

Elastic Cloud Computing in the Open Cirrus Testbed implemented via Eucalyptus

International Symposium on Grid Computing 2009 (Taipei)

Christian Baun



Agenda

- Definiton of Cloud-Computing
- Clouds vs. Grids
- Types of Cloud Services
- The OpenCirrus™ project
- Hadoop
- Eucalyptus
- AppScale

- **Cloud Computing** is on-demand access to virtualized IT resources that are sourced inside or outside of a data center, scalable, shared by others, simple to use, paid for via subscription or as you go and accessible over the web.

Dr. Behrend Freese (Zimory GmbH)

- **Cloud Services** are the consumer and business products, services and solutions that are delivered and consumed in realtime over the internet.

IDC - Analyze the Future

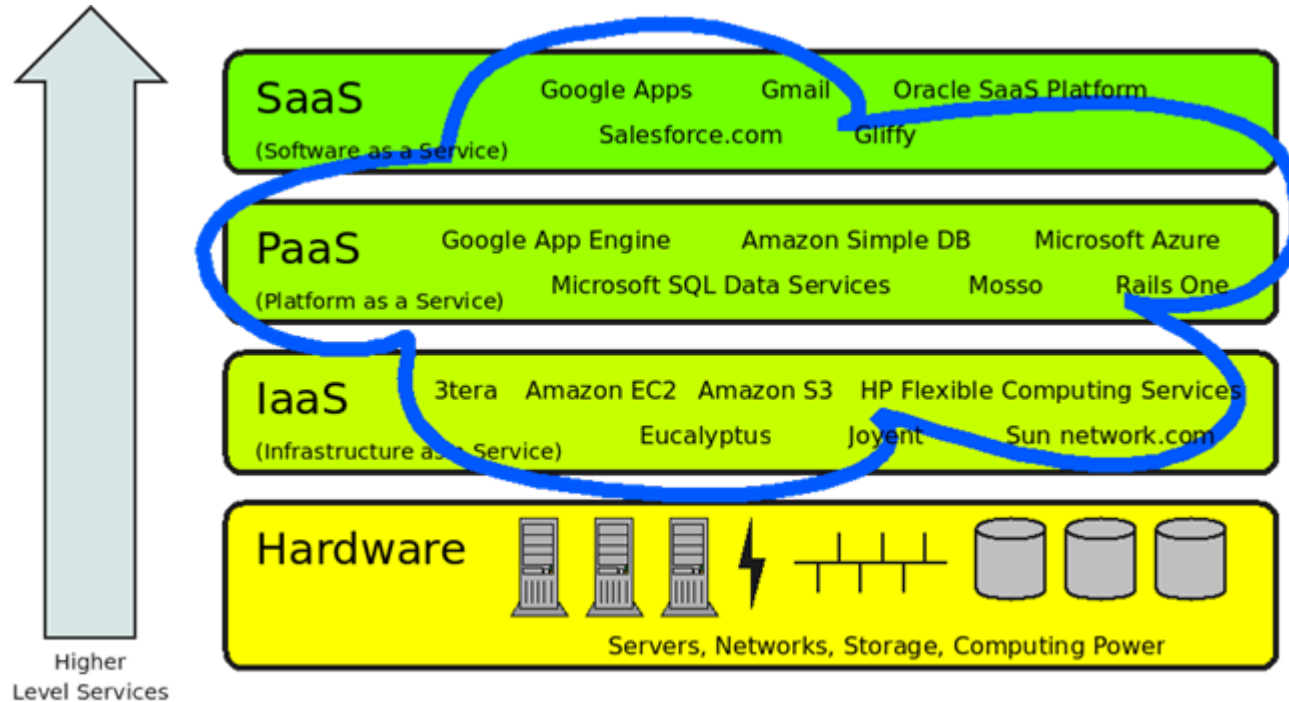
- A computing **Cloud** is a set of network enabled on demand IT services, scalable and QoS guaranteed, which could be accessed in a simple and pervasive way.

Dr. Marcel Kunze (SCC/KIT)

Clouds vs. Grids: A Comparison

	Cloud Computing	Grid Computing
Objective	Provide desired computing platform via network enabled services	Resource sharing Job execution
Infrastructure	One or few data centers, heterogeneous/homogeneous resource under central control, Industry and Business	Geographically distributed, heterogeneous resource, no central control, VO Research and academic organization
Application	Suited for generic applications	Special application domains like High Energy Physics
Business Model	Commercial: Pay-as-you-go	Publicly funded: Use for free
Middleware	Proprietary, several reference implementations exist (e.g. Amazon)	Well developed, maintained and documented
User interface	Easy to use/deploy, no complex user interface required	Difficult use and deployment Need new user interface, e.g., commands, APIs, SDKs, services ...
Operational Model	Industrialization of IT Fully automated Services	Mostly Manufacture Handcrafted Services
QoS	Possible	Little support
On-demand provisioning	Yes	No

Three Major Types of Cloud Services



- SaaS:
 - Provides enterprise quality software (complete applications)
- PaaS:
 - Appears as one single large computer and makes it simple to scale from a single server to many
 - No need to worry about the operating system or other foundational software
- IaaS:
 - Abstracts away the hardware (servers, network,...) and allows to run virtual instances of servers without ever touching a piece of the hardware



HP, Intel, Yahoo Join Government, Academia In Cloud Computing Research

Each of the founding members will host a cloud-computing infrastructure largely based on HP computers and Intel processors in six data centers.

