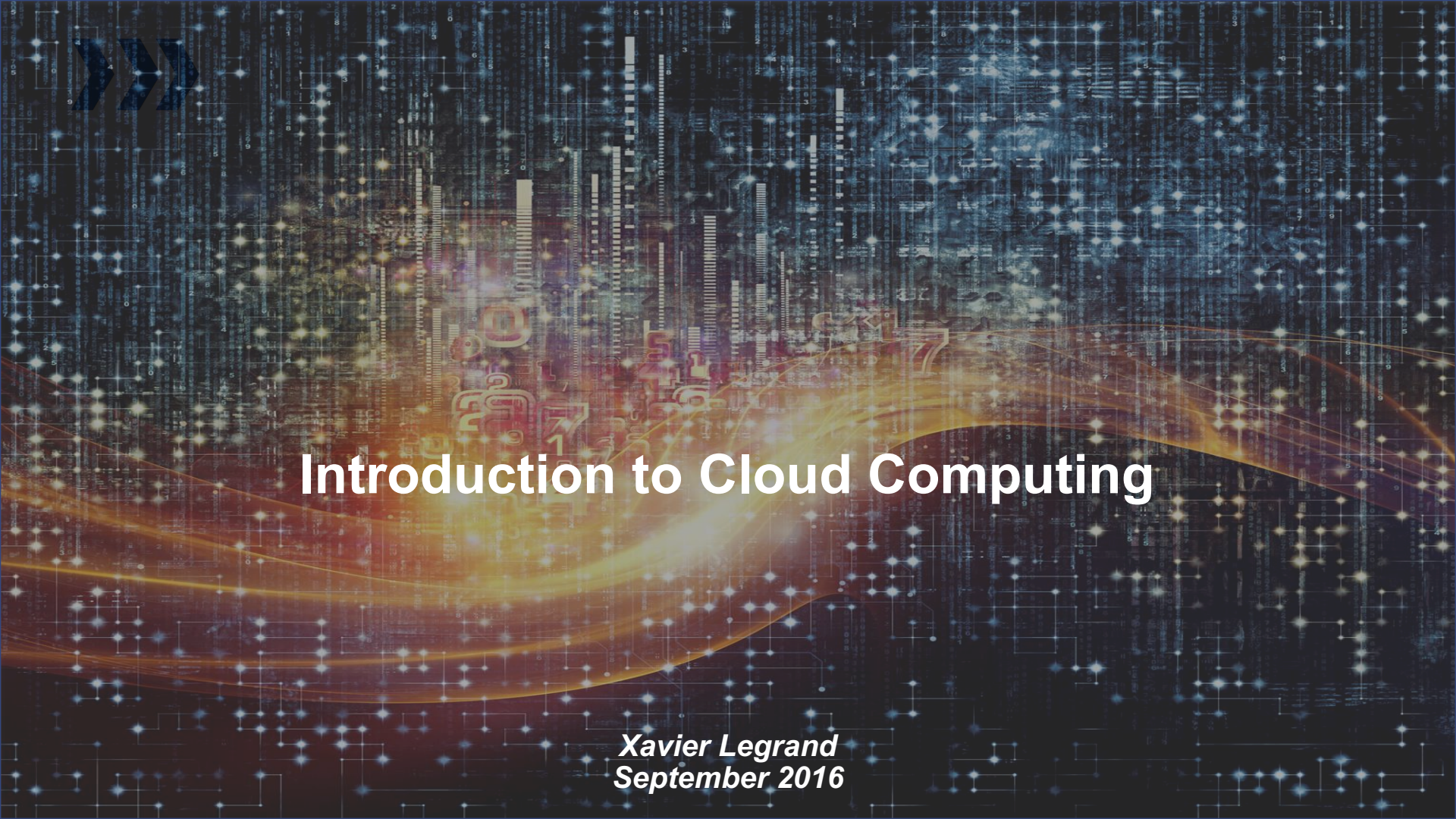


Introduction to Cloud Computing

Xavier Legrand
September 2016

Plan

What is Cloud Computing?

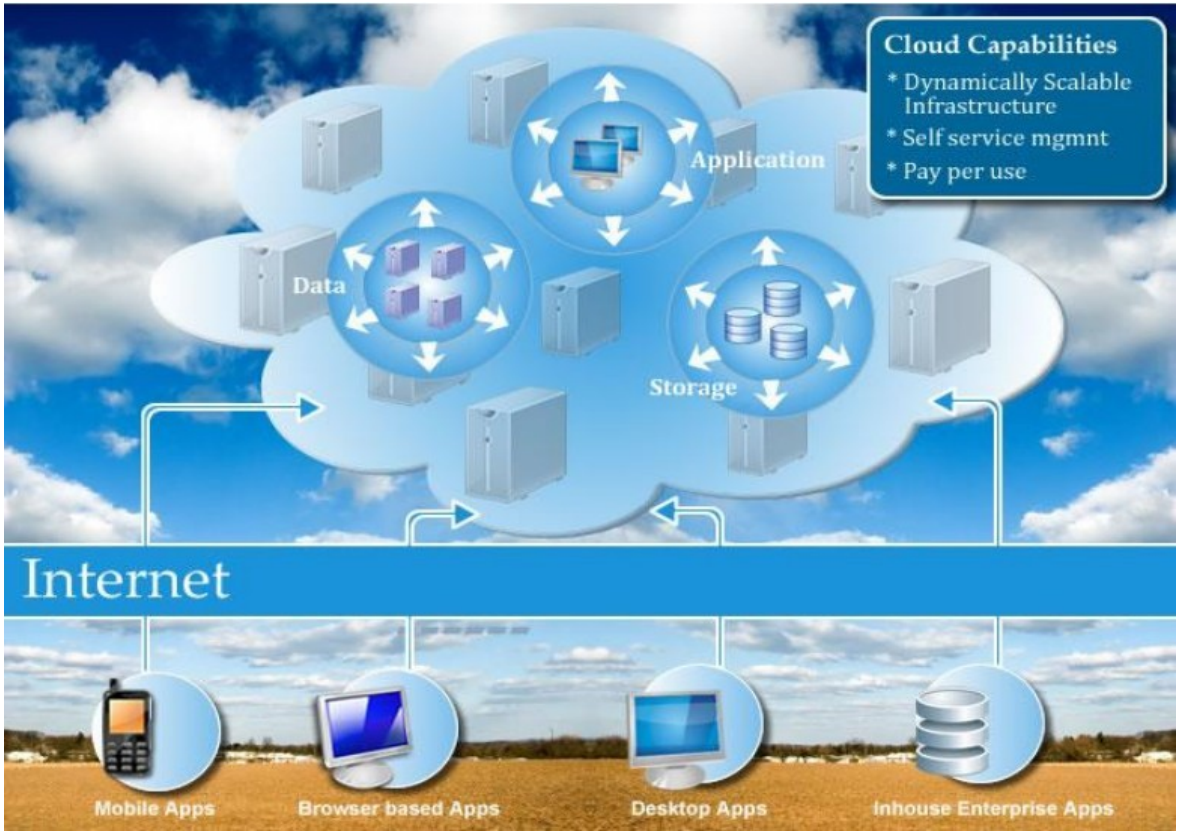
- Why Cloud Computing?
- Virtualization and Cloud
- Cloud vs. Grid Computing
- Cloud Computing Adoption
- Cloud Computing Landscape
- Cloud Computing Security
- Cloud clients Tools
- Backend As A Service (BaaS)
- Is cloud Cost Effective?

Cloud Computing Definitions

- Forrester
  - A standardized IT capability (services, software, or infrastructure) delivered via the Internet in a pay-per-use, self-service way
- NIST (National Institute of Standards and Technologies)
  - Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.
- Larry Ellison
  - Water Vapor... [other than that] it is just a computer connected to a network!
  - Changed its mind in 2015 …

5 Essential Cloud Characteristics

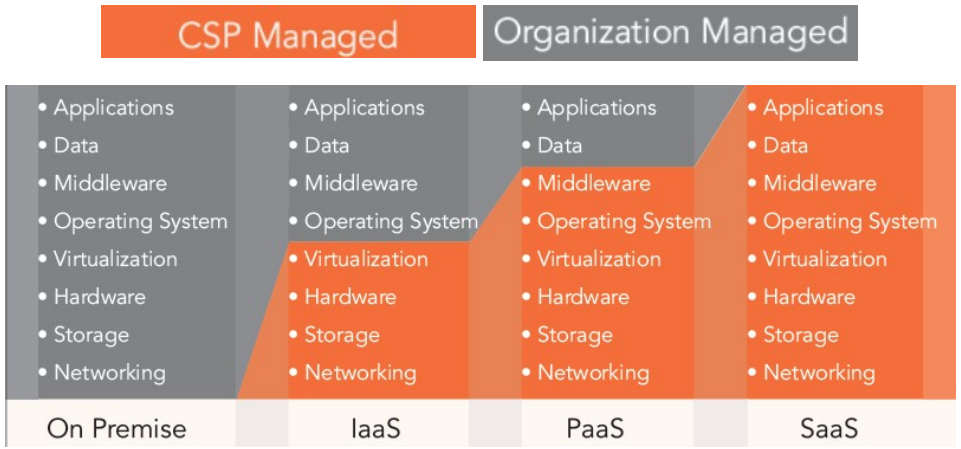
- On-demand self-service
- Broad network access
- Resource pooling
  - Location independence
- Rapid elasticity
- Measured service



Cloud Services Taxonomy

- Software as a Service (SaaS)
  - Use provider's applications over a network
- Platform as a Service (PaaS)
  - Deploy customer-created applications to a cloud
- Infrastructure as a Service (IaaS)
  - Rent processing, storage, network capacity, and other fundamental computing resources

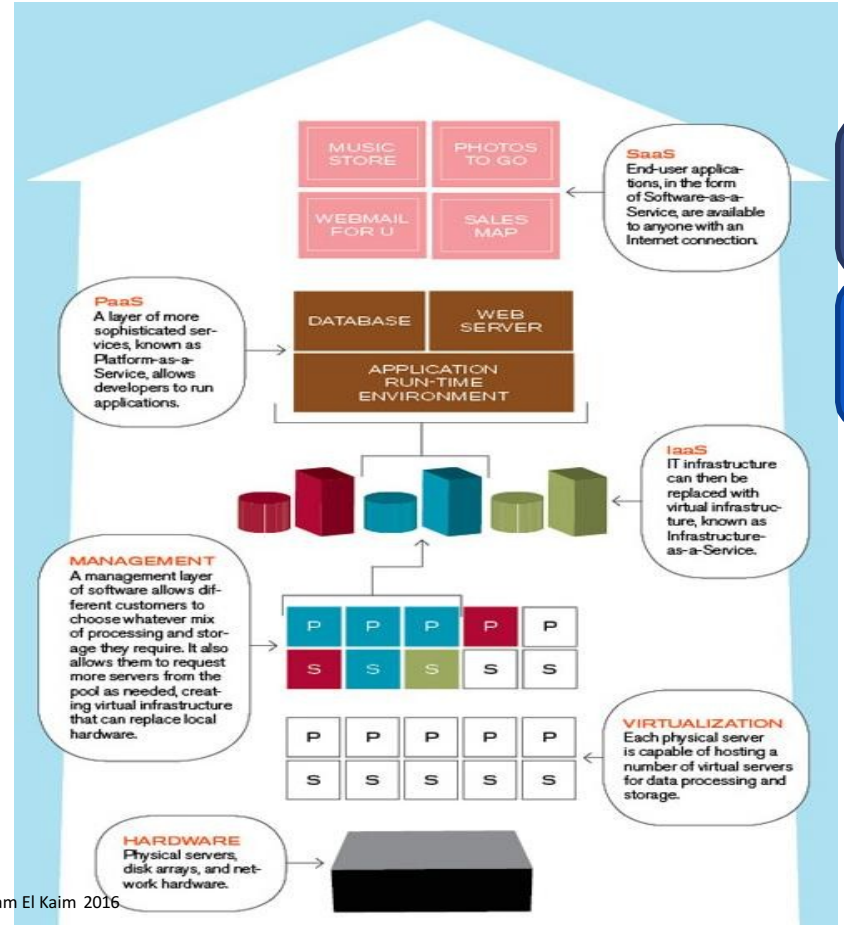
Cloud Services Taxonomy



Software as a Service (SaaS):	The capability provided to the customer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser (e.g., web-based email), or a program interface. The customer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.
Platform as a Service (PaaS):	The capability provided to the customer is to deploy onto the cloud infrastructure customer-created or acquired applications created using programming languages, libraries, services, and tools supported by the provider. The customer still does not manage or control the underlying cloud infrastructure but has control over the deployed applications and possibly configuration settings for the application-hosting environment.
Infrastructure as a Service (IaaS):	The capability provided to the customer is to provision processing, storage, networks, and other fundamental computing resources. The customer is able to deploy and run arbitrary software which can include operating systems and applications. The customer again does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, and deployed applications; and possibly limited control of select networking components (e.g., host firewalls).

Source: BSA

Cloud Services Taxonomy



Software-as-a-service (SaaS)

Finished applications that you rent and customize

Platform-as-a-service (PaaS)

Developer platform that abstracts the infrastructure, OS, and middleware to drive developer productivity

Infrastructure-as-a-service (IaaS)

Deployment platform that abstracts the infrastructure

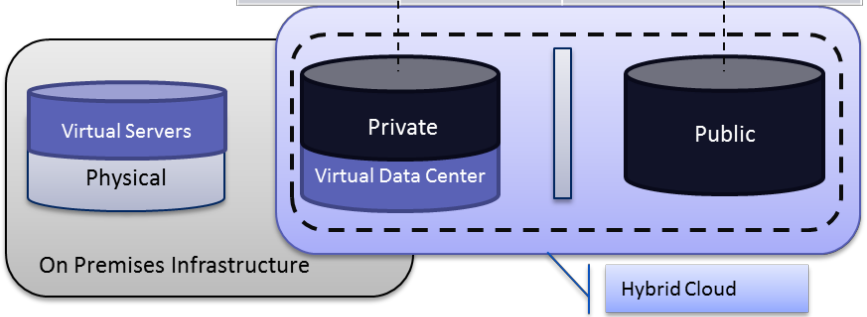
Cloud Services Taxonomy

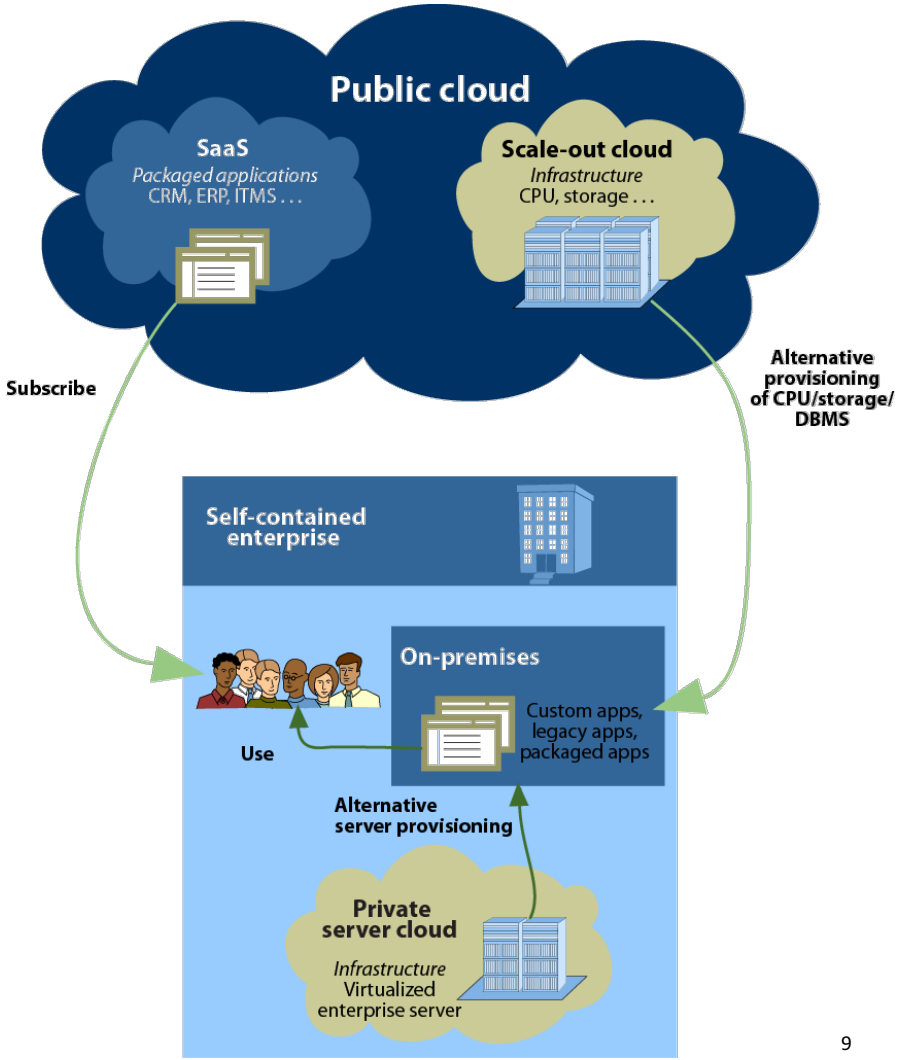
Private cloud:	The cloud infrastructure is provisioned for exclusive use by a single organization (customer) comprising multiple internal customers (e.g., business units). It may be owned, managed, and operated by the customer, a third party, or some combination of them, and it may exist on or off premises.
Community cloud:	The cloud infrastructure is provisioned for exclusive use by a specific community of customers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and it may exist on or off-premises.
Public cloud:	The cloud infrastructure is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider.
Hybrid cloud:	The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

