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Grilles vs Clouds, *évolution ou révolution ?*

Thierry Priol

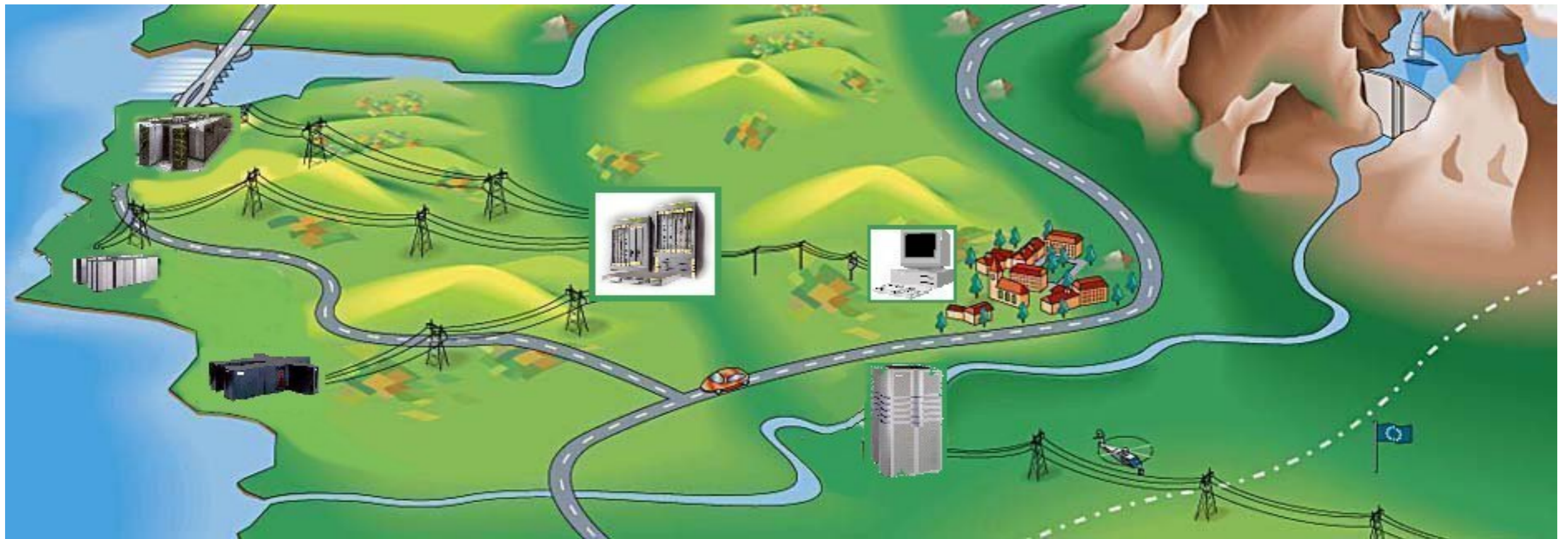
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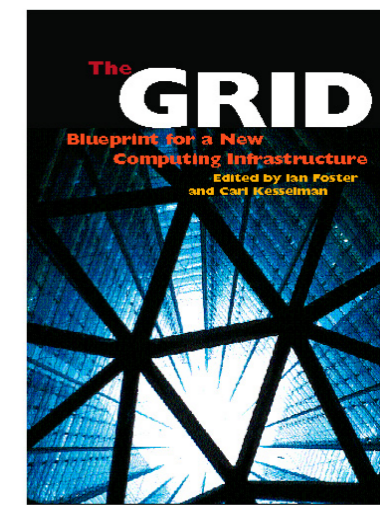


Computing as a Utility

first suggested by John McCarthy in 1961 !

