Cloud Computing and Open Source: Watching Hype meet Reality

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Exciting Weather Forecasts

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What is a cloud?

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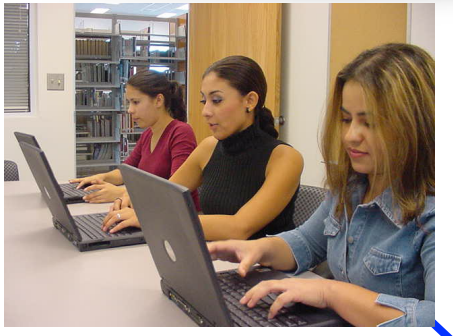

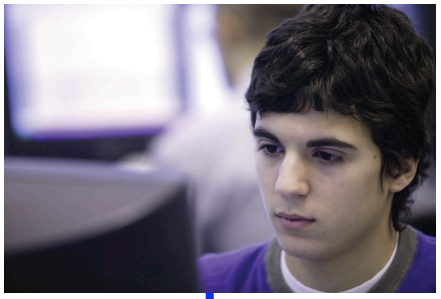

SLAs

Web Services

Virtualization

eCommerce + Infrastructure

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- **Self-service and "zero touch."**
  - Scalable automatic rental of resource intensive goods
- **Transactional and asynchronous**
  - Interaction with the site is transactional
  - Delivery is asynchronous
- **Site integrity and site availability are critical**
  - Individual transactions can fail but the site cannot
- **Customer requests must be isolated**
  - Service venue must manage competing needs
- **Scale out for request volume, scale up for request weight**

Open-source Cloud Infrastructure

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- ***Idea:*** **Develop an open-source, freely available cloud platform for commodity hardware and software environments**
  - Stimulate interest and build community knowledge
  - Quickly identify useful innovations
  - Act to dampen the “hype”
- **First-principles cloud implementation**
  - Not a refactorization of previously developed technology
- **Build from mature open source technologies**
  - J2EE, MySQL, Web Services are high quality and scalable as open source

What's in a name?

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- **Elastic Utility Computing Architecture Linking Your Programs To Useful Systems**
- **Web services based implementation of elastic/utility/cloud computing infrastructure**
  - Linux image hosting ala Amazon
- ***How do we know if it is a cloud?***
  - Try and emulate an existing cloud: Amazon AWS
- **Functions as a software overlay**
  - Existing installation should not be violated (too much)
- **Focus on installation and maintenance**
  - *"System Administrators are people too."*

Goals for Eucalyptus

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- **Foster greater understanding and uptake of cloud computing**
  - Provide a vehicle for extending what is known about the utility model of computing
- **Experimentation vehicle prior to buying commercial services**
  - Provide development, debugging, and “tech preview” platform for Public Clouds
- **Homogenize local IT environment with Public Clouds**
  - AWS functionality locally makes moving using Amazon AWS easier, cheaper, and more sustainable
- **Provide a basic software development platform for the open source community**
  - E.g. the “Linux Experience”
- **Not designed as a replacement technology for AWS or any other Public Cloud service**

Requirements

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- **Implement cloud abstractions and semantics**
  - Must be a cloud (inarguably)
- **Simple**
  - Must be transparent and easy to understand
- **Scalable**
  - Interesting effects are observed at scale (e.g. not an SDK)
- **Extensible**
  - Must promote experimentation
- **Non-invasive**
  - Must not violate local control policies
- **System Portable**
  - Must not mandate a system software stack change
- **Configurable**
  - Must be able to run in the maximal number of settings
- **Easy**
  - To distribute, install, secure, and maintain

