

Virtualization/Vagrant/ Cloud Computing

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Cloud Computing

- ▶ Computing as a “service” rather than a “product”
 - Everything happens in the “cloud”: both storage and computing
 - Personal devices (laptops/tablets) simply interact with the cloud
- ▶ Advantages
 - Device agnostic – can seamlessly move from one device to other
 - Efficiency/scalability: programming frameworks allow easy scalability (relatively speaking)
 - Increasing need to handle “Big Data”
 - Reliability
 - Cost: “pay as you go” allows renting computing resources as needed – much cheaper than building your own systems

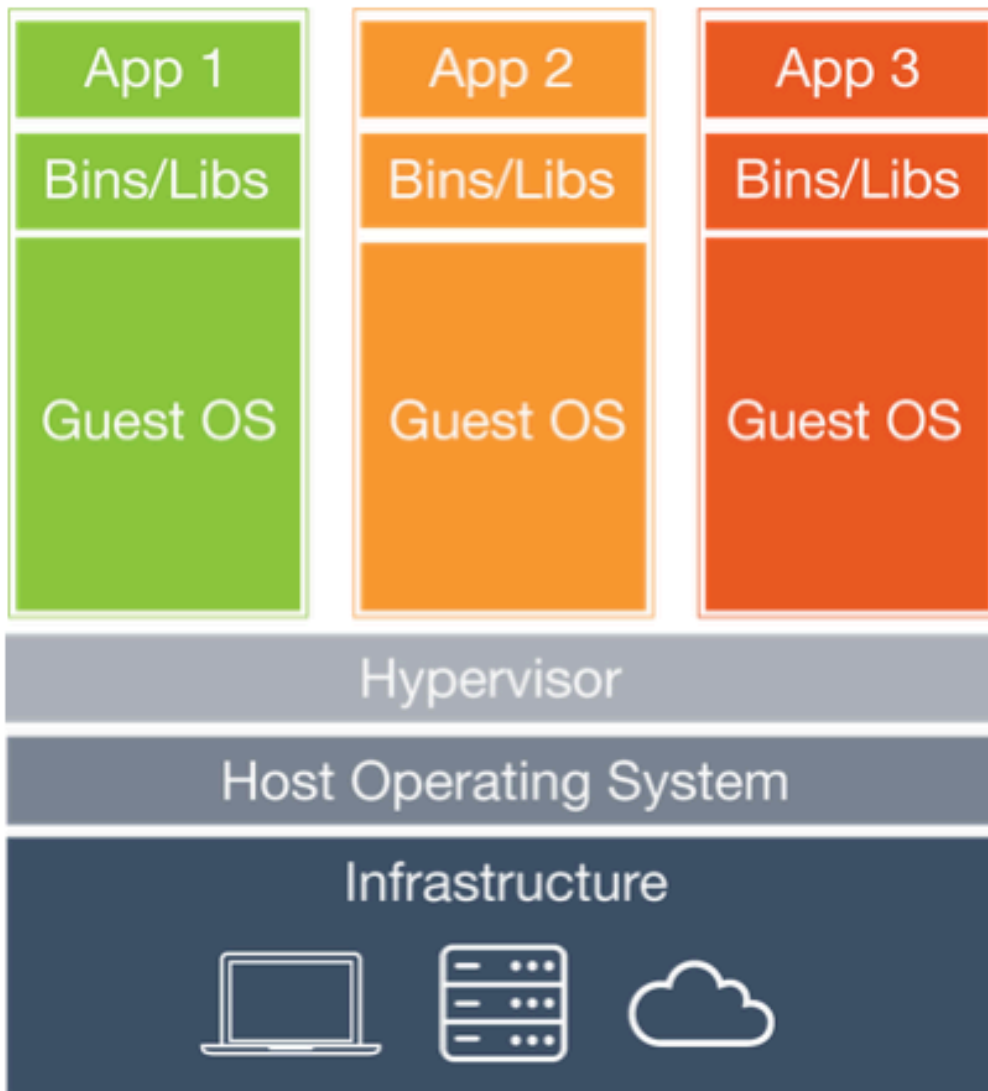
Cloud Computing

- ▶ Basic ideas have been around for a long time (going back to 1960's)
 - Mainframes + thin clients (more by necessity)