By Antone Gonsalves, [InformationWeek](#)
July 29, 2008

URL: <http://www.informationweek.com/story/showArticle.jhtml?articleID=209800449>

Hewlett-Packard, Intel, and Yahoo on Tuesday said they have joined government and academia in launching a global, multi-data center test bed for experimentation and research in cloud computing, which many experts believe will be the dominant IT delivery model of the future.

The [initiative aims at building a computing network](#) comprised of six data centers spanning three continents. The idea is to have a large-scale [platform](#) for testing all technology -- hardware and [software](#) -- related to delivering application services over the Internet.

"This is a global collaboration that spans the industry, spans academia and government," Prith Banerjee, senior VP for research at HP, told reporters during a teleconference held by the three founding companies.

The other founders of the effort include the Infocomm Development Authority of Singapore, the University of Illinois at Urbana-Champaign, and the Karlsruhe Institute of Technology in Germany. The partnership with the University of Illinois also includes the National Science Foundation.

Each of the founding members will host a cloud-computing infrastructure largely based on HP computers and Intel processors. The [infrastructure](#) will include from 1,000 to 4,000 [processor](#) cores capable of supporting data-intensive research. The six facilities are up and running today in "bits and pieces" and are expected to be fully operational this year and accessible to researchers worldwide through a selection process.

OpenCirrus™ Cloud Computing Research Testbed

- An open, internet-scale global testbed for cloud computing research
 - Data center management & cloud services
 - Systems level research
 - Application level research
- Structure: a loose federation
 - Sponsors: HP Labs, Intel Research, Yahoo!
 - Partners: University of Illinois at Urbana-Champaign (UIUC), Singapore Infocomm Development Authority (IDA), KIT
- Great opportunity for cloud R&D
- <http://opencirrus.org>

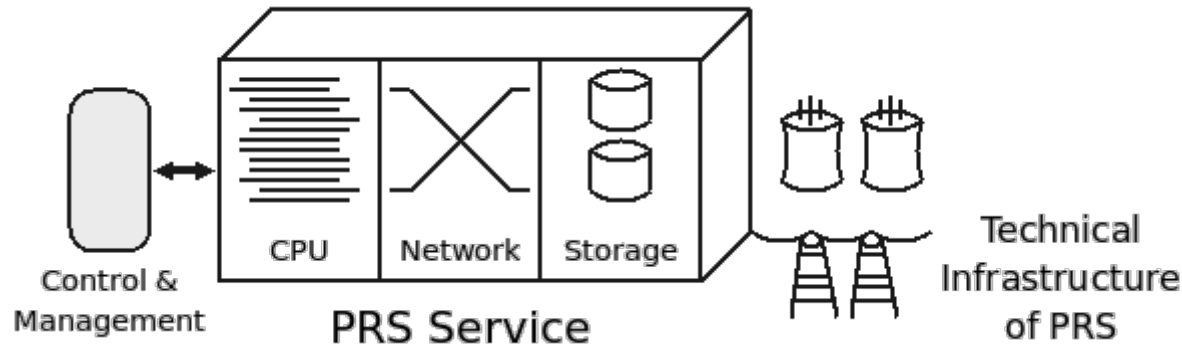


Where are the OpenCirrus™ sites?

- Six sites initially:
 - Sites distributed world-wide: HP Research, Yahoo!, UIUC, Intel Research Pittsburgh, KIT, Singapore IDA
 - 1000 - 4000 processor cores per site
- KIT-Site available in Summer 2009
 - 3300 Nehalem cores, 10TB memory, 192TB hard disk storage



OpenCirrus™ - Physical Resource Sets (PRS)