Source: BSA

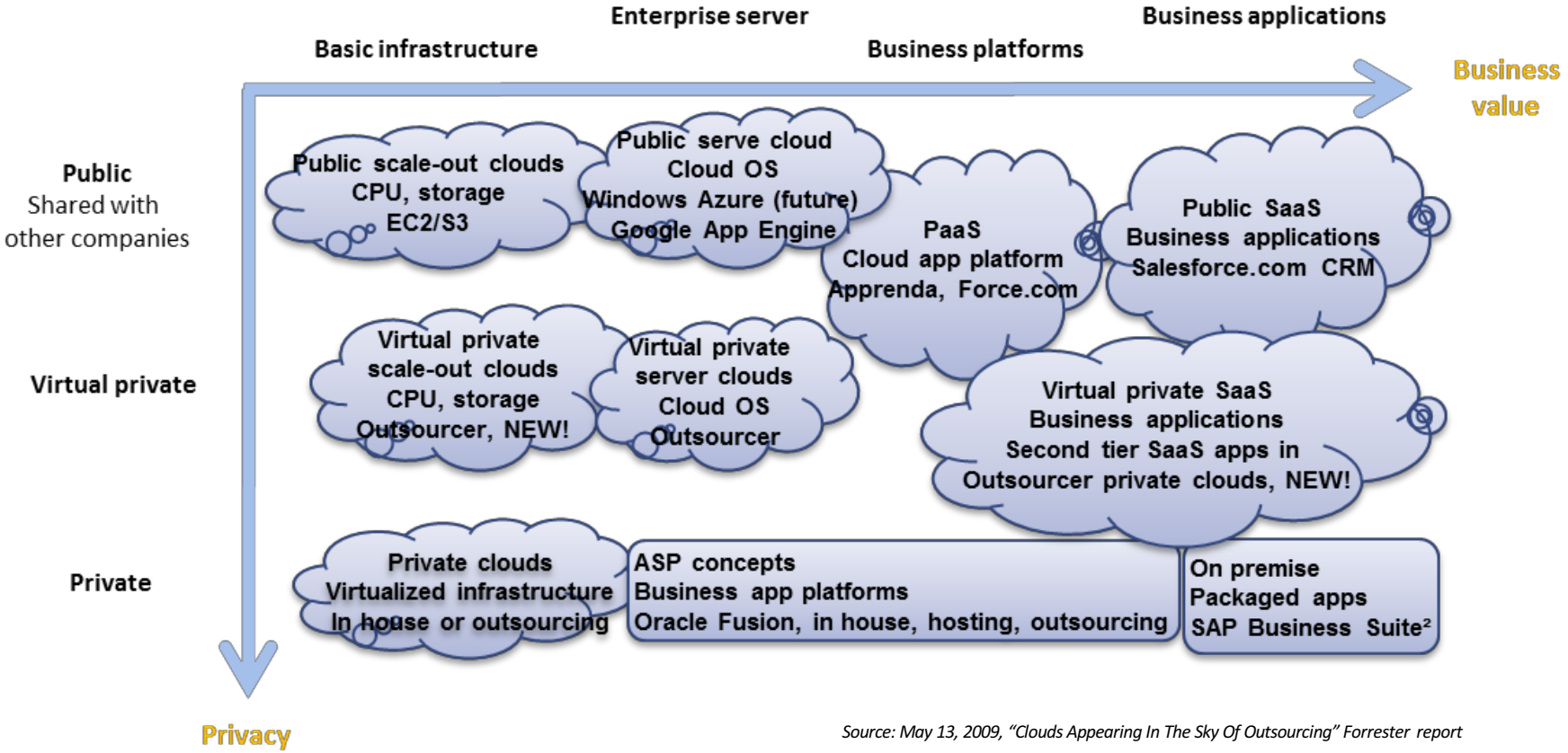
Cloud Services Taxonomy

Private Internal Cloud	Private External Cloud	Community Cloud	Public Cloud
Self	Self	Selected Companies	Anyone
Deployment needed Use it or loose it	Contract / SLA Use it or loose it	Contract / Pay per use	No Contract Pay with a Credit Card
Eucalyptus Amazon	Savvis Terremark		Amazon Google Microsoft





Cloud Services Taxonomy



Source: May 13, 2009, "Clouds Appearing In The Sky Of Outsourcing" Forrester report

Plan

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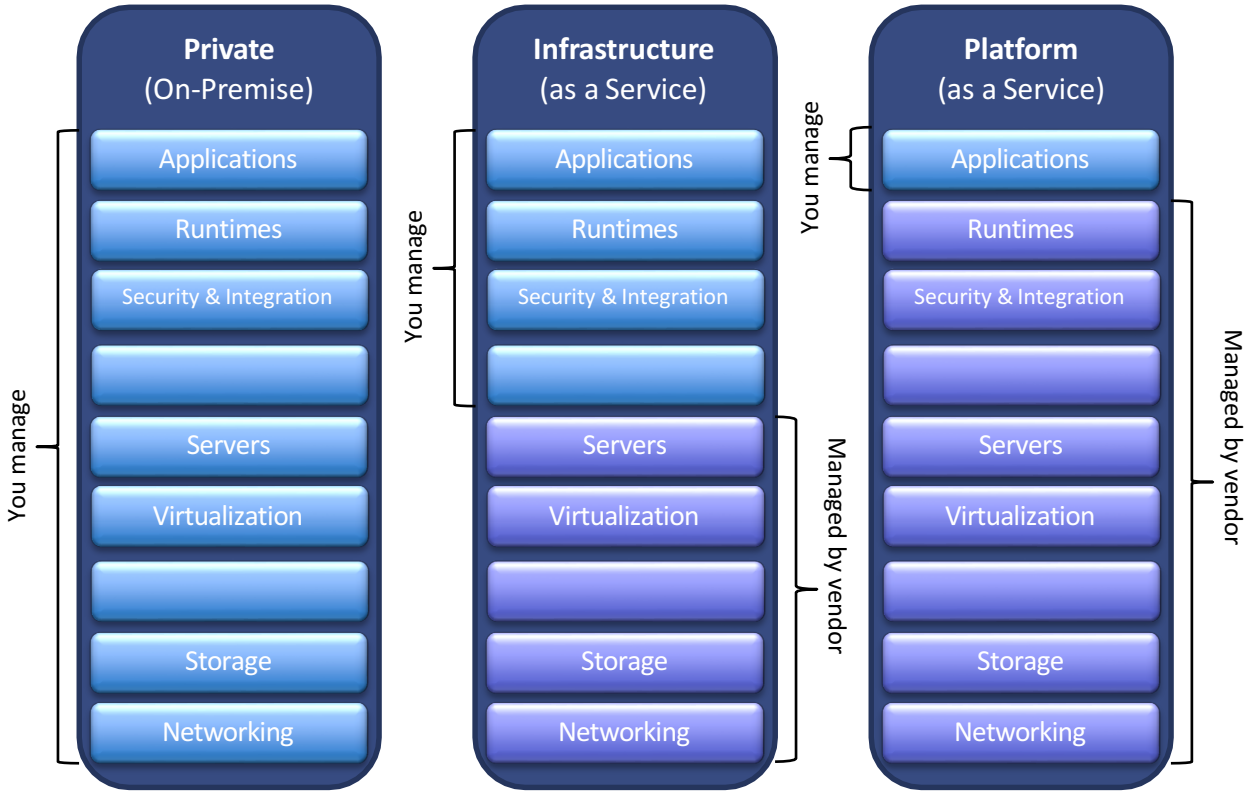
Highly Available Infrastructure

- Public Infrastructure composed of computing power, storage, security
  - Platforms, software, applications, services reside on top
- Immediate availability, ordering, provisioning on the web
  - Easier and cheaper than deploying it in-house
- Easily manageable from a single web interface
  - Partition, synchronize, distribute, secure, store data/apps
- Run from centralized deployments/datacenters
  - Supports Platforms as a Service
- Real-time accessible and usable across the web
  - Many (often smaller) applications run off more consistently available resources

IT as a Service



Cloud Computing Is Attractive To Businesses

- Pay by the drink - Credit card billable
- SLA driven
  - defined response times, immediate recreation of instances, consistent service for all users
- Providing easy integration with back-end services
- Should always be available and self-healing
- Unobstructive/transparent: client only sees end workload
- Multi-tenant infrastructure with complete security/privacy
- Linearly scalable on the fly (up/down) – cost reducing

Private Enterprise clouds are not included in this discussion

Utility Computing & On-Demand Storage

- Two developer driven components of the Cloud
- Utility computing
  - Range from minute to monthly provisioning/billing
    - Target is web based ordering + instant provisioning
  - Should be pay by the drink & include an SLA
  - Should be desktop mountable & immediately available
  - Should have back-end storage and other web services
- On-demand Storage
  - Range from Managed hosters offering on-demand SAN,NAS and DAS - orders possible with seasonal billing
  - Back-up/Protection wins when on-demand storage fails

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Virtualization and Cloud

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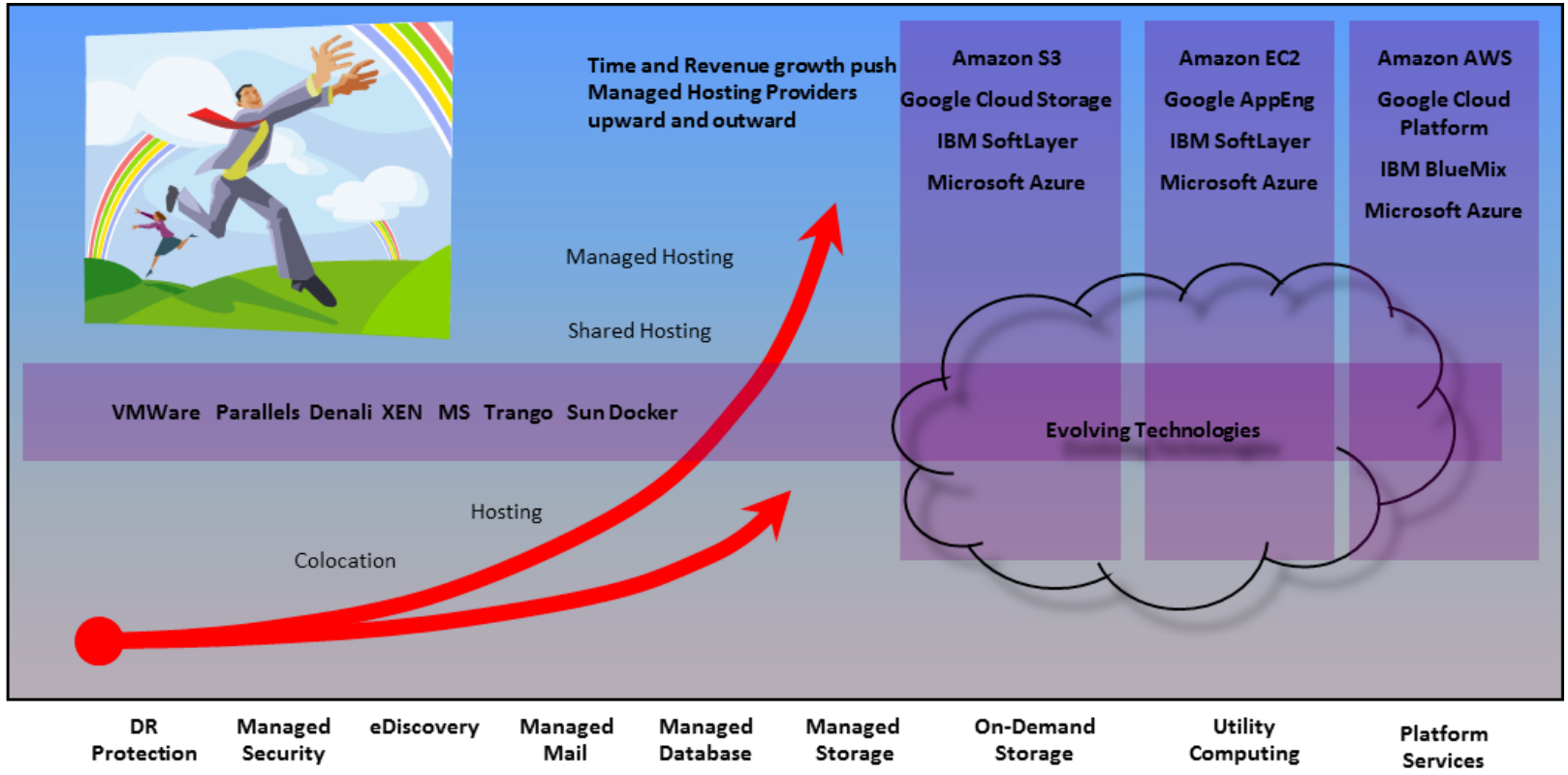
Why Virtualization?

