UNIVERSITY OF MANNHEIM

Hybrid Clouds: Comparing Cloud Toolkits

Master Seminar

Chair in Information Systems III
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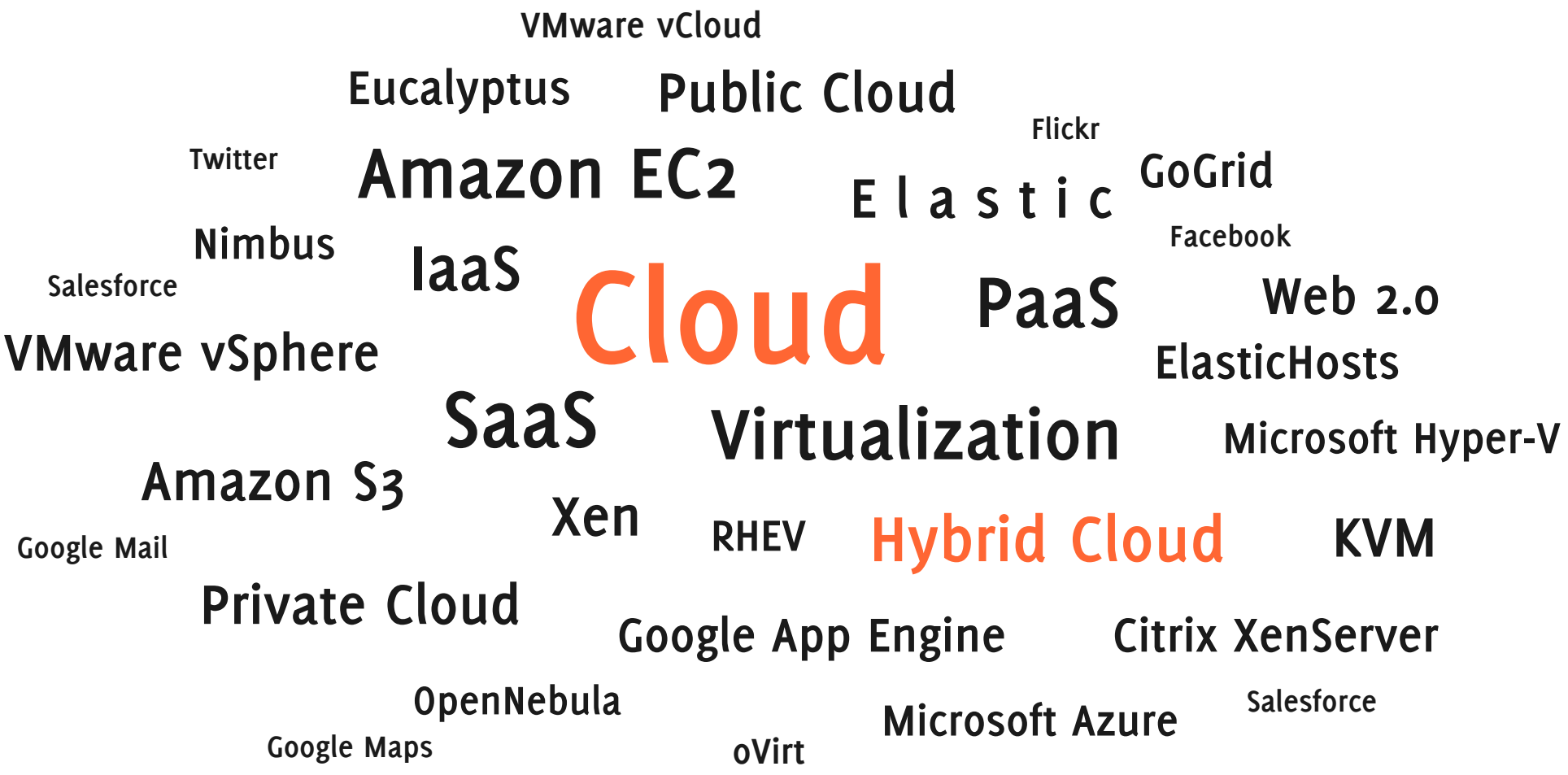
Agenda

1. Cloud Computing
   - Status Quo
   - Definitions & Classifications
2. Hybrid Clouds
3. Cloud Toolkits
   - Market Overview
   - Technical Requirements
   - OpenNebula & Eucalyptus

Cloud Computing: Status Quo



Cloud Computing: Status Quo

"Cloud computing is the next step in the evolution of the Internet"

– Tim O'Reilly, CEO of O'Reilly Media

"We've redefined cloud computing to include everything that we currently do"

– Larry Ellison, CEO of Oracle

Defining Cloud Computing

"Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources [..] that can be rapidly provisioned and released with minimal management effort or service provider interaction."