■ PRS service goals

- Provide mini-datacenters to researchers
- Isolate experiments from each other

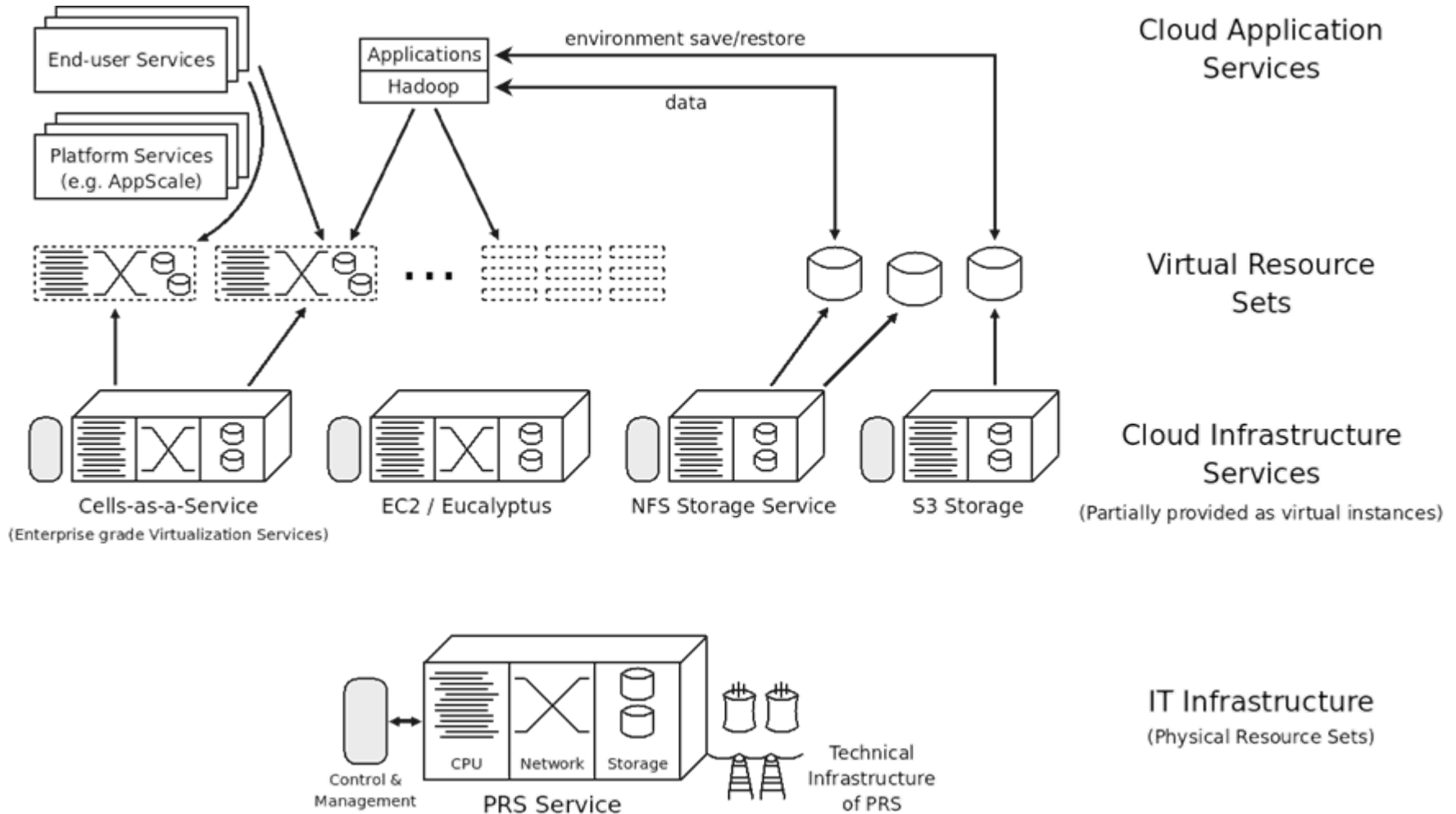
■ PRS service approach

- Allocate sets of physical co-located nodes, isolated inside VLANs using existing software
 - Utah Emulab - Network Emulation Testbed
 - HP Opware - Server provisioning, configuration and management
 - ...
- Start simple, add features as we go
- Basis to implement Virtual Resource Sets (VRS)

■ Hardware as a Service (HaaS)

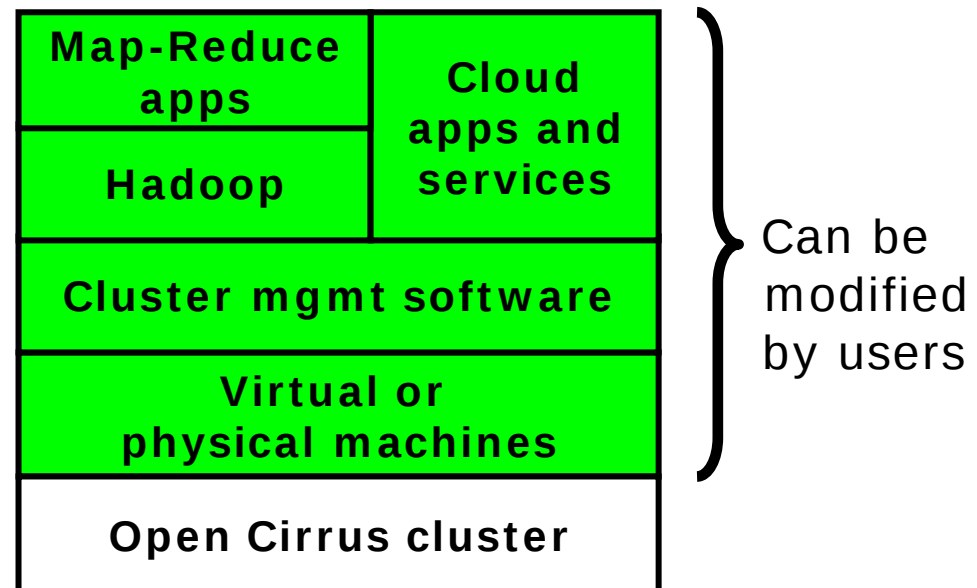
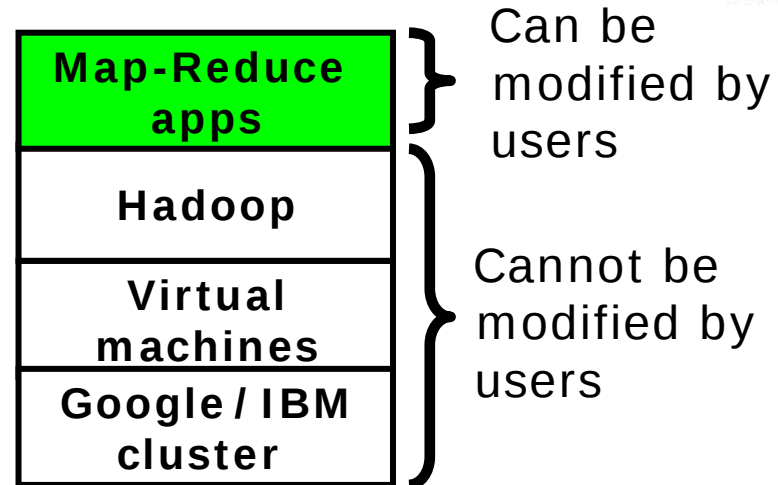
- Basic idea: Abstract from physical resources by the introduction of a virtualization layer
- Concept applies to all IT aspects: CPU, storage, networks and applications, ...
- Main advantages
 - Implement IT services **exactly** fitting customers varying needs
 - Deploy IT services on demand
 - Automated resource management
 - Easily guarantee service levels
 - Live migration of services
 - Reduce both: **Capital Expenditures** and **Operational Expenditures**
- Infrastructure as a Service (IaaS)
 - Implement Compute and Storage Services
 - De-facto standard: Amazon Web Services interface

