DEFINITION AND TAXONOMY OF CLOUD COMPUTING

DR. JUNE SUNG PARK, KAIST

http://flavors.me/june_sung_park

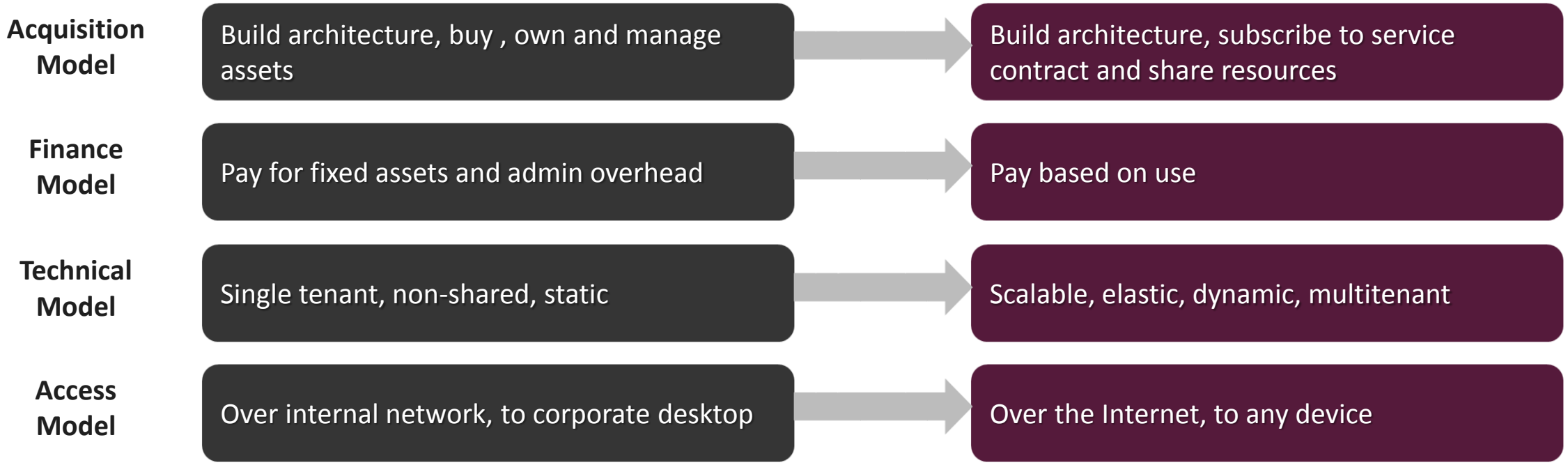
MODULE OBJECTIVE

- Understand common essential properties of cloud services.
- Understand different service models of cloud: IaaS, PaaS and SaaS.
- Understand different deployment models of cloud: public cloud, private cloud, hosted private cloud, and on-premise public cloud.

DEFINITION OF CLOUD SERVICES

DEFINITION OF CLOUD COMPUTING

- Cloud computing is a style of computing where scalable and elastic IT-related capabilities are provided as a service to customers using Internet technologies. (Gartner)
- Cloud computing is a pay-per use model for enabling available, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. (NIST)



ESSENTIAL ATTRIBUTES OF CLOUD SERVICES

Shared Comupting Resources and Multitenancy

Learn to share

On-demand Self-service with Simple Interface

Get it yourself

Elasticity and Scalability

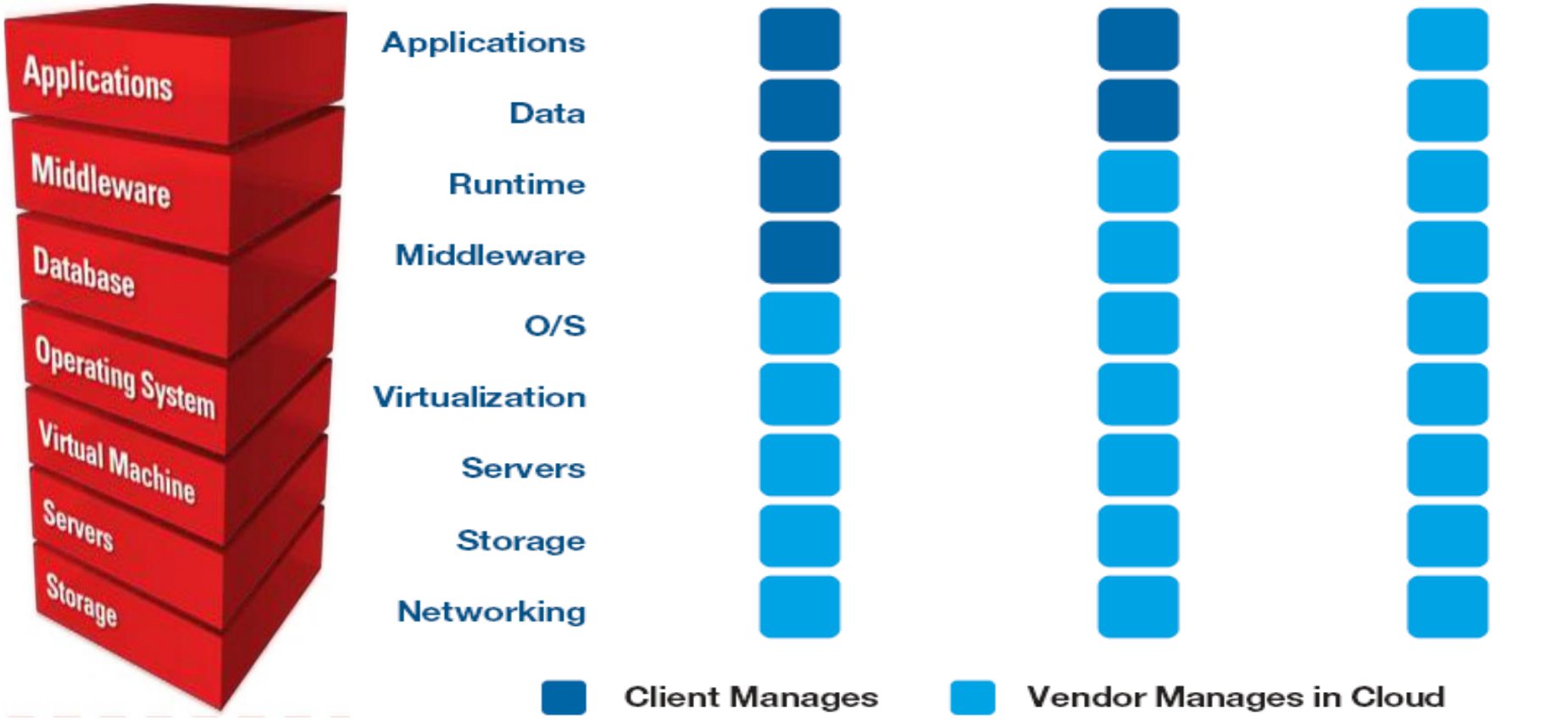
All you can eat

Consumption-Based Pricing

Pay per use

CLOUD SERVICE MODELS

CLOUD SERVICE MODELS



CLOUD SERVICE MODELS

SaaS

Applications designed for global-class delivery and delivered as a service via Web-centric architecture to a browser or RIA/Ajax front-end. Customizations and extensions and data are isolated among tenants.

