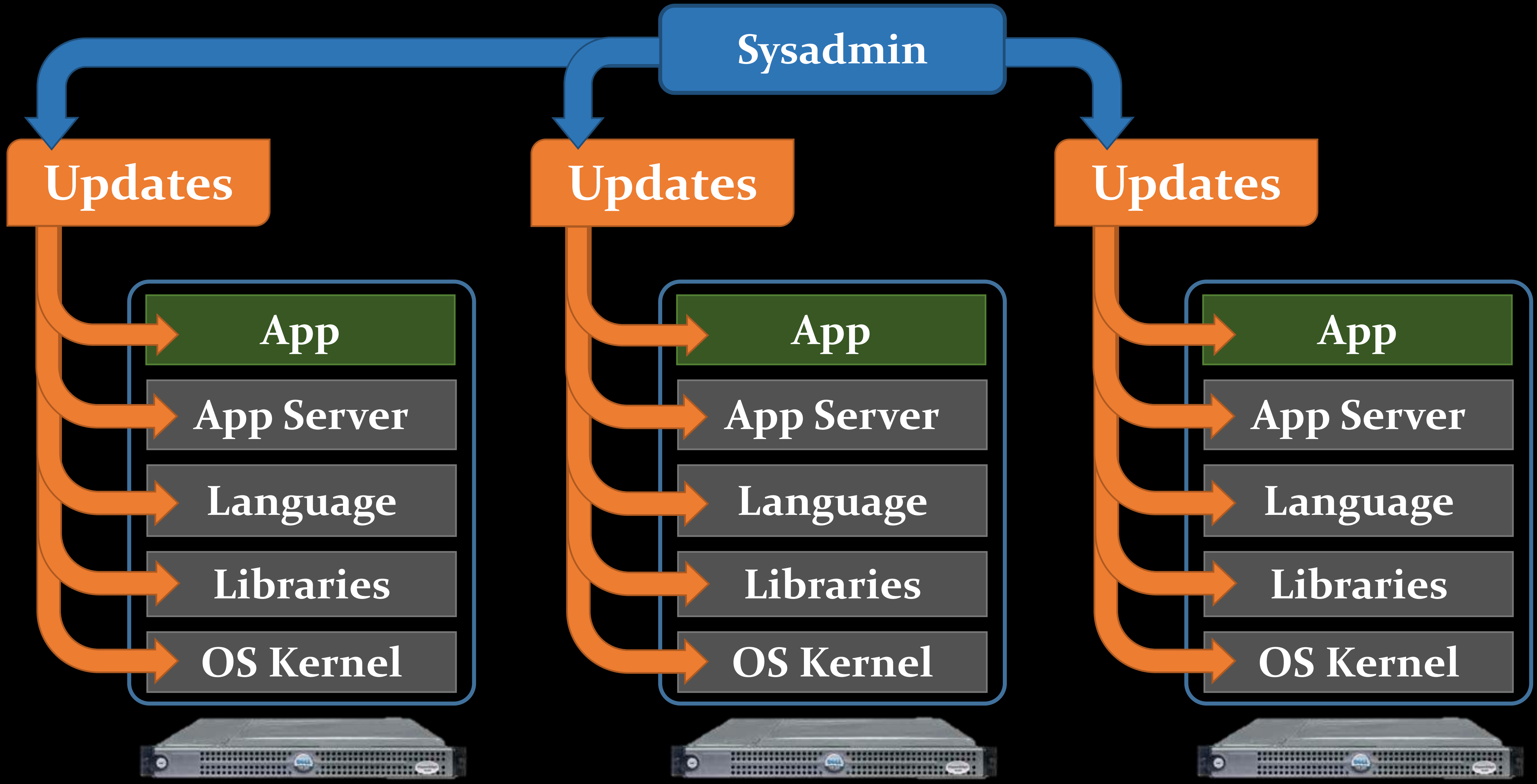
Any difference is a potential source of errors



App
App Server
Language
Libraries
OS Kernel

App
App Server
Language
Libraries
OS Kernel

App
App Server
Language
Libraries
OS Kernel



Sysadmin

Updates

App
App Server
Language
Libraries
OS Kernel

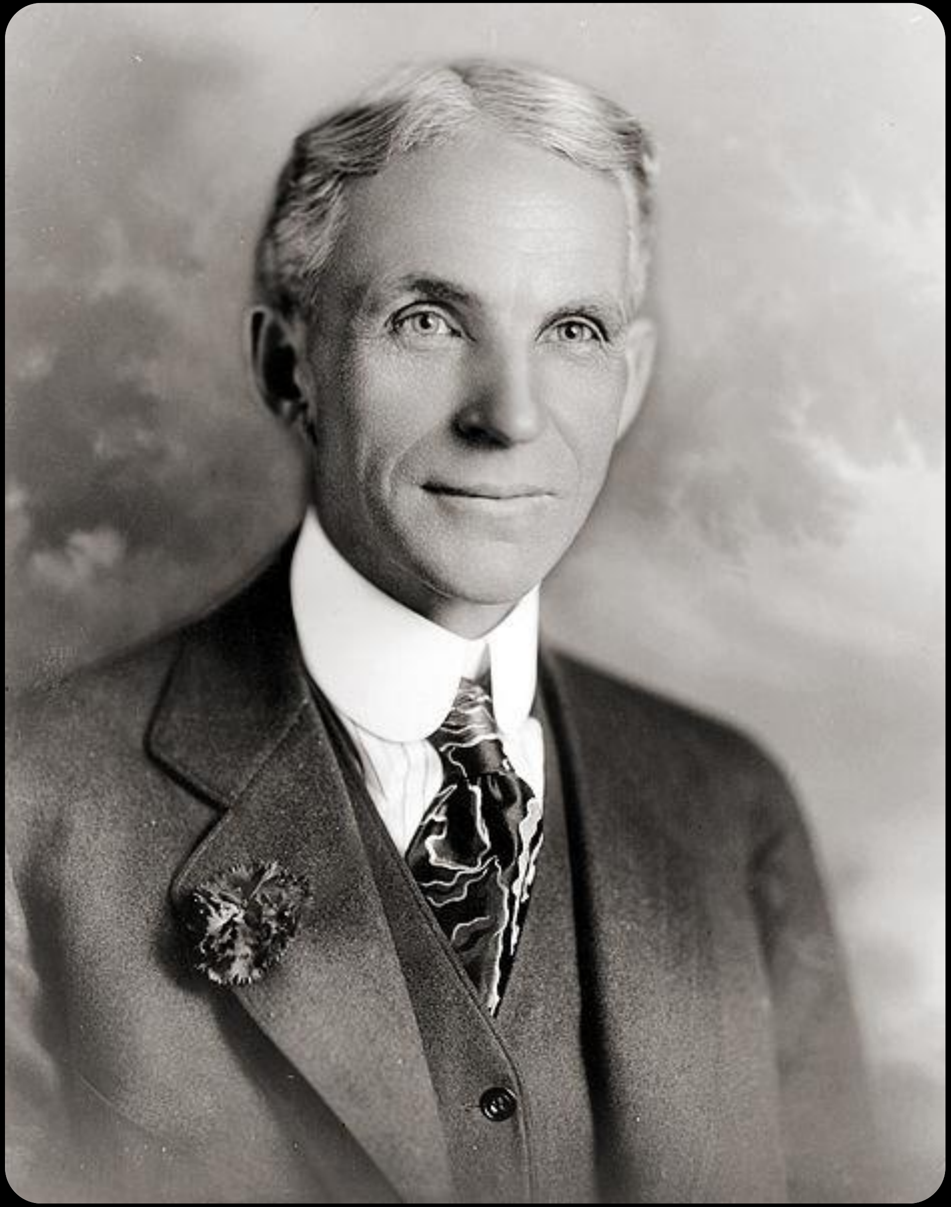
Updates

App
App Server
Language
Libraries
OS Kernel

Updates

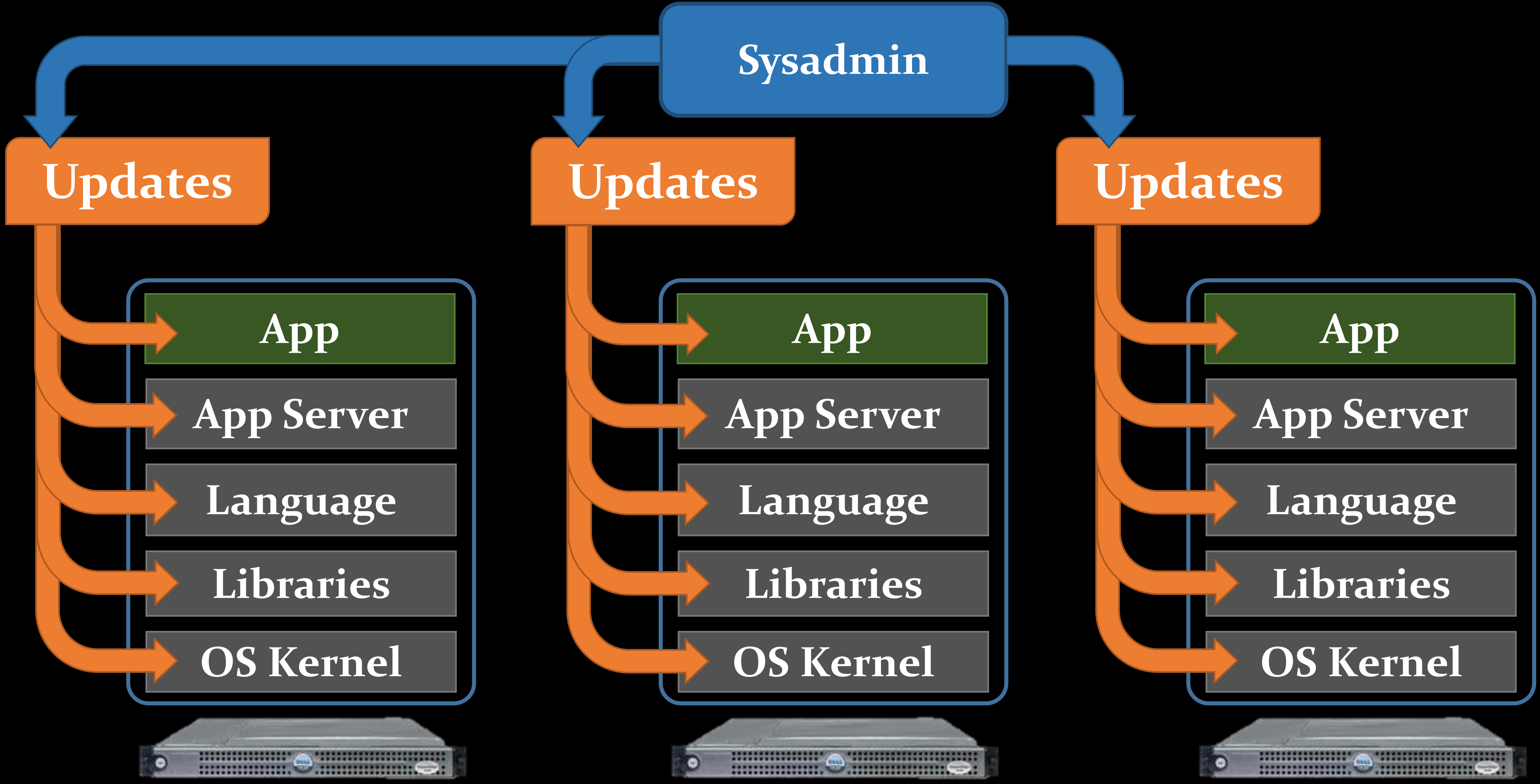
App
App Server
Language
Libraries
OS Kernel

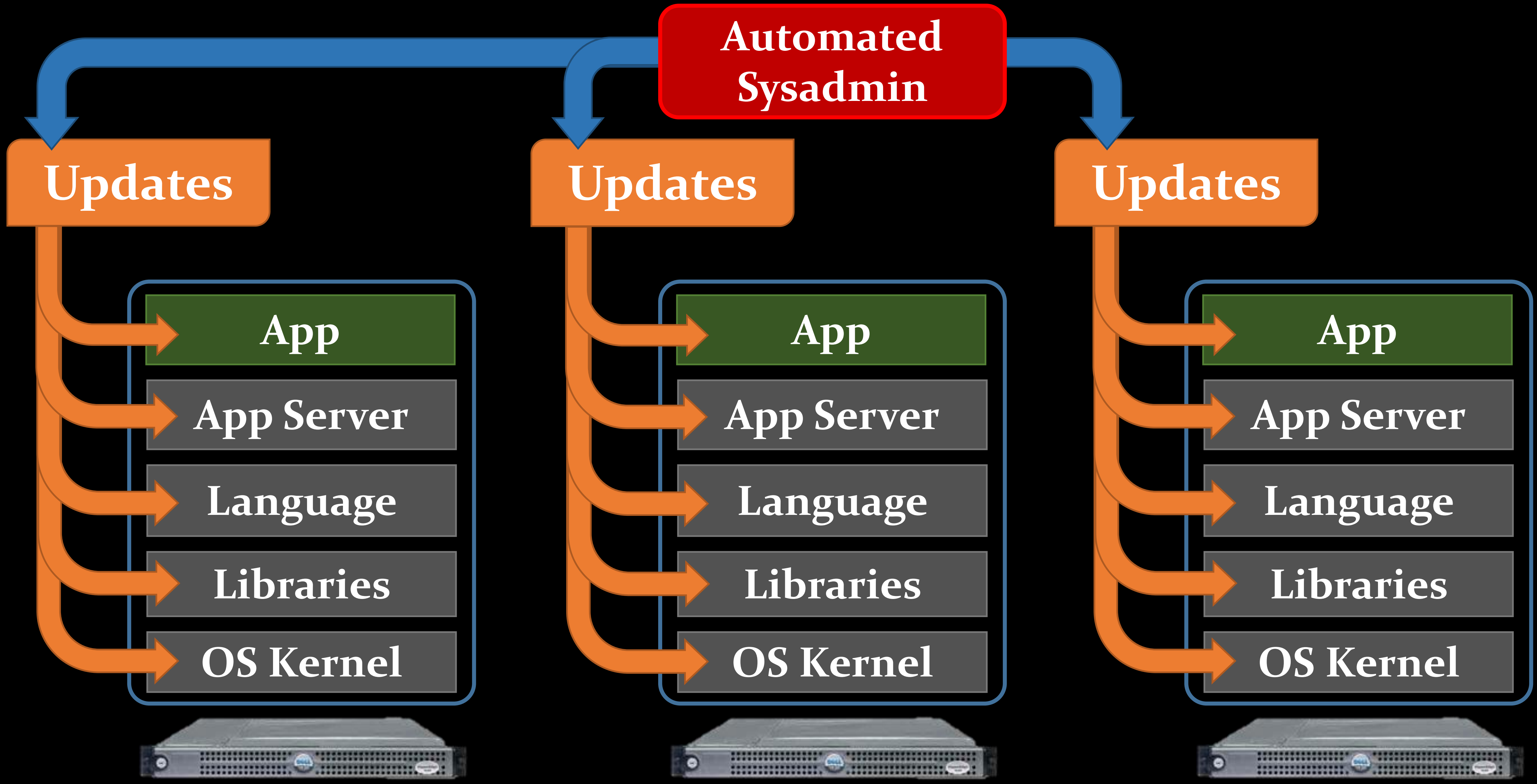
boxfuse



If I had asked my customers what they wanted they would have said a faster horse.

Henry Ford


Sysadmin
Updates
Updates
Updates
App
App Server
Language
Libraries
OS Kernel
App
App Server
Language
Libraries
OS Kernel
App
App Server
Language
Libraries
OS Kernel



Automated Sysadmin

Updates

App

App Server

Language

Libraries

OS Kernel

Updates

App

App Server

Language

Libraries

OS Kernel

Updates

App

App Server

Language

Libraries

OS Kernel

boxfuse

fast forward to 2016 …

Every day, AWS adds enough server capacity to power the whole $7B enterprise Amazon.com was in 2004. Weekends included.