OpenCirrus™ Blueprint



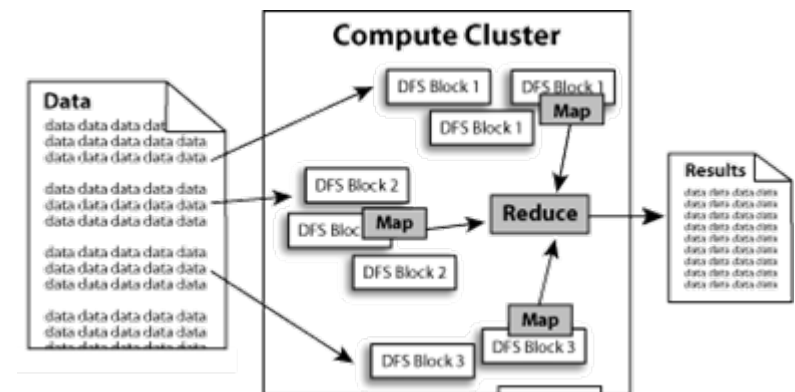
How is OpenCirrus™ different from other testbeds?

- OpenCirrus™ supports both system- and application-level research
 - n/a at Google/IBM and EC2/S3
 - OpenCirrus™ researchers will have complete access to the underlying hardware and software platform.
 - OpenCirrus™ allows Intel platform features that support Cloud computing to be exposed, and exploited. e.g. Intel Data Center Management Interface (DCMI)





- An open-source Java framework developed by the Apache Software Foundation and sponsored by Yahoo!
 - <http://wiki.apache.org/hadoop/ProjectDescription>
 - intent is to reproduce the proprietary software infrastructure developed by Google
- Provides a parallel programming model (MapReduce), a distributed file system (inspired by Google File System), and a parallel database
 - <http://code.google.com/edu/parallel/mapreduce-tutorial.html>
- MapReduce is a software framework that supports distributed computing on large data sets.
 - With MapReduce petabyte of data can be sorted in only a few hours



Commercial Cloud Offerings (Small Excerpt)