 - Grid computing a few year ago
 - Peer-to-peer
 - Client-server models
 - ...
- ▶ But it finally works as we wished for...
 - Why now?... A convergence of several key pieces over the last few years
 - Does it really? ... Still many growing pains

Virtualization

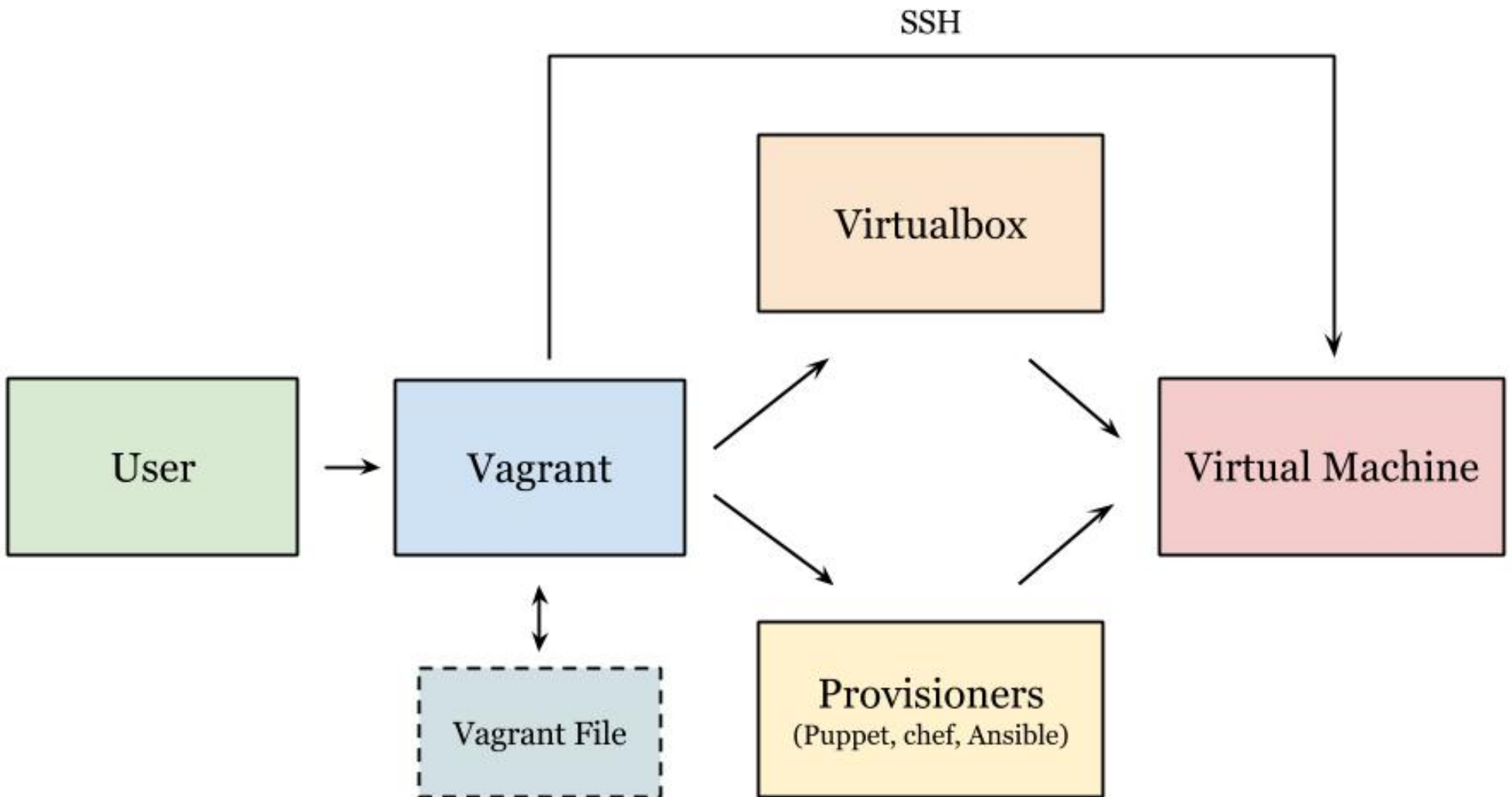
- ▶ Virtual machines (e.g., running Windows inside a Mac) etc. has been around for a long time
 - Used to be very slow...
 - Only recently became efficient enough to make it a key for CC
- ▶ Basic idea: run virtual machines on your servers and sell time on them
 - That's how Amazon EC2 runs
- ▶ Many advantages:
 - Security: virtual machines serves as almost impenetrable boundary
 - Multi-tenancy: can have multiple VMs on the same server
 - Efficiency: replace many underpowered machines with a few high-power machines