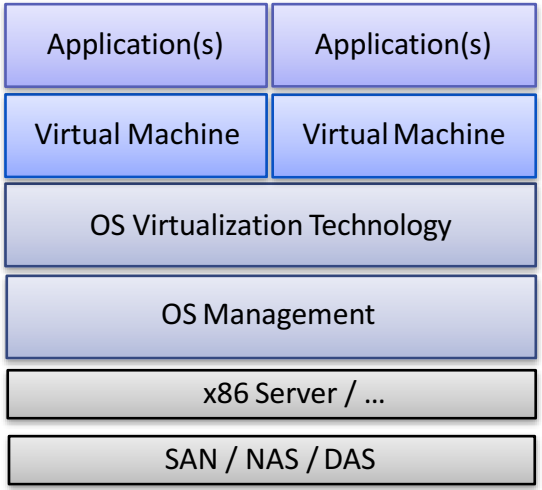
- Without virtualization, the application and operations architecture teams design, acquire and install the servers, storage and networking needed for each application
- Virtualization offers only a hardware abstraction layer that can adjust to the specific CPU, memory, storage, and network needs of applications on a per server basis
- Of course, this is not enough
  - What is the right density of VMs per host and type of workloads?
  - Virtualization may require an expensive shared storage infrastructure (Fiber Channel SAN)
  - It is not elastic, turn-key or upgradeable by itself
    - Same old Operations and Management processes apply
- Cloud computing is an “operation model” applied to virtualization

Managed Hosting Services Evolutions



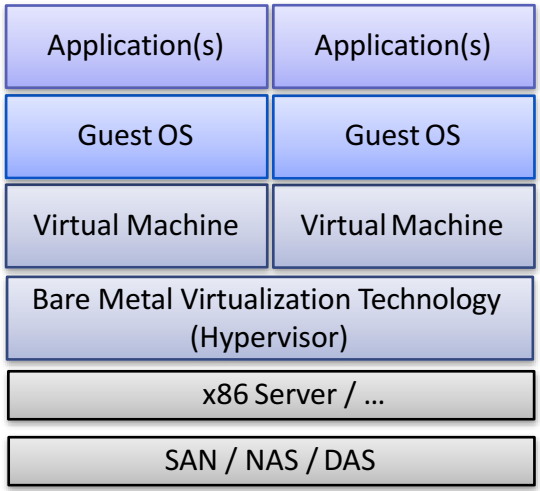
Technology: Operating System Virtualization

- Only one OS at a time
  - Reduces OS sprawl
  - Reduces in-memory consumption
- Best for
  - Applications that do not coexist well with others
  - Individual workloads
  - SaaS
- Examples
  - Parallels Virtuozzo Containers
  - Sun Solaris Containers
  - OpenVZ
  - Unix chroot command
  - Linux V-Server



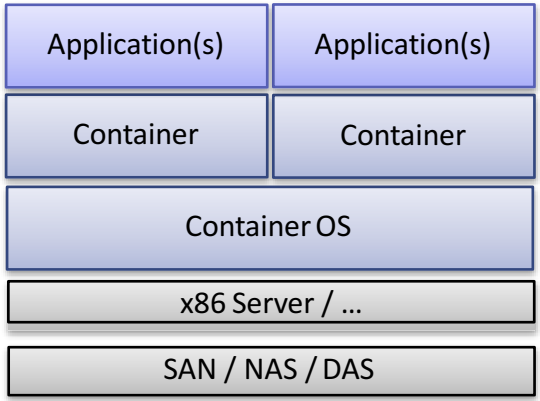
Technology: Bare Metal Hypervisor

- Best for heterogeneous environments
  - Development and testing environments
  - Virtual desktop
  - legacy server consolidation
- Virtualizes access to hardware (CPU, Memory, Storage)
  - assisted by Intel and AMD
- Each VM has a guest OS
  - Reduces server sprawl
- Examples
  - VMware ESX
  - Citrix XenServer (Linux)
  - Parallels Server
  - Microsoft Hyper-V
  - Trango
  - Sun xVM

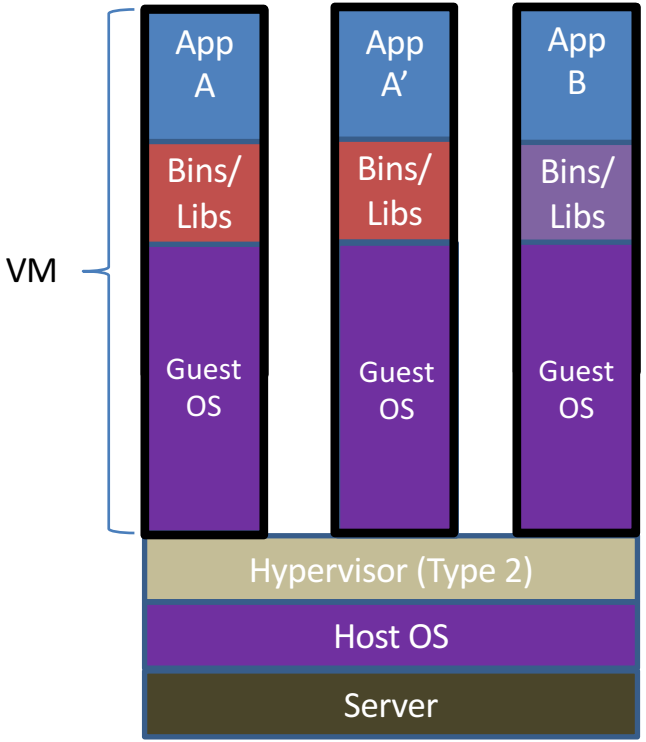


Technology: Containerization

- Containers are the products of operating system virtualization.
  - Lightweight virtual environment that groups and isolates a set of processes and resources such as memory, CPU, disk, etc., from the host and any other containers.
  - The isolation guarantees that any processes inside the container cannot see any processes or resources outside the container.
- Only one App (or microservice) at a time
  - Run in isolated process on the host operating system
  - Portable and efficient
  - Reduces in-memory consumption
- Best for
  - Multi-tenant application
  - Elastic applications (automatic scaling)
- Examples
  - Docker, CoreOS, RancherOS, Snappy Ubuntu Core, RedHat Atomic, Mesosphere DCOS, VMware Photon

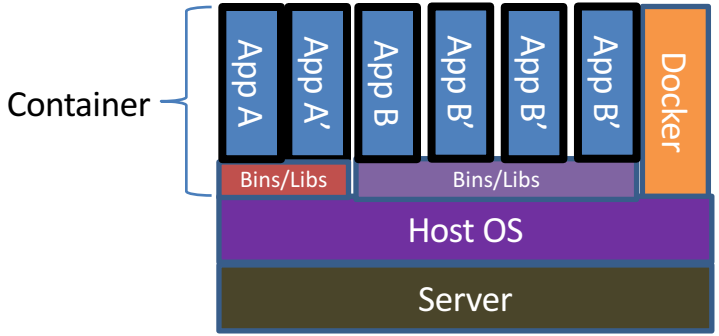


Containers vs. VMs



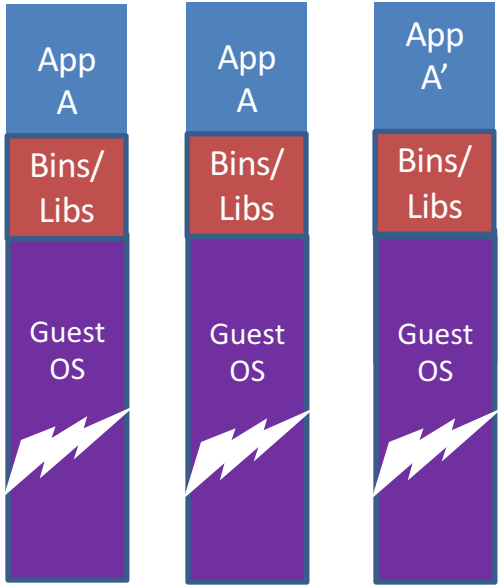
Containers are isolated, but share OS and, where appropriate, bins/libraries

…result is significantly faster deployment, much less overhead, easier migration, faster restart



Why are Docker containers lightweight?

VMs



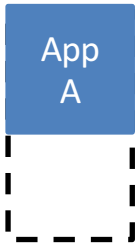
VMs

Every app, every copy of an app, and every slight modification of the app requires a new virtual server

Containers

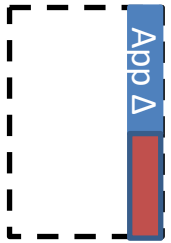
Original App

(No OS to take up space, resources, or require restart)



Copy of App

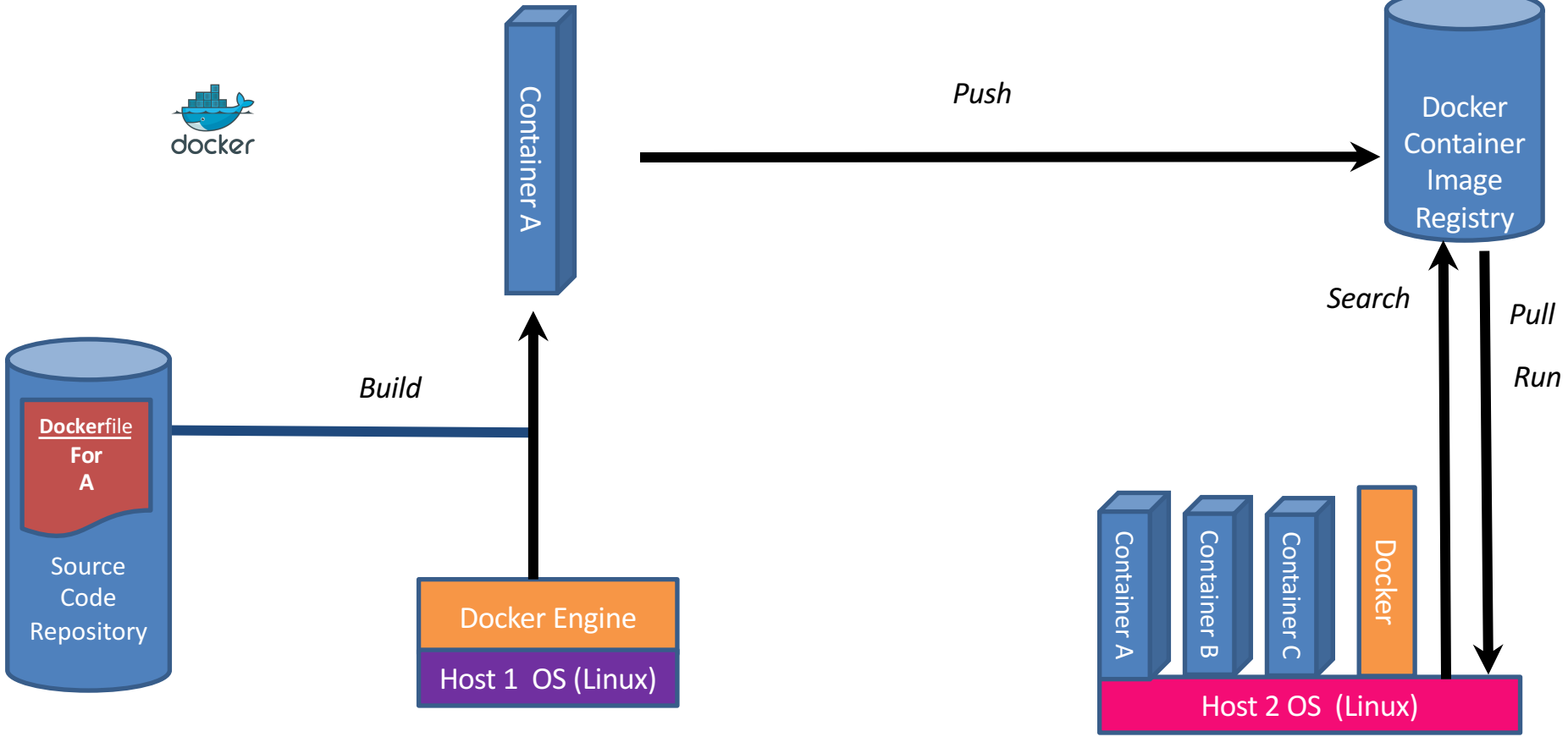
No OS. Can Share bins/libs



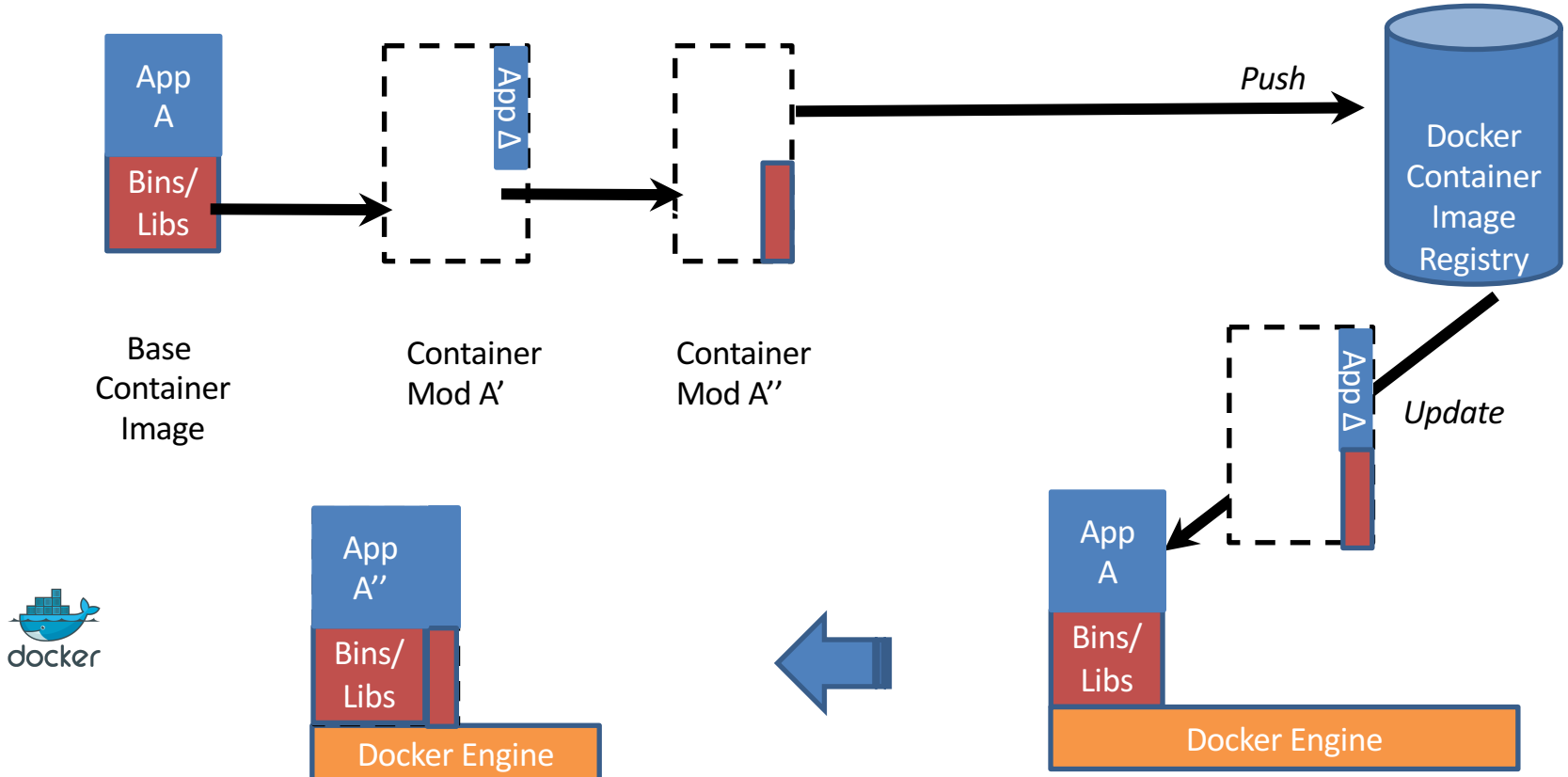
Modified App

Copy on write capabilities allow us to only save the diffs Between container A and container A'

What are the basics of the Docker system?