Architecture

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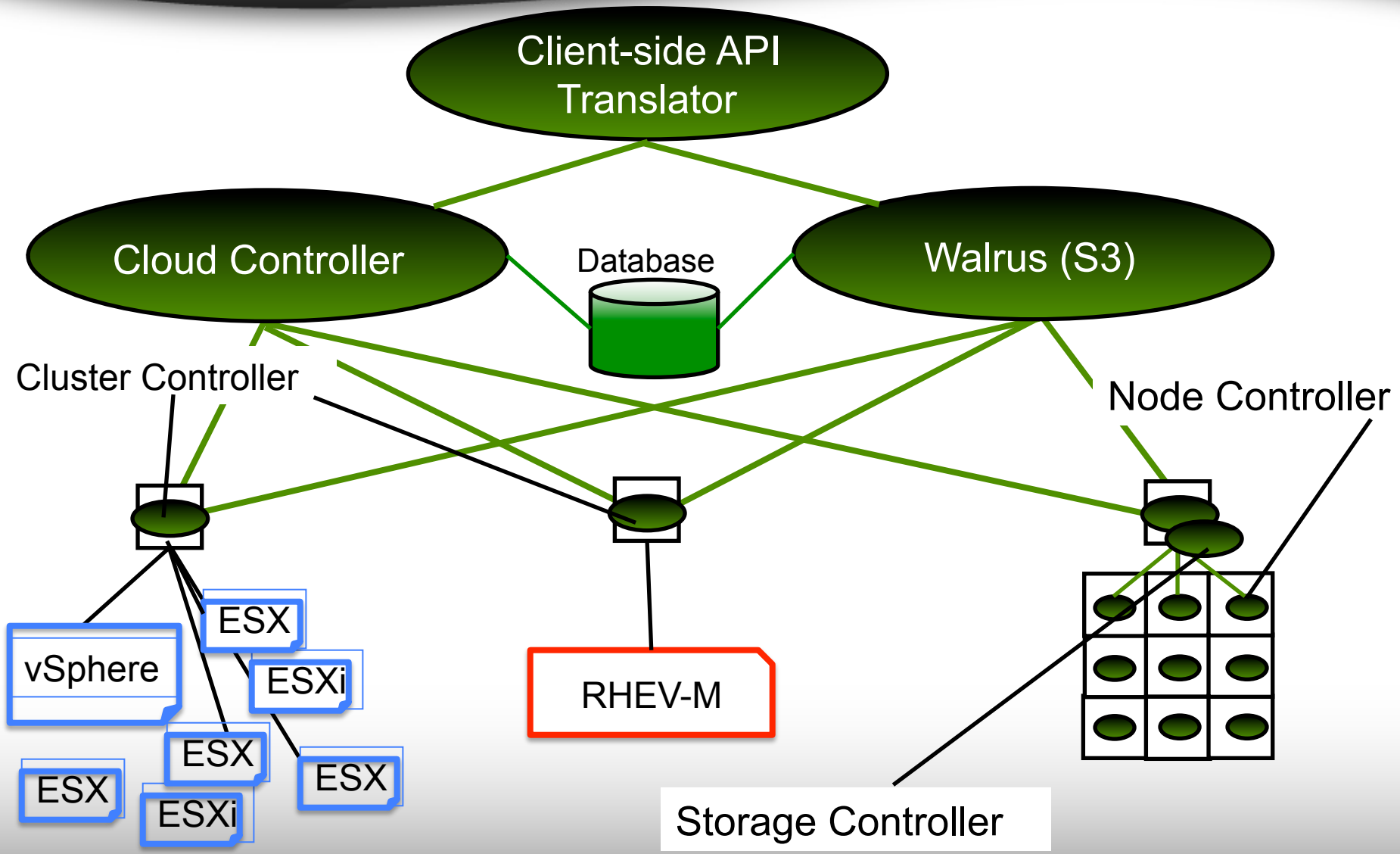

The Elements of Cloud Style

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- **The terms SaaS, PaaS, and IaaS are often viewed as creating a pain in the…**
- **SaaS (Software as a Service)**
  - Applications exporting network-facing user interfaces
  - User transfers data to the cloud
- **PaaS (Platform as a Service)**
  - Program or scripting runtime exports network-facing interfaces
  - Internal platform services available
  - User transfers program code and data to the cloud
- **IaaS (Infrastructure as a Service)**
  - Resource provisioning services export network-facing interfaces
  - Internal platform services available
  - User transfers code, data, and environment to the cloud

Why IaaS?