Virtual Machines

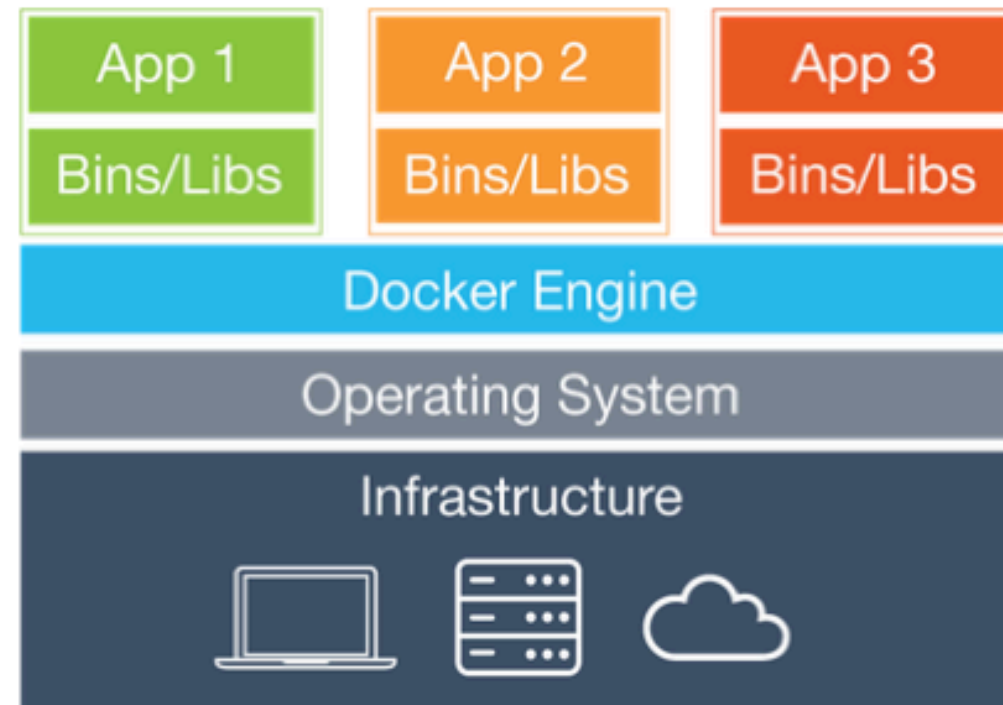
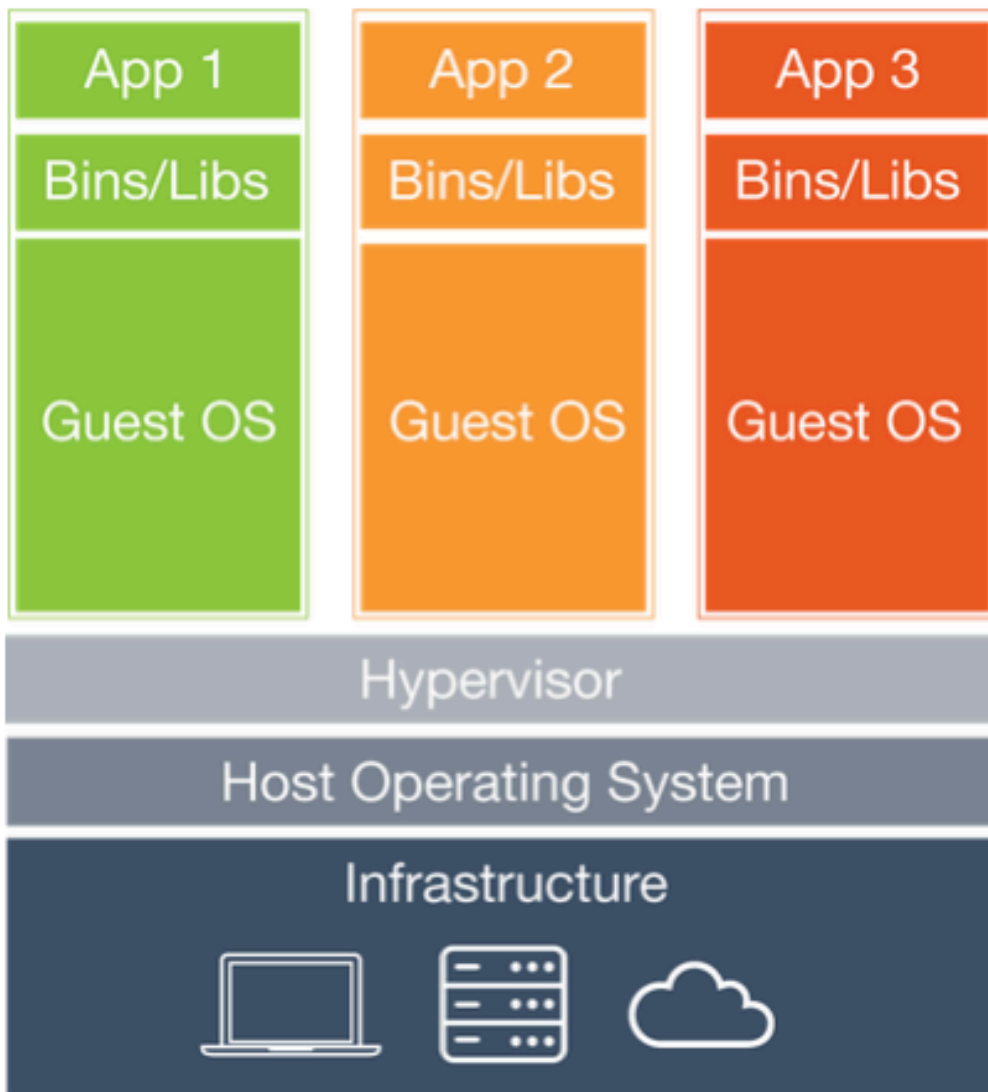


Vagrant

Vagrant makes it easy to create and configure virtual environments.