Changes and Updates



Ecosystem Support

Operating systems
- Virtually any distribution with a 2.6.32+ kernel
- Red Hat/Docker collaboration to make work across RHEL 6.4+, Fedora, and other members of the family (2.6.32 +)
- CoreOS—Small core OS purpose built with Docker

OpenStack
- Docker integration into NOVA (& compatibility with Glance, Horizon, etc.) accepted for Havana rele

Private PaaS
- OpenShift
- Solum (Rackspace, OpenStack)
- Other TBA

Public PaaS
- Deis, Voxoz, Cocaine (Yandex), Baidu PaaS

Public IaaS
- Native support in Rackspace, Digital Ocean,+++
- AMI (or equivalent) available for AWS & other

DevOps Tools
- Integrations with Chef, Puppet, Jenkins, Travis, Salt, Ansible +++

Orchestration tools
- Mesos, Heat, ++
- Shipyard & others purpose built for Docker

Applications
- 1000's of Dockerized applications available at index.docker.io

Demo

```
docker run -d -e POSTGRES_USER=odoo -e POSTGRES_PASSWORD=odoo
--name db postgres:9.4

docker run -p 8069:8069 --name odoo --link db:db -t odoo
```

Plan

- *What is Cloud Computing?*
- *Why Cloud Computing?*
- *Virtualization and Cloud*

Cloud vs. Grid Computing

- Cloud Computing Adoption
- Cloud Computing Landscape
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What is Grid Computing?

- Grid computing is the collection of computer resources from multiple locations to reach a common goal.
  - The grid can be thought of as a distributed system with non-interactive workloads that involve a large number of files.
- Grid computing is distinguished from conventional high performance computing systems such as cluster computing in that grid computers have each node set to perform a different task/application.
  - For certain applications, distributed or grid computing can be seen as a special type of parallel computing that relies on complete computers (with onboard CPUs, storage, power supplies, network interfaces, etc.) connected to a computer network (private or public) by a conventional network interface, such as Ethernet.
  - Although a single grid can be dedicated to a particular application, commonly a grid is used for a variety of purposes.
- Grids are a form of distributed computing whereby a "super virtual computer" is composed of many networked loosely coupled computers acting together to perform large tasks.
  - This is in contrast to the traditional notion of a supercomputer, which has many processors connected by a local high-speed computer bus.

Source: Wikipedia

Cloud vs. Grid Computing?

Cloud Computing

- Cloud computing evolves from grid computing and provides on-demand resource provisioning.
- Grid computing may or may not be in the cloud depending on what type of users are using it.
  - If the users are systems administrators and integrators, they care how things are maintained in the cloud. They upgrade, install, and virtualize servers and applications.
  - If the users are consumers, they do not care how things are run in the system.

Cloud vs. Grid Computing?

Grid Computing

- Grid computing requires the use of software that can divide and farm out pieces of a program as one large system image to several thousand computers.
- One concern about grid is that if one piece of the software on a node fails, other pieces of the software on other nodes may fail.
- This is alleviated if that component has a failover component on another node, but problems can still arise if components rely on other pieces of software to accomplish one or more grid computing tasks.
- Large system images and associated hardware to operate and maintain them can contribute to large capital and operating expenses

Cloud vs. Grid Computing?

Similarities

- Cloud computing and grid computing are scalable.
  - Scalability is accomplished through load balancing of application instances running separately on a variety of operating systems and connected through Web services.
- Both computing types involve multi-tenancy and multitask
  - Meaning that many customers can perform different tasks, accessing a single or multiple application instances.
  - Sharing resources among a large pool of users assists in reducing infrastructure costs and peak load capacity.
- Cloud and grid computing provide service-level agreements (SLAs) for guaranteed uptime availability
- Storage as a service
  - While the storage computing in the grid is well suited for data-intensive storage, it is not economically suited for storing objects as small as 1 byte.

Clouds Versus Grids

Clouds and Grids are distinct

- Cloud
  - Full private cluster is provisioned
  - Individual user can only get a tiny fraction of the total resource pool
  - No support for cloud federation except through the client interface
  - Opaque with respect to resources
- Grid
  - Built so that individual users can get most, if not all of the resources in a single request
  - Middleware approach takes federation as a first principle
  - Resources are exposed, often as bare metal
  - In a data grid, the amounts of distributed data must be large for maximum benefit. A computational grid focuses on computationally intensive operations.

Grid Computing: Tools

- EMI: Software platform for high performance distributed computing
- Globus Toolkit: open source software toolkit used for building grids. It is being developed by the Globus Alliance.
- GridWay: Metascheduler enables large-scale, reliable and efficient sharing of computing resources
- Parabon: Software platform for high performance distributed computing

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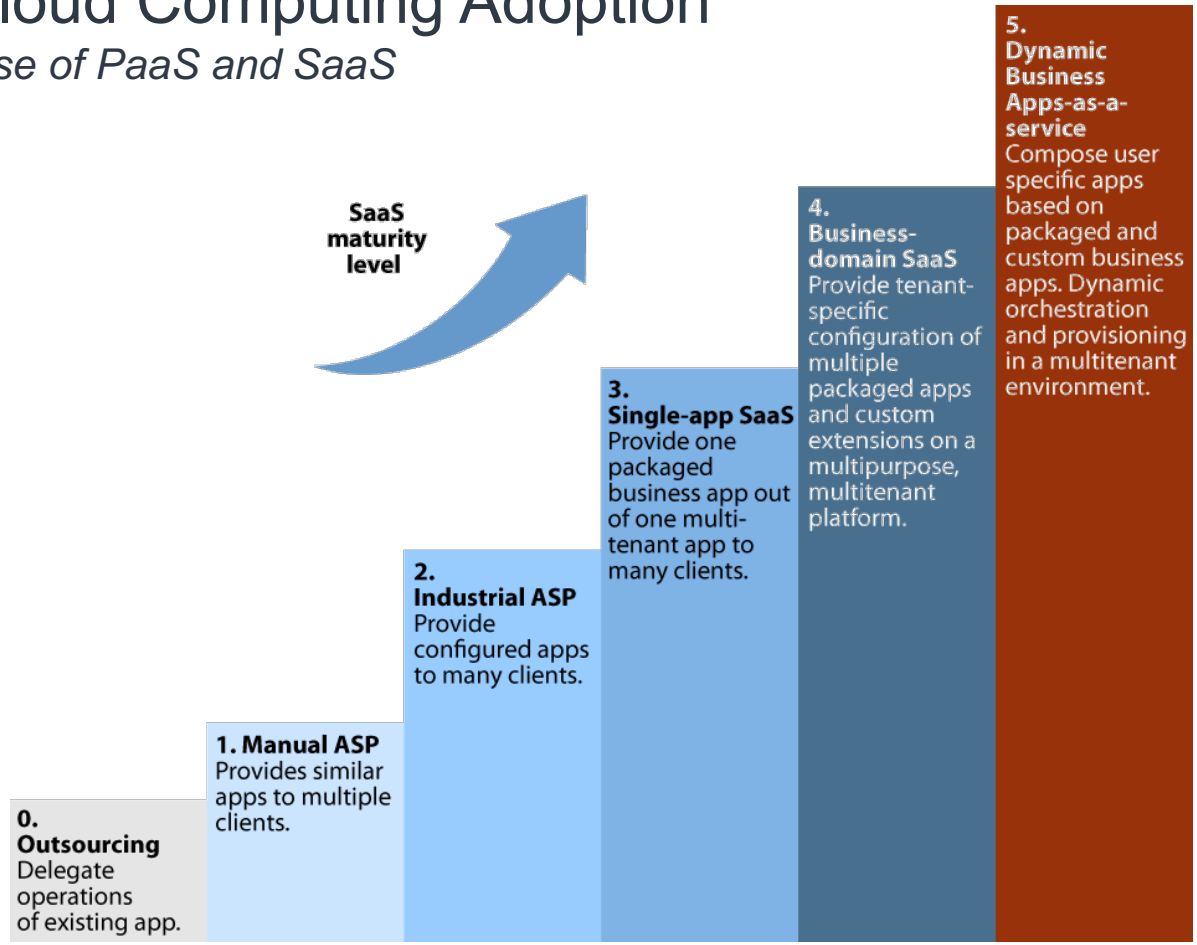
Cloud Computing Adoption

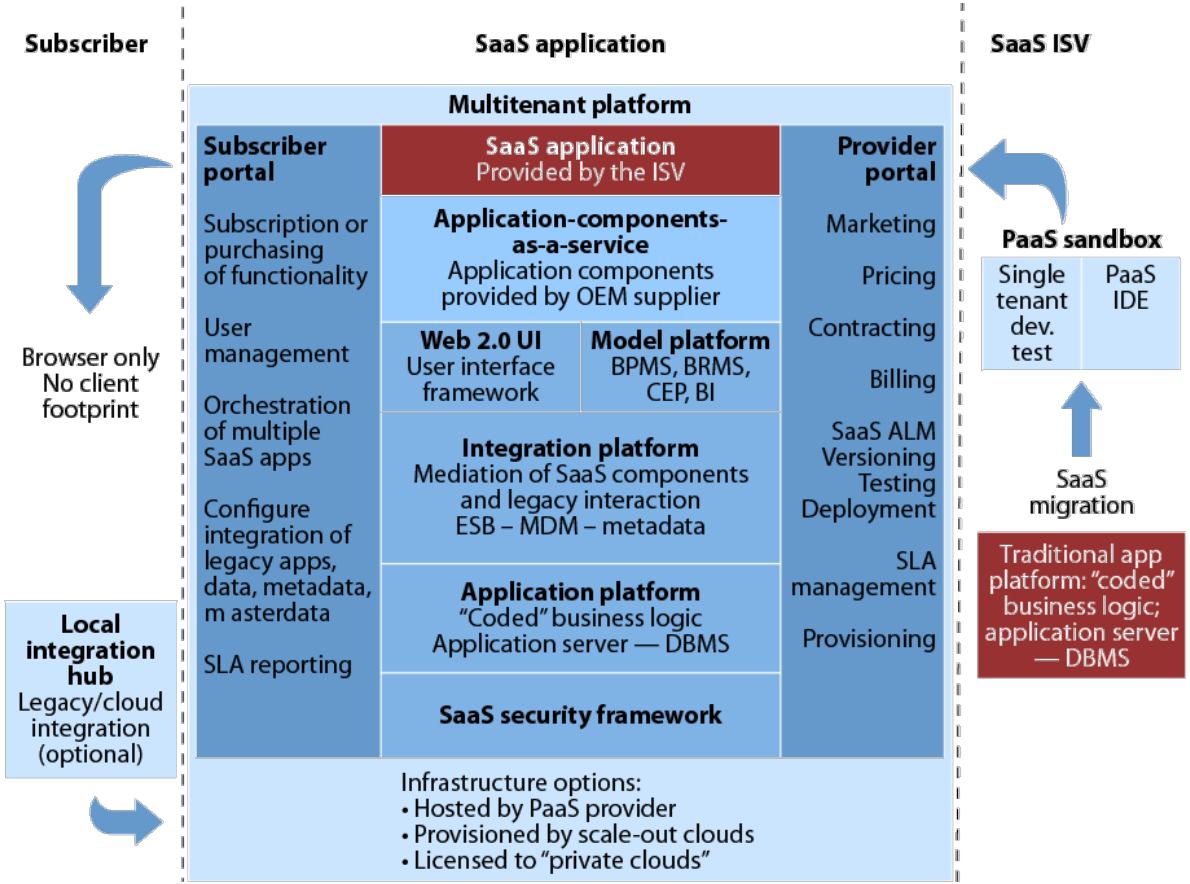
Rise of PaaS and SaaS



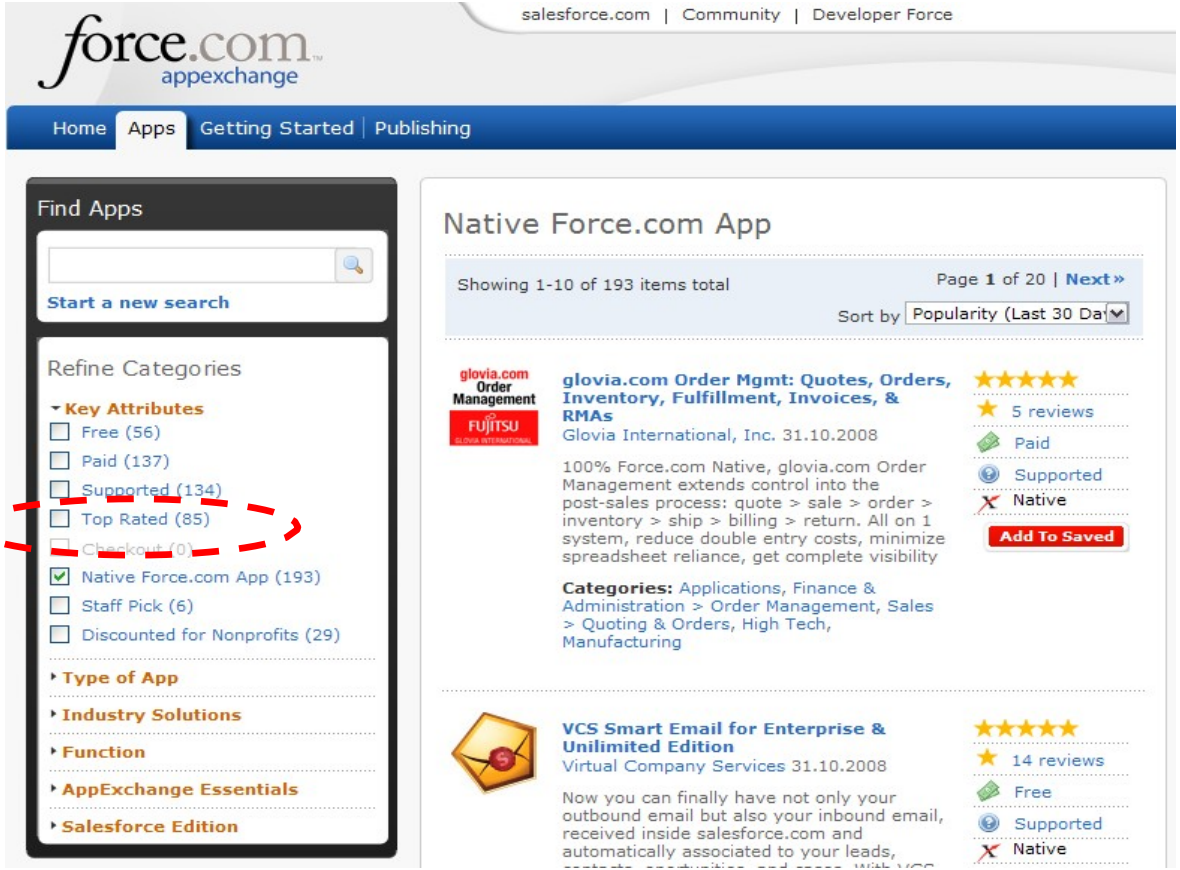
Source: August 14, 2008, "Forrester's SaaS Maturity Model" Forrester report