APPLIC | UTILITY COMPUTING | TECHNOLOGY | PARTNERS | GRID UNIVERSITY | COMPANY

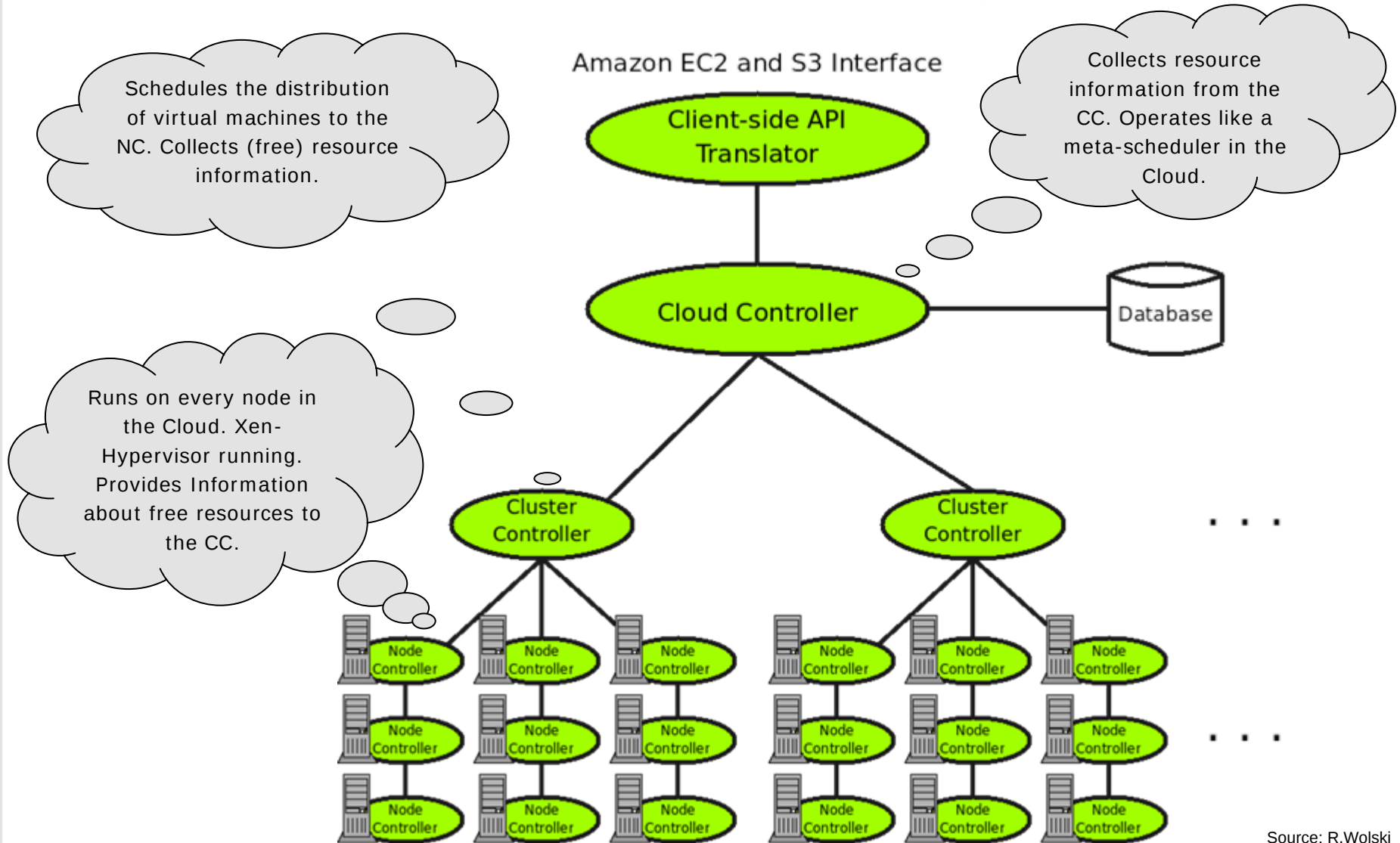
Cloud Computing

Cloudware - Cloud Computing Without Compromise



- Problem: Commercial offers are proprietary and usually not open for Cloud systems research and development!

- Open-Source software infrastructure for implementing Cloud computing on clusters from UC Santa Barbara
- EUCALYPTUS - Elastic Utility Computing Architecture for Linking Your Programs To Useful Systems
- Implements Infrastructure as a Service (IaaS) – gives the user the ability to run and control entire virtual machine instances (Xen, KVM) deployed across a variety of physical resources
- Interface compatible with Amazon EC2
- Includes Walrus, a basic implementation of Amazon S3 interface
- Potential to interact with the same tools, known to work with Amazon EC2 and S3
- Eucalyptus is an important step to establish an open Cloud computing infrastructure standard



Source: R.Wolski

■ R&D Cloud I

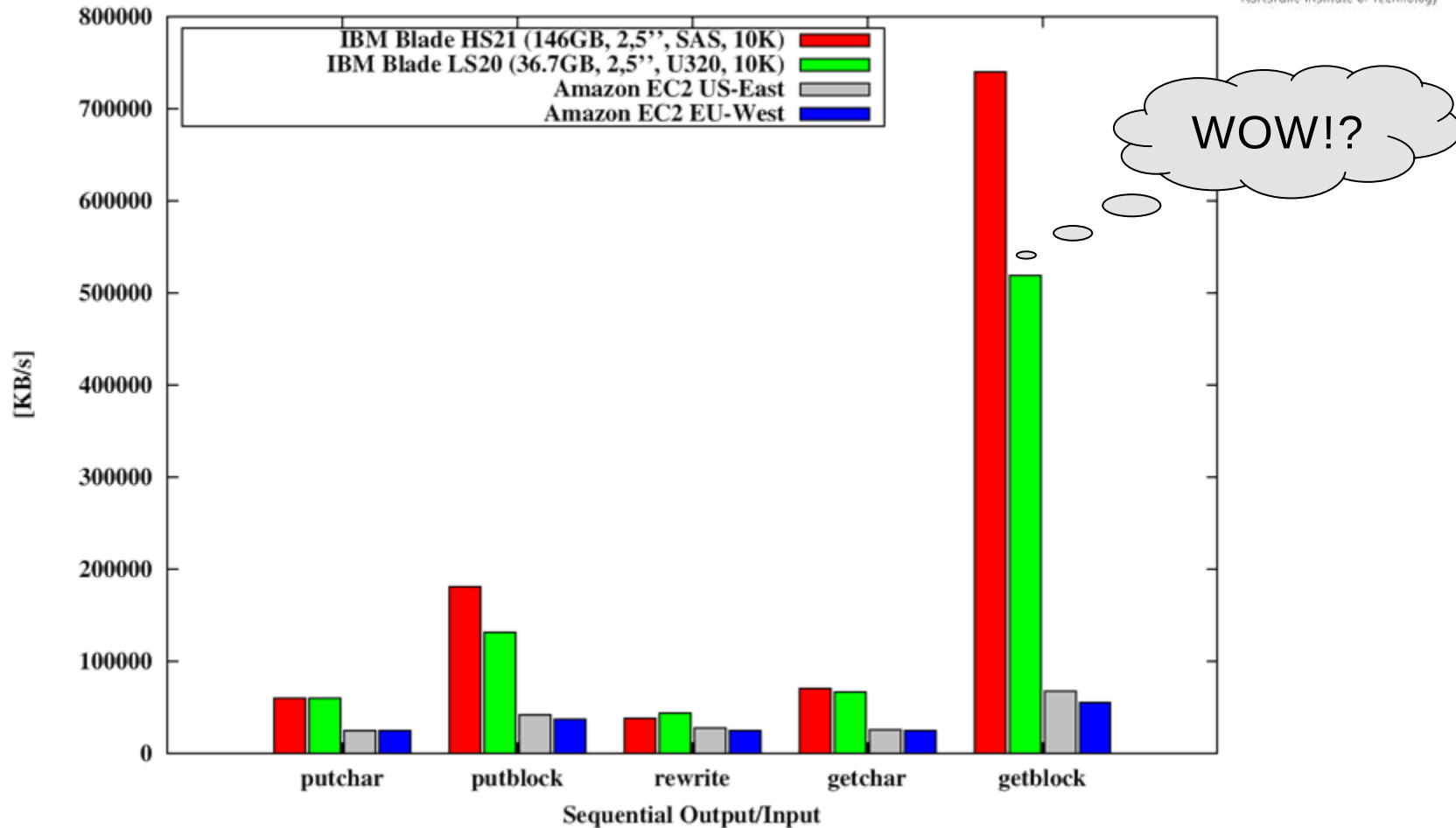
- 2x IBM Blade LS20
 - Dual Core Opteron (2,4GHz)
 - 4GB RAM
- 2x IBM Blade HS21
 - Dual Core Xeon (2,33GHz)
 - 16GB RAM