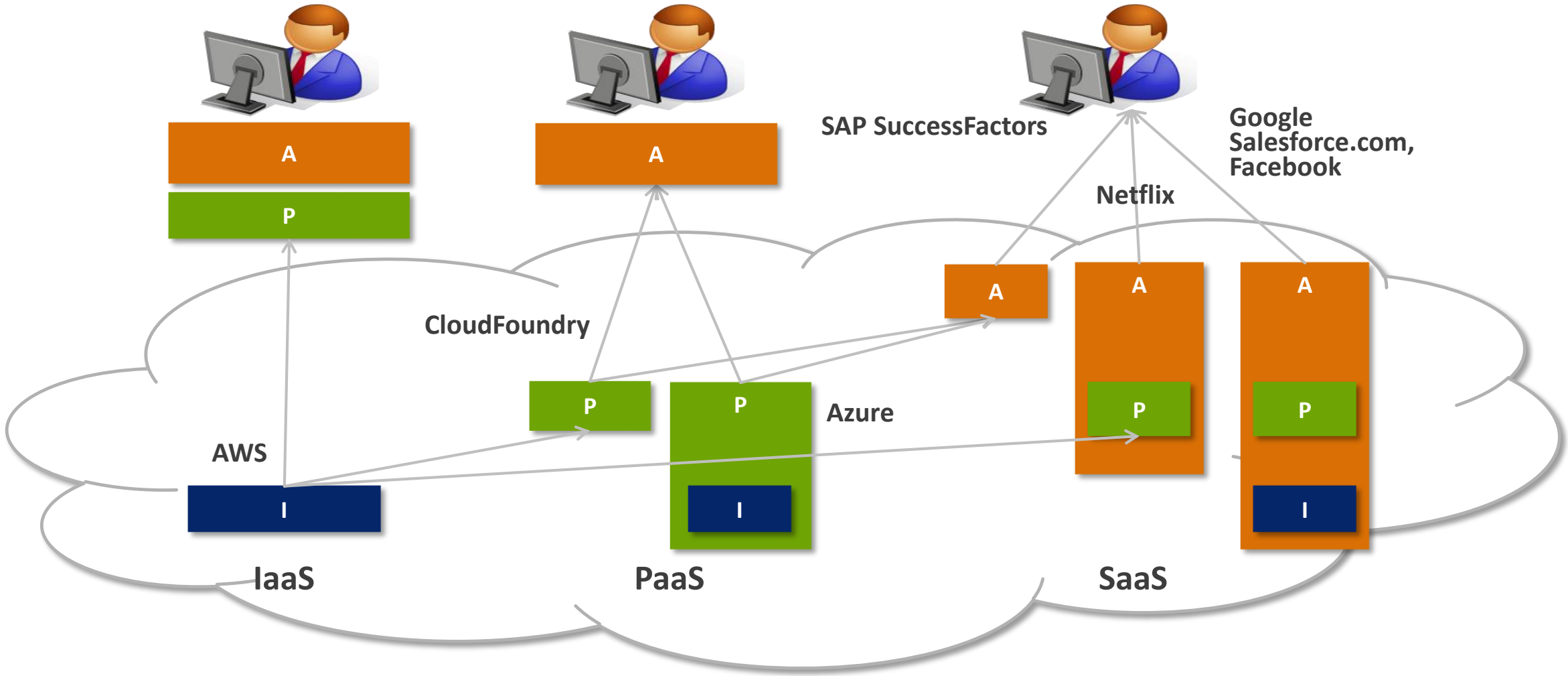
PaaS

A set of services built to use global-class design, Web-centric architectures and Web-centric RAD environments that parallels traditional middleware and development technologies

IaaS

Virtualized system software on which consumers can run any application. Web-based provisioning allows consumers to dynamically access resources via a browser, programmatic calls or automated response to an application load.

TYPES OF CLOUD SERVICES



CLOUD ADOPTION BY CLOUD SERVICE MODELS

North Bridge, Future of Cloud Computing Survey, 2014.

CLOUD DEPLOYMENT MODELS

PUBLIC VS. PRIVATE CLOUD

Private	Public
Assets owned by service consumer	No assets owned by service consumer
Access limited to exclusive members	Access open to anyone who pays for service
Moving towards standardization, shared service, virtualization, automation, pay-for-use chargeback model, and E2E service management, all of which are essentially the engine for a cloud computing	Industrialization of IT exploiting economies of scale
More secure, control and learning	CapEx eliminated; Value-driven price per use

PUBLIC CLOUD SERVICES: IAAS

Infrastructure as a Service
Delivery of raw, virtualized computing infrastructure such as servers and storage as a service to build applications. IaaS vendors let enterprises customize infrastructure to their application needs.

Backup & Recovery (14)
Platforms providing services to backupand recover file systems and raw data stores on servers and desktop systems.

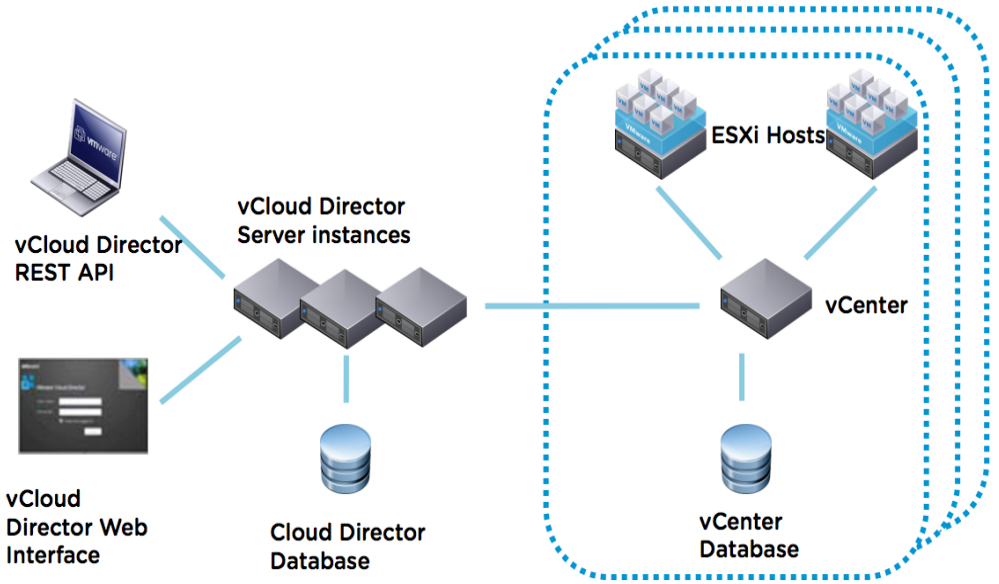
Cloud Broker (7)
Tools that manage services on more than one cloud infrastructure platform. Some tools support private-public cloud configurations.

Compute (31)
Provides server resources for running cloud based systems that can be dynamically provisioned and configured as needed.

Content Delivery Networks (2)
CDNs store content and files to improve the performance and cost of delivering content for web based systems.

Services Management (7)
Services that manage cloud infrastructure platforms. These tools often provided features that cloud providers do not provide or specialize in managing certain application technologies.

Storage (12)
Provides massively scalable storage capacity which can be used for applications, backups, archiving, file storage, and more.



http://cloudtaxonomy.opencrowd.com/

PUBLIC CLOUD SERVICES: PAAS

Platform as a Service
Delivery of a virtualized application runtime platform that has a software stack for developing applications or application services. PaaS applications and infrastructure are run and managed by the services vendor.

Big Data as a Service (19)
Big data as a service (BDaaS) are cloud based services for the analysis of large or complex data sets that require high scalability.

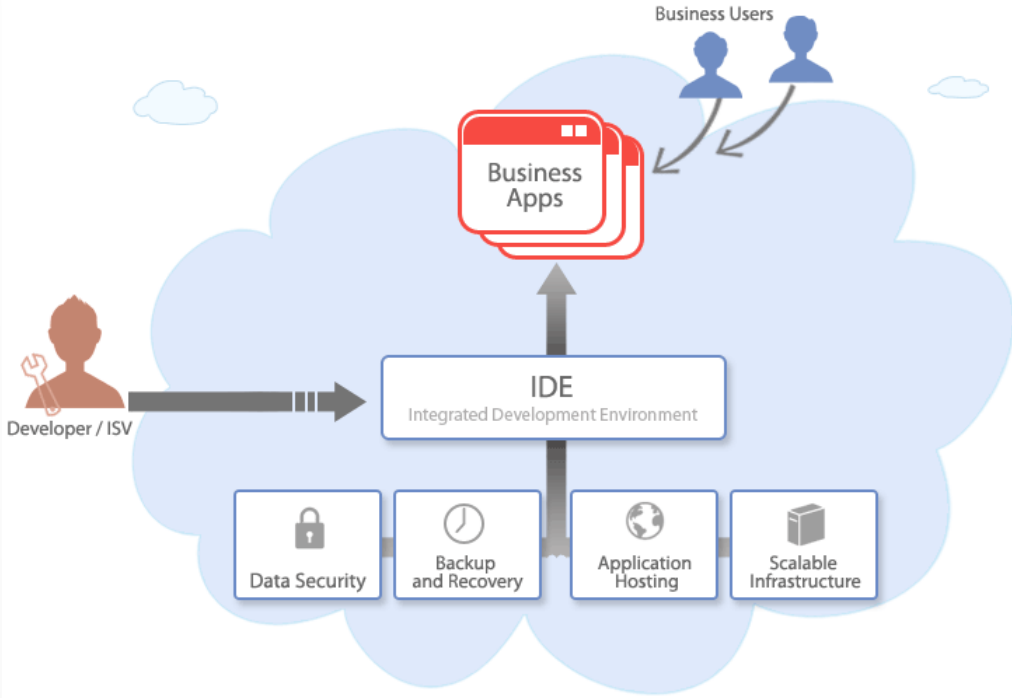
Business Intelligence (18)
Platforms for the creation of business intelligence applications such as dashboards, reporting systems, and big data analysis.

Database (18)
These services offer scalable database systems that ranging from relational database solutions to massively scalable non-sql datastores.