Cloud Computing Adoption

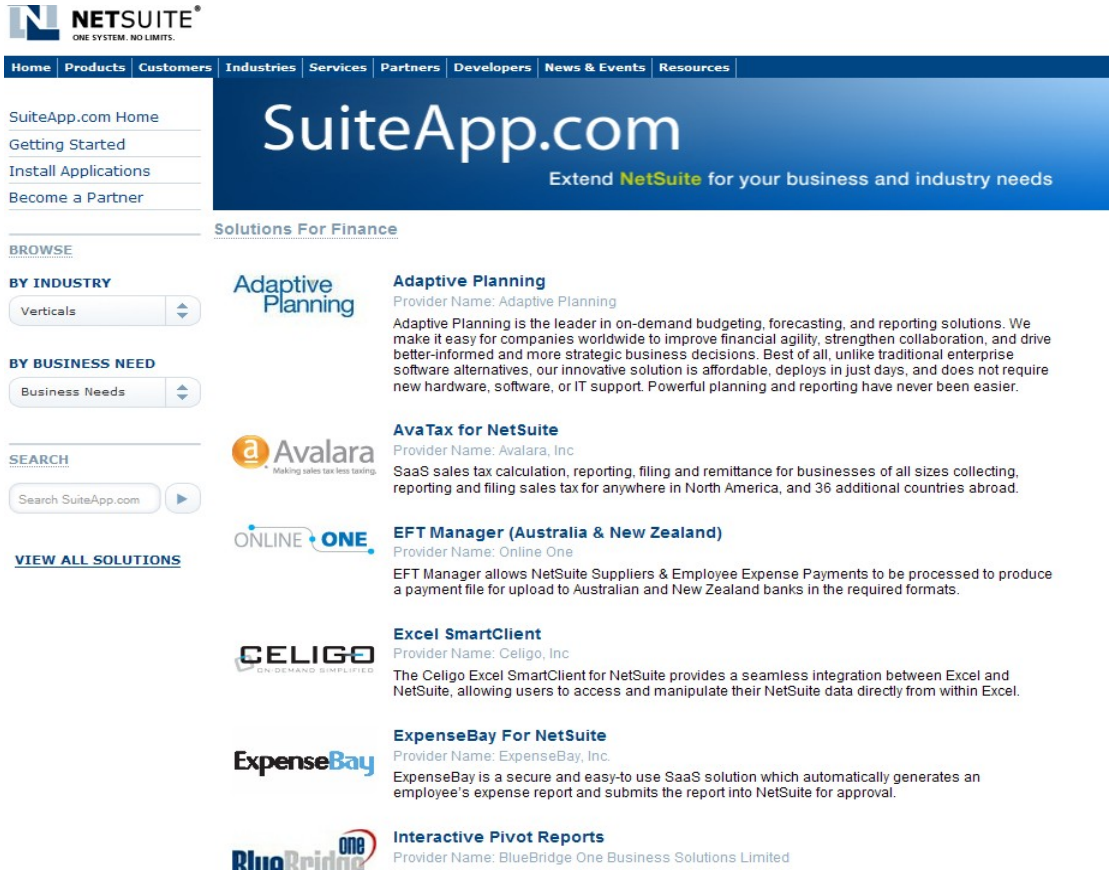
Forrester's PaaS Reference Architecture



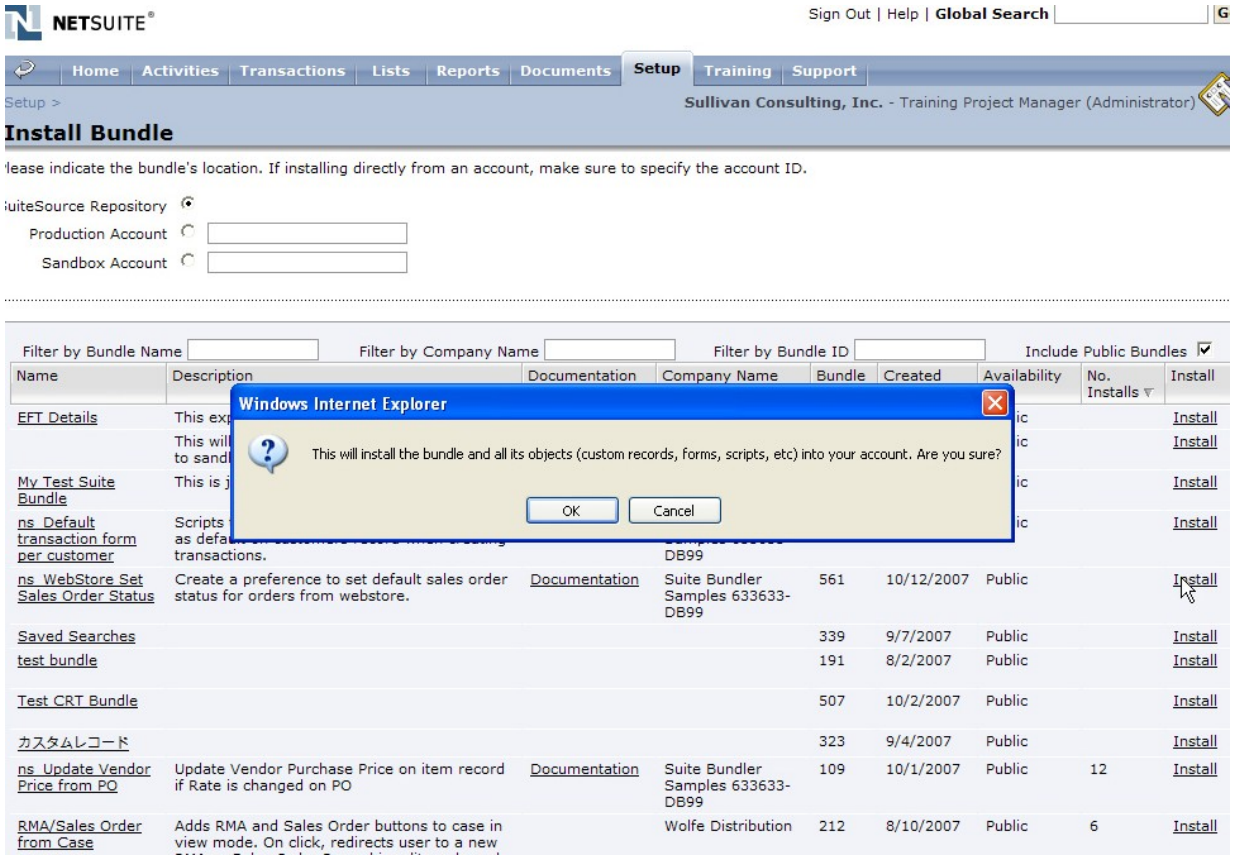
Example In The Public Cloud



Example Around ERP System



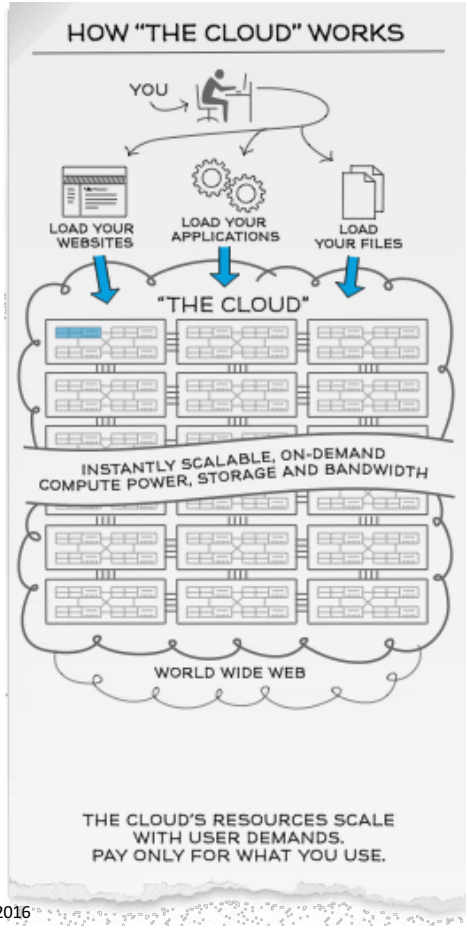
Easy Subscription Into Own Tenant



Cloud Computing Adoption
When Cloud Computing may be a Fit?

- When the processes, applications, and data are largely independent.
- When the points of integration are well defined.
- When a lower level of security will work just fine.
- When the core internal enterprise architecture is healthy.
- When the Web is the desired platform.
- When cost is an issue.
- When the applications are new.

Start planning when your app…



- is not yet in your data center
- is used intermittently
- is out of support
- can't be upgraded easily
- requires significant changes
- can't scale (computing, network, storage)
- costs too much to operate and manage
- is down more than you can handle
- is difficult to secure

Cloud Computing Adoption

When Cloud Computing may not a Fit?

- When the processes, applications, and data are largely coupled.
- When the points of integration are not well defined.
- When the core internal enterprise architecture needs work.
- When the application requires a native interface.
- When cost is an issue.

Cloud Computing Adoption

Stepping to the Clouds

1. Access the business.
2. Access the culture.
3. Access the value.
4. Understand your data.
5. Understand your services.
6. Understand your processes.
7. Understand the cloud resources.
8. Identify candidate data.
9. Identify candidate services.
10. Identify candidate processes.
11. Create a governance strategy.
12. Create a security strategy.
13. Bind candidate services to data and processes.
14. Relocate services, processes, and information.
15. Implement security.
16. Implement governance.
17. Implement operations.

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Cloud Computing Landscape

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Cloud Computing Landscape: IAAS

- Leaders
  - Amazon AWS
  - Microsoft Azure
  - Google Cloud Platform
  - IBM SoftLayer (IAAS)
- Others
  - Joyent
  - Virtustream
  - Rackspace
  - VMWare Air Cloud

Figure 1. Magic Quadrant for Cloud Infrastructure as a Service, Worldwide

Source: Gartner (May 2015)

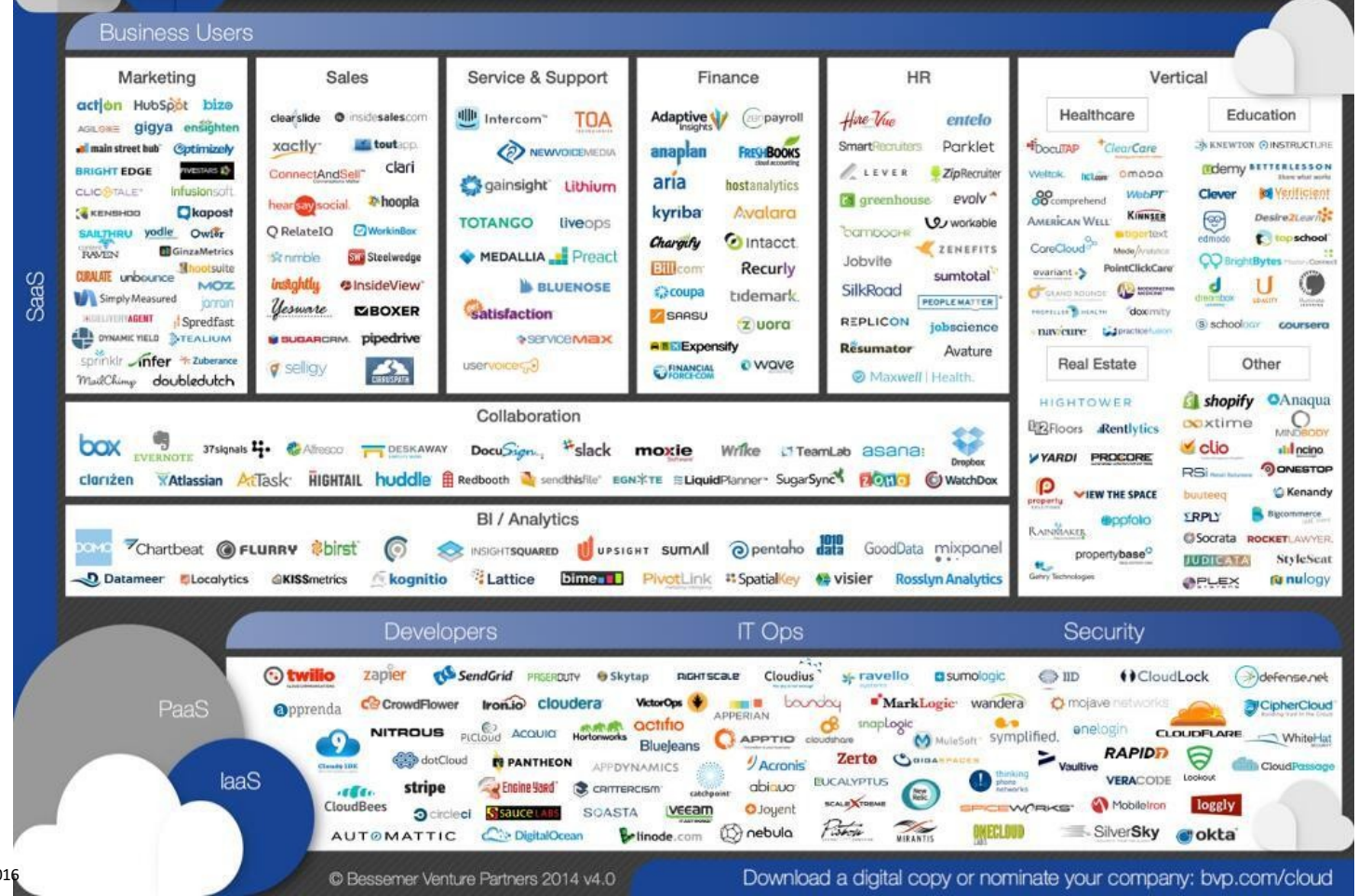
Cloud Computing Landscape (PAAS)

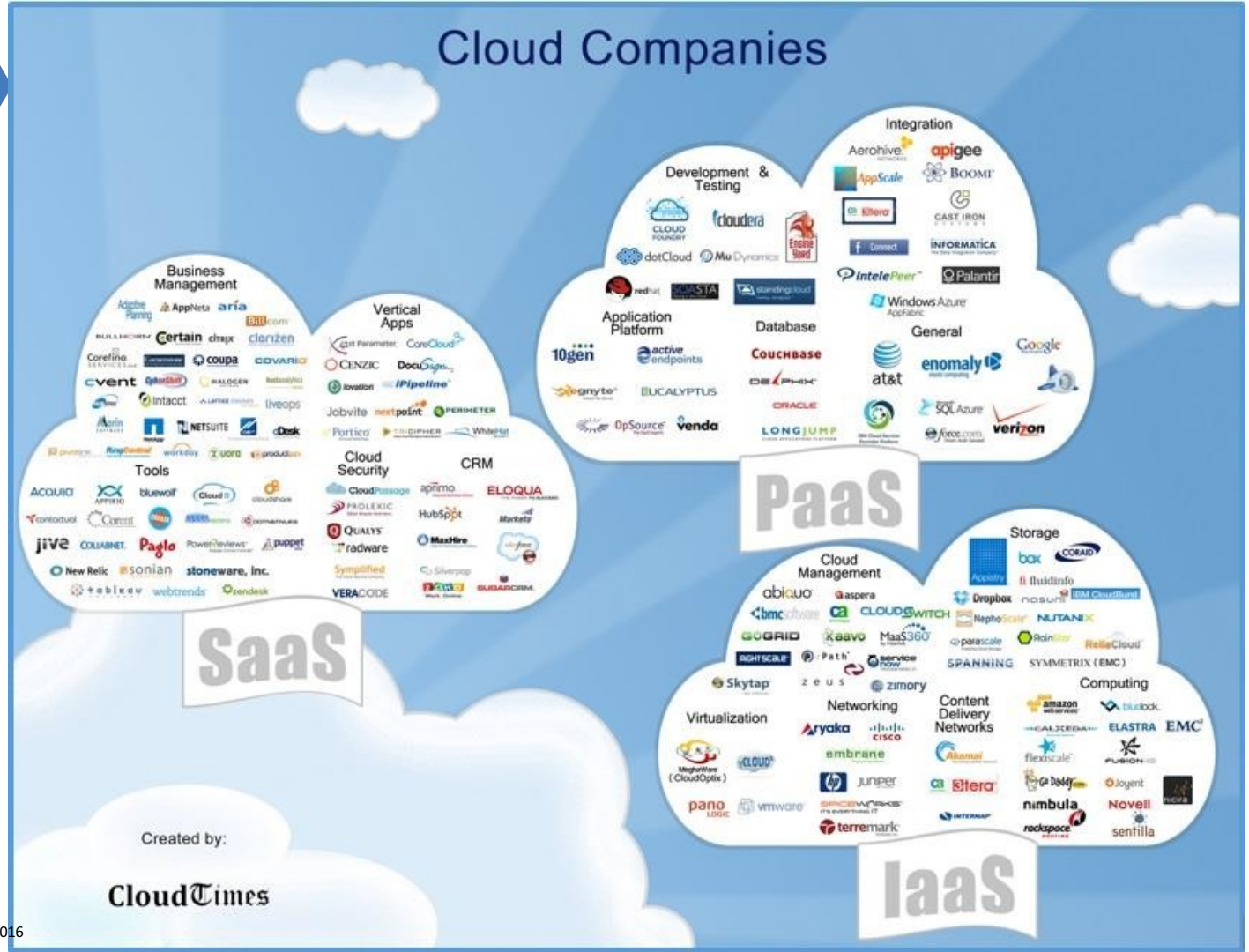
- ActiveState (HP)
- Amazon AWS
- Apache Stratos
- Apache Ignite
- Apprenda
- CenturyLink
- CloudBees
- Cloud Foundry (Pivotal)
- Docker
- Dokku
- Engine Yards
- Google Cloud Platform
- GridGrain
- Heroku
- IBM Bluemix
- Microsoft Azure
- Openshift (Redhat)
- OrangeScape
- ProfitBricks
- VMware Air Cloud