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- **Applications are often multi-technology**
  - System “images” for different technologies can be combined
  - Multiple language technologies at different revision levels
- **Legacy support**
  - System images that mimic bare metal deployments can be used
  - Legacies are archived with the environment necessary to run them
- **Transparency**
  - Debugging and performance tuning can go down to the hypervisor
- **QoS containers**
  - QoS is implemented in the infrastructure today => familiar
- **Anti-lock in**
  - If clouds fail, a return path to bare metal is available

Why not IaaS?

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- **Self-service pushes system administration tasks to the end-user**
  - Users must understand dynamic resource provisioning
- **QoS hard to optimize at a fine-grained level**
  - A machine is a pretty big QoS bundle
- **Heterogeneity is powerful but hard to manage**
  - Multi-technology development and maintenance is a tough software engineering problem
- **Tenancy density and cloud platform optimization**
  - Less optimization potential at the VM level

Three Research Questions for IaaS

- ***How can a cloud resolve the tension between elasticity and specialization?***
- ***What is the best development model for hybrid clouds?***
- ***How should cloud software be organized within an application?***

Elasticity and Specialization

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- **Elasticity measures the ability of the cloud to map a single user request to different resources.**
  - AWS VM can be implemented on a wide variety of infrastructure configurations
  - Simple device model is necessary for OS elasticity
- **Most data centers use specialization to encode "process"**
  - Technology lifecycle
  - User priority
  - Workload priority
  - QoS
- **The more elastic, the less specialized, but the less specialized, the less customized**

Hybrid Clouds

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- **Public Cloud**
  - Flat ID Management system and “limitless” scale
  - “roll forward” development
    - Craft a new VM when a run time exception occurs
    - Garbage collect asynchronously
- **Private Cloud**
  - Complex access controls and limited resources/quotas
  - Resource management throughout the stack is critical
- ***How can one application live comfortably in both worlds?***

Cloud Software Architecture

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- **Software stacks are losing their "polarity" in clouds**
  - File system on top of NoSQL on top of Put/Get on top of File system on top of…
  - "The Stack is Lost."
- **New Model: The Service Ensemble**
  - Applications are composed of service graphs not layered stacks
- ***What software engineering principles make sense?***
  - Communication is asynchronous
  - Failures are common
  - Whole "machines" can be composed dynamically

Three Questions we have Answered

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- ***How is Cloud Computing Different from other Approaches?***
- ***Why use a private cloud?***
- ***Can the "cloudification" of applications be automated?***

It is and It isn't

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- **Cloud: Elastic eCommerce-style service venue for resource access and automatic configuration**
- **Not Cloud:**
  - Data Center Virtualization
    - synchronous
    - Not user scalable
  - Grid
    - Policy federated
    - Inelastic
    - One user, many resources
  - Peer2Peer
    - Lack of administratable abstractions

Why Private Clouds?

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- **Technology Lifecycle Independence**
  - Lost of OS, Communication, Hardware, Data, Virtualization in the data center
  - One platform to remain stable as these technologies age and roll forward
- **Separation of support concerns**
  - “Below” the cloud platform managed by administrators
  - “Above” the cloud platform managed by users
  - Infrastructure support externalized toward the users
- **On-boarding Ecosystem**
  - Isolation properties imply the “Linux Distro of the Future.”

“Cloudification” of Applications

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- **Step 1: Configuration must be discovered**
  - Metadata service
  - Templating
- **Step 2: SLA is in the abstraction and not in the configuration**
  - Examples:
    - Network interface and not IP address carries QoS
    - Block device and not the specific volume carries the DB QoS
- **It is not, at present, possible to map arbitrary Data Center semantics onto an elastic cloud model**
  - Requires some human intervention

The Case for Open Source

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- **Linux is the operating system platform of choice for machines because…**
  - Hardware portable
    - Separates software lifecycle from hardware lifecycle
    - Prevents lock-in
  - Vast ecosystem of software
    - Linux distros provide QA (free or paid)
  - Transparent
    - Possible to own the source code for everything
  - Fast to remediate
    - Open source web community is often faster than paid support
  - Cost effective
    - Possible to mix free and paid offerings fluidly

OSS and The Next Data Center

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- **If…**
  - the most mature eCommerce technologies are open source
- **And…**
  - Enterprise IT prefers open source platforms for deployment at scale
- **And…**
  - Private Clouds are the next platform for IT
- **Then…**
  - The On-premise Private Cloud will be built from Open Source

Happening Already?