Development & Testing (18)
These platforms are only for the development and testing cycles of application development, which expand and contract as needed.

General Purpose (22)
Platforms suited for general purpose application development. These services provide a database, a web application runtime environment, and typically support web services for integration.

Integration (14)
Services for integrating applications ranging from cloud-to-cloud integration to custom application integration.



http://cloudtaxonomy.opencrowd.com/

PUBLIC CLOUD SERVICES: SAAS

Software as a Service
Cloud based delivery of complete software applications that run on infrastructure the SaaS vendor manages. SaaS applications are accessed over the Internet and typically charged on a subscription basis.

Billing (3)
Application services to manage customer billing based on usage and subscriptions to products and services.

Collaboration (18)
Platforms providing tools that allow users to collaborate in workgroups, within enterprises, and across enterprises.

Content Management (7)
Services for managing the production and access to content for web based applications.

CRM (13)
Platforms for CRM application that range from call center applications to sales force automation.

Document Management (6)
Platforms of managing documents, document production workflows, and providing workspaces for groups or enterprises to find and access documents.

Education (4)
Provides of online services to Educators and Educational institutions.

ERP (8)
Enterprise resource planning (ERP) is an Integrated computer-based system used to manage internal and external resources, including tangible assets, financial resources, materials, and human resources.

Financials (11)
Applications for managing financial processes for companies that range from expense processing and invoicing to tax management.

Healthcare (10)
Services for improving and managing people's health and healthcare management.

Human Resources (10)
Software for managing human resources functions within companies.

IT Services Management (5)
Software that helps enterprises manage IT Services delivery to services consumers and manage performance improvement.

Personal Productivity (5)
Software that business users use on a daily basis in the normal course of business. The typical suite includes applications for word processing, spreadsheets, and presentations.

Project Management (12)
Software packages for managing projects. Features of packages may specialize the offering for specific types of projects such as software development, construction, etc.

Sales (7)
Applications that are specifically designed for sales functions such as pricing, commission tracking, etc.

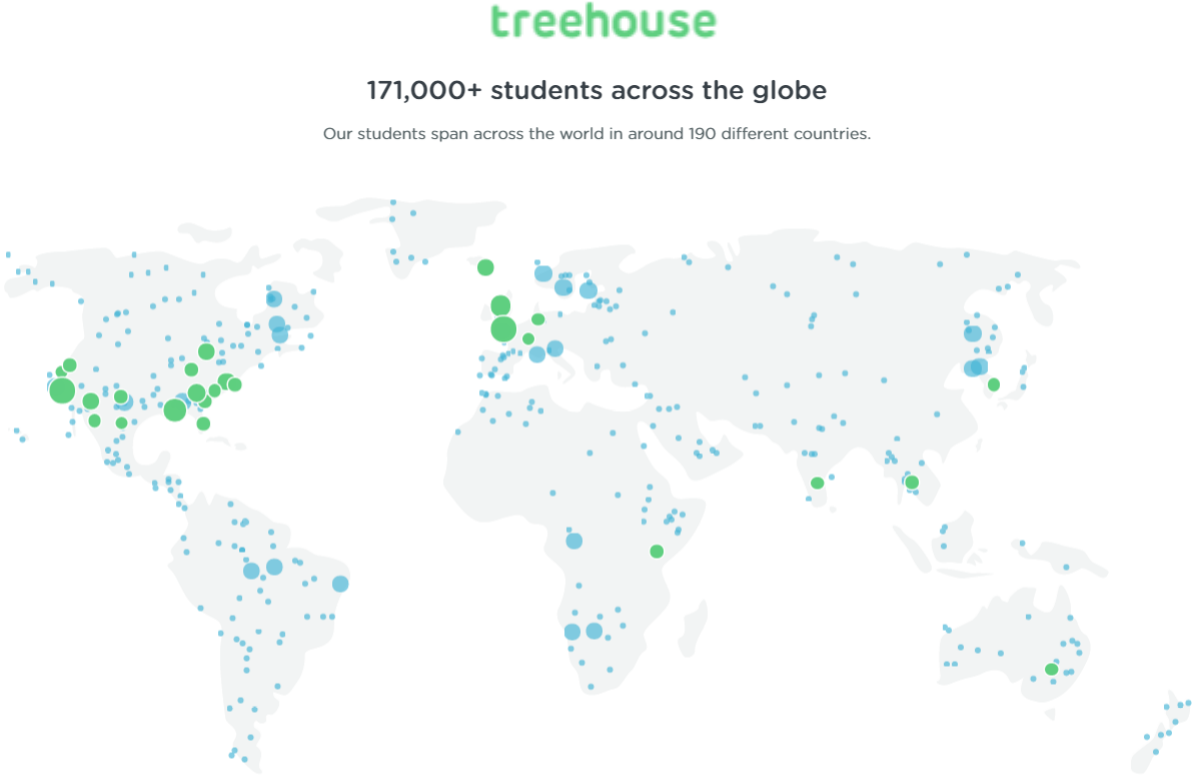
Security (10)
Hosted products for security services such as malware and virus scanning, single sign-on, etc.

Social Networks (4)
Platforms for creating and customizing social networking applications.

DIVERSIFICATION OF CLOUD SERVICE DELIVERY MODEL

			Public Cloud	Private Cloud	On-Premise Public Cloud	Hosted Private Cloud	Managed Service	Hosting Service	Utility Service
Computing Resource	Ownership	Owned by user		■			■		
		Owned by provider	■		■	■		■	■
	Location	User premise		■	■		■		
		Provider's data center	■			■		■	■
	Contract	Customized contract		■	■	■	■	■	■
		Standard contract	■						
	Use	Dedicated to user org.		■	■	■	■	■	
		Shared with other org.	■						■
Service Management		Done by user		■					
		Done by provider	■		■	■	■	■	■
Payment for Service		By strategic contract					■	■	■
		Per use	■	■	■	■			

- Treehouse provides guided e-learning of software, certifies skills, and helps finding jobs in the software industry.
- Maintaining the educational technology site required a reliable, solid infrastructure that's scalable.
- When unexpected AWS outages and noisy neighbors were plaguing Treehouse, they decided it was necessary to switch to a managed hosting solution that provided more predictability and human support when needed.
- Treehouse chose Blue Box Cloud which provides an isolated private cloud infrastructure to individual customers.



HOSTED PRIVATE CLOUD

Treehouse

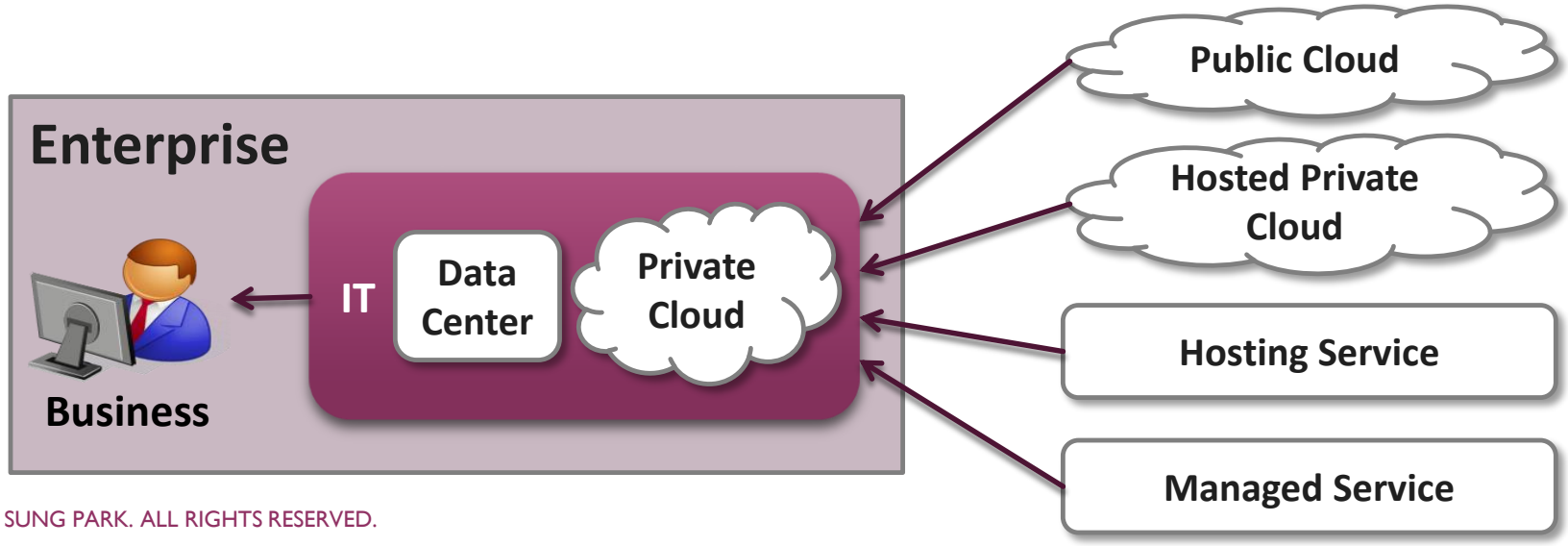
- In July 2014, a $600 million computing cloud developed by Amazon Web Services for the Central Intelligence Agency (CIA) began servicing all 17 agencies that make up the intelligence community (IC) of the United States.
- The Amazon-built cloud operates behind the IC's firewall, or more simply: It's a public cloud built on private premises.
- IC's pays only for services they actually use, which is expected to generate massive savings for the IC.
- Security in the IC cloud is as safe as or safer than security on previous data centers.
- Whenever Amazon introduces a new innovation or improvement in cloud services, the IC cloud will evolve.