– National Institute of Standards and Technology (NIST)

Key Characteristics

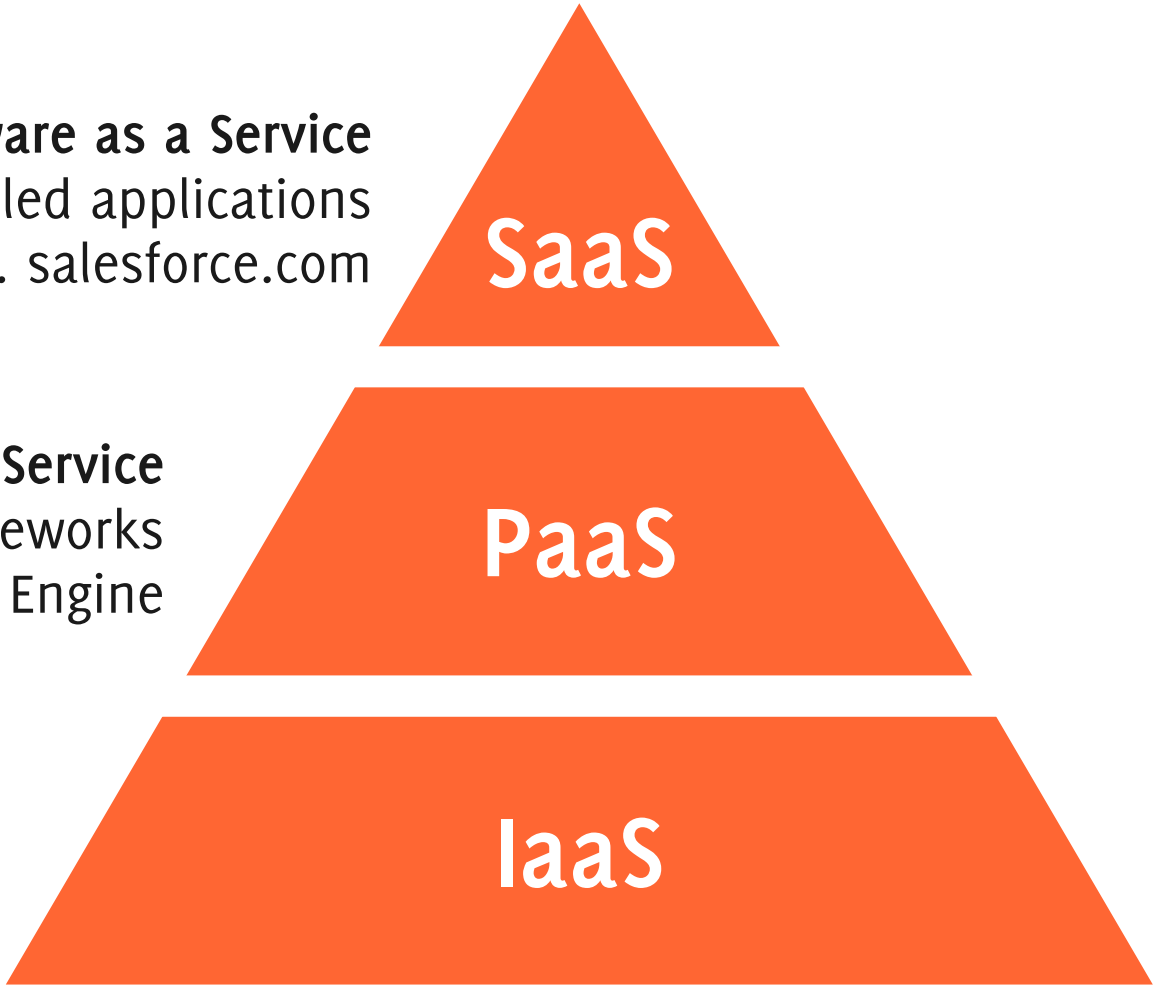
- Resource abstraction
- Elastic capacity
- Utility-based pricing