■ R&D Cloud II

- 5x HP Blade ProLiant BL2x220c
- Each Blade: 2 Server Nodes
 - 2x Intel Quad-Core Xeon (2,33GHz)
 - 16GB RAM

■ OpenCirrus site at KIT in summer 2009

Comparing Storage Performance between S3 and Eucalyptus



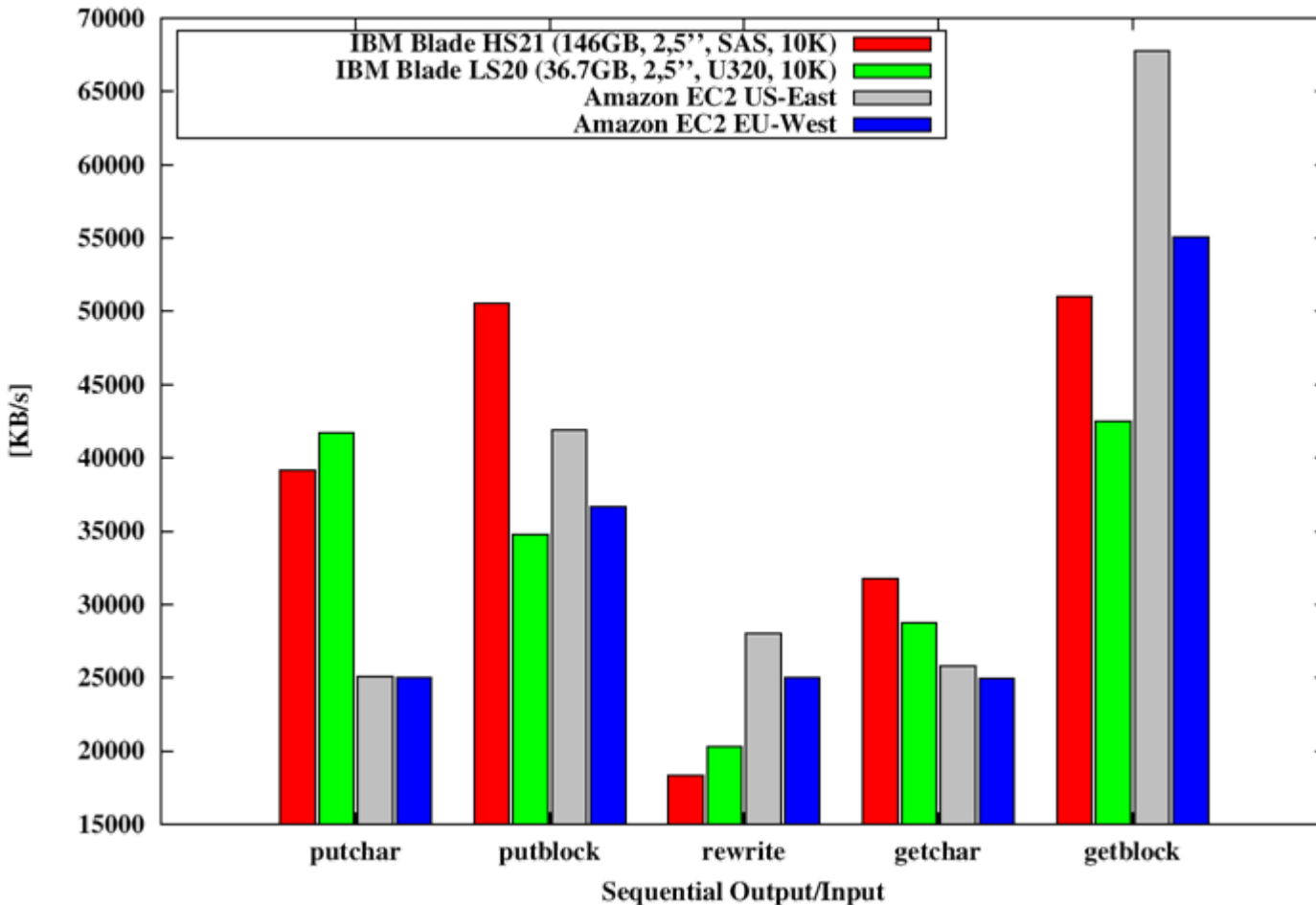
■ Sequential Output

- Per-Character: file is written using `putc()`
- Block: file is written using `write()`
- Rewrite: `read()` and `write()`