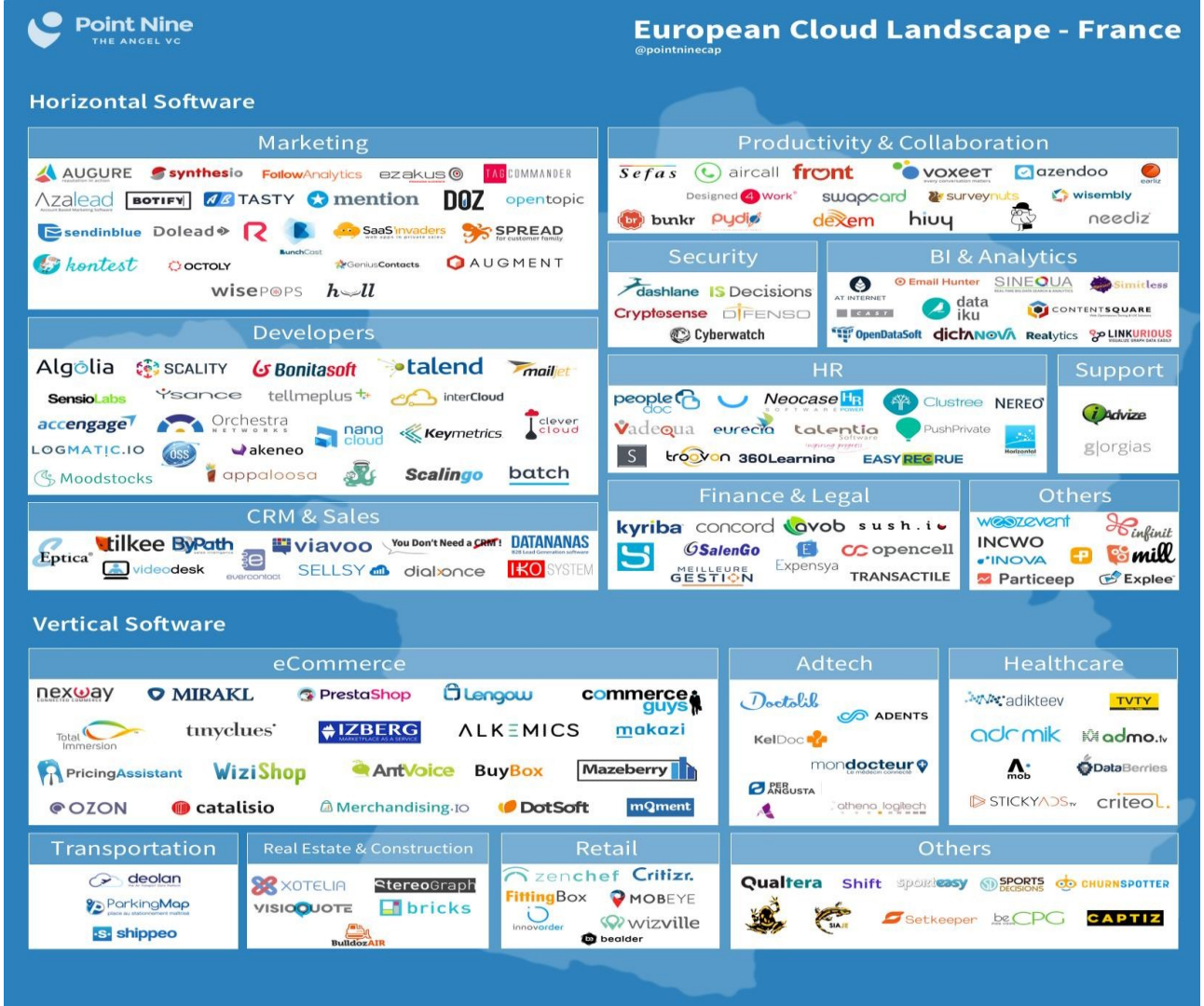
The BVP Cloudscape

Top 300 Privately Held Cloud Companies

Source: Bessemer Venture Partners







Plan

- *What is Cloud Computing?*
- *Why Cloud Computing?*
- *Virtualization and Cloud*
- *Cloud vs. Grid Computing*
- *Cloud Computing Adoption*
- *Cloud Computing Landscape*

Cloud Computing Security

- Cloud clients Tools
- Backend As A Service (BAAS)
- Is cloud Cost Effective?

Cloud Computing Security

IaaS Security

- General Rules
  - Provider secures “their” infrastructure
  - Remainder of the stack is your problem
    - Focus on VM and container
- Example Amazon IAAS
  - “We strive to keep Your Content secure, **but cannot guarantee** that we will be successful at doing so, given the nature of the Internet.
  - **you acknowledge that you bear sole responsibility for adequate security, protection and backup** of Your Content and Applications...
  - **We will have no liability to you** for any unauthorized access or use, corruption, deletion, destruction or loss of any of Your Content or Applications.”

Cloud Computing Security

PaaS Security

- General Rules
  - Provider owns the compute, network, storage layers and programmatic interface security
  - The consumer creates the application based upon supported development environment
  - Writing secure applications and ensuring your data is safe is on you
- Example: Google App Engine
  - **"You must provide accurate and complete registration information** any time you register to use the Service.
  - **You are responsible for the security of your passwords and for any use of your account.**
  - If you become aware of any unauthorized use of your password or of your account, you agree to notify Google immediately."

Cloud Computing Security

SaaS Security

- General Rules
  - The provider owns the entire stack
  - Security is defined by internal policy and customer contract
- Example: Salesforce.com
  - “We shall maintain appropriate administrative, physical, and technical safeguards for protection of the security, confidentiality and integrity of Your Data.
  - We shall not (a) modify Your Data, (b) disclose Your Data except as compelled by law in accordance with Section 7.5 (Compelled Disclosure) or as expressly permitted in writing by You, or (c) access Your Data except to provide the Services or prevent or address service or technical problems, or at your request in connection with customer support matters.”

Cloud Computing Security

Advantages

- Shifting public data to a external cloud reduces the exposure of the internal sensitive data
- Cloud homogeneity makes security auditing/testing simpler
- Clouds enable automated security management
- Redundancy / Disaster Recovery
- Data Fragmentation and Dispersal
- Dedicated Security Team
- Greater Investment in Security Infrastructure
- Fault Tolerance and Reliability
- Greater Resiliency
- Hypervisor Protection Against Network Attacks
- Possible Reduction of C&AActivities (Access to Pre-Accredited Clouds)
- Simplification of Compliance Analysis
- Data Held by Unbiased Party (cloud vendor assertion)
- Low-Cost Disaster Recovery and Data Storage Solutions
- On-Demand Security Controls
- Real-Time Detection of System Tampering
- Rapid Re-Constitution of Services
- Advanced Honeynet Capabilities

Cloud Computing Security

Challenges

- Trusting vendor's security model
- Customer inability to respond to audit findings
- Obtaining support for investigations
- Indirect administrator accountability
- Proprietary implementations can't be examined
- Loss of physical control
- Data ownership issues
- Quality of service guarantees
- Data dispersal and international privacy laws
  - EU Data Protection Directive and U.S. Safe Harbor program
  - Exposure of data to foreign government and data subpoenas
  - Data retention issues
- Need for isolation management
- Multi-tenancy
- Logging challenges

Cloud Computing Security

Challenges

- Dependence on secure hypervisors
- Attraction to hackers (high value target)
- Security of virtual OSs in the cloud
- Possibility for massive outages
- Encryption needs for cloud computing
  - Encrypting access to the cloud resource control interface
  - Encrypting administrative access to OS instances
  - Encrypting access to applications
  - Encrypting application data at rest
- Public cloud vs internal cloud security
- Lack of public SaaS version control
- Issues with moving PII and sensitive data to the cloud
  - Privacy impact assessments
- Using SLAs to obtain cloud security
  - Suggested requirements for cloud SLAs
  - Issues with cloud forensics
- Contingency planning and disaster recovery for cloud implementations
- Handling compliance
  - FISMA, HIPAA, SOX, PCI, SAS 70 Audits

Cloud Security Landscape

EMERGENCE CAPITAL PARTNERS

Source: CloudNewsDaily

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Cloud clients Tools

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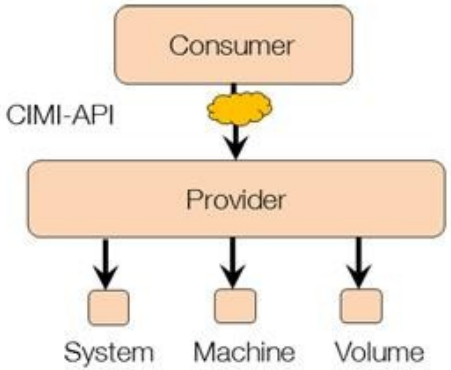
CIMI: Cloud IaaS Standard

- Cloud Infrastructure Management Interface
  - Specification that standardizes interactions between cloud environments to achieve interoperable cloud infrastructure management between service providers and their consumers and developers, enabling users to manage their cloud infrastructure use easily and without complexity.
  - Primer / Cloud Infrastructure Management Interface Model



Cloud Tools

Free clients

- CloudBerry S3 Explorer
  - This is a free Amazon S3 file browser application that enables creating-deleting-updating buckets, folders & files.
  - It supports: multiple S3 accounts, setting up file access permissions, generating external URLs & more..
- S3Fox Organizer
  - A FTP-like Firefox add-on which enable anyone to reach S3 buckets for uploading & downloading files.
  - It supports managing CloudFront, changing access policies & syncronizing S3 with the local system.
- S3tools
  - Various open source tools for reaching Amazon S3.

Cloud Tools

Free clients

- JetS3t (free)
  - It is an open-source Java toolkit and application suite for the Amazon S3 and Amazon CloudFront content delivery network.
  - The toolkit contains 5 applications for reaching, synchronizing & creating an authorization service to mediate to S3 accounts.
- GridGain (free)
  - An open source cloud platform, built with Java, that enables developers to develop and run applications on private or public clouds.
- Abiquo (free)
  - Online software for creating & managing public or private clouds.
  - The tool mainly offers users the capacity for scaling, management, automatic and immediate provision of servers, storage, networks, virtual network devices as well as applications.

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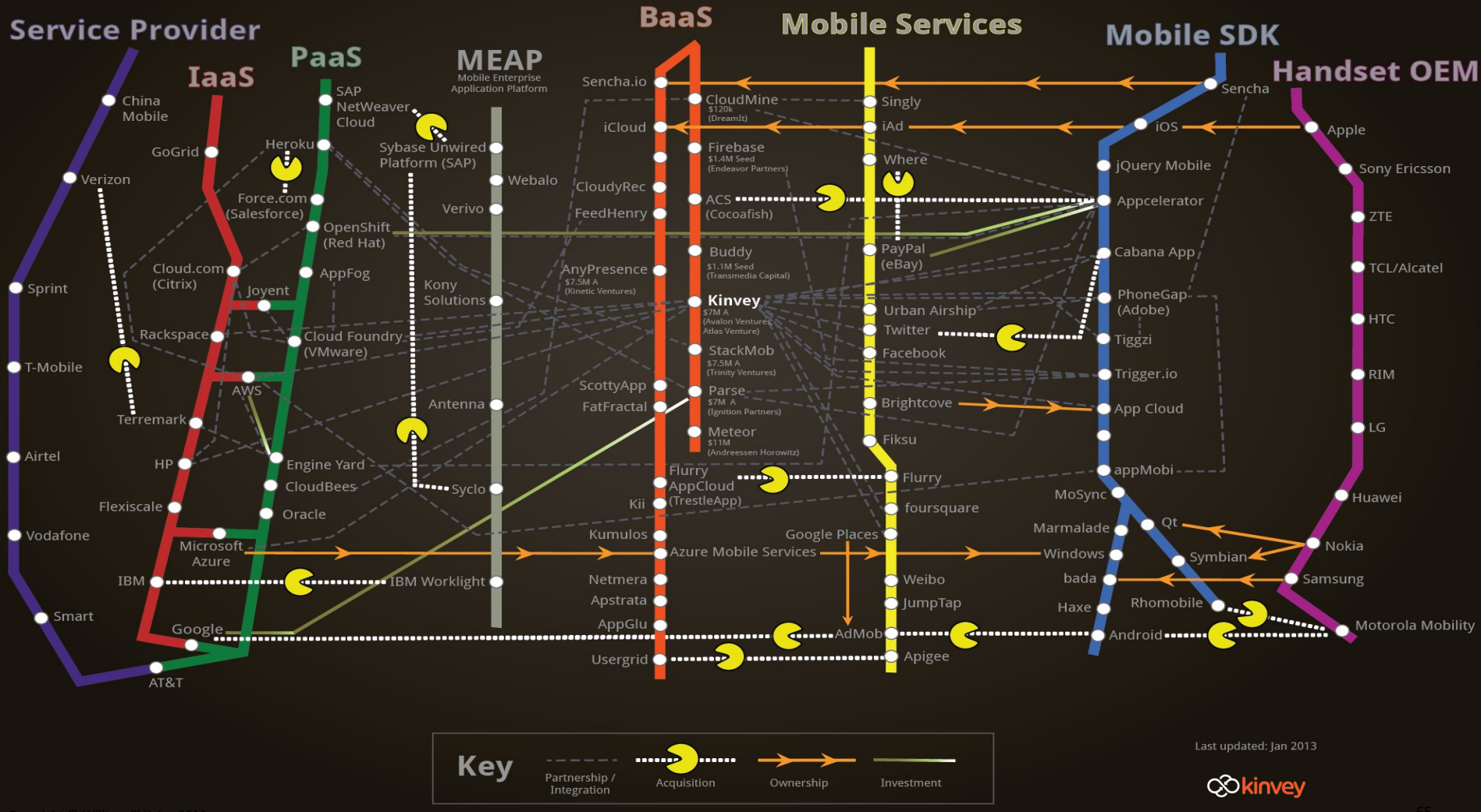
Backend As AService (BAAS)

- Is cloud Cost Effective?