Classifications: Service Models

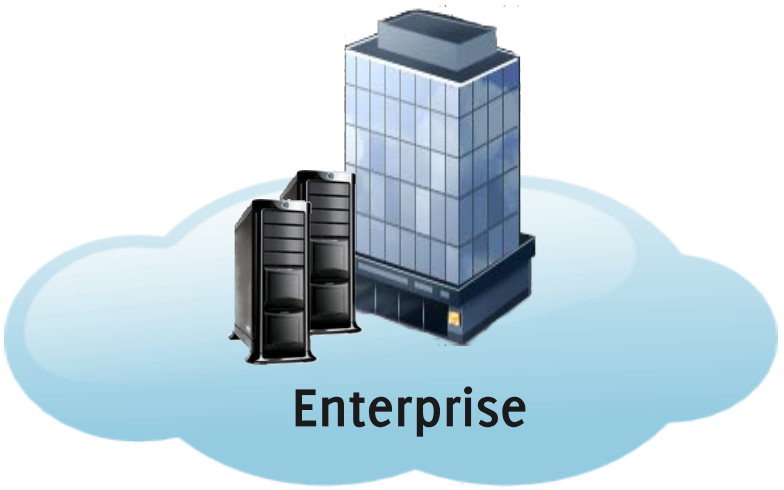
Software as a Service
Cloud-enabled applications
e.g. salesforce.com

Platform as a Service
Cloud-hosted application frameworks
e.g. Google App Engine

Infrastructure as a Service
Virtualized resources & VMs
e.g. Amazon EC2



Classifications: Deployment Models



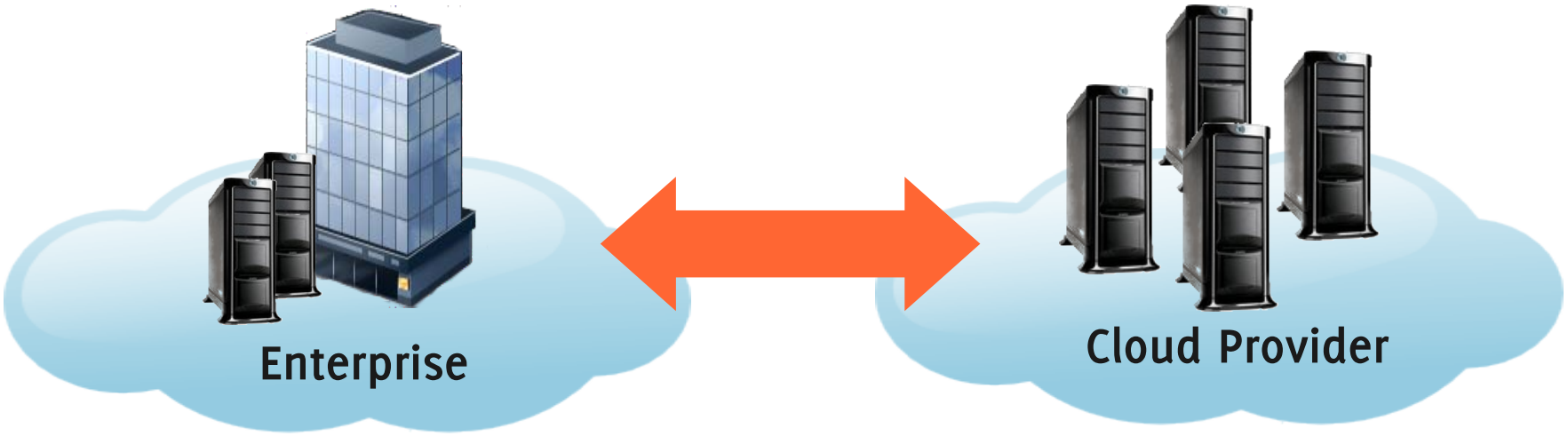
Private Cloud

- On premises
- Focus: virtualized data center

Public Cloud

- Off premises
- Focus: sell resource capacity

Classifications: Deployment Models



Hybrid Cloud

- Extends the private cloud model by using both local and remote resources
- Seamless integration of public resources in the private cloud
- Focus: scale out to handle flash crowds / elastic capacity