Virtual Machines vs Containers



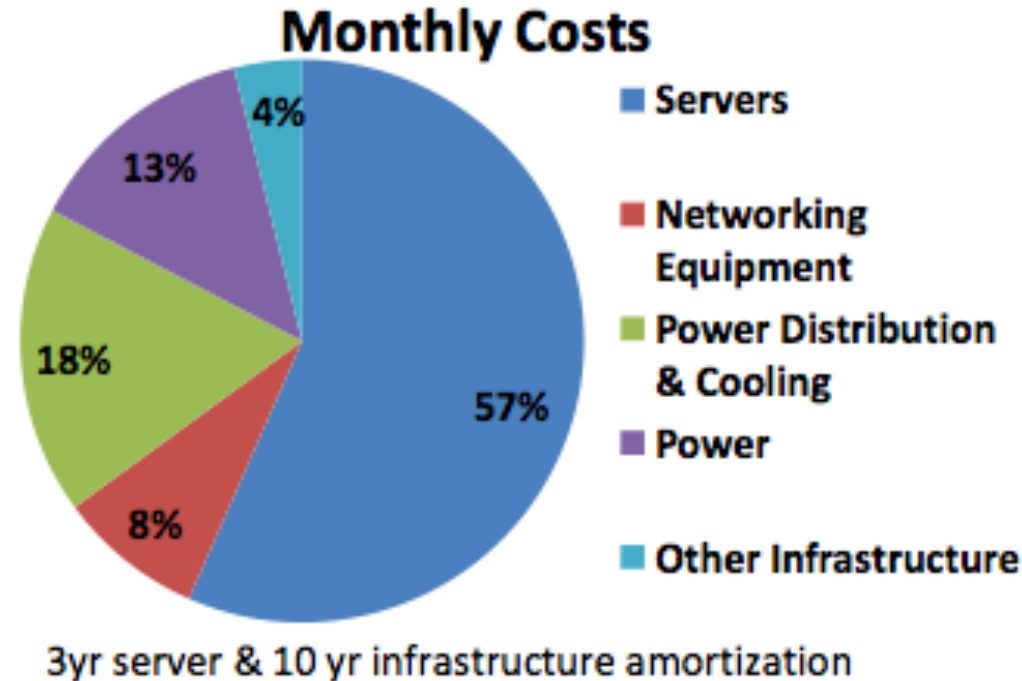
Data Centers

- ▶ The key infrastructure piece that enables CC
- ▶ Everyone is building them
- ▶ Huge amount of work on deciding how to build/design them



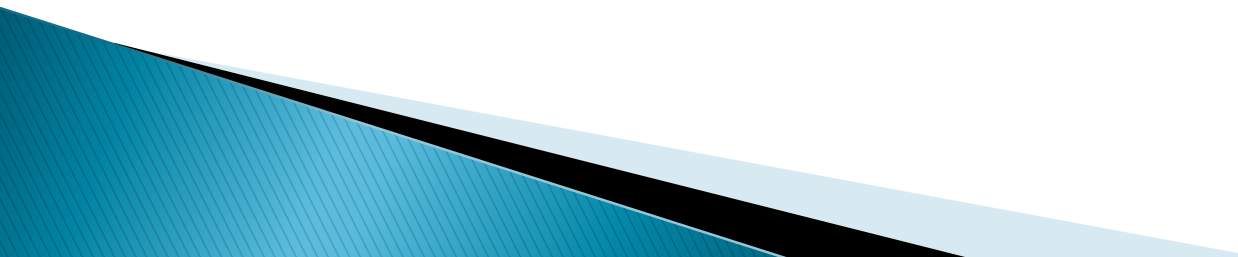
Data Centers

- ▶ Amazon data centers:
Some recent data
 - 8 MW data center can include about 46,000 servers
 - Costs about \$88 million to build (just the facility)
 - Power a pretty large portion, but server costs still dominate



“Every day, Amazon Web Services adds enough new capacity to support all of Amazon.com’s global infrastructure through the company’s first 5 years, when it was a \$2.76B annual revenue enterprise”

Putting it together

- ▶ A Cloud Computing Provider builds and manages “Data Centers”, often with millions of servers
 - ▶ They may rent you:
 - Raw hardware (not that common)
 - Virtual machines in those data centers (Infrastructure-as-a-service)
 - A software service that does something specific for you (Software-as-a-service)
 - Something in-between (Platform-as-a-service)
- 