ON-PREMISE PUBLIC CLOUD

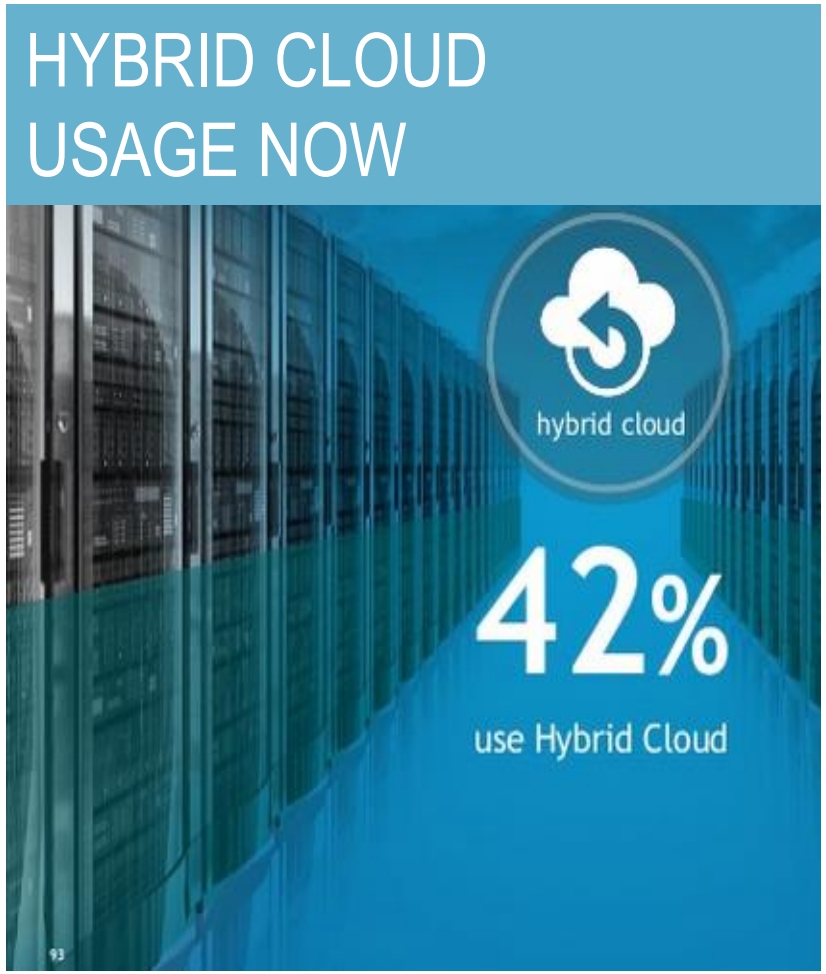
CIA

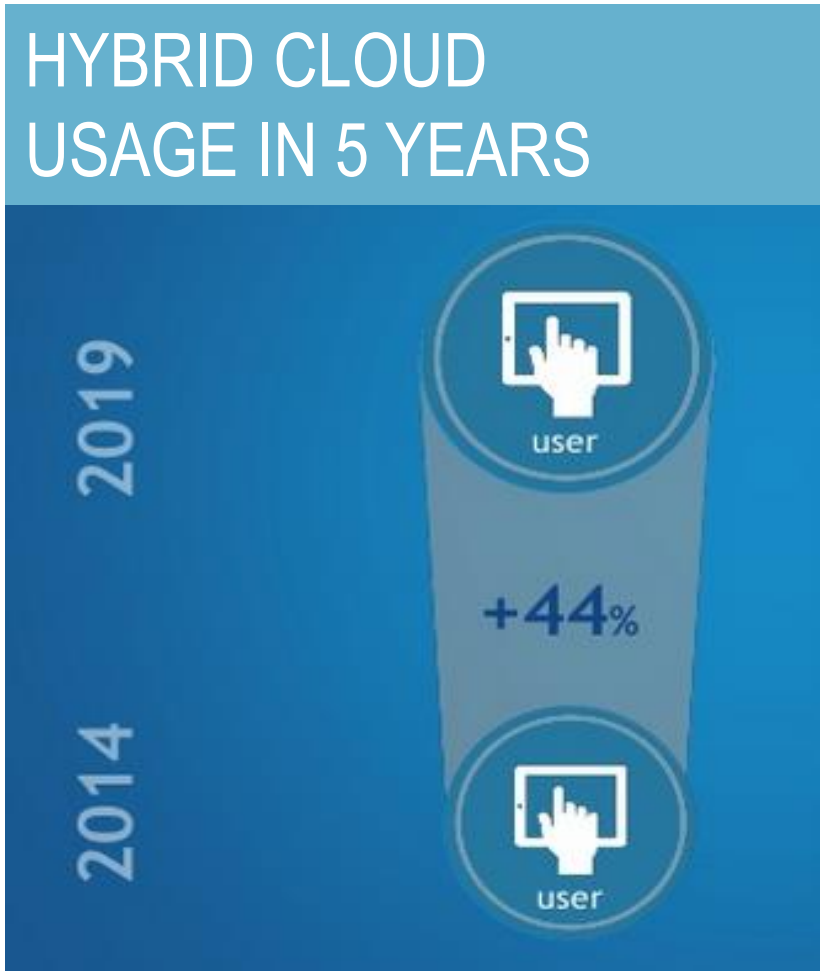
HYBRID CLOUD

- Public vs. private doesn't have to be an either/or proposition. An optimal approach is to evaluate specific applications, factor in security, compliance, accountability and availability considerations, and then decide what apps or user groups are appropriate for a private cloud, and what apps and user groups can be shifted to the public cloud.
- Full-fledged hybrid IT requires integration of traditional internal IT services, internal cloud services and external cloud services.
- Both internal and external cloud services share the basic properties of clouds, i.e., infrastructure virtualization, multitenancy, service catalog and portal, automated service provisioning and management, etc.