Hybrid Clouds

Opportunities

- Optimal utilization
- Data center consolidation
- Risk transfer
- Availability

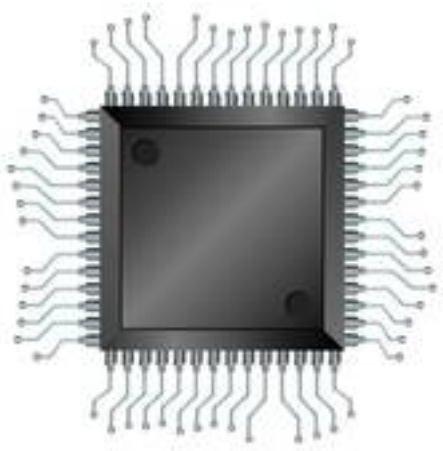
Challenges & Issues

- Cost
- Security & data confidentiality
- **Interoperability**
- Availability

Cloud Toolkits: Market Overview

	VMware vSphere	RHEV	Xen-Server	Hyper-V	Euca-lyptus	Nimbus	Open Nebula	oVirt
Hypervisor	VMware	KVM	Xen, *Hyper-V*	Hyper-V, Xen	Xen, KVM, VMware	Xen	Xen, KVM, VMware	KVM
VLAN	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Scheduling	Yes	Yes	N/A	N/A	Limited	External	External	No
Live Migr.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
High Avail.	Yes	Yes	*Yes*	Yes	No	No	No	No
Hybrid Cloud	No	No	No	No	Partially	Partially	**Yes**	No
Admin GUI	Yes	Yes	Yes	Yes	No	No	No	Yes
Req. Intel VT / AMD-V	No	Yes	only for Windows guests	No	if KVM hypervisor is used	only for Windows guests	if KVM hypervisor is used	if KVM hypervisor is used
Guest OSs	W/L/So/N	W/R	W/R/C/S/D	W/S/R	Depends	Depends	Depends	Depends
License	Propr.	Propr.	Propr.	Propr.	BSD	Apache 2	Apache 2	GPLv2
Annual Cost	up to $4400 per CPU	up to $750 per socket	Free / *up to $5500 per host*	up to $3300 per CPU	Free / *N/A*	Free	Free	Free

Technical Requirements & Restrictions



Hardware Requirements

- Commercial solutions
  - Have large hardware compatibility lists (200 – 700 pages)
  - Often CPU virtualization technology needed, i.e. Intel VT or AMD-V
  - Some features require specific hardware configurations, e.g.
    - vSphere live migration needs compatible CPUs on different hosts
    - RHEV requires a SAN for resource pooling, live migration, and high availability
- Open source solutions
  - No hardware compatibility lists
  - Requires a trial-and-error approach