On-Premises



IaaS

Infrastructure as a Service



PaaS

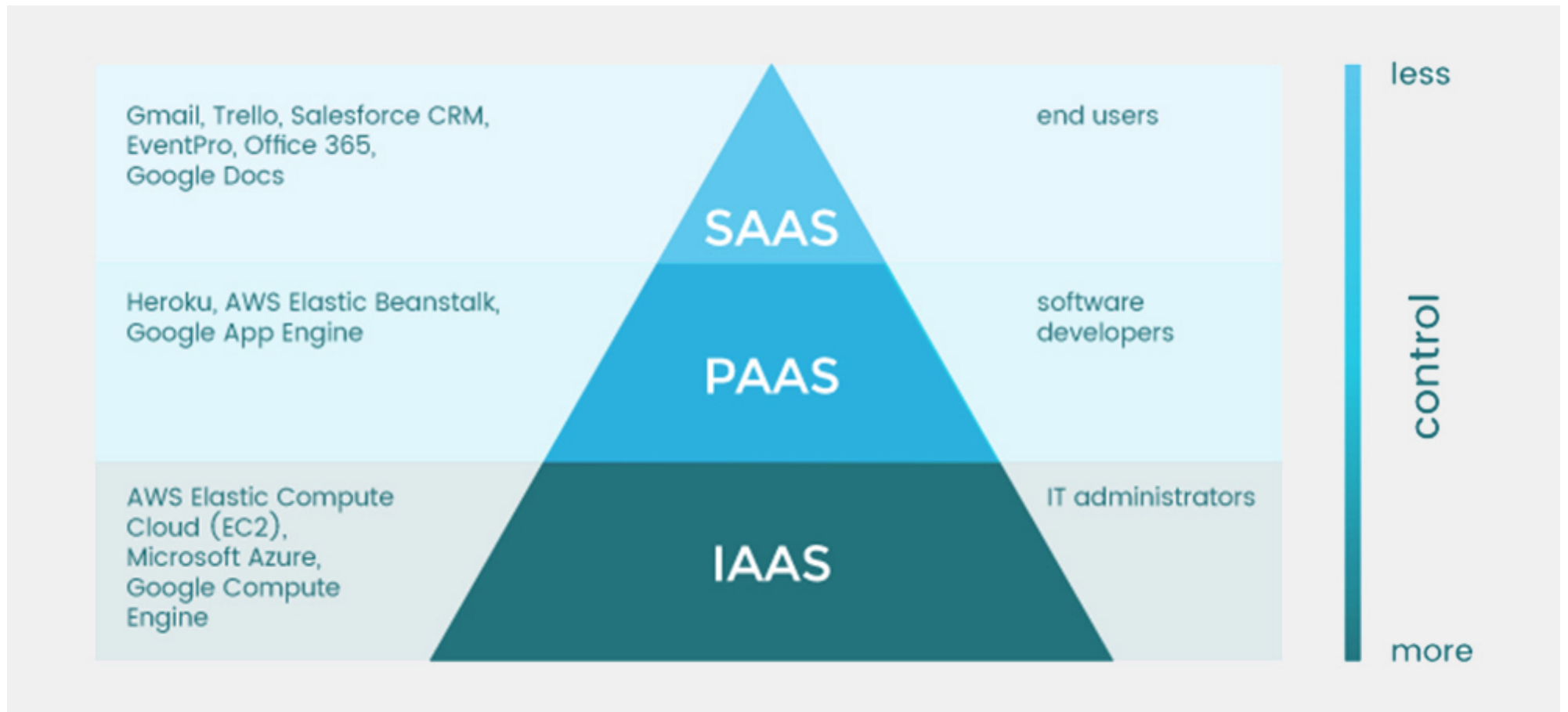
Platform as a Service



SaaS

Software as a Service

Applications	Applications	Applications	Applications
Data	Data	Data	Data
Runtime	Runtime	Runtime	Runtime
Middleware	Middleware	Middleware	Middleware
O/S	O/S	O/S	O/S
Virtualization	Virtualization	Virtualization	Virtualization
Servers	Servers	Servers	Servers
Storage	Storage	Storage	Storage
Networking	Networking	Networking	Networking