HYBRID CLOUD

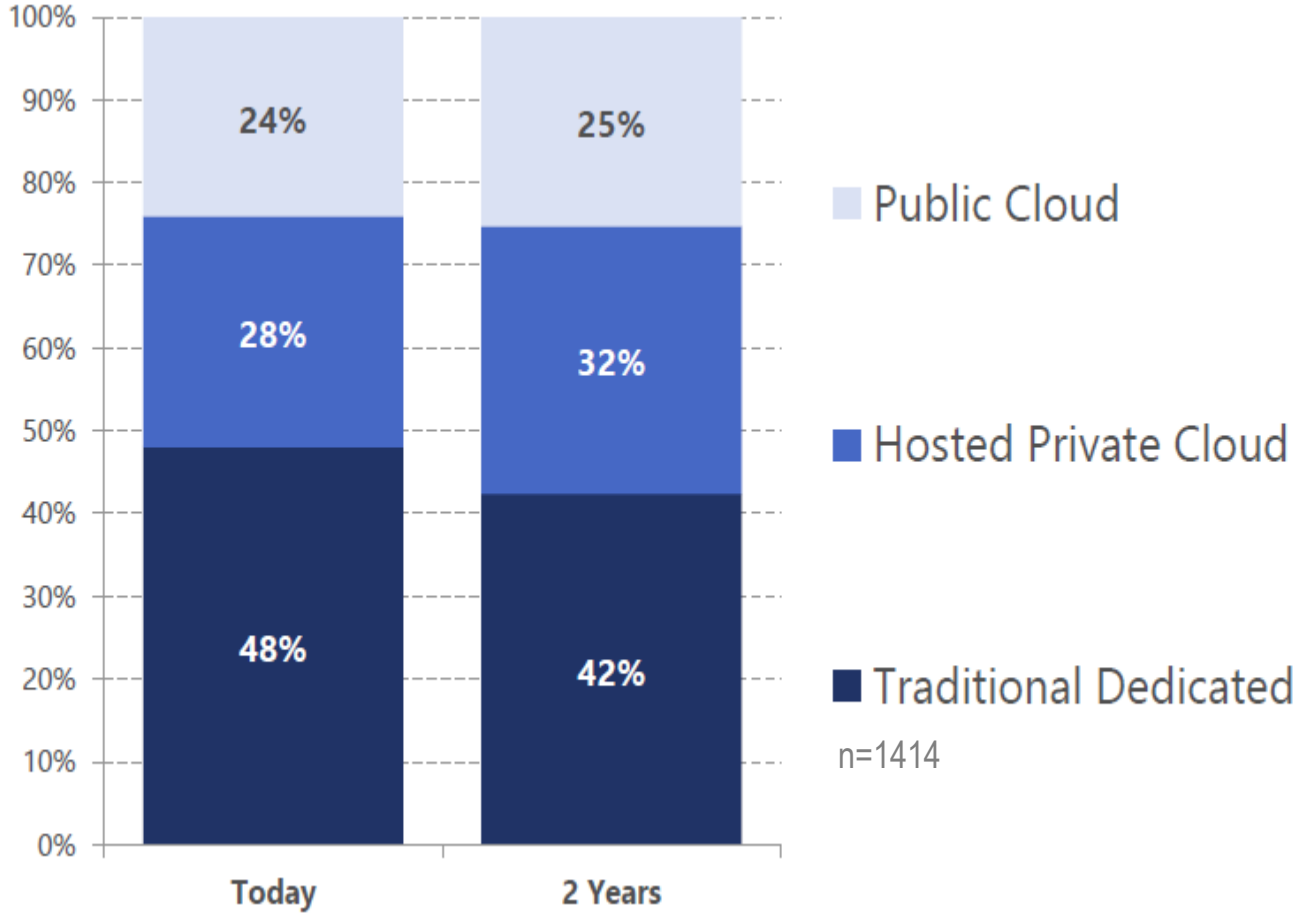




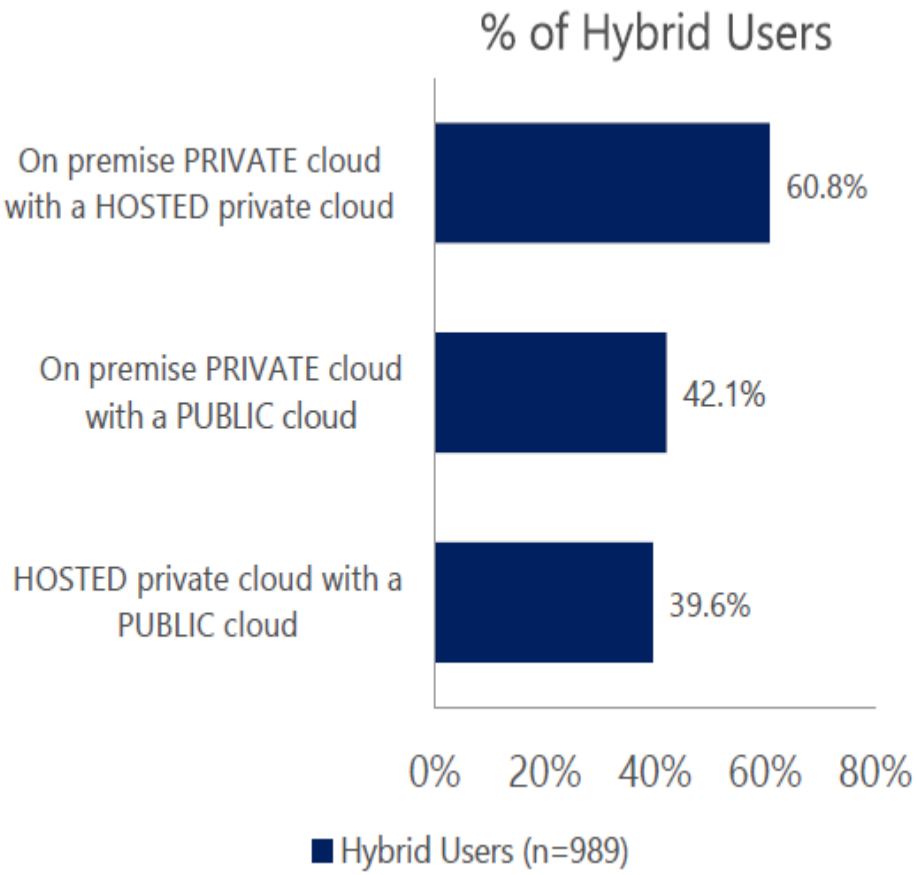
North Bridge, Future of Cloud Computing Survey, 2014.

HYBRID CLOUD

Percentage of Spending on Infrastructure Outsourcing Models



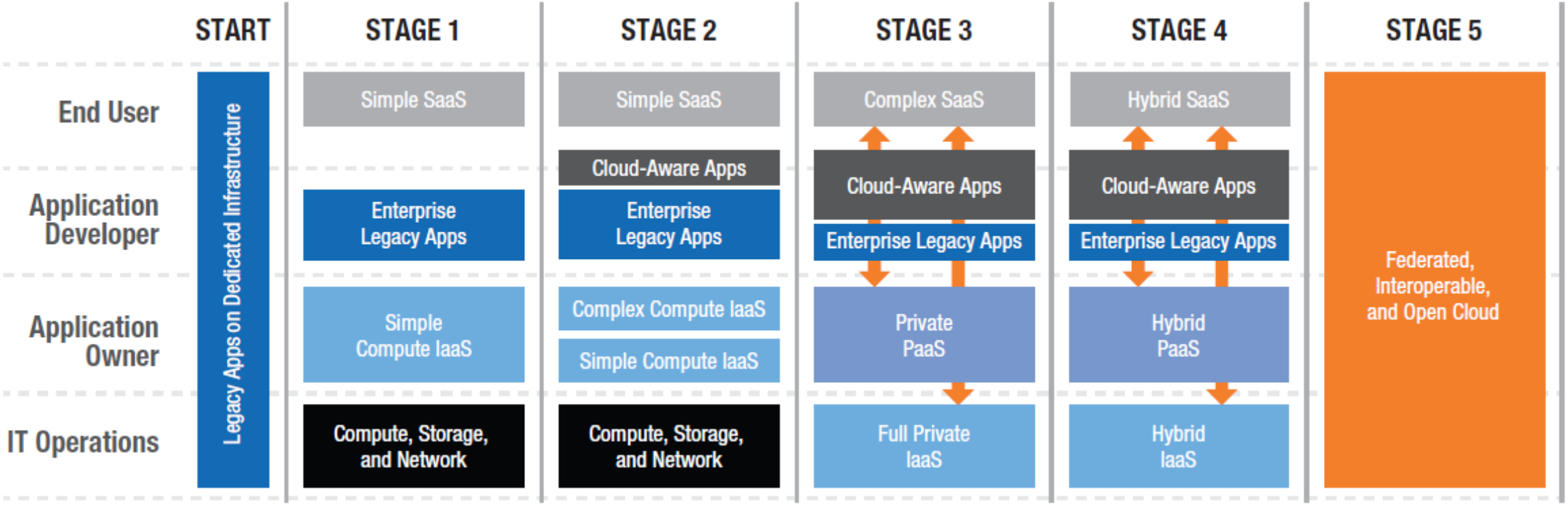
Percentage of Hybrid Outsourcing



451 Research, Hosting and Cloud Study, 2014.

CLOUD ADOPTION ROADMAP

- The cloud adoption roadmap provides an end-to-end visualization for how the technical use of cloud technologies in the enterprise develops over time.
- As technical implementation matures, the use of cloud becomes more sophisticated, comprehensive, and optimized.



- Cloud Adoption Strategy was set up to answer two related questions:
  - Which workloads should we move to cloud and when?
  - How do we map a path to cloud computing from out current environment?
- Cloud Adoption Strategy Planning Process
  - Conducted an environment scan.
  - Created cloud definitions, attributes and taxonomy.
  - Identified potential benefits and risks of cloud services.
  - Developed a cloud use case model.
  - Revised the enterprise architecture to accommodate cloud services.
  - Developed cloud adoption roadmap.

"For 2014, we have aligned our IT priorities to Intel's key focus areas. Building on 2013, we will extend our investments in SMAC to accelerate Intel products TTM, grow revenue and improve operational efficiency."