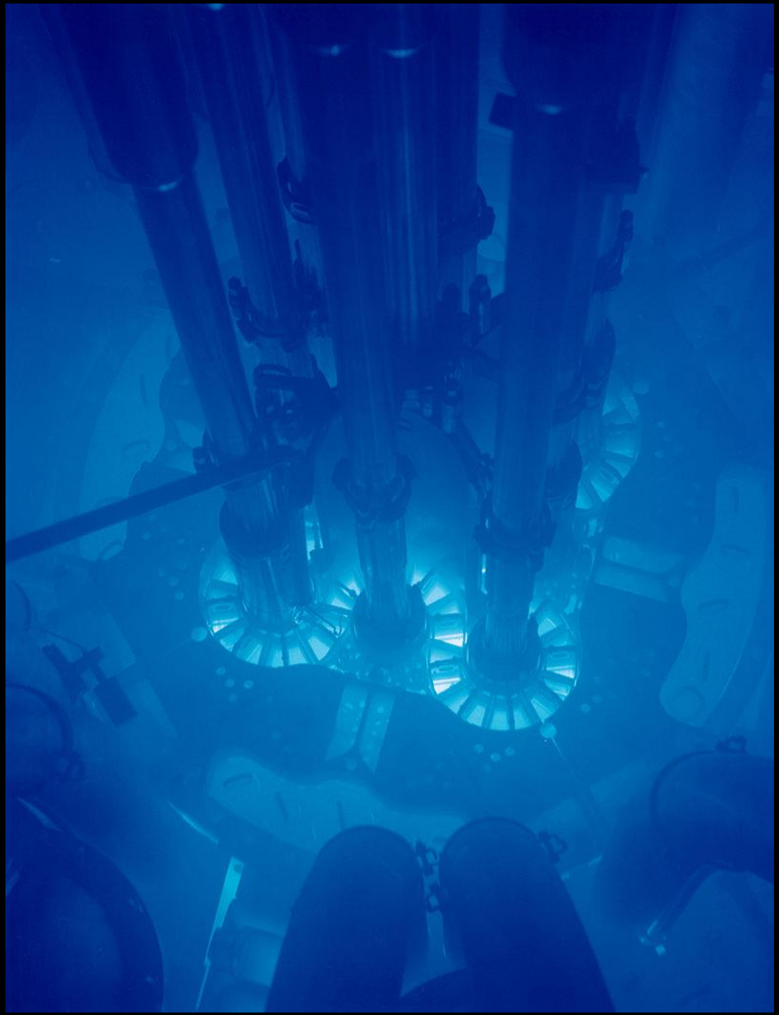
amazon web services

boxfuse

Shift to a world of abundance
(no more resource scarcity)

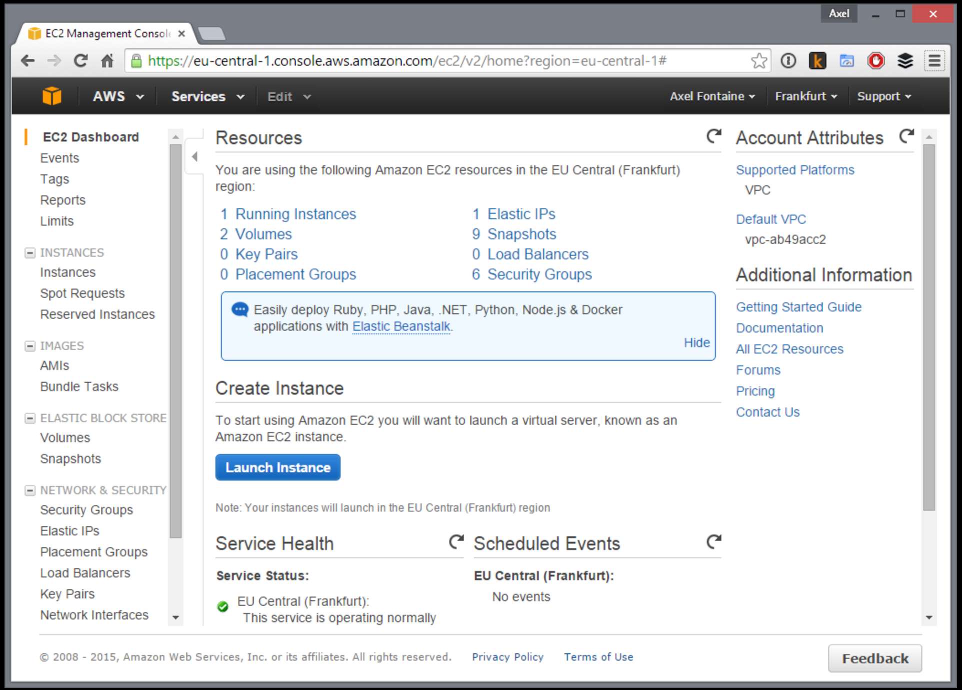
Control Plane

"RIAN archive 341194 Kursk Nuclear Power Plant" by RIA Novosti archive, image #341194 / Sergey Pyatakov / CC-BY-SA 3.0. Licensed under CC BY-SA 3.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:RIAN_archive_341194_Kursk_Nuclear_Power_Plant.jpg#mediaviewer/File:RIAN_archive_341194_Kursk_Nuclear_Power_Plant.jpg



Data Plane

"Advanced Test Reactor" by Argonne National Laboratory - originally posted to Flickr as Advanced Test Reactor core, Idaho National LaboratoryUploaded using F2ComButton. Licensed under CC BY-SA 2.0 via Wikimedia Commons - http://commons.wikimedia.org/wiki/File:Advanced_Test_Reactor.jpg#mediaviewer/File:Advanced_Test_Reactor.jpg



Resources

You are using the following Amazon EC2 resources in the EU Central (Frankfurt) region:

1 Running Instances
2 Volumes
0 Key Pairs
0 Placement Groups
1 Elastic IPs
9 Snapshots
0 Load Balancers
6 Security Groups

Easily deploy Ruby, PHP, Java, .NET, Python, Node.js & Docker applications with Elastic Beanstalk.

Create Instance

To start using Amazon EC2 you will want to launch a virtual server, known as an Amazon EC2 instance.

Note: Your instances will launch in the EU Central (Frankfurt) region

Service Health

Service Status:

EU Central (Frankfurt):
This service is operating normally

Scheduled Events

EU Central (Frankfurt):
No events

Account Attributes

Supported Platforms
VPC

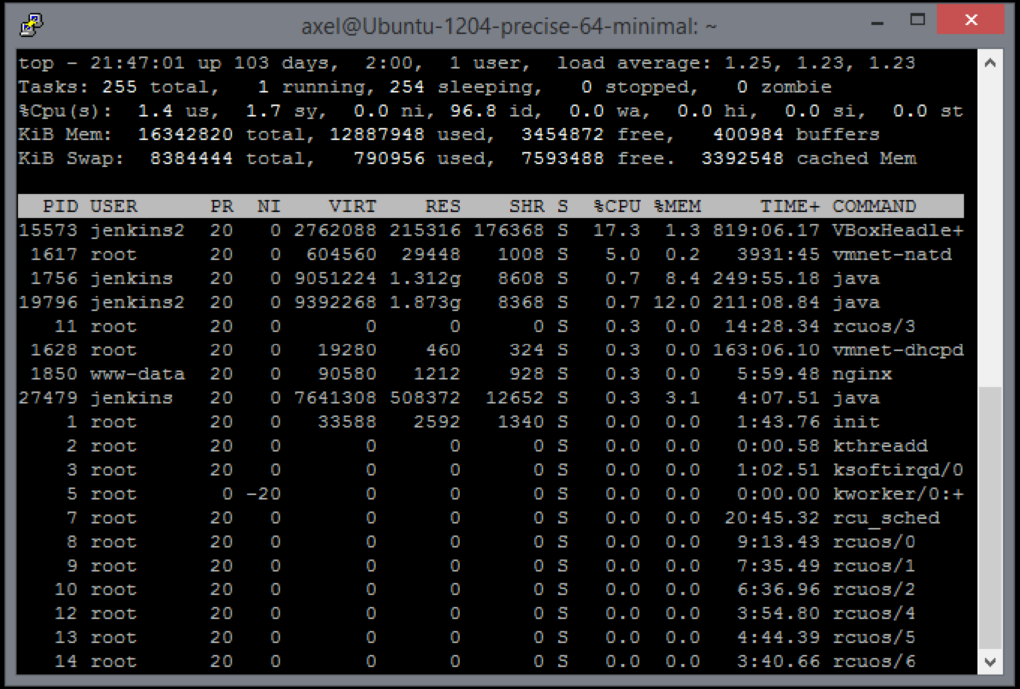
Default VPC
vpc-ab49acc2

Additional Information

Getting Started Guide
Documentation
All EC2 Resources
Forums
Pricing
Contact Us

© 2008 - 2015, Amazon Web Services, Inc. or its affiliates. All rights reserved. Privacy Policy Terms of Use

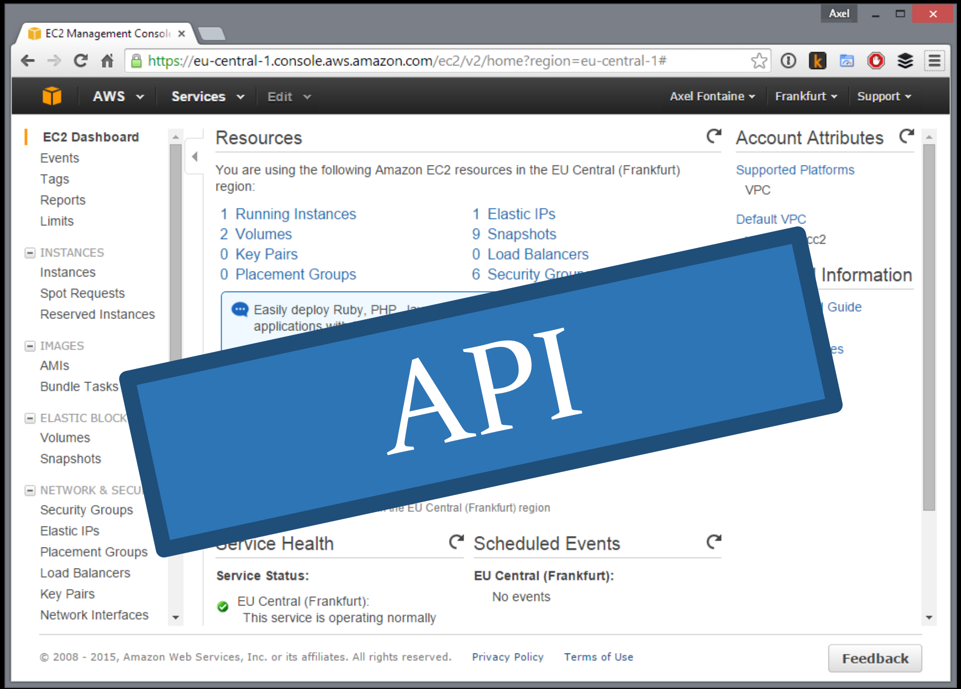
Control Plane



```
top - 21:47:01 up 103 days,  2:00,  1 user,  load average: 1.25, 1.23, 1.23
Tasks: 255 total,   1 running, 254 sleeping,   0 stopped,   0 zombie
%Cpu(s):  1.4 us,  1.7 sy,  0.0 ni, 96.8 id,  0.0 wa,  0.0 hi,  0.0 si,  0.0 st
KiB Mem:  16342820 total, 12887948 used,  3454872 free,   400984 buffers
KiB Swap:  8384444 total,   790956 used,  7593488 free.  3392548 cached Mem

  PID USER      PR  NI    VIRT    RES    SHR S  %CPU %MEM     TIME+ COMMAND
15573 jenkins2  20   0 2762088 215316 176368 S  17.3  1.3 819:06.17 VBoxHeadle+
 1617 root      20   0  604560  29448   1008 S   5.0  0.2   3931:45 vmnet-natd
 1756 jenkins   20   0 9051224 1.312g   8608 S   0.7  8.4 249:55.18 java
19796 jenkins2  20   0 9392268 1.873g   8368 S   0.7 12.0 211:08.84 java
   11 root      20   0       0      0      0 S   0.3  0.0  14:28.34 rcuos/3
 1628 root      20   0   19280    460    324 S   0.3  0.0 163:06.10 vmnet-dhcpd
 1850 www-data  20   0   90580   1212    928 S   0.3  0.0   5:59.48 nginx
27479 jenkins   20   0 7641308 508372  12652 S   0.3  3.1   4:07.51 java
    1 root      20   0   33588   2592   1340 S   0.0  0.0   1:43.76 init
    2 root      20   0       0      0      0 S   0.0  0.0   0:00.58 kthreadd
    3 root      20   0       0      0      0 S   0.0  0.0   1:02.51 ksoftirqd/0
    5 root       0 -20       0      0      0 S   0.0  0.0   0:00.00 kworker/0:+
    7 root      20   0       0      0      0 S   0.0  0.0  20:45.32 rcu_sched
    8 root      20   0       0      0      0 S   0.0  0.0   9:13.43 rcuos/0
    9 root      20   0       0      0      0 S   0.0  0.0   7:35.49 rcuos/1
   10 root      20   0       0      0      0 S   0.0  0.0   6:36.96 rcuos/2
   12 root      20   0       0      0      0 S   0.0  0.0   3:54.80 rcuos/4
   13 root      20   0       0      0      0 S   0.0  0.0   4:44.39 rcuos/5
   14 root      20   0       0      0      0 S   0.0  0.0   3:40.66 rcuos/6
```

Data Plane



Resources

You are using the following Amazon EC2 resources in the EU Central (Frankfurt) region:

1 Running Instances
2 Volumes
0 Key Pairs
0 Placement Groups
1 Elastic IPs
9 Snapshots
0 Load Balancers
6 Security Grou

Easily deploy Ruby, PHP, Ja
applications wi

the EU Central (Frankfurt) region

Service Health

Service Status:

EU Central (Frankfurt):
This service is operating normally

Scheduled Events

EU Central (Frankfurt):
No events

Account Attributes

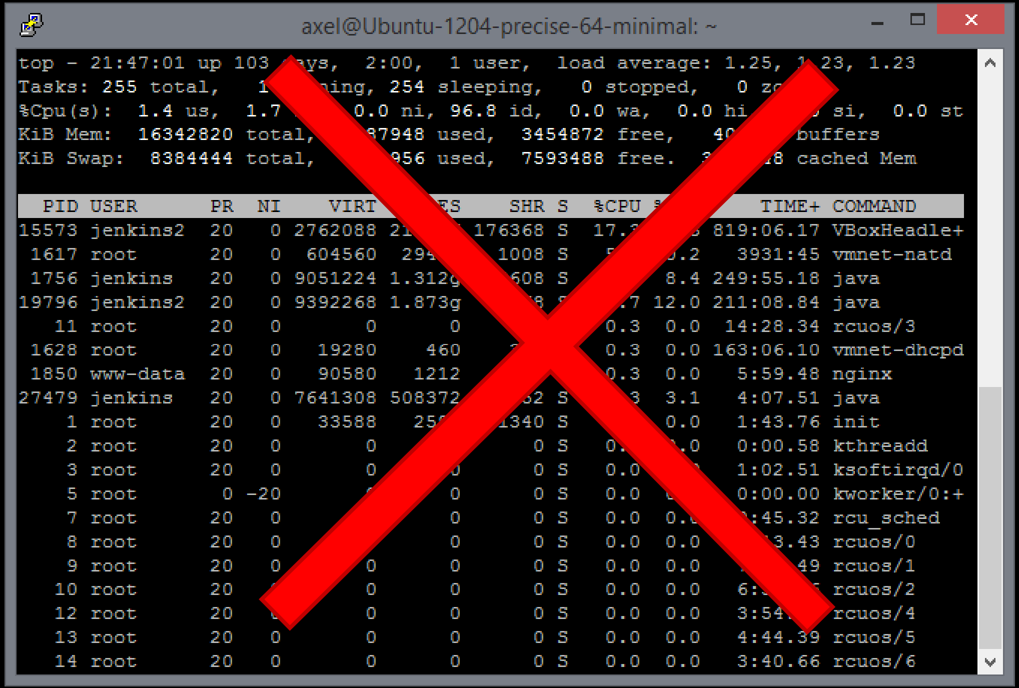
Supported Platforms
VPC

Default VPC
cc2

Information
Guide
es

© 2008 - 2015, Amazon Web Services, Inc. or its affiliates. All rights reserved. Privacy Policy Terms of Use