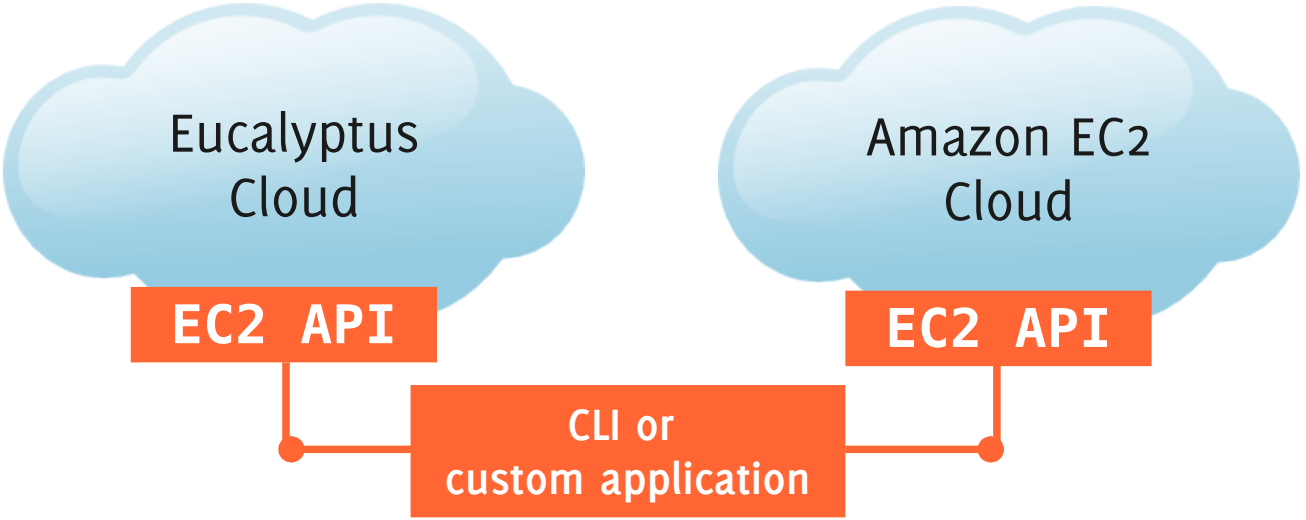
Technical Requirements & Restrictions

Software and Guest OS Restrictions

- Commercial solutions
  - Support a very limited number of guest operating systems
  - But: vendors guarantee a working OS
  - Focus: production stability
- Open source solutions
  - Large OS support (KVM supports over 100 OSs)
  - But: no guarantee that it works
  - Focus: support a variety of operating systems

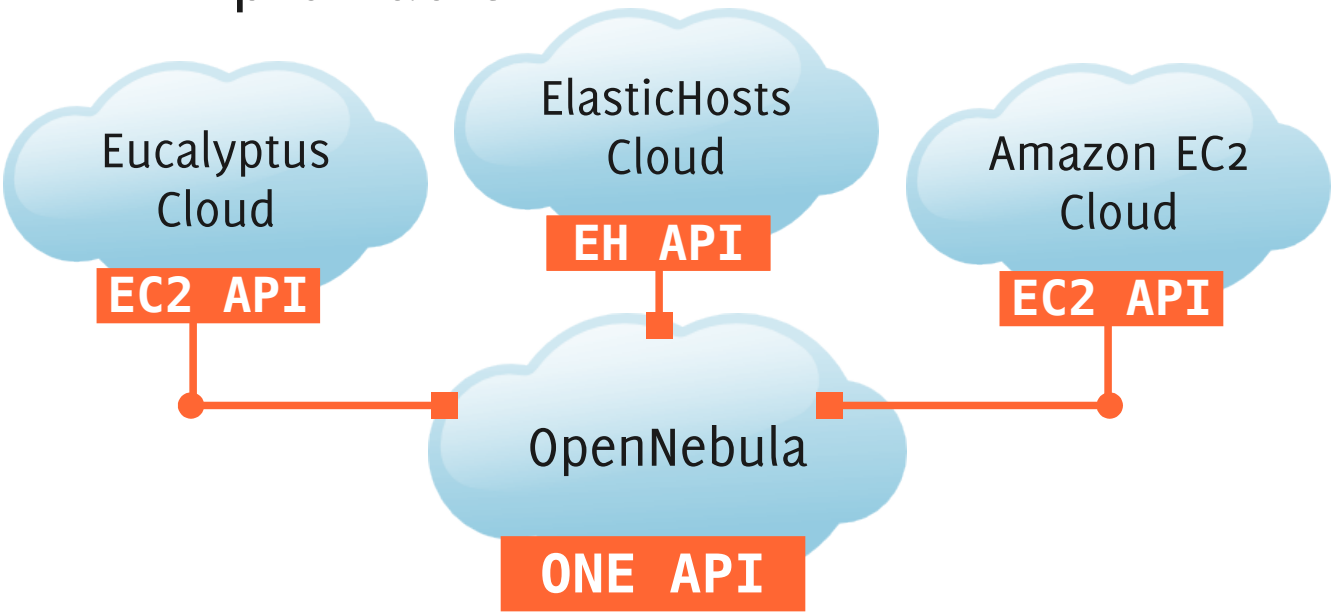
Eucalyptus

- Initiated in 2007 at the UC Berkeley
- Open source IaaS framework
- Allows deploying private and public clouds
- Emulates the Amazon EC2 interface



OpenNebula

- Started in 2009 at the University of Chicago
- Hybrid cloud toolkit
- Uses a plugin-based architecture to support a variety of hypervisors and public cloud providers



Conclusion

- Cloud computing is a very young and poorly researched area
- Private and public cloud solutions are production-ready, but the cloud toolkits are not built for hybrid cloud environments