■ Sequential Input

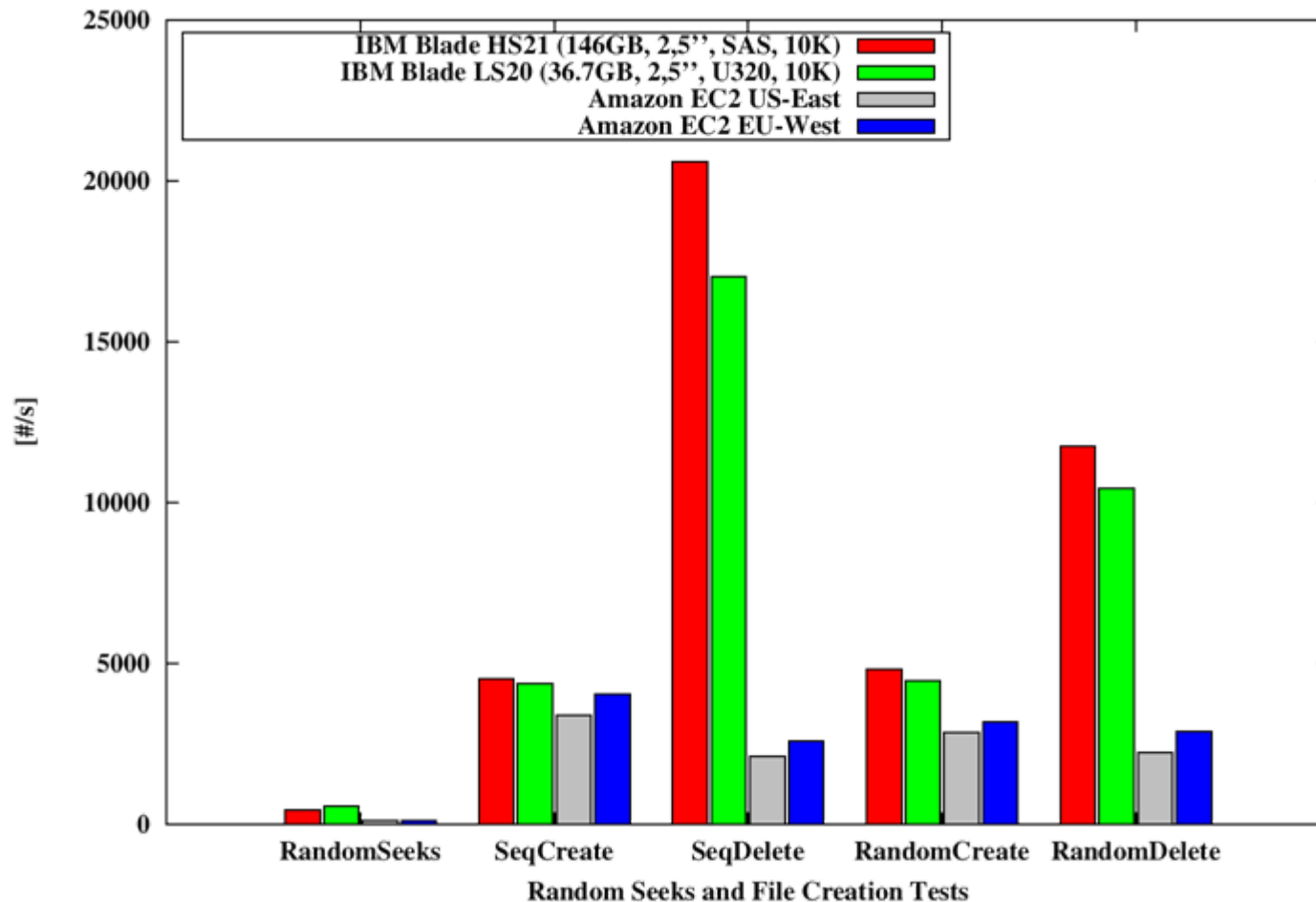
- Per-Character: file is read using `getc()`
- Blockwise: file is written using `read()`

Realistic values...



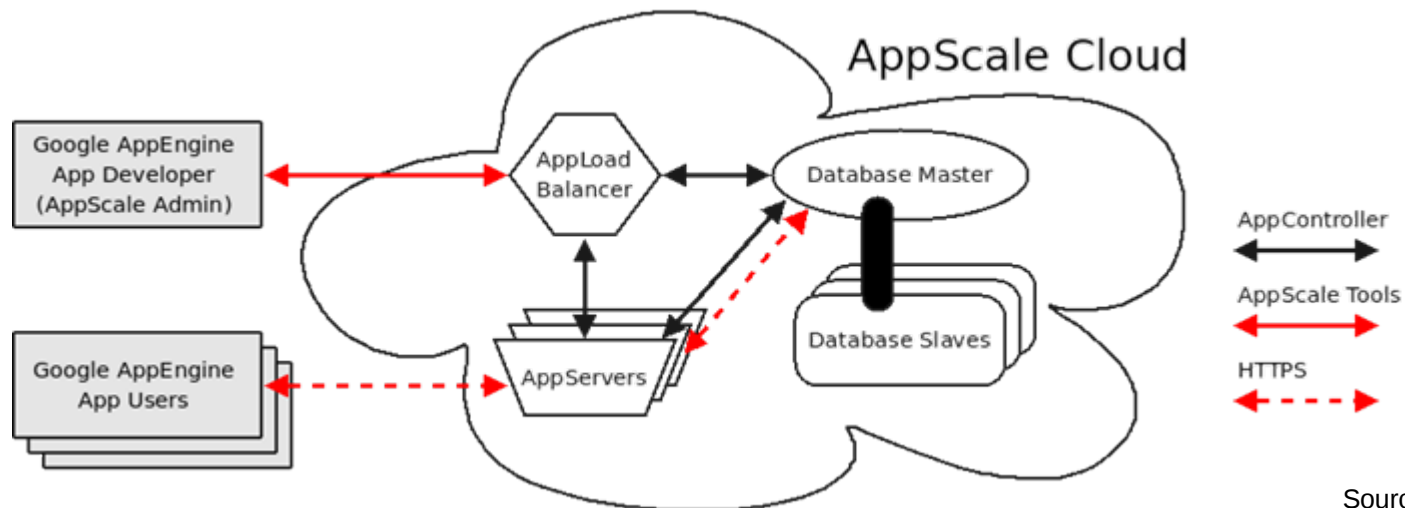
- The RAM of the Eucalyptus Node Controller was reduced to overcome memory caching
- The storage performance of Eucalyptus depends on the available storage sub-system
 - Write performance of Eucalyptus is faster. Because of the close distance?!