Feedback



axel@Ubuntu-1204-precise-64-minimal: ~

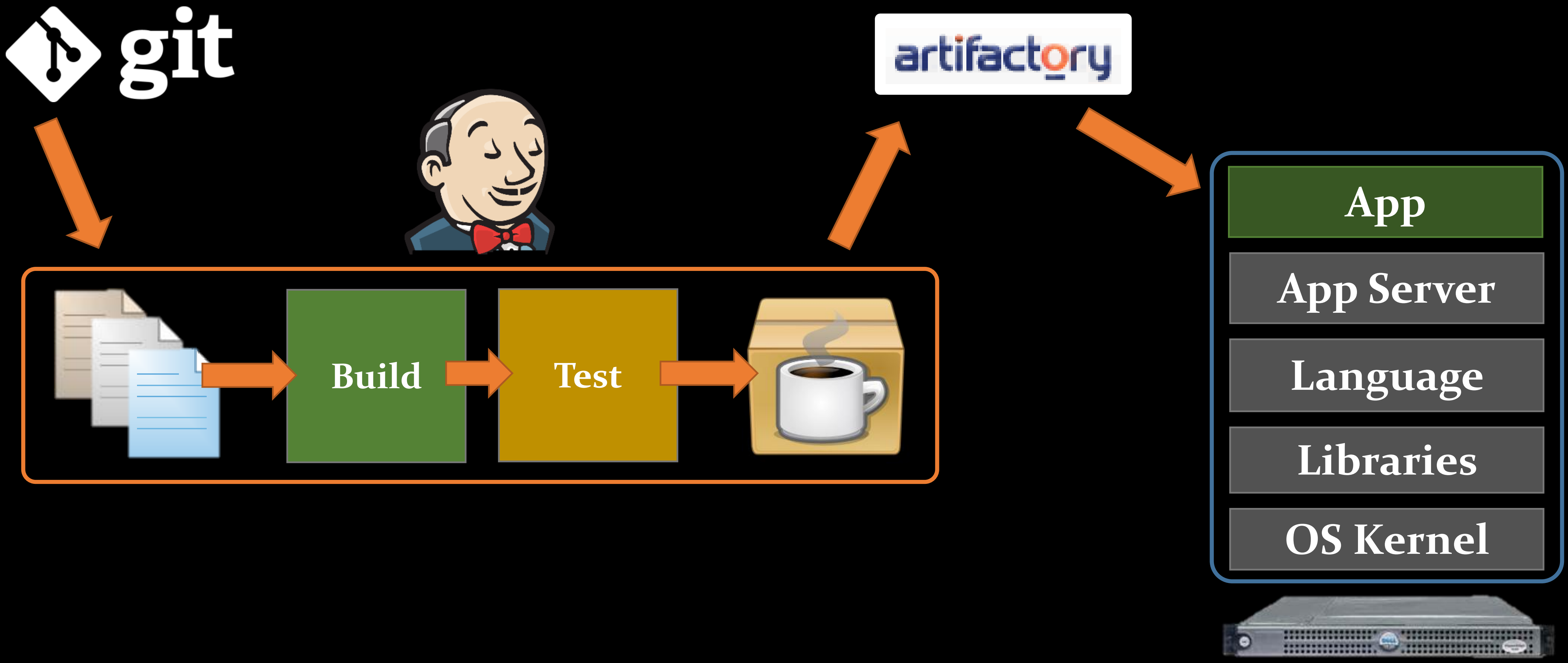
```
top - 21:47:01 up 103  ays,  2:00,  1 user,  load average: 1.25,   23, 1.23
Tasks: 255 total,   1     ing, 254 sleeping,   0 stopped,   0 zo
%Cpu(s):  1.4 us,  1.7      0.0 ni, 96.8 id,  0.0 wa,  0.0 hi       si,  0.0 st
KiB Mem:  16342820 total,    87948 used,  3454872 free,   40       buffers
KiB Swap:  8384444 total,      956 used,  7593488 free.   3     8 cached Mem

  PID USER      PR  NI    VIRT     ES    SHR S  %CPU %        TIME+ COMMAND
15573 jenkins2  20   0 2762088 21       176368 S  17.         819:06.17 VBoxHeadle+
 1617 root      20   0  604560  29        1008 S  5    .2   3931:45 vmnet-natd
 1756 jenkins   20   0 9051224 1.312g      608 S        8.4 249:55.18 java
19796 jenkins2  20   0 9392268 1.873g      8      .7 12.0 211:08.84 java
   11 root      20   0       0      0            0.3  0.0  14:28.34 rcuos/3
 1628 root      20   0   19280    460            0.3  0.0 163:06.10 vmnet-dhcpd
 1850 www-data  20   0   90580   1212            0.3  0.0   5:59.48 nginx
27479 jenkins   20   0 7641308 508372      52 S    3  3.1   4:07.51 java
    1 root      20   0   33588    25      1340 S        0.0   1:43.76 init
    2 root      20   0       0              0 S  0.    .0   0:00.58 kthreadd
    3 root      20   0       0      0       0 S  0.0        1:02.51 ksoftirqd/0
    5 root       0 -20              0       0 S  0.0        0:00.00 kworker/0:+
    7 root      20   0              0       0 S  0.0  0.    :45.32 rcu_sched
    8 root      20   0              0       0 S  0.0  0.0     3.43 rcuos/0
    9 root      20   0       0      0       0 S  0.0  0.0       49 rcuos/1
   10 root      20           0      0       0 S  0.0  0.0   6:     rcuos/2
   12 root      20           0      0       0 S  0.0  0.0   3:54   rcuos/4
   13 root      20   0       0      0       0 S  0.0  0.0   4:44.39 rcuos/5
   14 root      20   0       0      0       0 S  0.0  0.0   3:40.66 rcuos/6
```