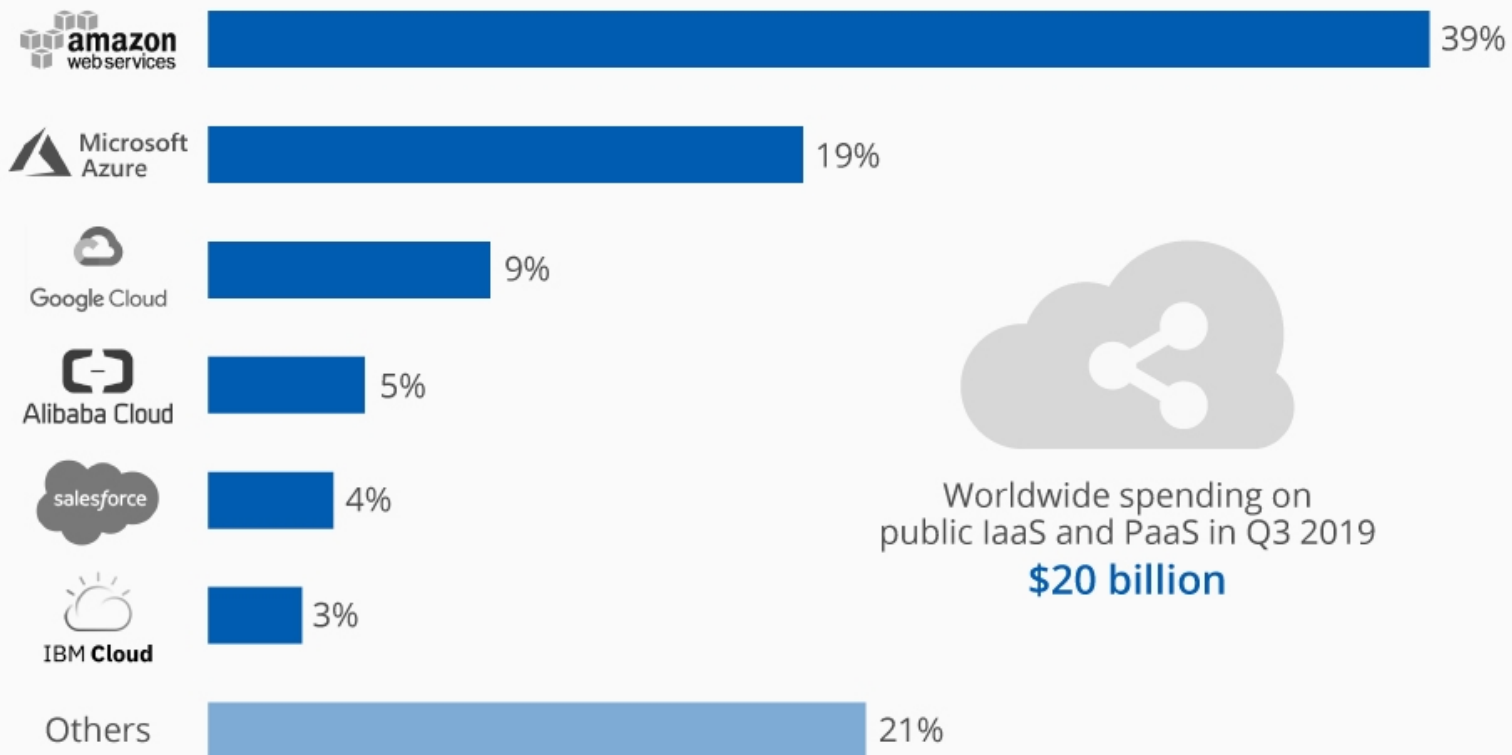


Amazon Web Services

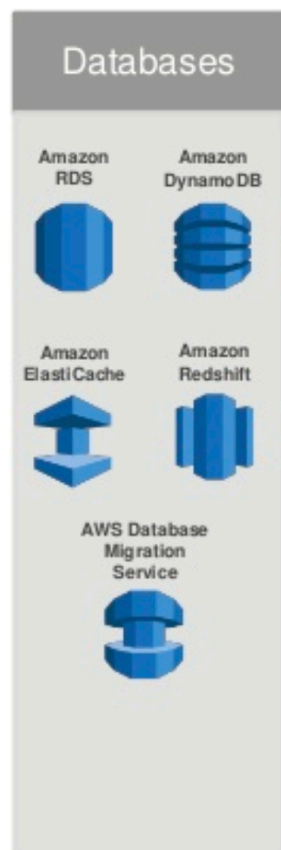
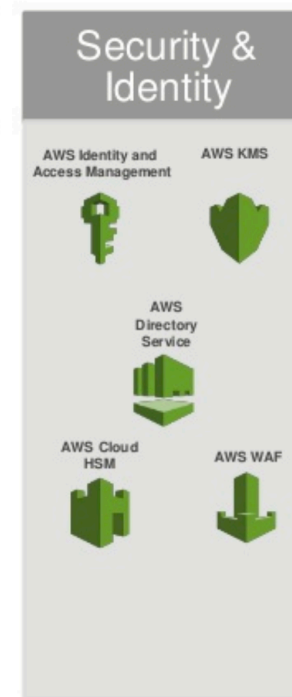
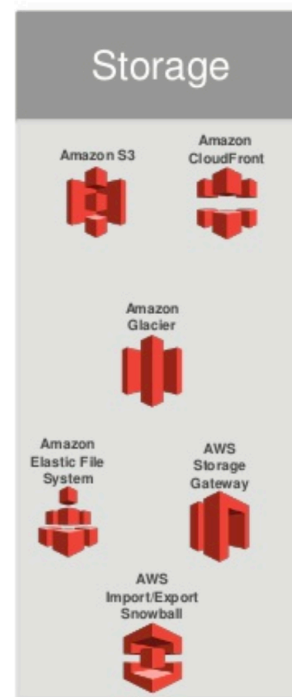
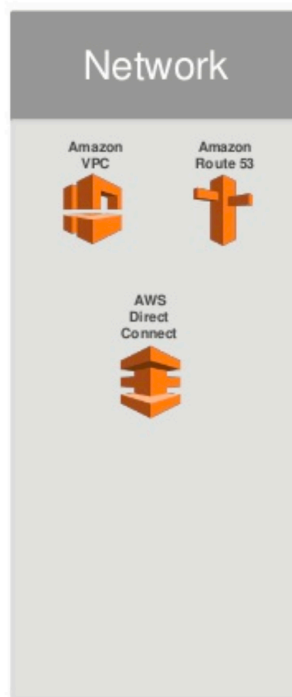
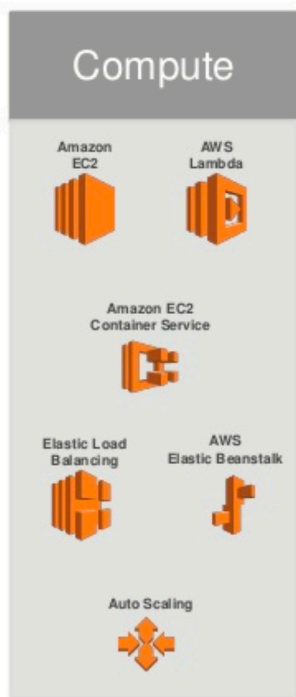
- ▶ Leader in this space for a while

Amazon Dominates Public Cloud Market

Global market share of public cloud infrastructure service providers in Q3 2019*



AWS has 175
Services
Today..
More every
year...



Microsoft Azure not far behind