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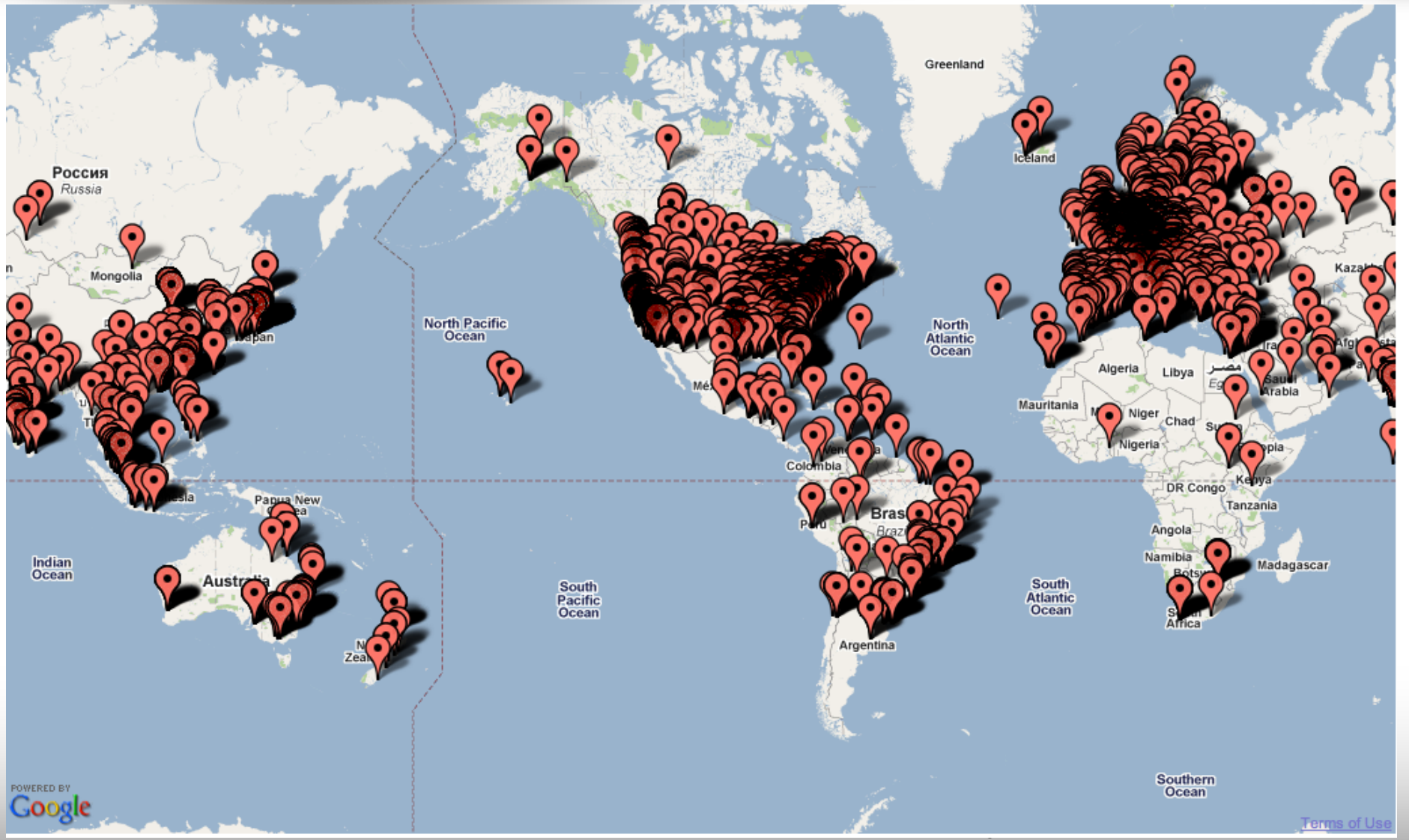

Thanks!

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- **Thanks to our original research sponsors…**

- **…and to our new commercial friends**

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