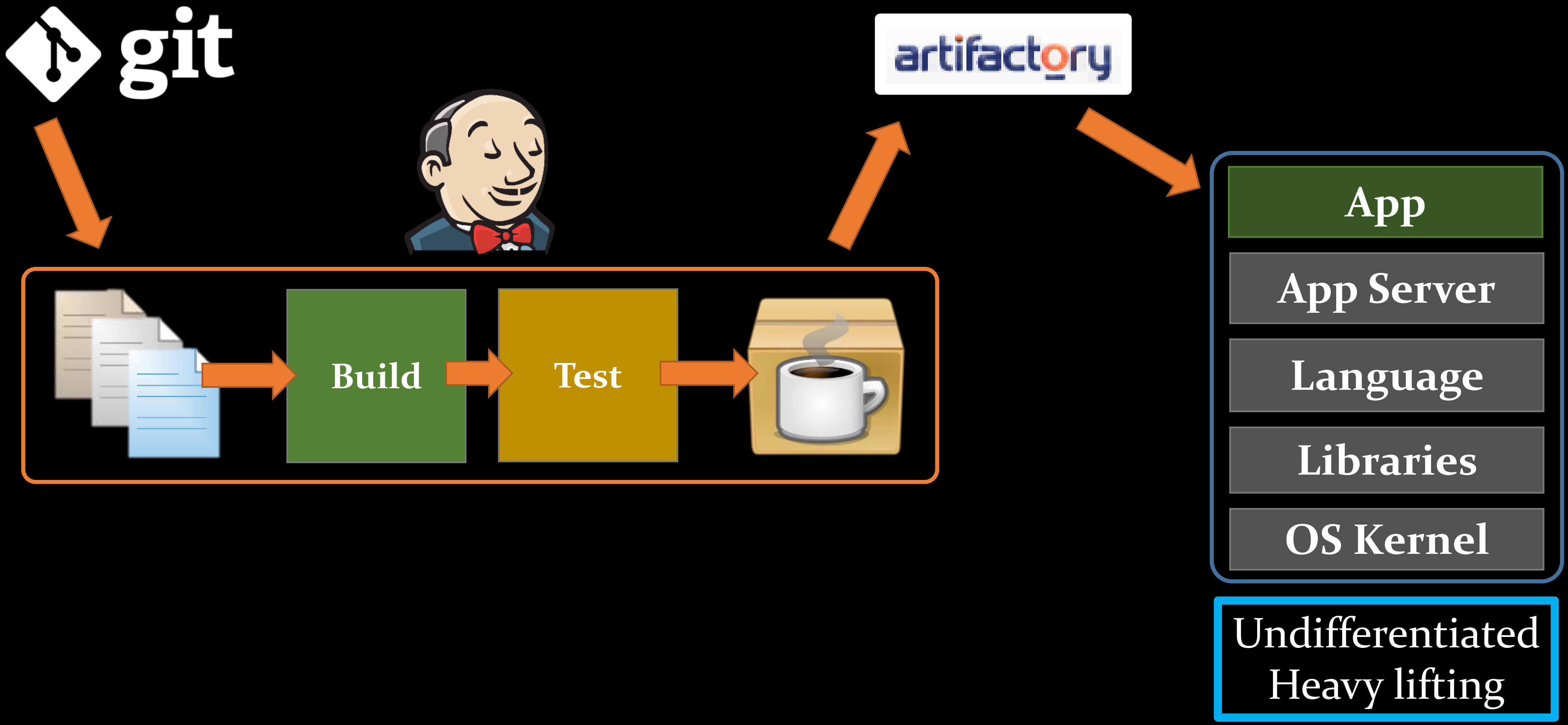
Automated Provisioning

Cost-driven Architectures

it is time to rethink the faster horse



git
artifactory
Build
Test
App
App Server
Language
Libraries
OS Kernel



git

Build

Test

artifactory

App

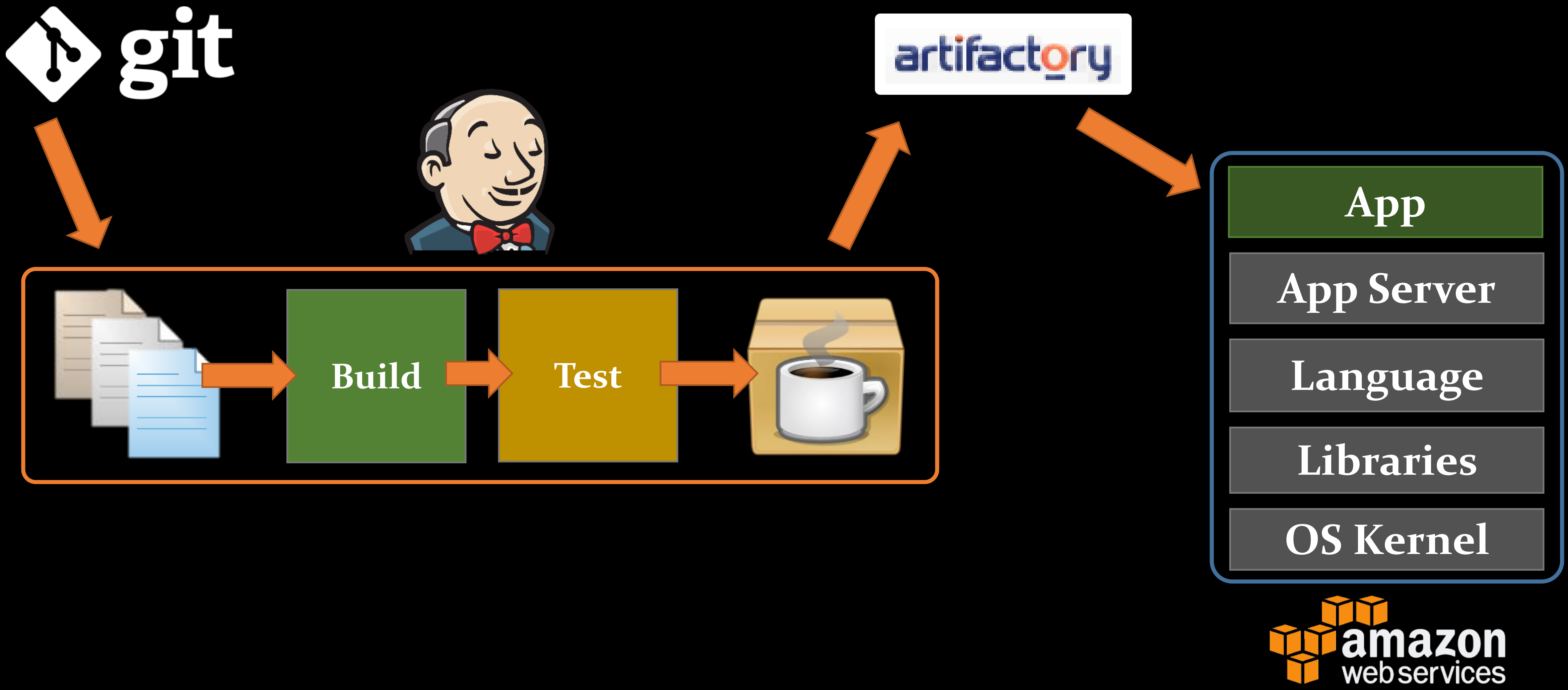
App Server

Language

Libraries

OS Kernel

Undifferentiated Heavy lifting



Build

Test

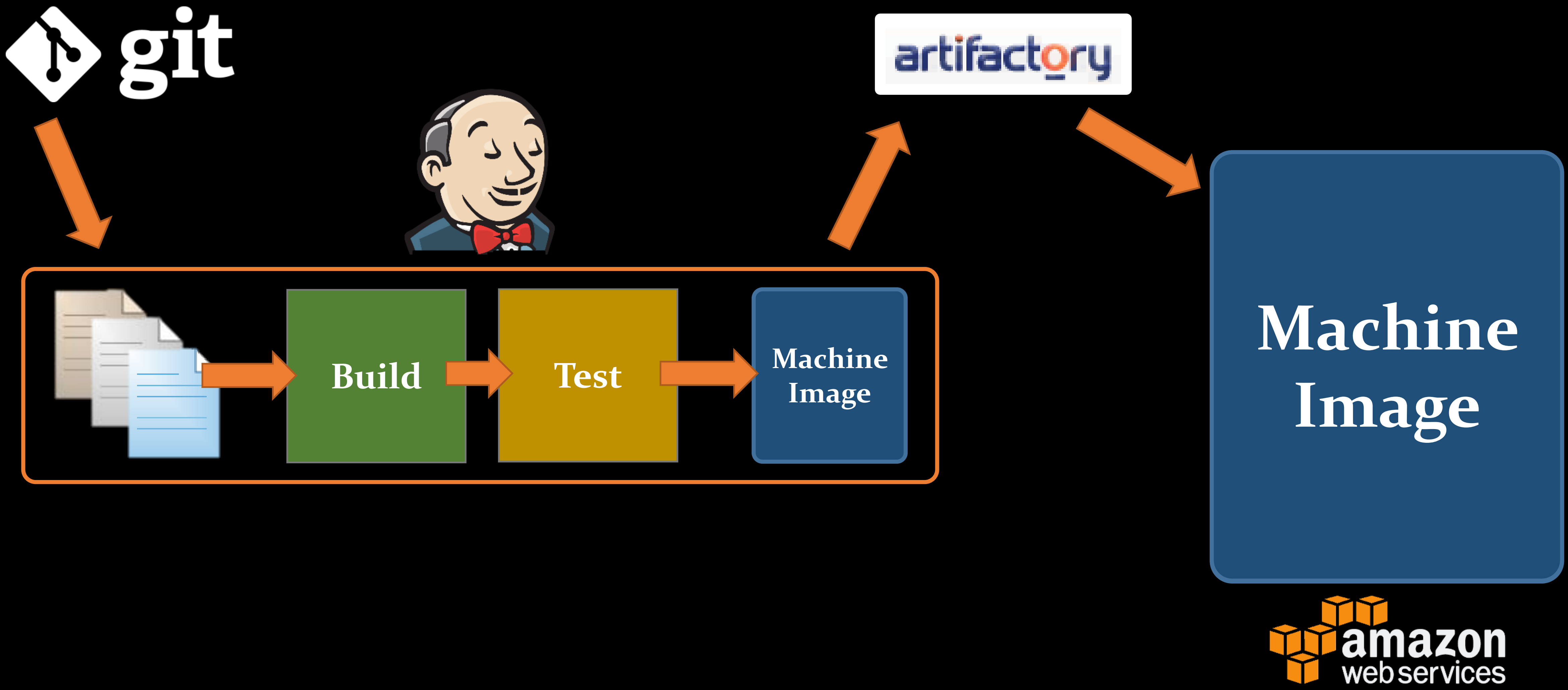
App

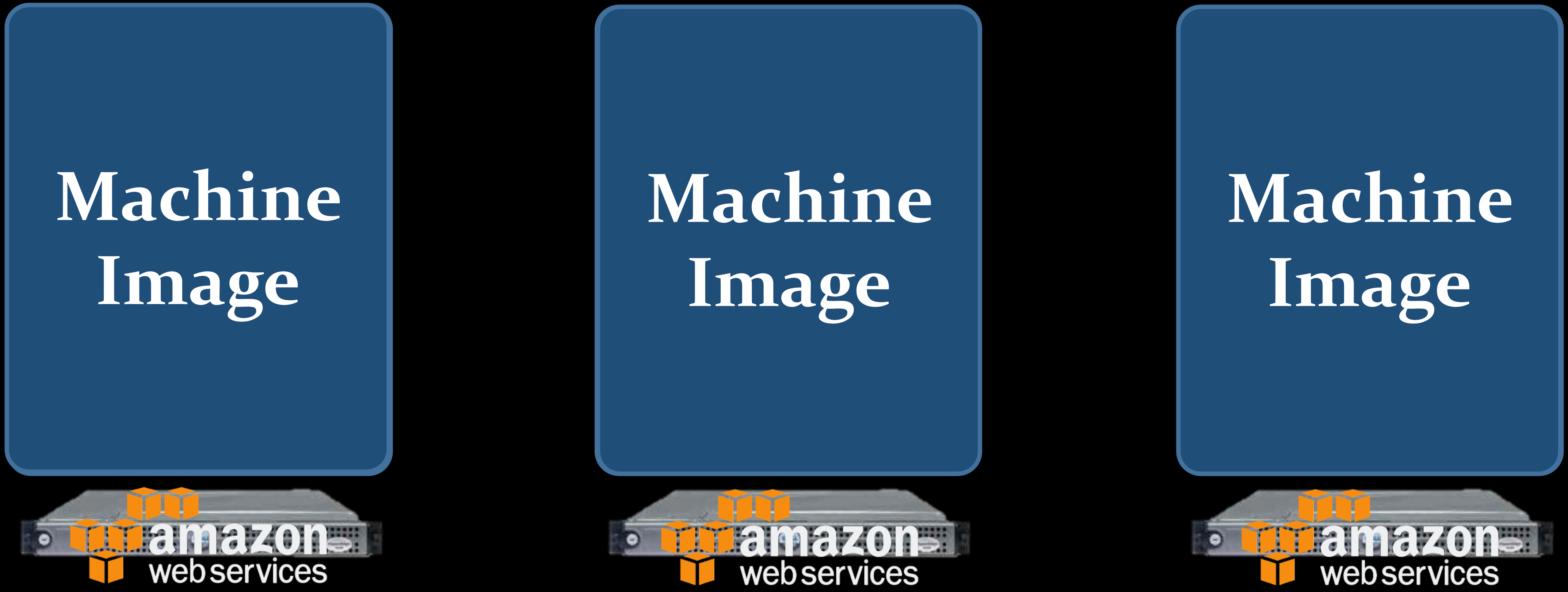
App Server

Language

Libraries

OS Kernel

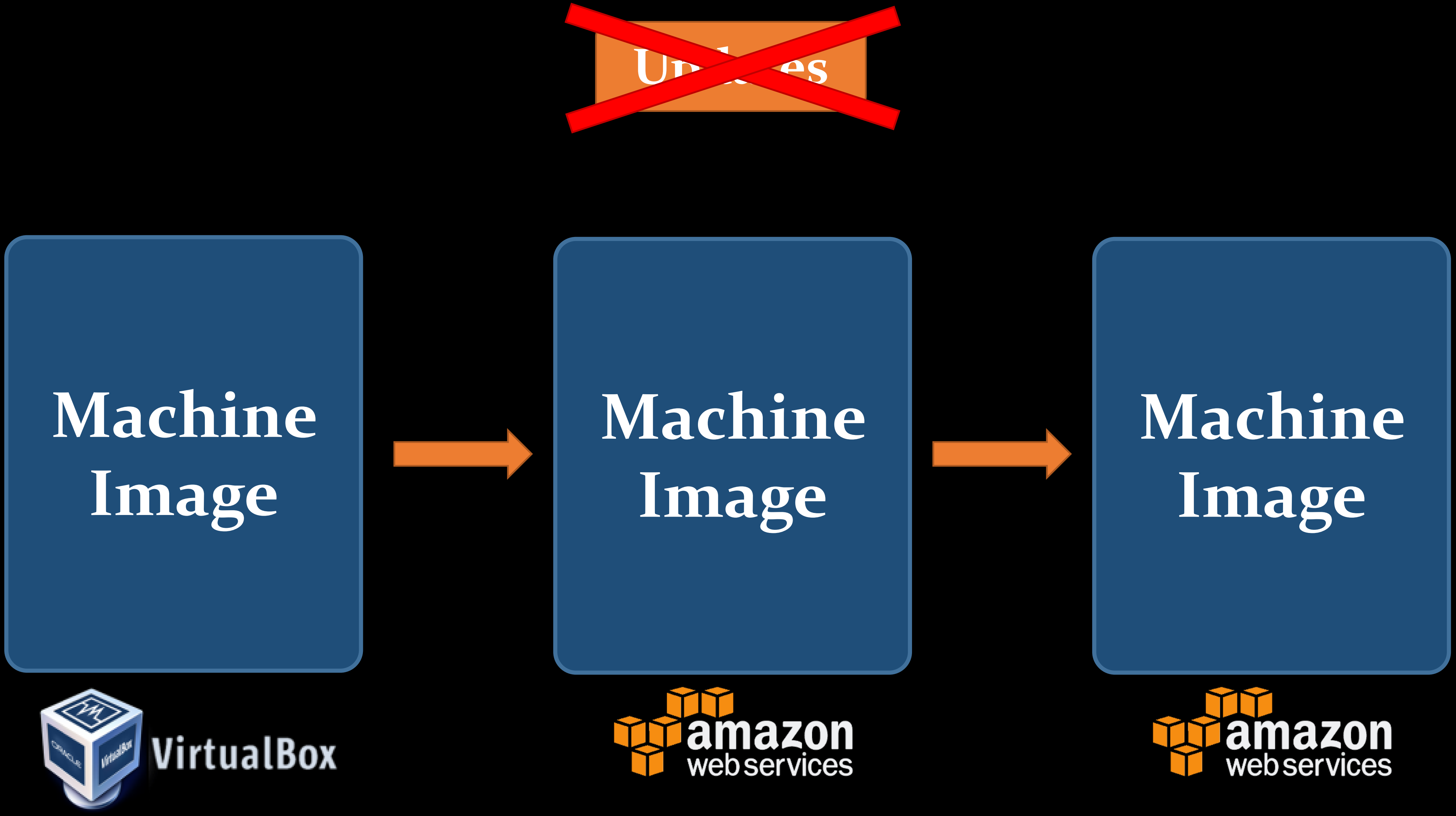

git
artifactory
Build
Test
Machine Image