Backend As AService (BaaS)

- BaaS is an approach for providing web and mobile app developers with a way to connect their applications to backend cloud storage and processing while also providing common features such as user management, push notifications, social networking integration, and other features that mobile users demand from their apps these days.
- This new breed of BaaS services are provided via custom software development kits (SDK) and application programming interfaces (APIs).
- BaaS is a relatively recent development in cloud computing, with most BaaS start-ups dating from 2011 or later.
- The global BaaS market is estimated to grow from $216.5 million in 2012 to $7.7 billion in 2017 from a report published by MarketsandMarkets.

Source: API Evangelist



How Does BaaS Differ From IaaS and PaaS?

- BaaS has evolved out of frustration around deployment of IaaS platforms like Amazon Web Services, just to fire up a single new mobile application.
- BaaS is about abstracting away the complexities of launching and managing your own infrastructure, then bridging a stack of meaningful resources targeting exactly what developers need to build the next generation of mobile apps.
- BaaS, has a lot of the same intent as PaaS, to speed up the application development process, but BaaS is purely a backend
  - Providing an infrastructure that automatically scales and optimizes, bundled with a set of essential resources developers require

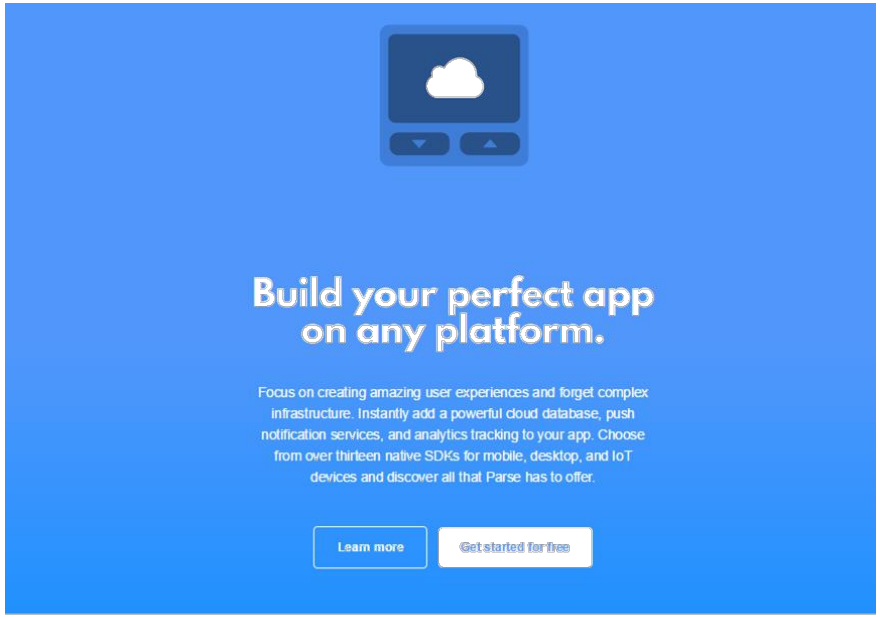
Source: API Evangelist

What Are The Benefits of BaaS?

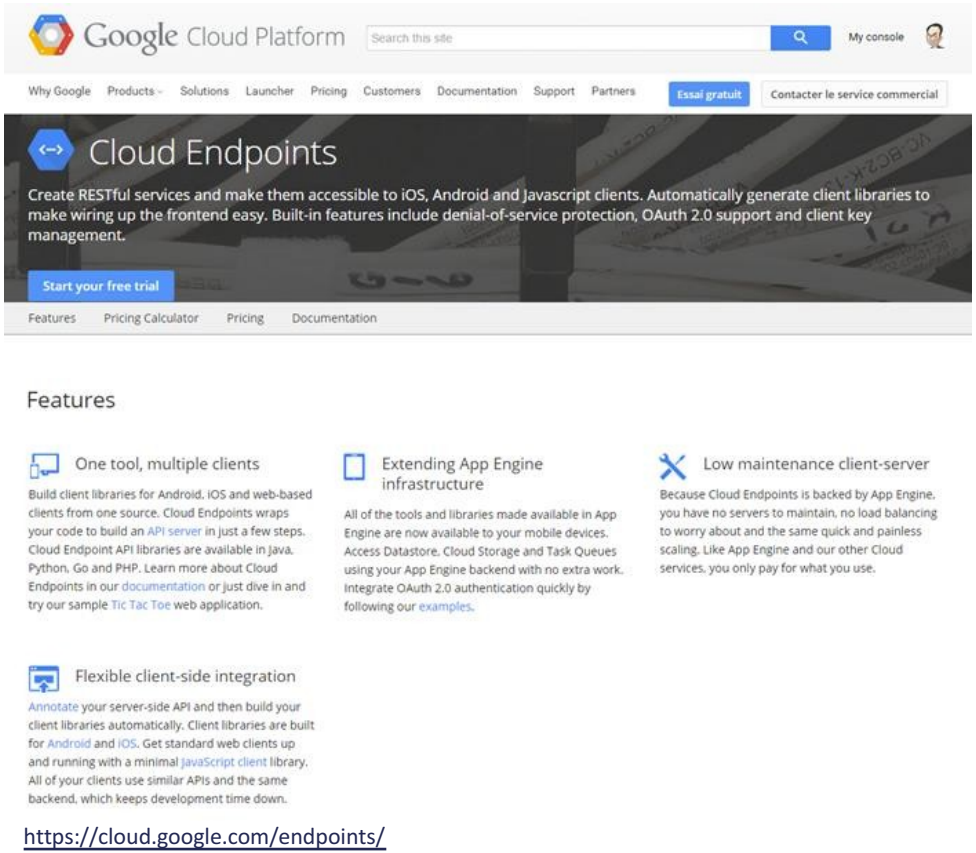
- Efficiency Gains - Reducing overhead in all aspects of app devt, increasing efficiency at all stages of development
- Faster Times to Market - Reducing the obstacles to take a mobile app from idea to production and overhead with operations once in production
- App Delivery With Fewer Resources
- Optimize for Mobile and Tablets - BaaS providers have put a lot of time and resources into optimization of data and network for mobile apps, and reduce fragmentation problems across multiple platforms and devices.
- Secure and Scalable Infrastructure
- Stack of Common API resources - BaaS brings common and essential 3rd party API resources into a single stack, preventing developers from having to go gather them separately

Source: API Evangelist

Facebook Parse / Google EndPoints

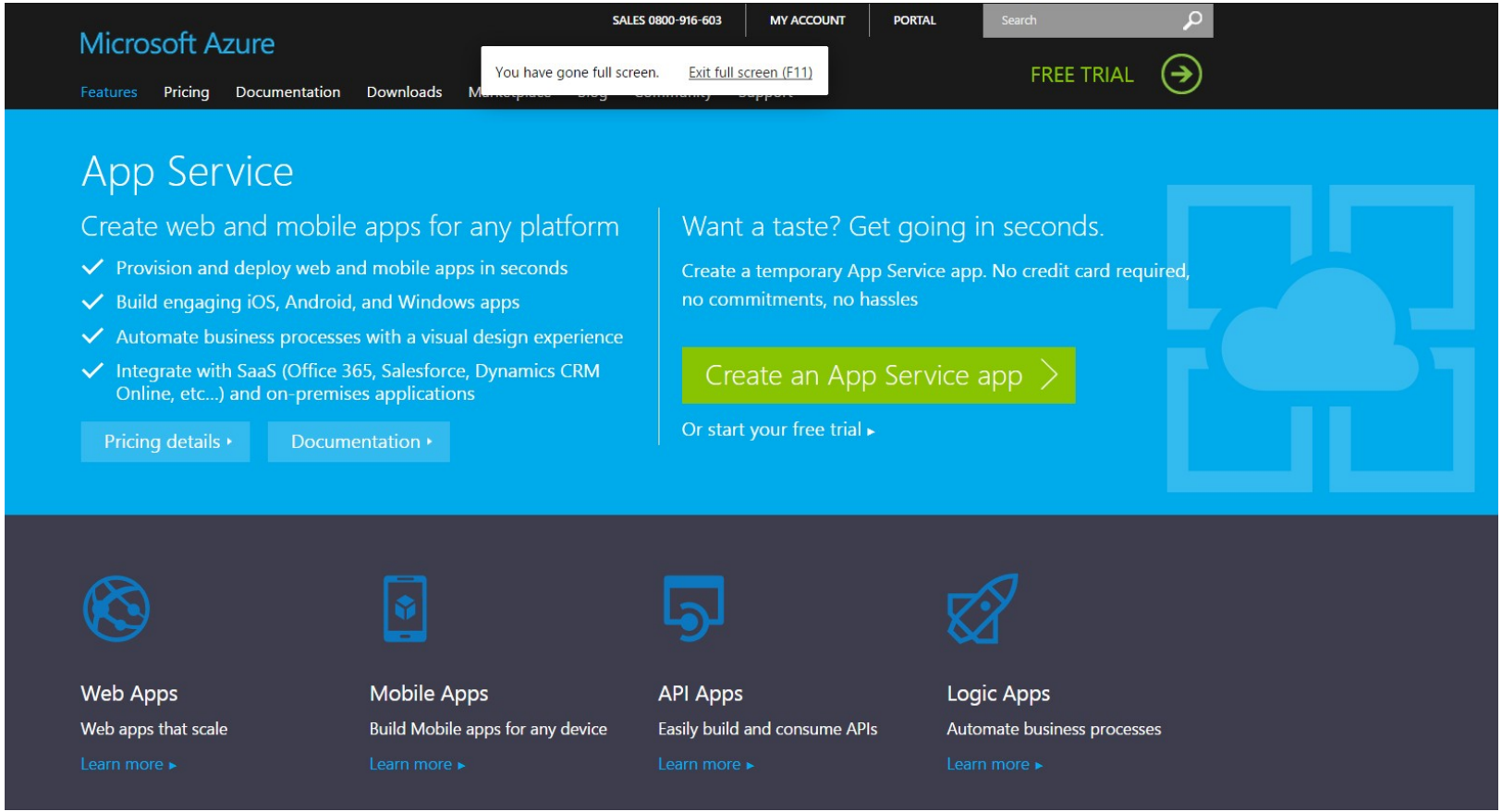


https://www.parse.com/



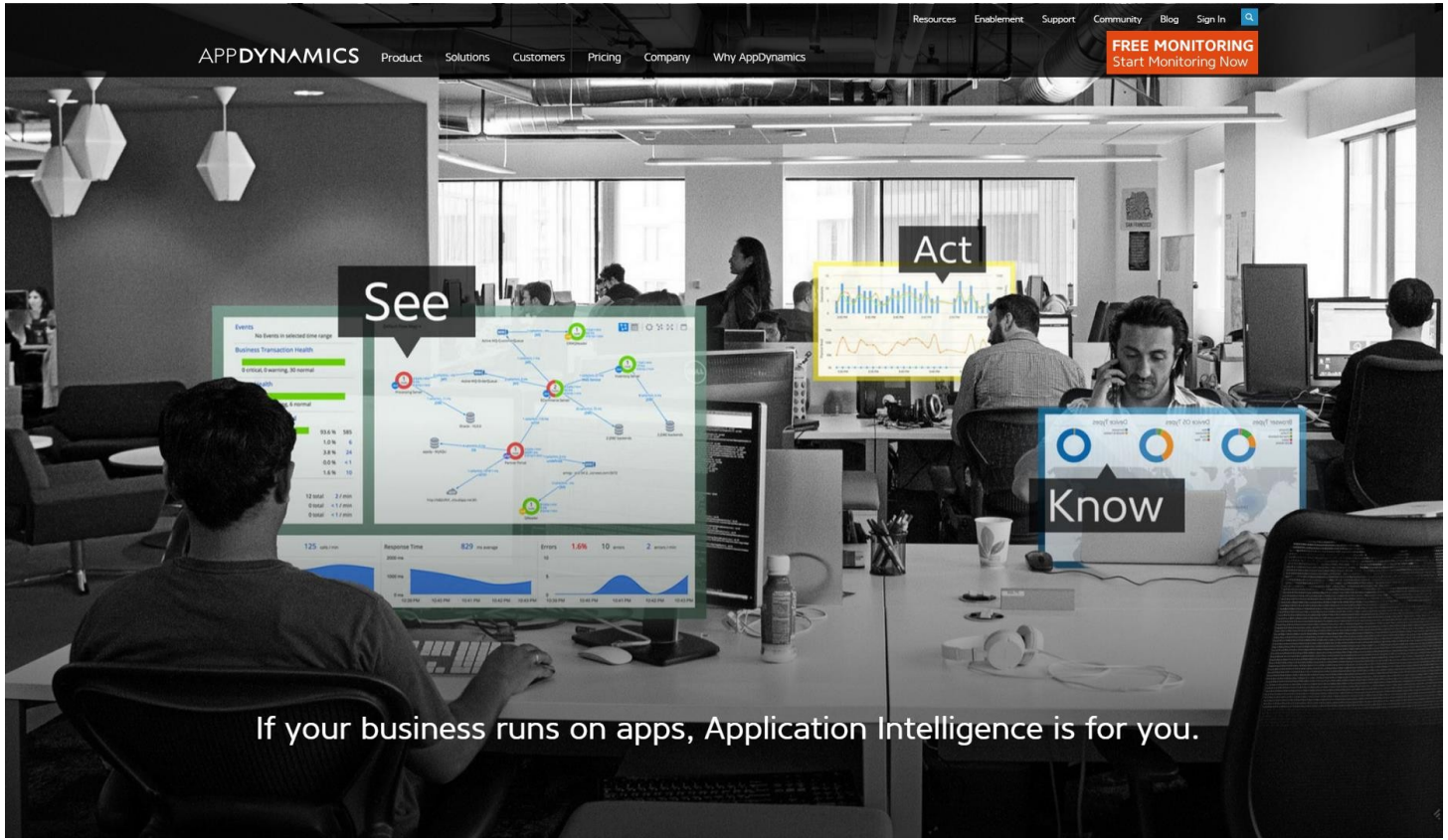
https://cloud.google.com/endpoints/

Microsoft Azure AppServices



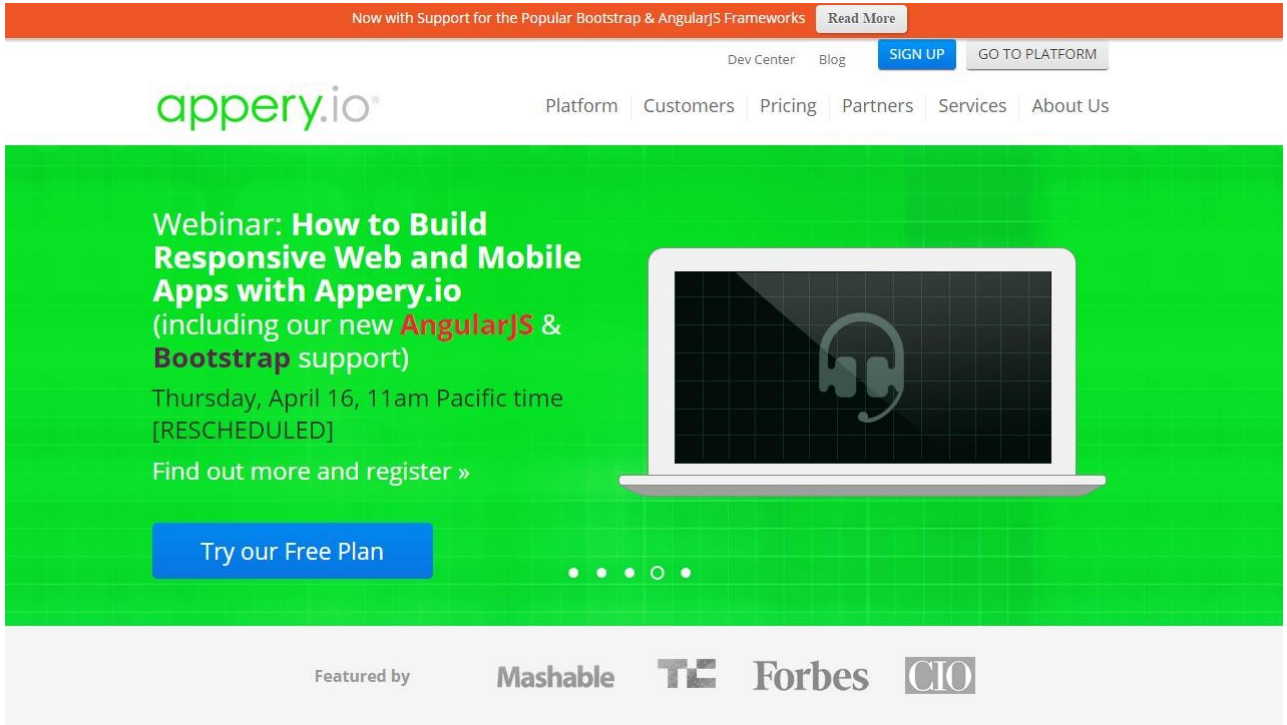
http://azure.microsoft.com/en-us/services/app-service/