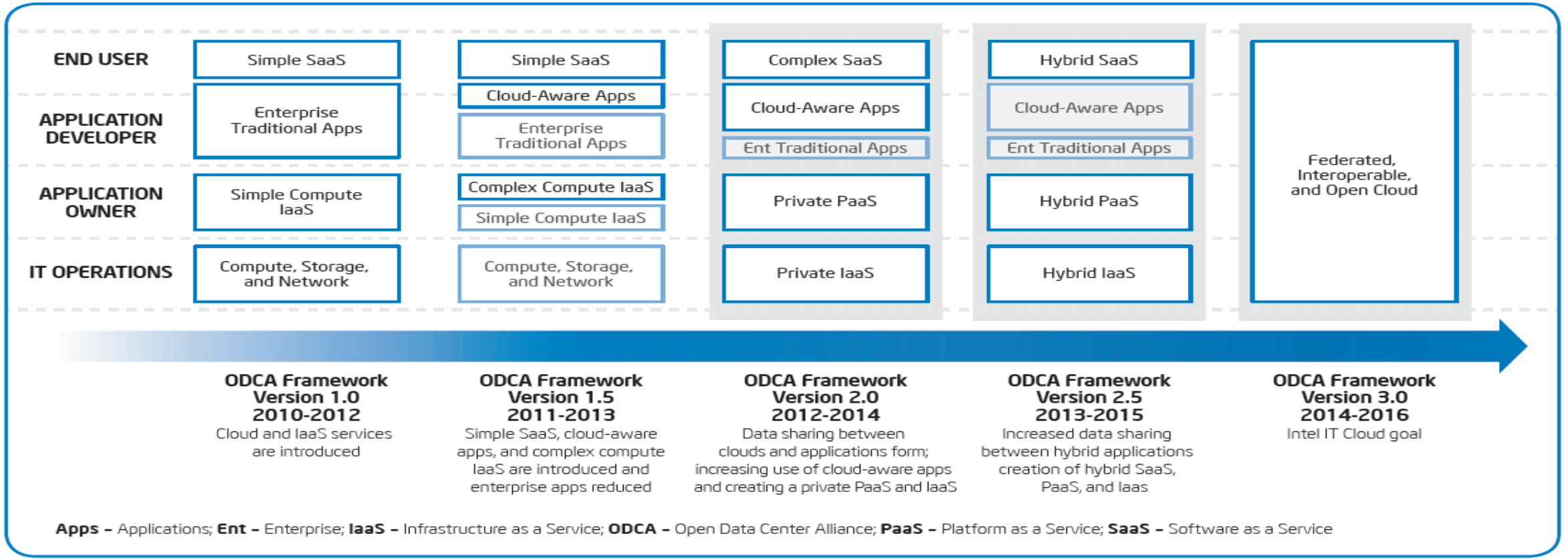
Kim Stevenson, Intel CIO

Intel IT, Developing an Enterprise Cloud Computing Strategy, 2009. (http://www.intel.com/content/www/us/en/it-management/intel-it/intel-it-best-practices.html)