Machine Image
amazon web services



Machine Image

Machine Image

Machine Image



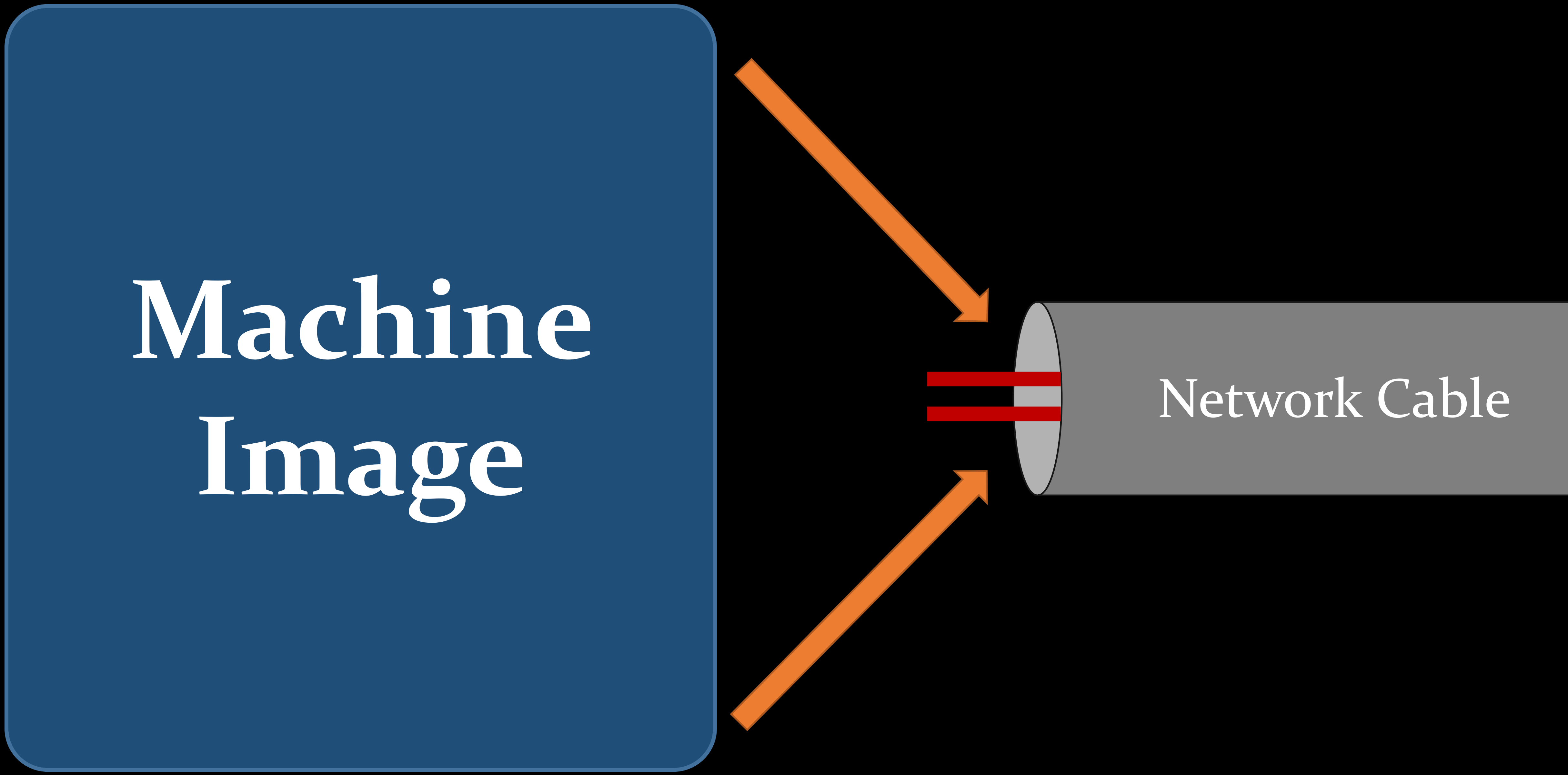
~~Updates~~

Machine Image

Machine Image

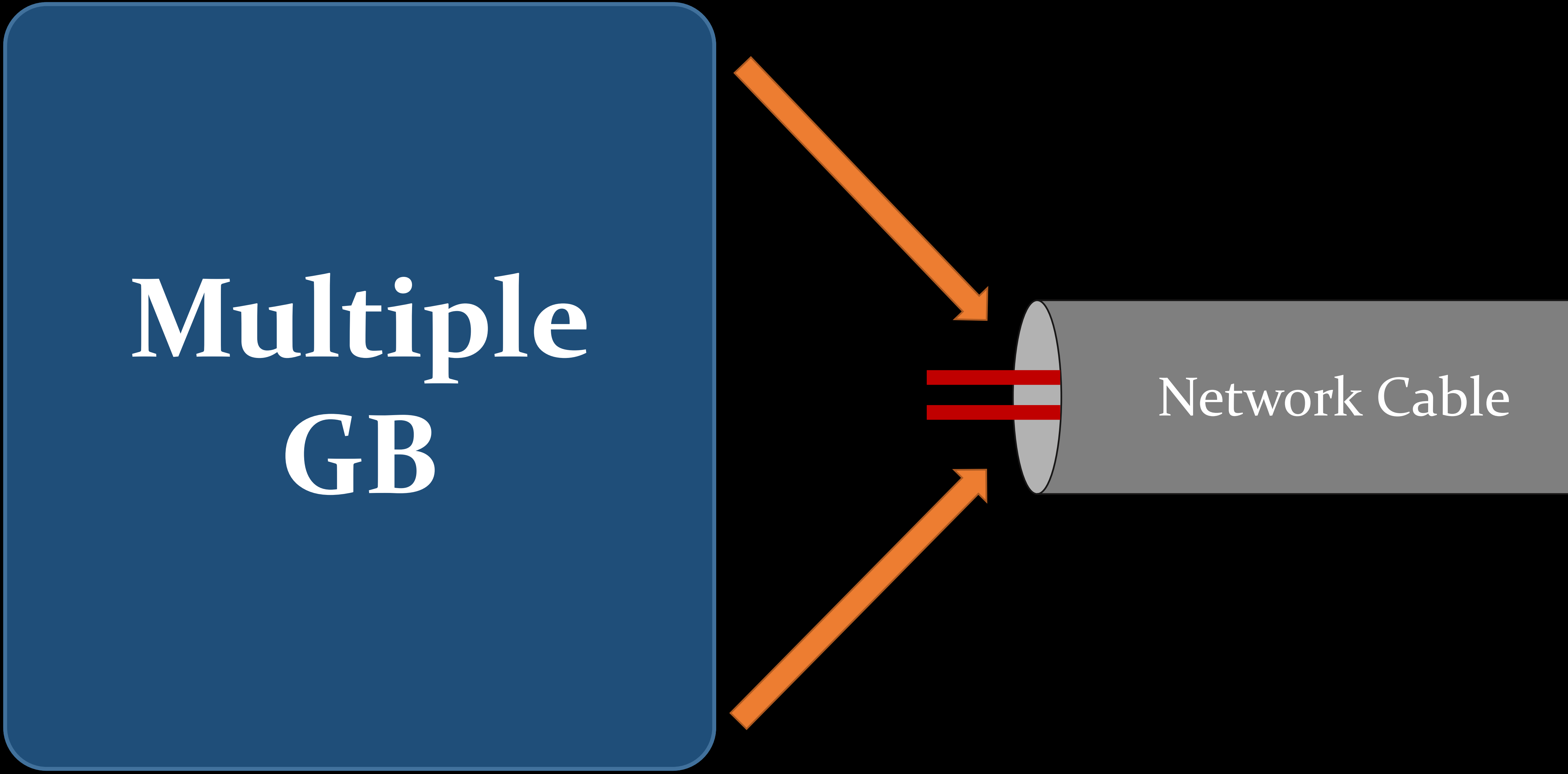
Machine Image

but there is one big problem left …



Machine Image

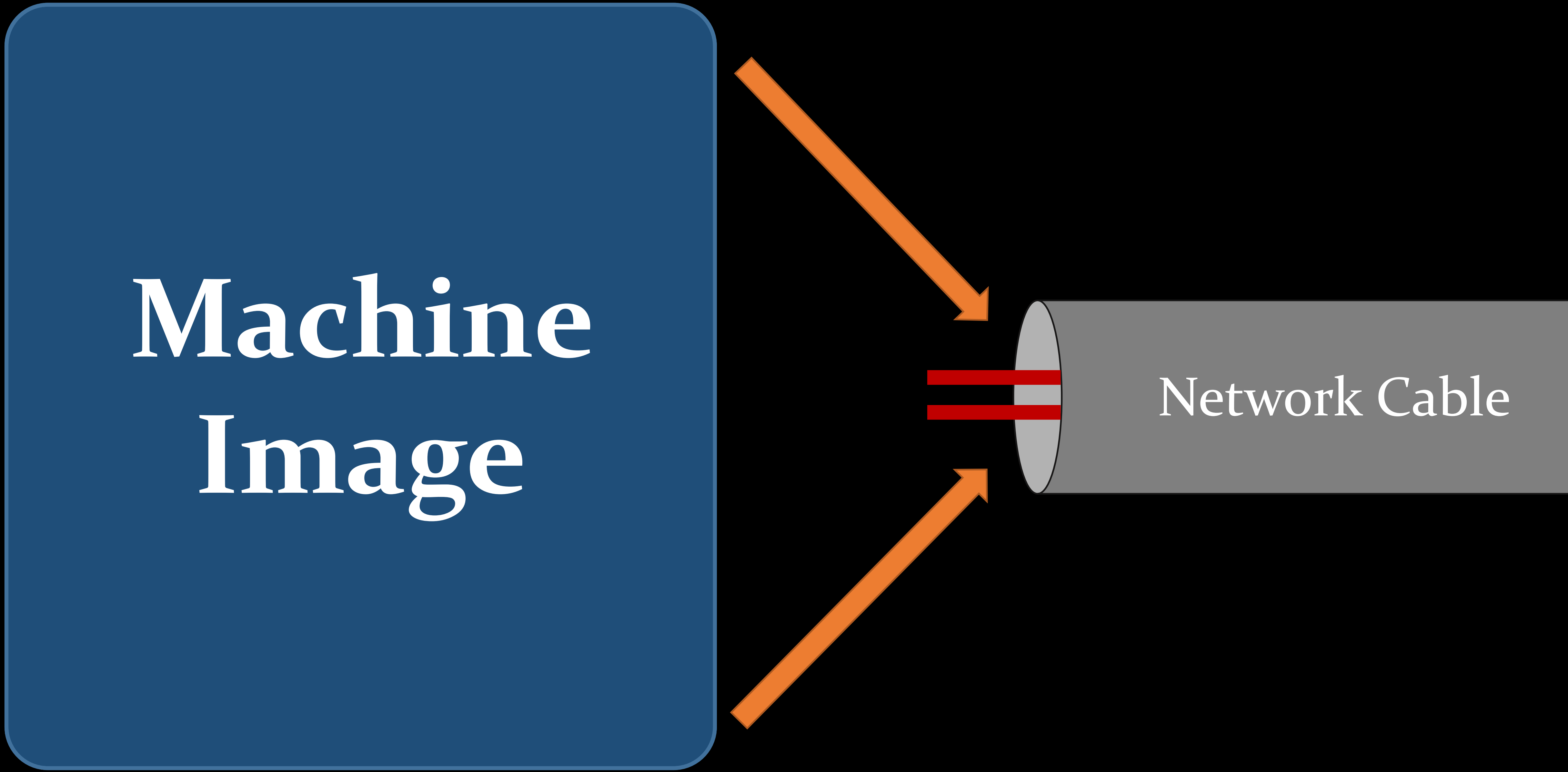
Network Cable


Multiple GB
Network Cable

Running servers in production should be like going backpacking. You take the bare minimum with you. Anything else is going to hurt.

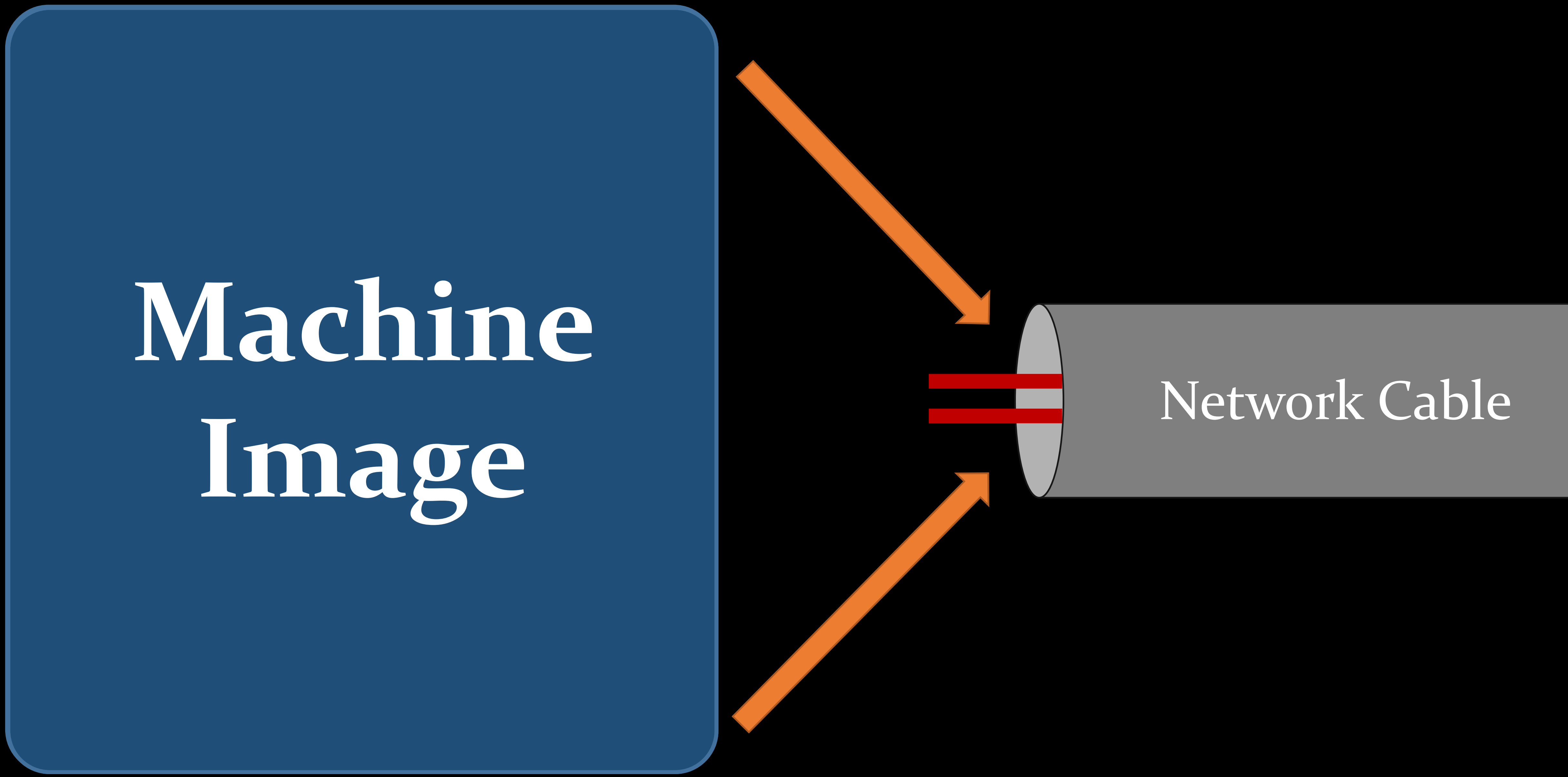
A Wise Man

what is really adding **business value** ???