AppDynamics



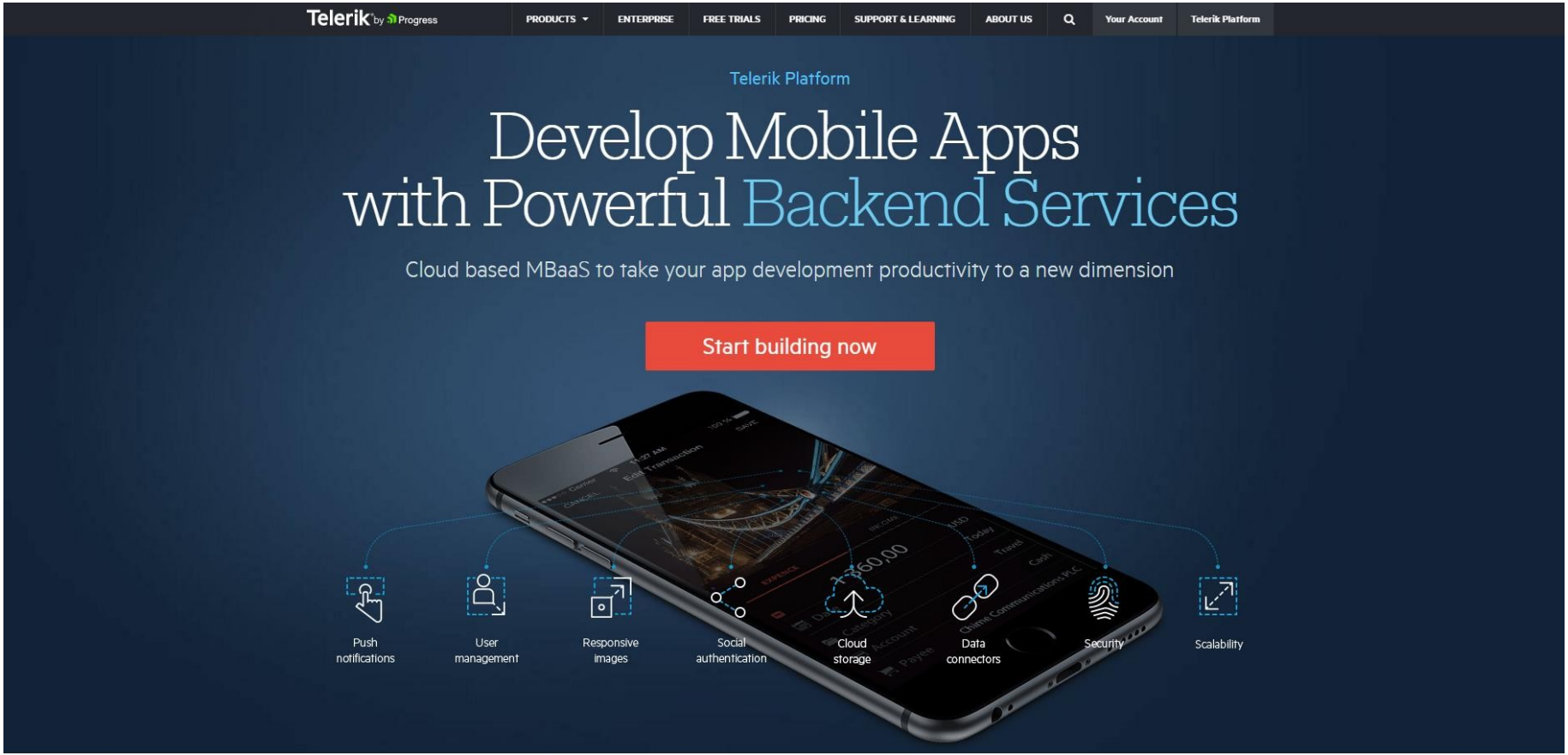
http://www.appdynamics.com/

Appery.io



https://appery.io/

Backend As A Service (BaaS)



http://www.telerik.com/platform/backend-services

Backend As A Service (BaaS)

- Anypresence: http://www.anypresence.com/
- Apigee App Services: http://apigee.com/docs/app_services (now Google)
- APISpark: http://apispark.com/
- Build.io: http://www.built.io/
- IFTTT: https://ifttt.com/login
- Kinvey: http://www.kinvey.com/
- Proxomo: http://www.proxomo.com/

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Is cloud Cost Effective?

Is cloud Cost Effective?

- When designing infrastructure systems, whether creating new applications or deploying existing software, it's crucial to manage cost.
- Costs come from a variety of sources, and every approach to delivering infrastructure has its own tradeoffs and complexities. Cloud infrastructure systems create a whole new range of variables in these complex equations.
- In addition, no two clouds are the same!
  - Some bundle components while others offer more granular purchasing.
  - Some bill in different time increments, and many offer a variety of payment structures, each with differing economic ramifications.
- How do you figure out what each costs and make a choice?

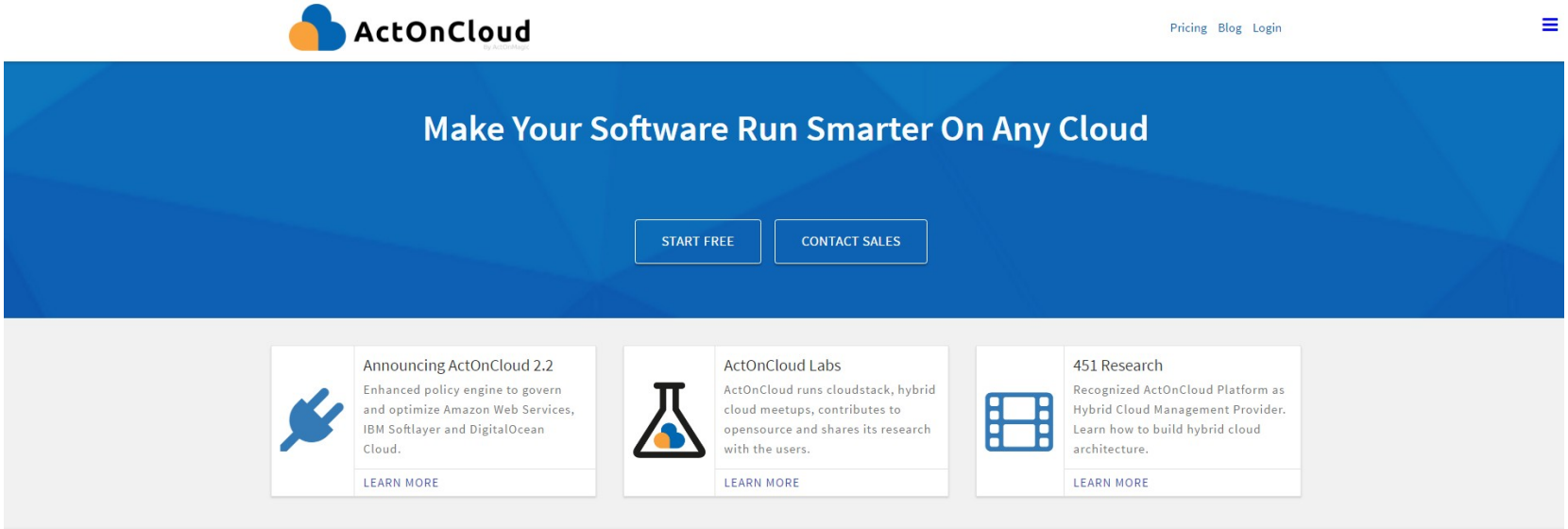
Is cloud Cost Effective?

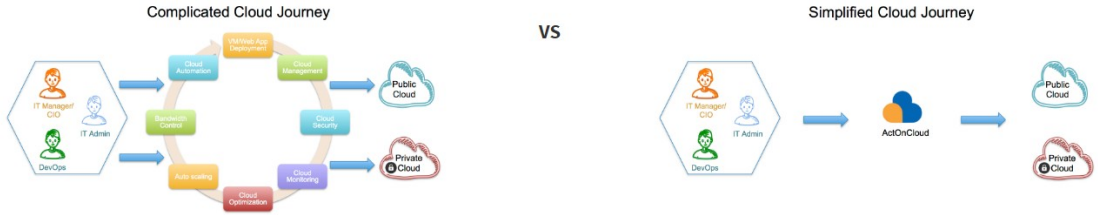
- Estimates vary widely on possible cost savings
- Brian Gammage, Gartner Fellow
  - “If you move your data centre to a cloud provider, it will cost a tenth of the cost.”
- CTO of Washington D.C.
  - “Use of cloud applications can reduce costs from 50% to 90%”
- Alchemy Plus cloud (backing from Microsoft)
  - “IT resource subscription pilot saw 28% cost savings”
- Preferred Hotel
  - Traditional: $210k server refresh and $10k/month
  - Cloud: $10k implementation and $16k/month
- George Reese, founder Valtira and enStratus
  - Using cloud infrastructures saves 18% to 29% before considering that you no longer need to buy for peak capacity

Cloud Pricing Calculator

- Pricing Calculator
  - Amazon Cloud Platform Pricing Calculator
  - AWS Total Cost of Ownership (TCO) Calculator
  - Google Cloud Platform Pricing Calculator
  - IBM Softlayer Cloud Calculator
  - Interoute Virtual Datacenter Calculator
  - Microsoft Azure Cloud Platform Pricing Calculator
  - Rackspace Cloud Calculator
  - Mware Cloud Calculator
- Documents
  - Price Comparison: Google Cloud Platform vs. Amazon Web Service
  - How to plan for the cost of cloud computing?

Cloud Pricing Optimization



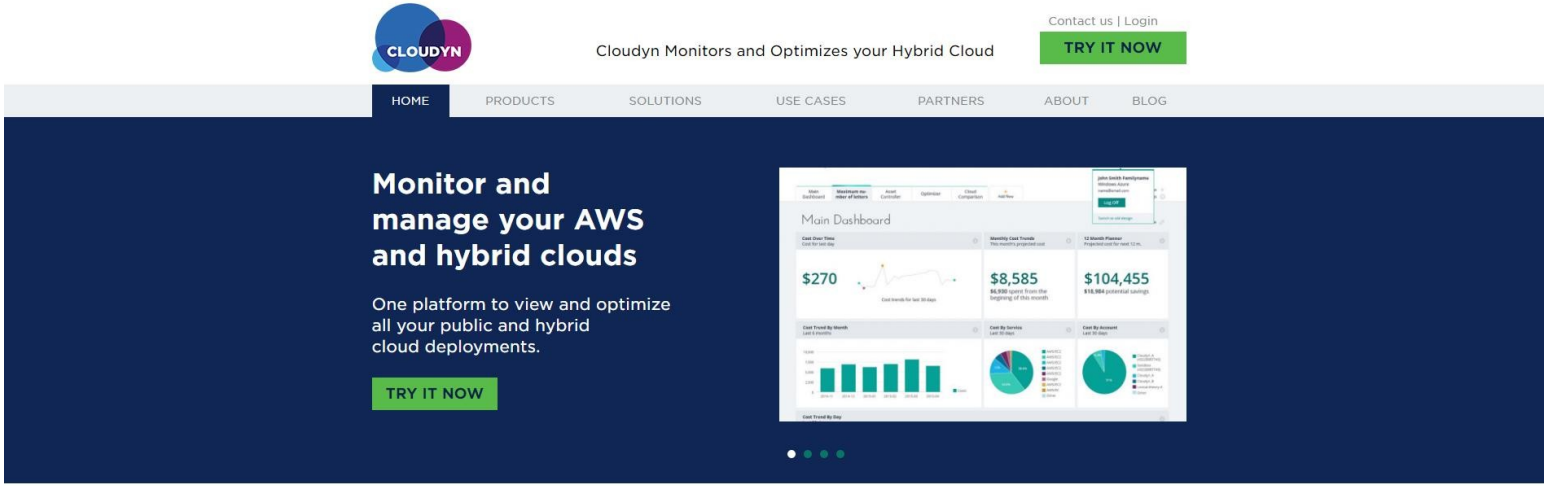


http://www.actonmagic.com/#!/

Hybrid Cloud Mgt. Tools

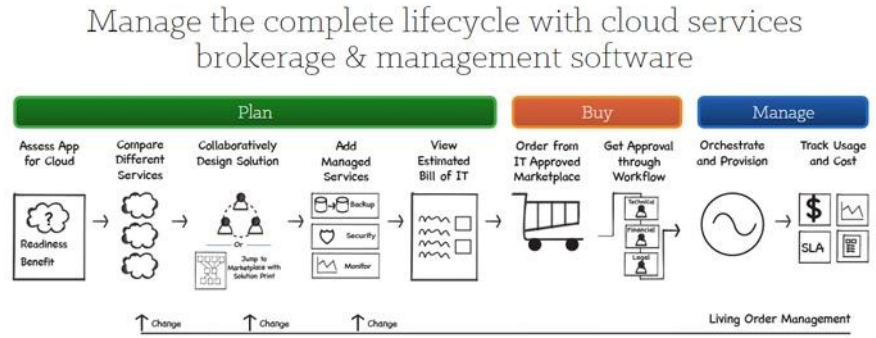
- Avni
  - Hybrid Cloud Platform To Deploy, Scale And Migrate Digital Services That Contain Containers, VMs And Cloud Specific Apps with Security, Analytics and Policy.
- CloudHealth
  - Gives visibility across the enterprise entire cloud ecosystem to optimize resources and define governance policies for ongoing management.
- Cloudyn
  - One platform to view and optimize all your public and hybrid cloud deployments.
- Embotics
  - Embotics vCommander is the fastest and easiest way to automate provisioning and enable self-service IT across private, public, and hybrid cloud infrastructures
- Platform9
  - Run OpenStack and Kubernetes like SaaS

Hybrid Cloud Mgt. Tools: Cloudyn



https://www.cloudyn.com/

Cloud Brokers



CloudOrbit

Gravitant

Thank You