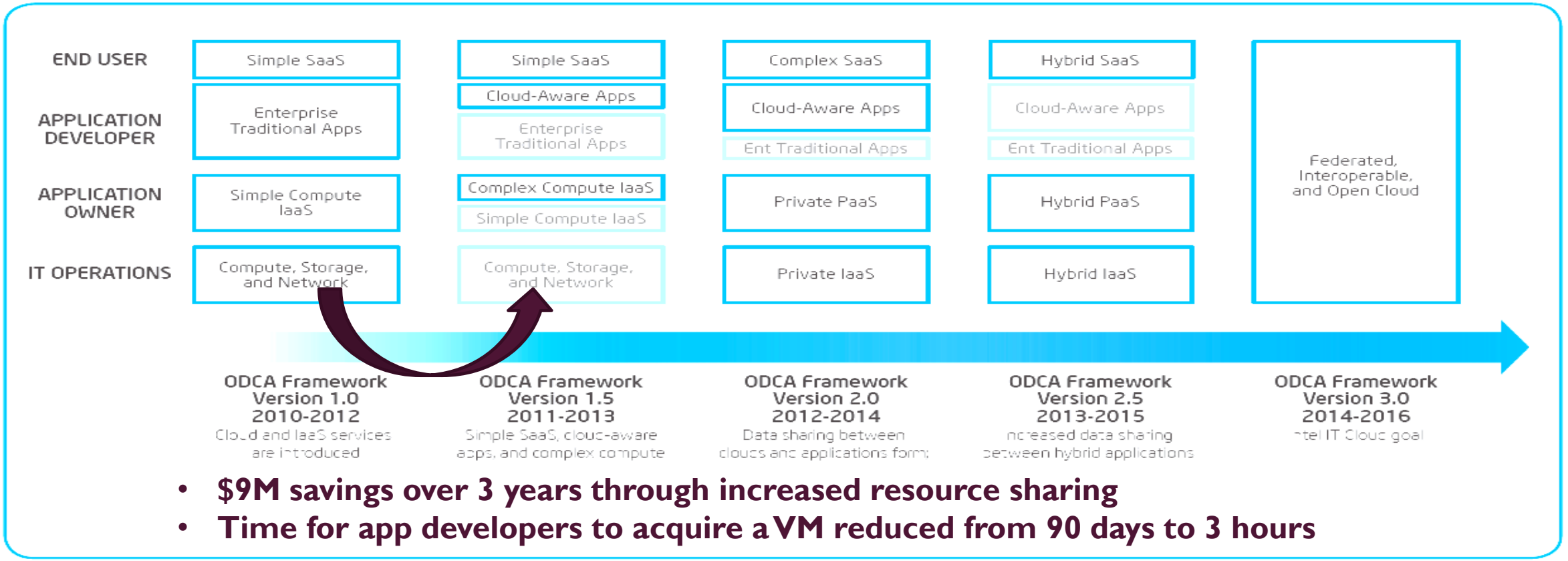
CLOUD ADOPTION STRATEGY

Intel

- Intel's Cloud Adoption Roadmap

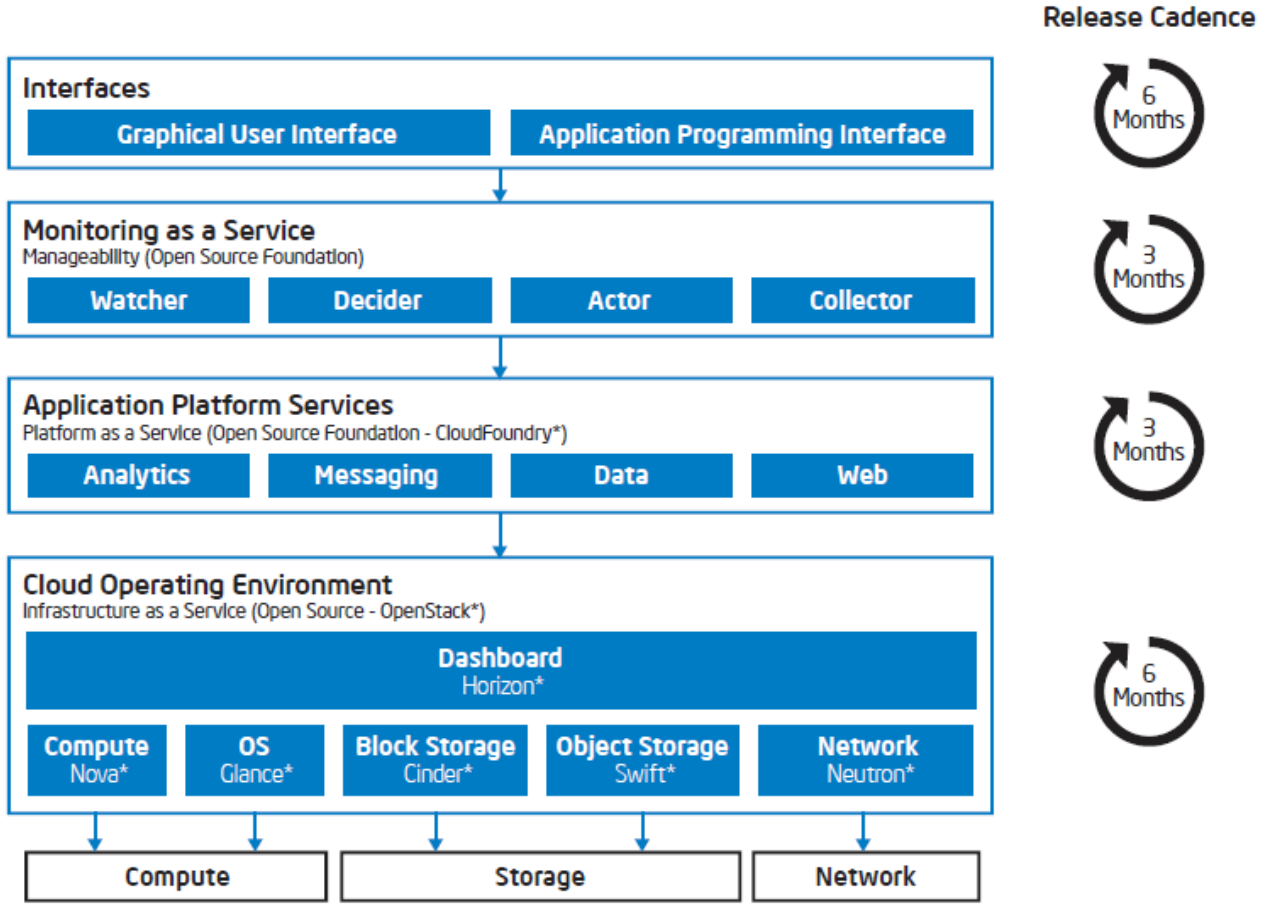


- Intel's Cloud Adoption Roadmap



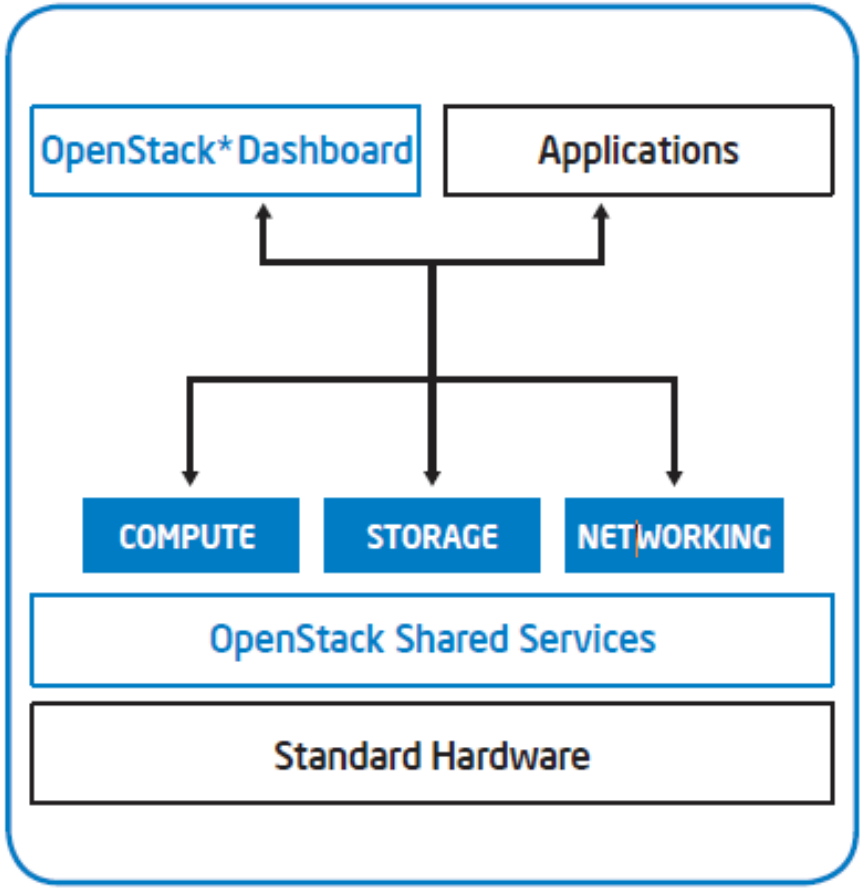
- **$9M savings over 3 years through increased resource sharing**
- **Time for app developers to acquire a VM reduced from 90 days to 3 hours**

- To operate our private cloud like a cloud service provider requires maximizing our resource efficiency while providing on-demand, self-service PaaS and IaaS. To achieve these objectives, Intel used OpenStack, making it the single control plane for all our hosting virtualization environments.
- Intel also took advantage of Cloud Foundry to implement PaaS.
- To manage our cloud operations at each level of the cloud capability stack, Intel followed Information Technology Infrastructure Library* (ITIL) standards.



Intel IT, Simplifying the Path for Building an Enterprise Private Cloud, 2014. (http://www.intel.com/content/www/us/en/it-management/intel-it/intel-it-best-practices.html)

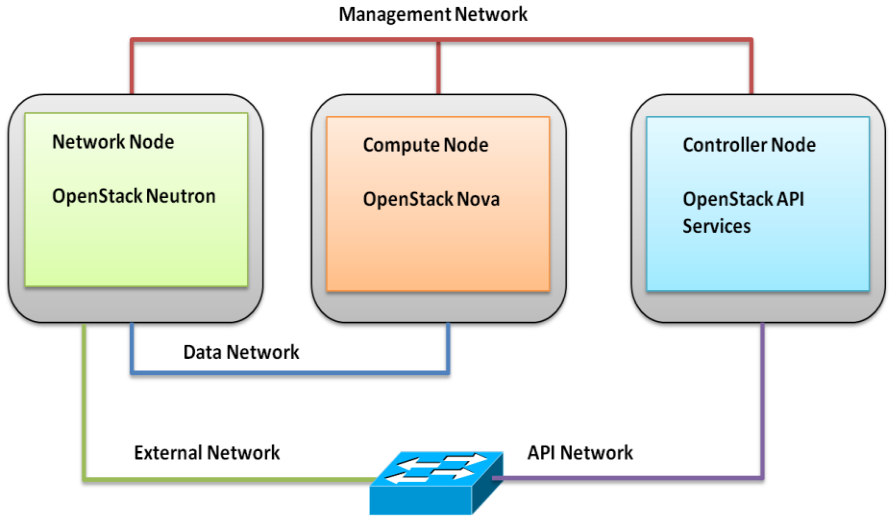
- Intel uses OpenStack as the single control plane for the entire virtualization environment. OpenStack provides a dashboard that gives administrators control.
- It also empowers end users to provision resources through a web portal, APIs, or OpenStack command line interface (CLI).
- Instances of PaaS are provisioned on top of IaaS through the control plane.
- Under the OpenStack layer is the hosting environment which can be based on a commercial hypervisor or OpenStack hypervisor.
- Intel is a Gold member of the OpenStack community, providing funding, strategic alignment, and expertise with the OpenStack mission. Intel IT staff is closely involved, contributing code, documentation, and reporting bugs and vulnerabilities—efforts all aimed at improving OpenStack's usefulness to Intel and other IT organizations.
- Intel participates in the Cloud Foundry community as a Gold Member as well. In addition, as a member of the Cloud Foundry Community Advisory Board, Intel IT provides strategic technical feedback on the Cloud Foundry roadmap, advocates for enterprise requirements, and provides more tactical input on the day-to-day operation of the Cloud Foundry project.