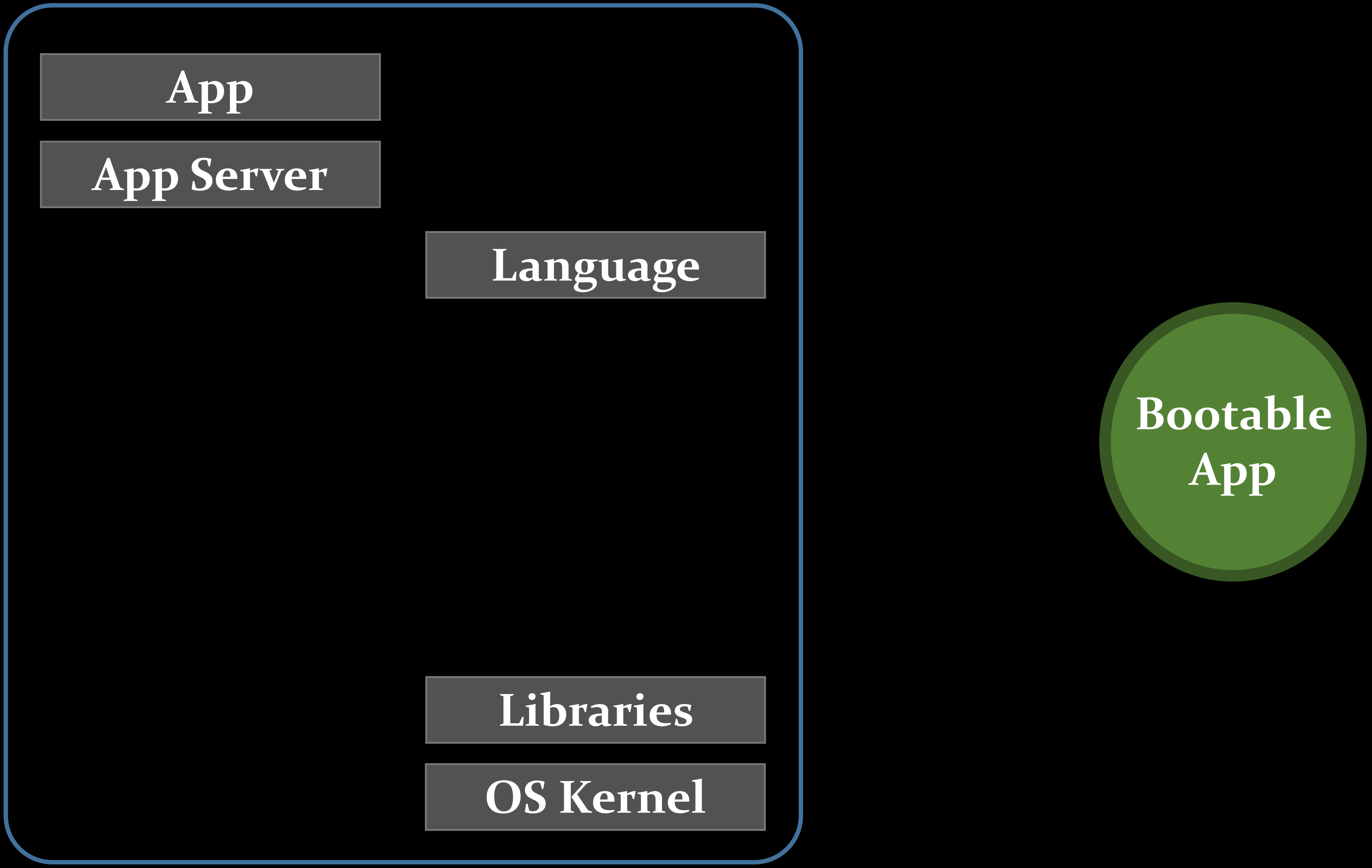
Machine Image

Network Cable



Machine Image

Network Cable



App

App Server

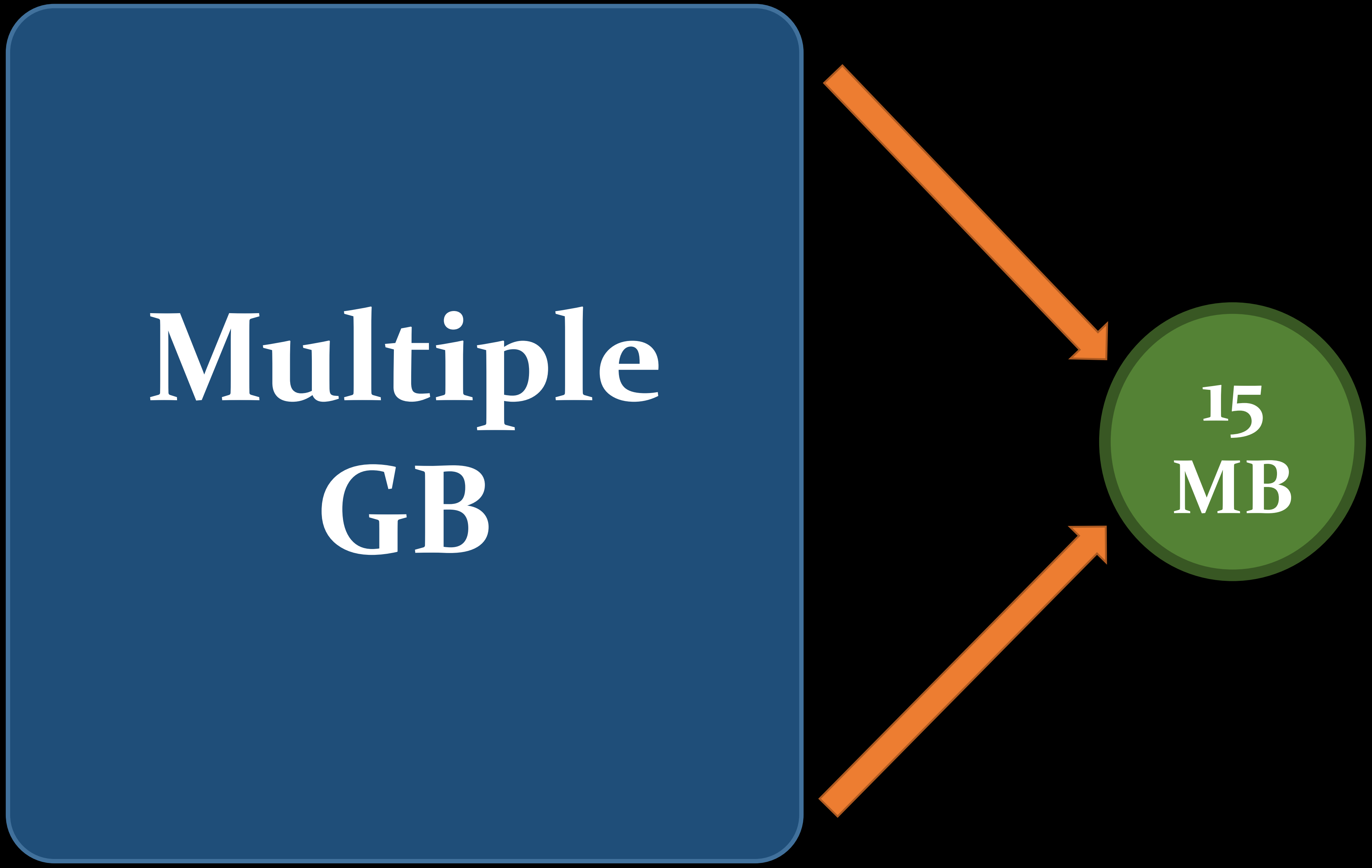
Language

Libraries

OS Kernel

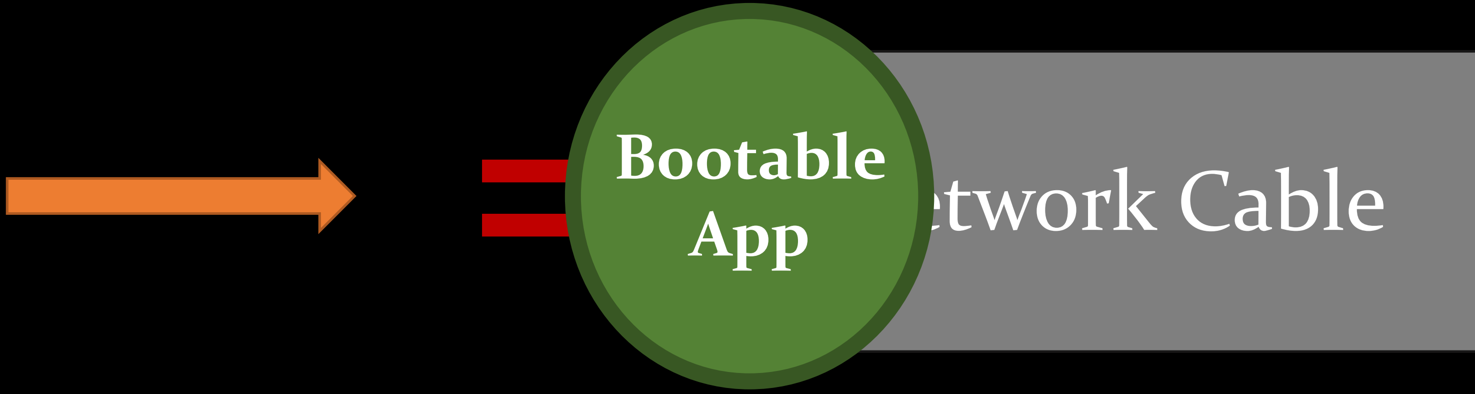
Bootable App

15
MB



Multiple GB

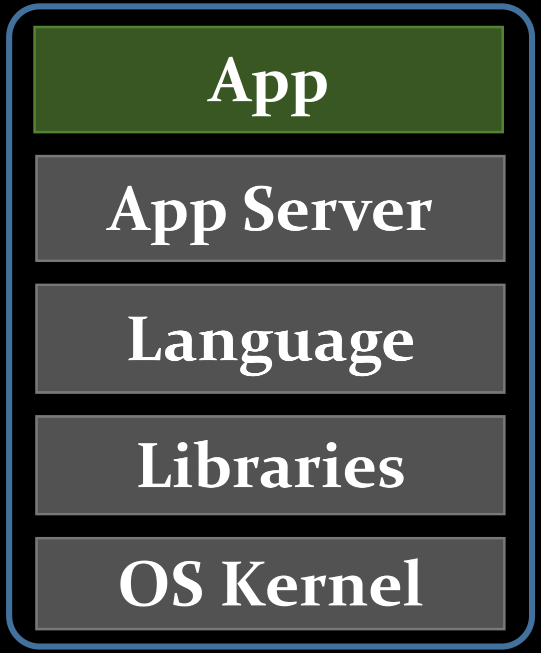
15 MB



Bootable App

twork Cable

who is this for ???



App

App Server

Language

Libraries

OS Kernel

12-factor app

demo

What are the implications ???

Focus shift

Instance → Service

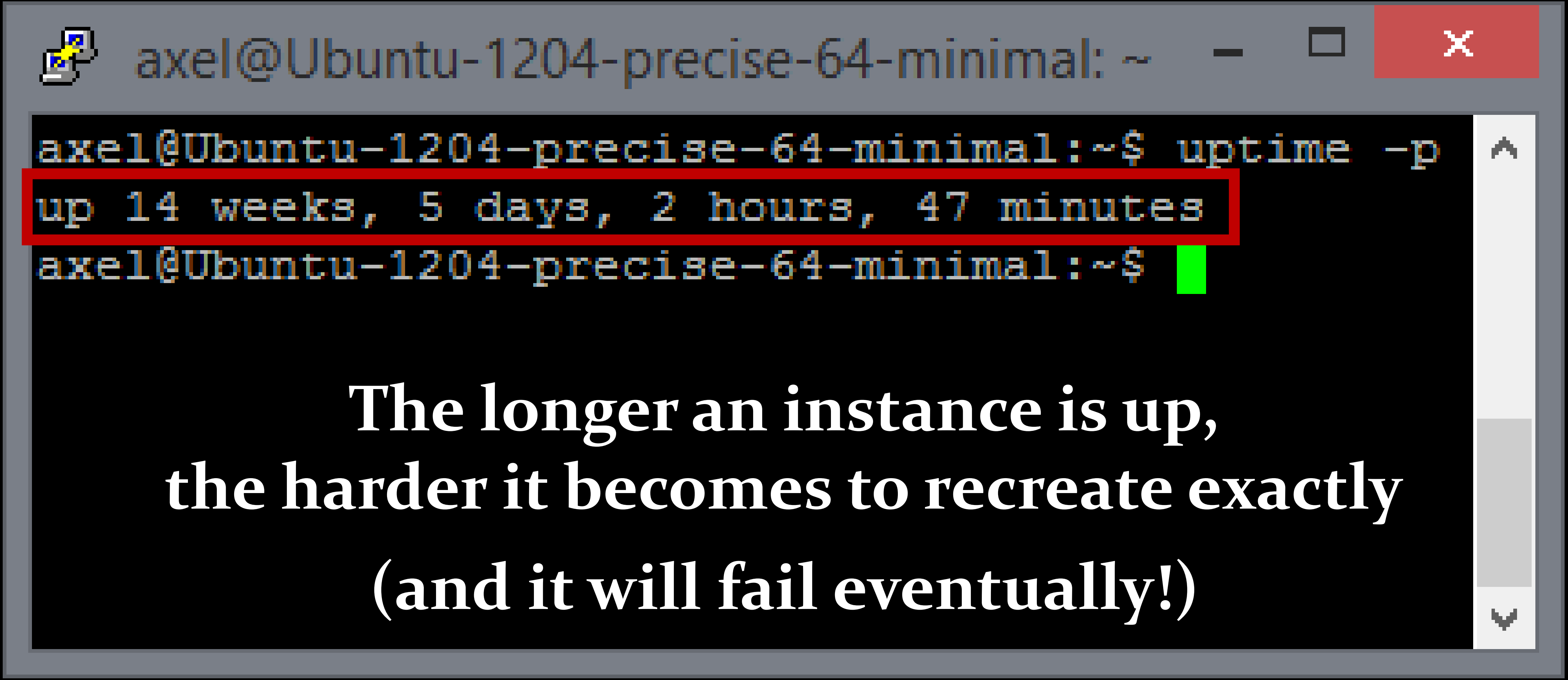
Individual instances become disposable

Treat servers like cattle instead of pets

C R ~~U~~ D

for servers is dead!

high uptime is a liability



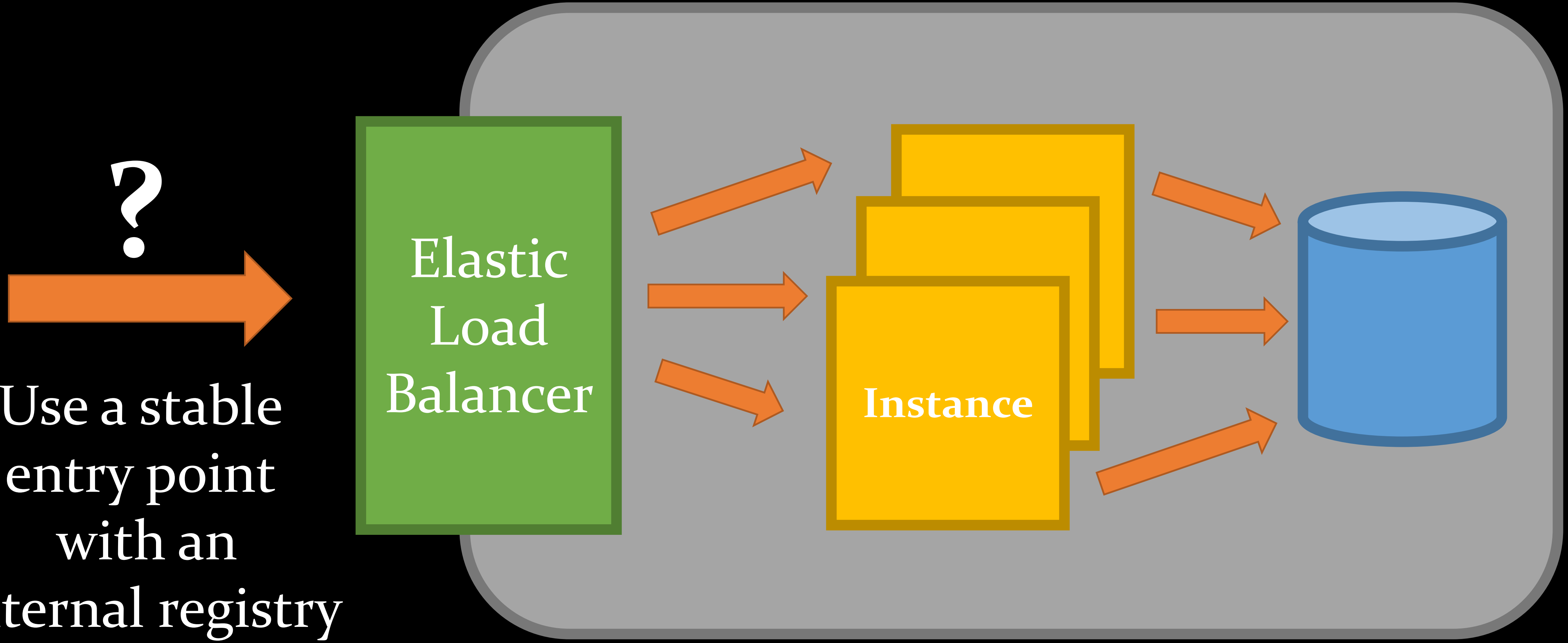
```
axel@Ubuntu-1204-precise-64-minimal:~$ uptime -p
up 14 weeks, 5 days, 2 hours, 47 minutes
axel@Ubuntu-1204-precise-64-minimal:~$
```

The longer an instance is up,
the harder it becomes to recreate exactly

(and it will fail eventually!)

boxfuse

How to solve service discovery ?



Use a stable entry point with an internal registry

What about security ?

When was the last time your toaster got hacked?

boxfuse

What about security ?

Complexity is the Enemy of Security

What about security ?

Bootable App

- Smallest possible attack surface
- Vastly reduced implications due to low uptime and transient nature of instances
- Very difficult to exploit other systems because essential tooling is missing

what about configuration ???

- Bake as much configuration as possible for all environments directly in the Bootable App

- Use environment detection and auto-configuration

what about configuration ???

- Bake as much configuration as possible for all environments directly in the Bootable App

Key	Value
JDBC_URL	jdbc:...
ENV	prod

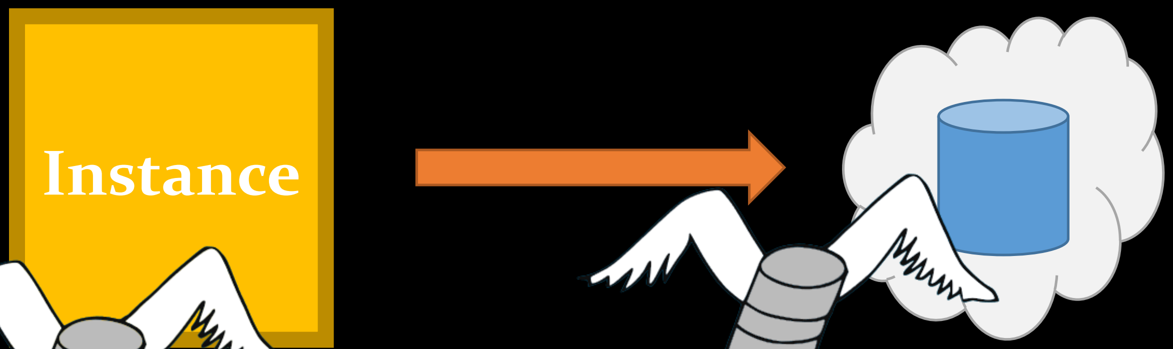
- Use environment detection and auto-configuration

Bootable App

- Pass remaining configuration at startup and expose it as environment variables

amazon
webservices

what about the database ???



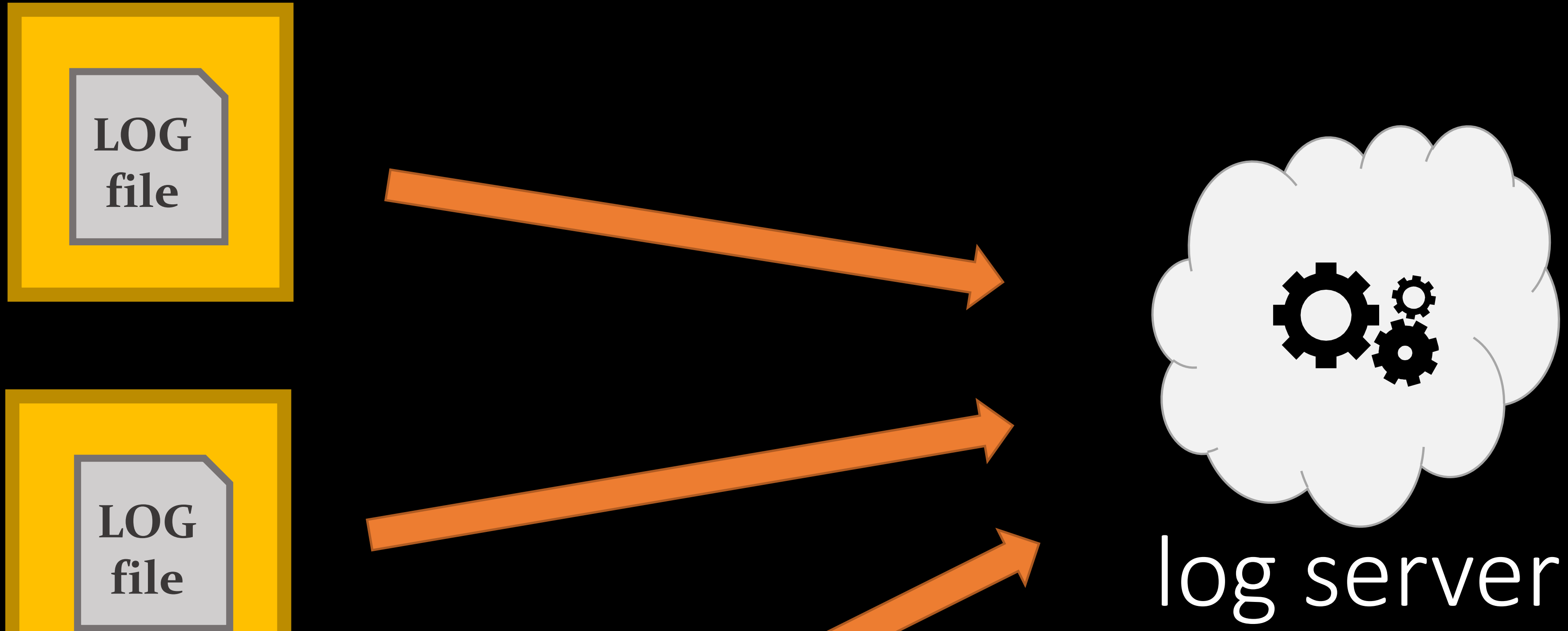
- Keep all persistent state out of the instance, including the database
- Use one of the many good hosted solutions available like Amazon RDS or Google Cloud SQL
- Use a database migration tool to update the schema on application startup

what about the logs ???