Performance of Random Seeks and File Creation



- Random seeks and file creation with Eucalyptus is faster
 - Because of the close distance?!

- Open-source implementation of the Google AppEngine Cloud computing interface from UC Santa Barbara
- AppScale executes automatically and transparently over Cloud infrastructures such as Eucalyptus, the open-source implementation of the Amazon Web Services interfaces
- AppScale provides a Platform-as-a-Service (PaaS) Cloud infrastructure that allows users to deploy, test, debug, measure, and monitor Google AppEngine applications prior to deployment on Google's proprietary resources



Source: Navraj Chohan

■ CernVM

- Integration of CernVM
- Virtual Software Appliance from CERN
- Offers demand-driven and user friendly creation of virtual machines for various operating systems and applications



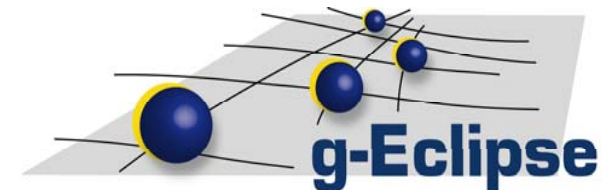
■ Improvements in Usability

- Customization of popular EC2/S3 tools for using with Eucalyptus
- e.g. ElasticFox, S3Fox, ElasticDrive, S3tools...

■ Transferring Grid services into the Cloud

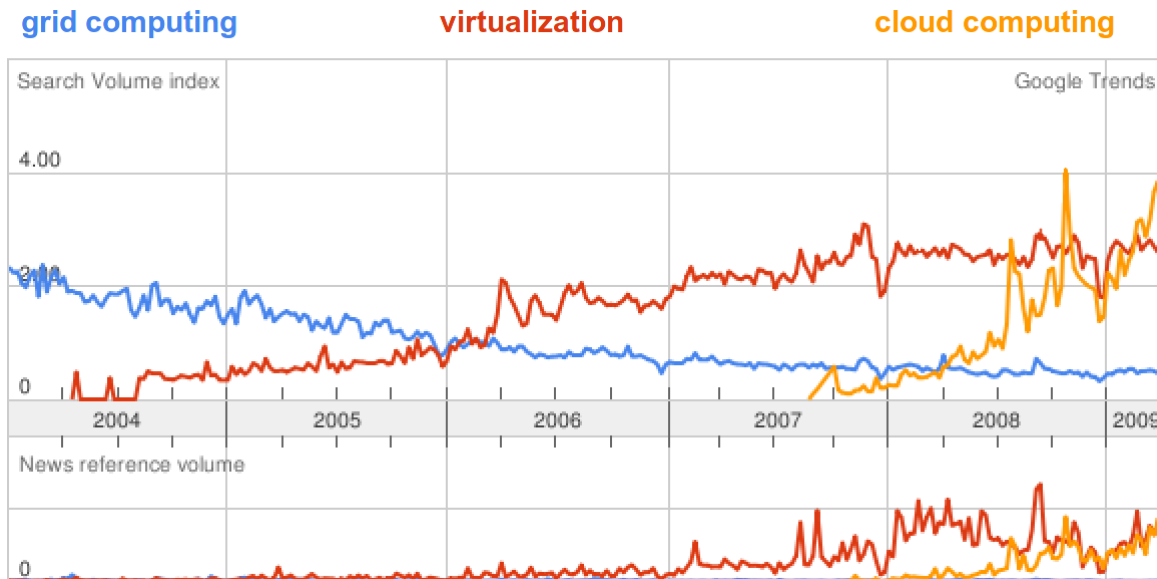
■ g-Eclipse

- User-friendly graphical client for dealing with Grids: gLite, GRIA, GT2, GT4
- Supports Cloud Infrastructures (S3, EC2)
- Has to be adapted for Eucalyptus
- <http://www.geclipse.eu>



Summary

- Cloud computing is the next big thing
 - Flexible and elastic resource provisioning
 - Economy of scale makes it attractive
 - Move from manufacture towards industrialization of IT
 - (Everything as a Service)
- OpenCirrus™ offers interesting R&D opportunities
 - Cloud systems and application development
 - Accepting research proposals soon



Thank you for your attention