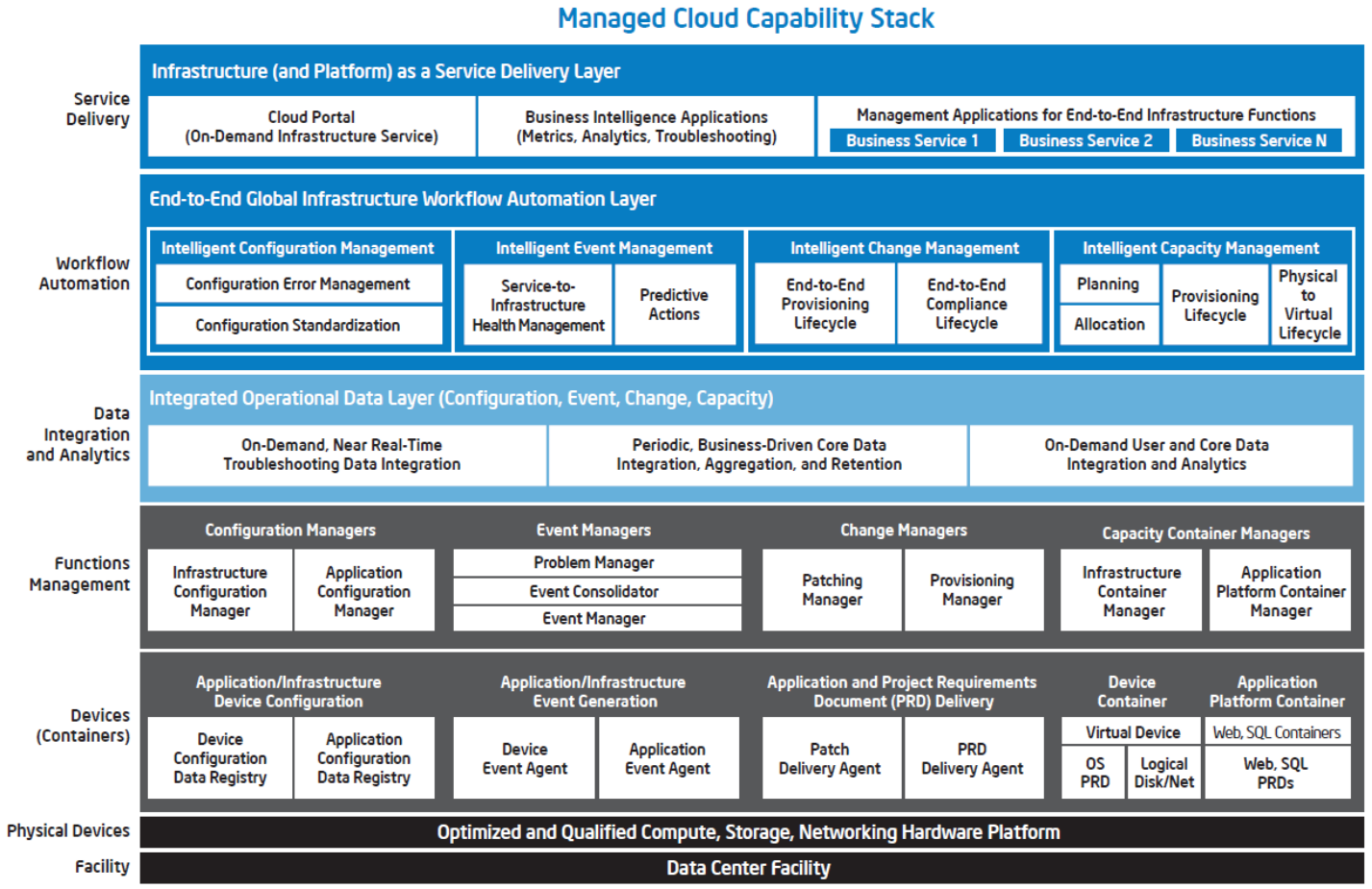
BUILDING PRIVATE CLOUD - IAAS

Intel

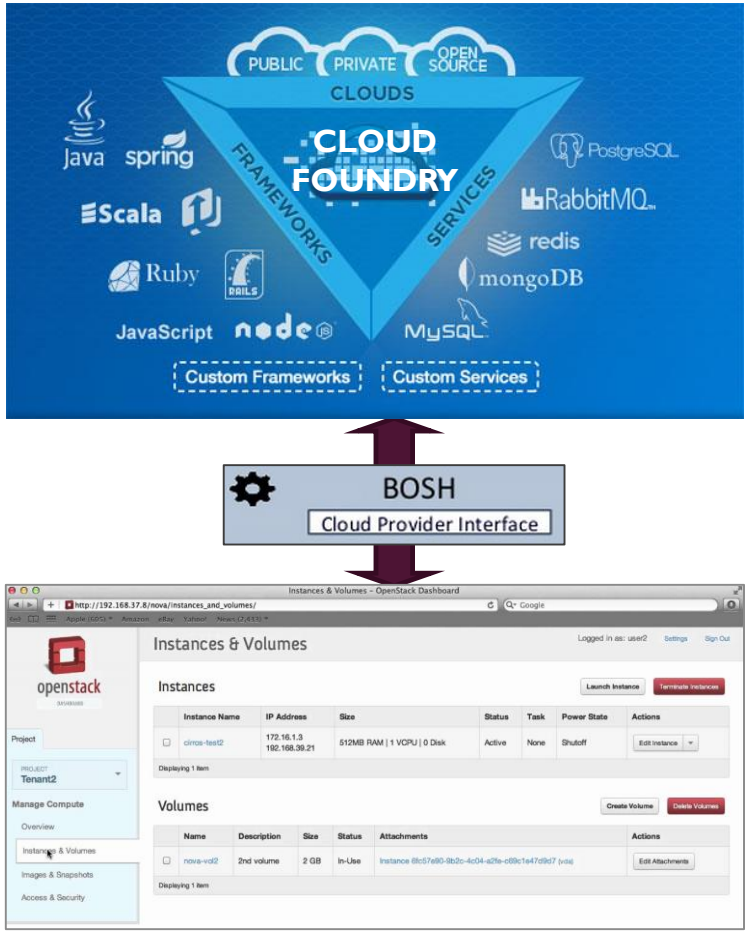
- Having automated the provisioning of compute and storage, Intel is implementing software-defined networks (SDN) to make the network component self-service.
- SDN separates the control plane (the element of the network used to configure the network) from the data plane (where the actual packet flow and traffic traverse the network).
- A key advantage of SDN is that it moves management of the data center network away from each individual switch, enabling configuration from centralized controllers.
- This centralization means users can now either go to a web portal or use APIs to request network services on their own and make them part of their application environment.
- Intel is integrating SDN as an overlay network on top of the virtual environment and providing core network connectivity (routing, switching, and network access control) for VMs in the cloud environment.
- The SDN solution, once deployed, integrates with OpenStack's Neutron APIs and can be configured programmatically and on-demand using those APIs.



- Implementing ITIL standards enabled Intel to enhance the use of automated monitoring and configuration tools and improve on-demand service.
  - Service delivery. Provides IaaS and PaaS.
  - Workflow automation. Provides an on-demand, highly available, and scalable cloud computing infrastructure for rapid VM provisioning and deprovisioning.
  - Data integration and analytics. Integrates data from all containers as well as from the functions management layer.
  - Functions management. Watches and acts on configuration management, event management, change management, and capacity management.
  - Device or container. Includes VMs, storage containers, and agents.

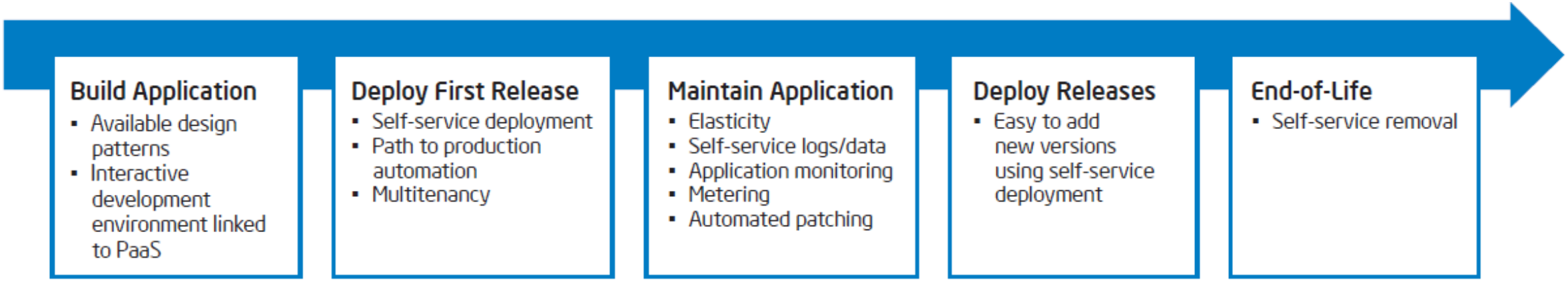


- Cloud Foundry is used as PaaS and Iron Foundry extends Cloud Foundry for .NET applications.
- Intel participates in the Cloud Foundry community as a Gold Member as well. In addition, as a member of the Cloud Foundry Community Advisory Board, Intel IT provides strategic technical feedback on the Cloud Foundry roadmap, advocates for enterprise requirements, and provides more tactical input on the day-to-day operation of the Cloud Foundry project.
- The Cloud Foundry PaaS stack delivers even more agility benefits than the IaaS because it requires no server provisioning step and significantly reduces the amount of support that developers perform as part of self-service hosting.
- Cloud Foundry contains a CLI and APIs that enable developers to interact with PaaS instances. Intel developed a PaaS portal that used Cloud Foundry APIs to make it even easier for developers.



- DBaaS is an important subset in Intel's PaaS offering. If an application requires a database, it can be provisioned through the DBaaS portal.
- This process involves specifying the database type (MySQL, MongoDB), and embedding the returned connection string in the application code and/or used with database management tools to create and manage application tables and data.
- Each database in DBaaS automatically inherits many standard features: high availability, security, disaster recovery, monitoring, elasticity, index tuning, and maintenance.

- With the use of PaaS, Intel developers are in control from development to deployment—exponentially reducing time to production, optimizing the use of resources, and encouraging the development of cloud-aware applications.
- Applications built using PaaS get inherent cloud benefits, such as elasticity, high availability, on-demand access, and a metered, multitenant environment.
- PaaS makes it possible for developers to secure infrastructure in 45 minutes and to transition from innovative idea to production in a single day.
- Intel architects and developers are learning to design cloud-aware applications that maximize cloud advantages, such as self-service provisioning, elasticity, run-anywhere design, multitenancy, and design for failure.
- They are also increasingly using agile methodologies, taking advantage of the growing number of self-service tools and self-service data available in the PaaS offerings.



BUILDING PRIVATE CLOUD – SAAS

Intel