~~ssh me@myserver1~~
~~tail -f server.log~~

~~ssh me@myserver2~~
~~tail -f server.log~~

~~ssh me@myserver3~~
~~tail -f server.log~~



LOG file

LOG file

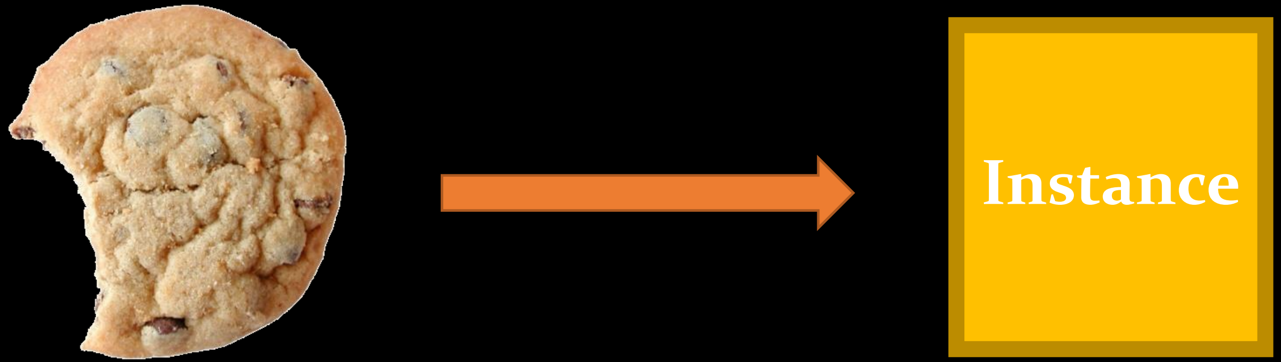
LOG file

log server

where logs can be

- aggregated
- stored and backuped
- indexed
- searched

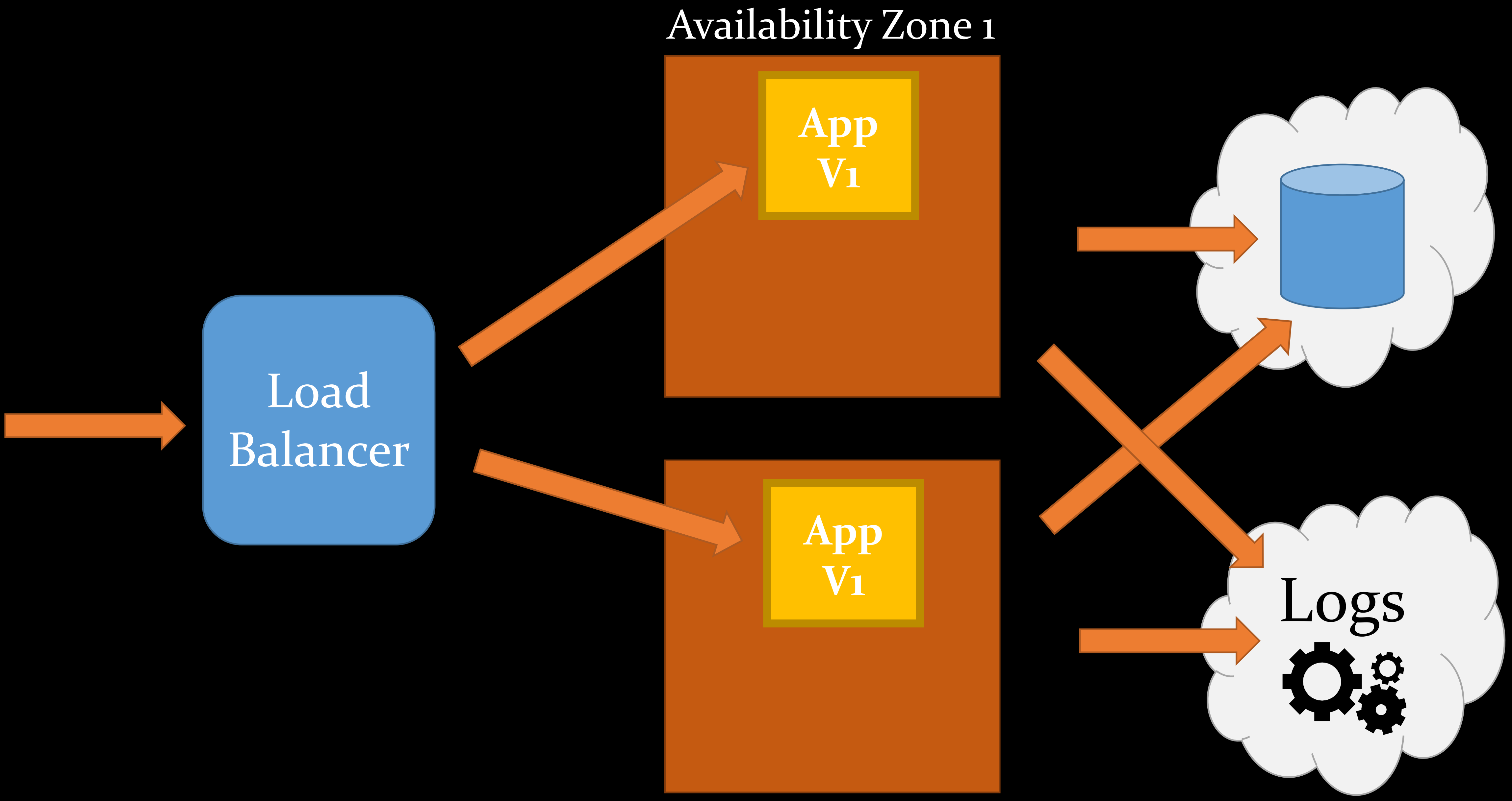
what about sessions ???



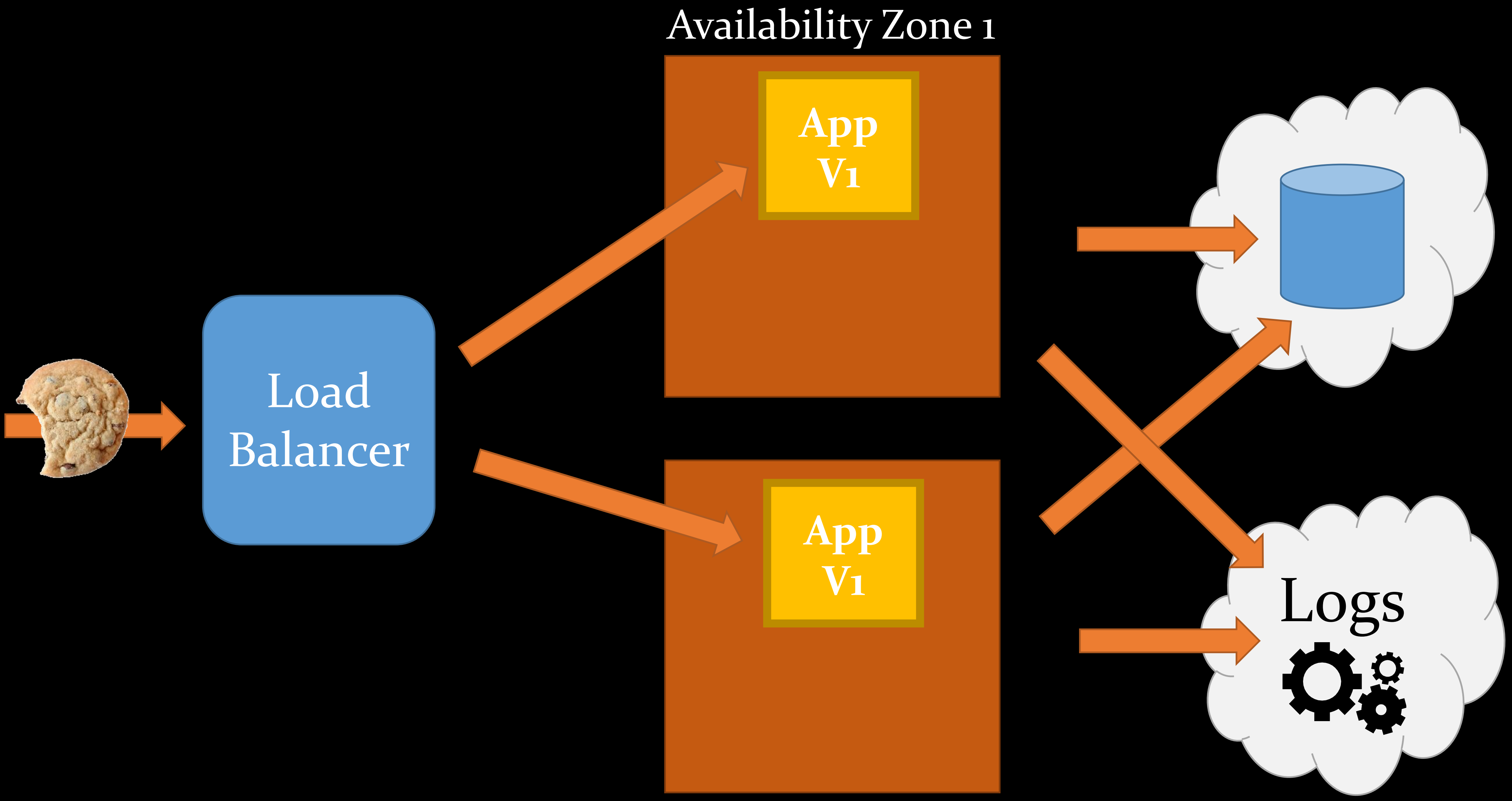
Keep session in an encrypted and signed cookie

- avoids session timeouts
- avoids server clustering & session replication
- avoids sticky sessions & server affinity

what about rolling out new versions ???


Availability Zone 1
App
V1
Load
Balancer
App
V1
Availability Zone 2
Logs

boxfuse



Availability Zone 1

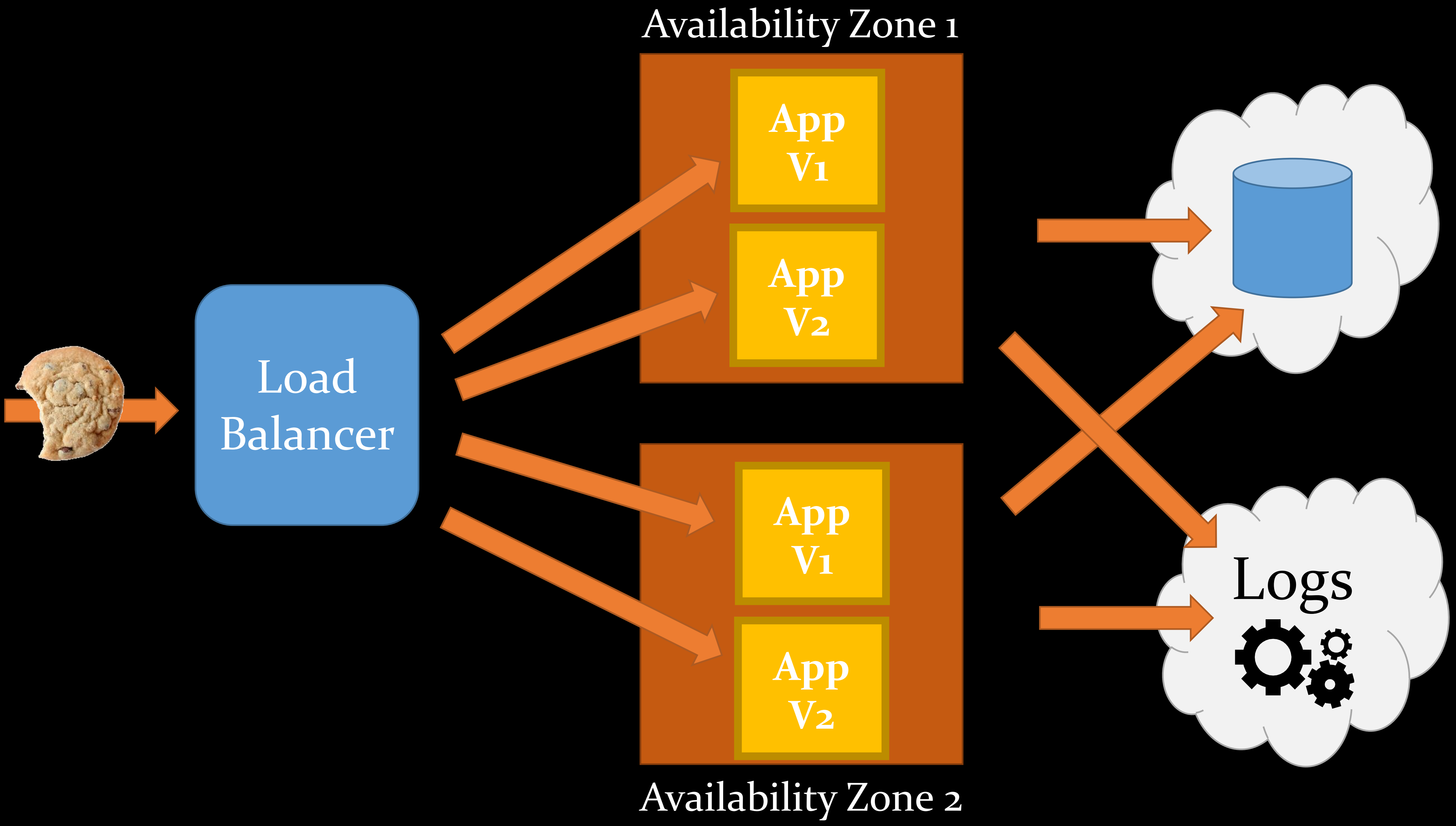
Load Balancer

App V1

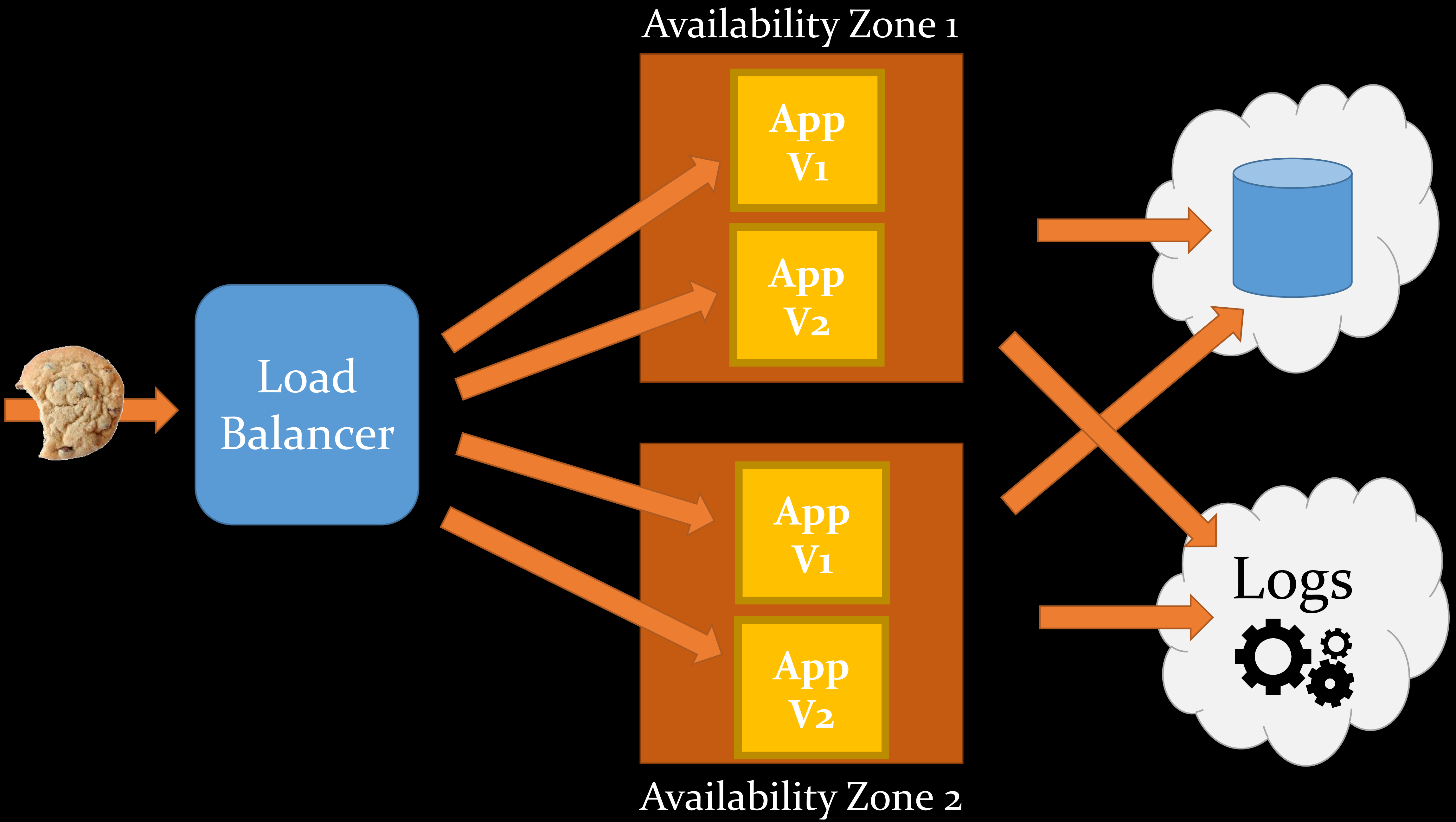
App V1

Logs

Availability Zone 2


Availability Zone 1
App V1
App V2
Load Balancer
App V1
App V2
Logs
Availability Zone 2

boxfuse


Availability Zone 1
App V1
App V2
Load Balancer
App V1
App V2
Availability Zone 2
Logs

boxfuse

what about containers ???

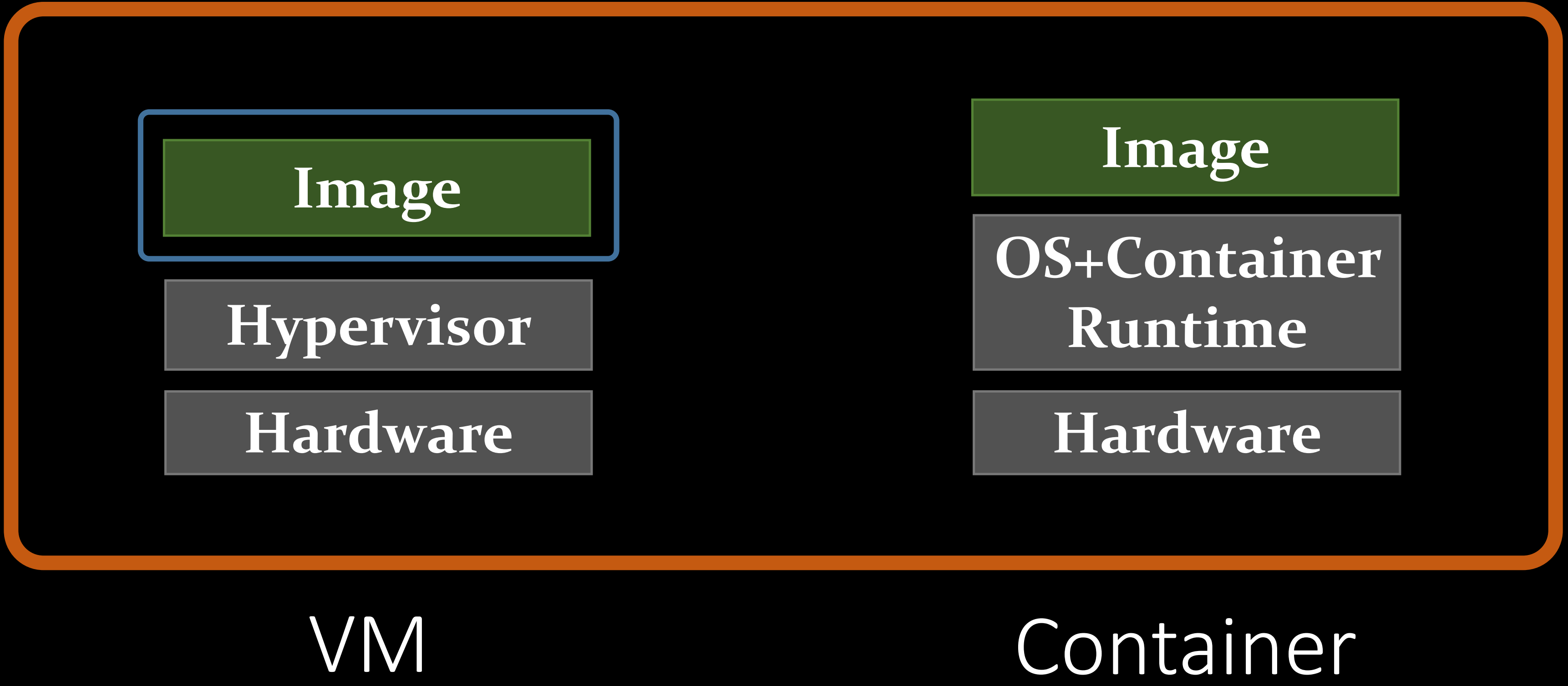
(as in OS-level virtualization)

understanding modern CPUs

Both Intel and AMD have hardware support for virtualization

- isolation
- performance penalty

on prem



Image

Hypervisor

Hardware

VM

Image

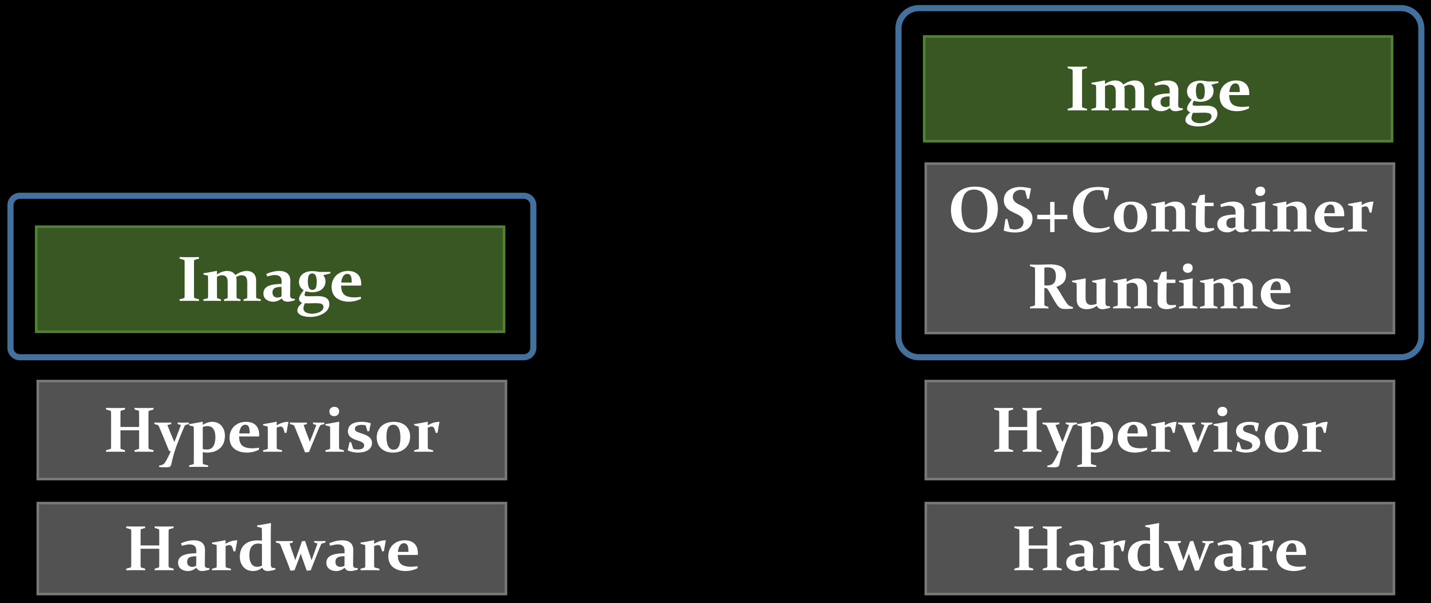
OS+Container Runtime

Hardware

Container

your responsibility

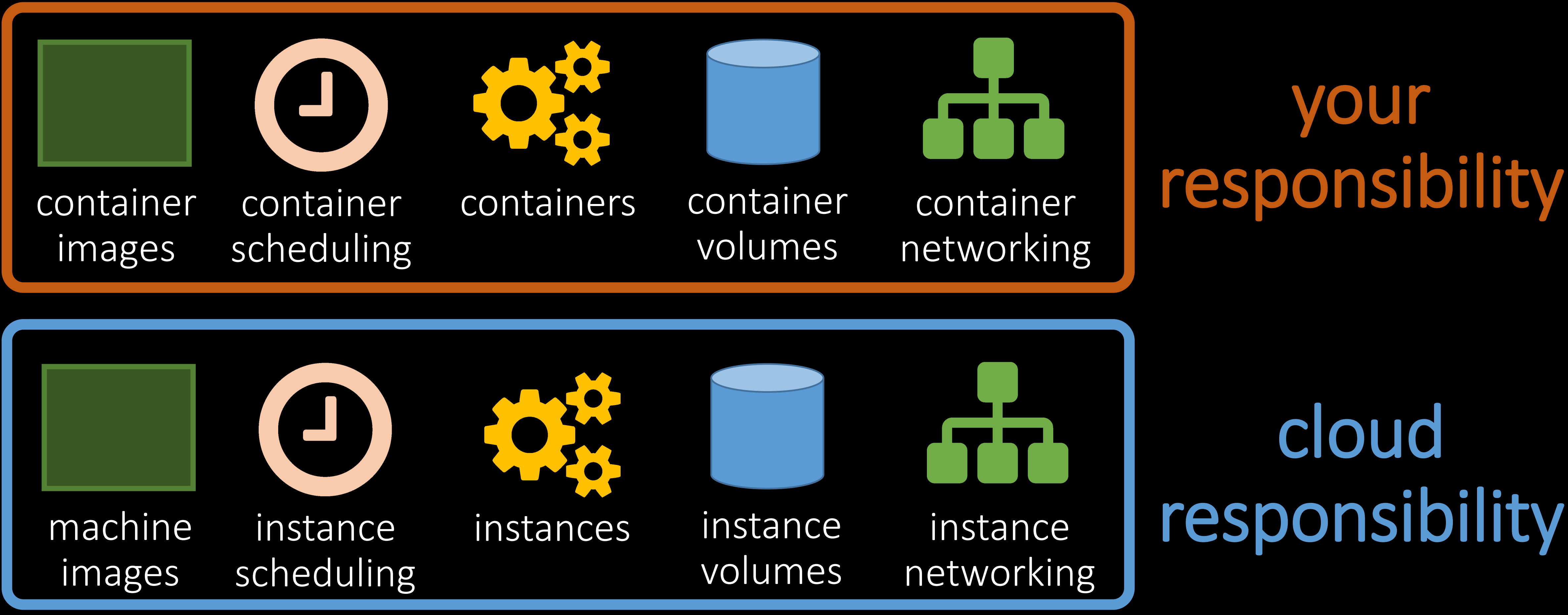
cloud



VM

Container

cloud



container images

container scheduling

containers

container volumes

container networking

your responsibility

machine images

instance scheduling

instances

instance volumes

instance networking

cloud responsibility

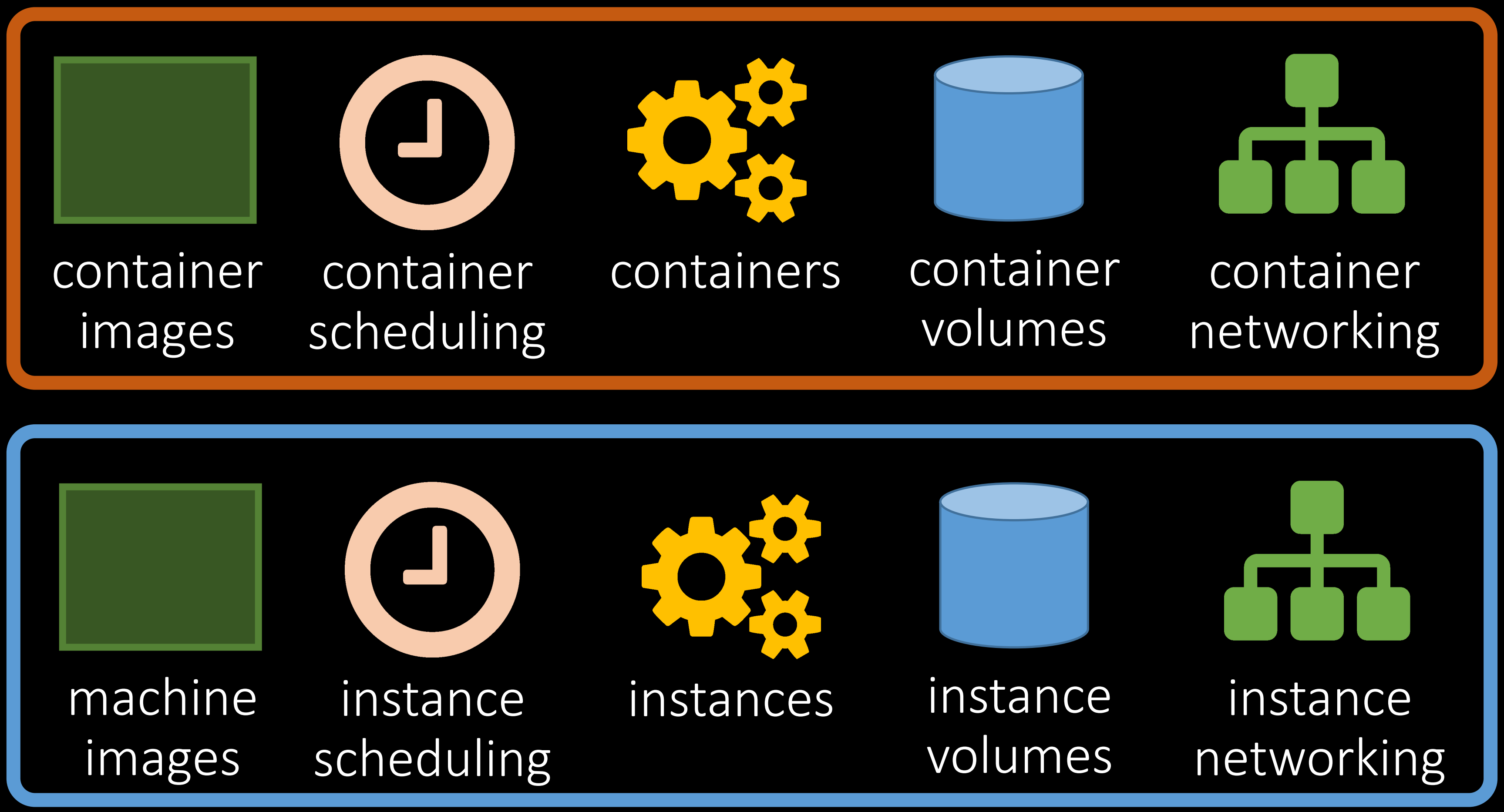
1.5 months of t2.nano

1 hour of t2.nano

boxfuse

cloud

Only makes sense if you cannot afford **0.5p/hour** granularity



container images

container scheduling

containers

container volumes

container networking

your responsibility

machine images

instance scheduling

instances

instance volumes

instance networking

cloud responsibility

summary

- One immutable unit
- Regenerated after every change
- Promoted from Environment to Environment

Classic Mistake: Build per Environment

Bootable App

- One immutable unit
- Regenerated after every change
- Promoted from Environment to Environment
- Use Minimal Images
- Focus on Cost in your architecture

Classic Mistake: Build per Environment

boxfuse

boxfuse.com

THANKS

boxfuse

AXEL FONTAINE

@axelfontaine

I'LL BE BACK

boxfuse

boxfuse.com