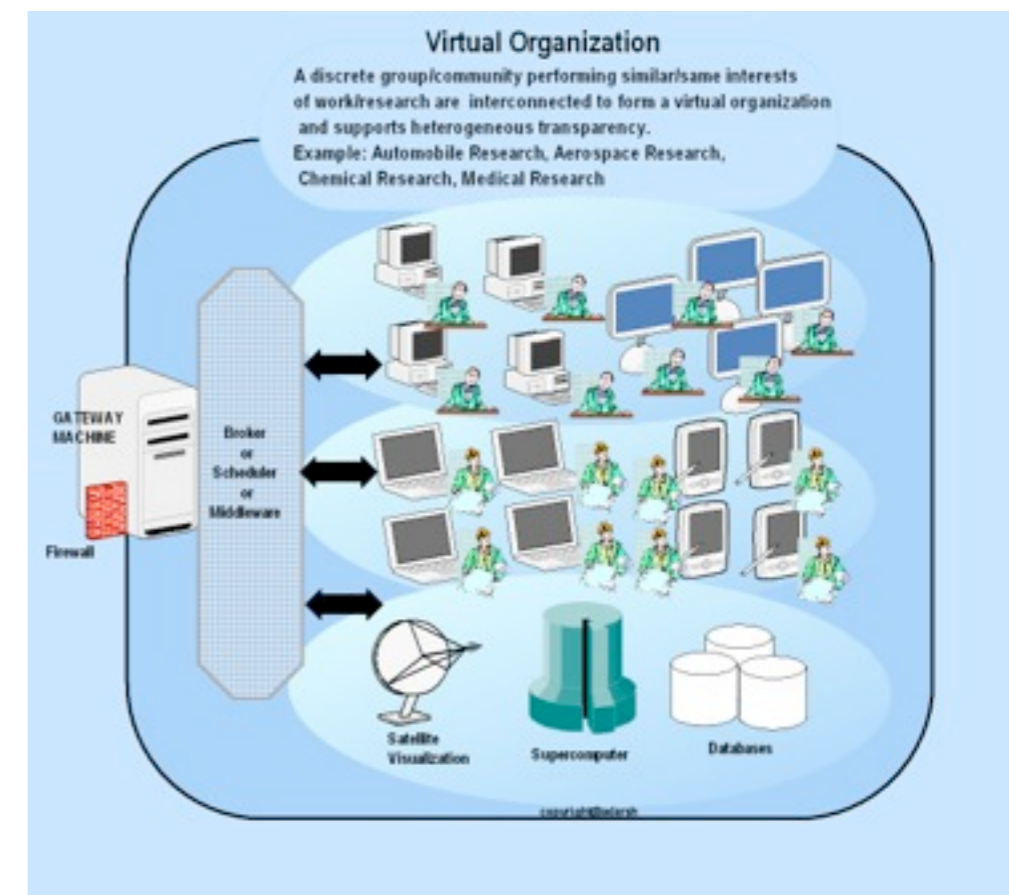
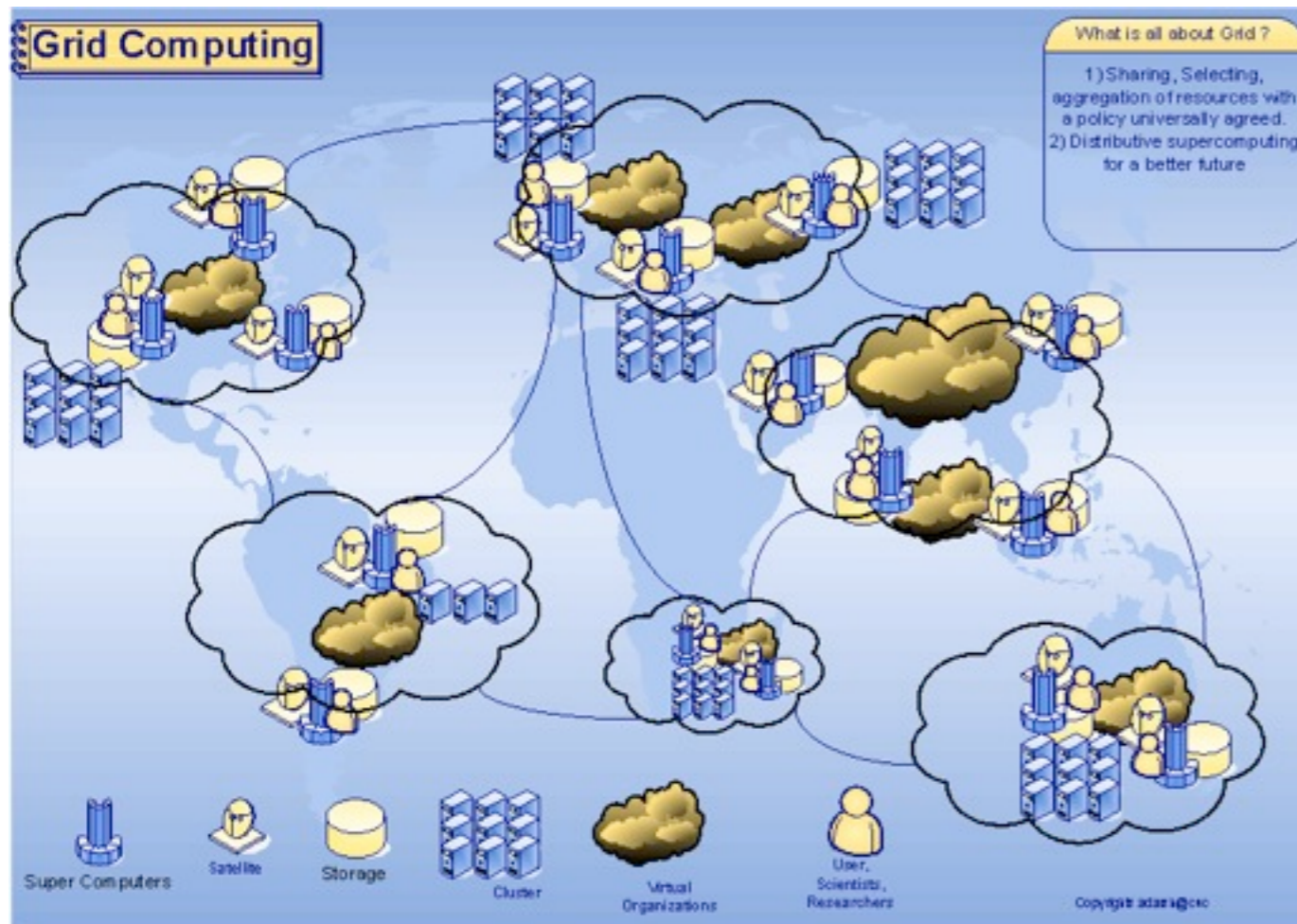


It is much cheaper to «rent» a computing infrastructure than building, operating and owning it !



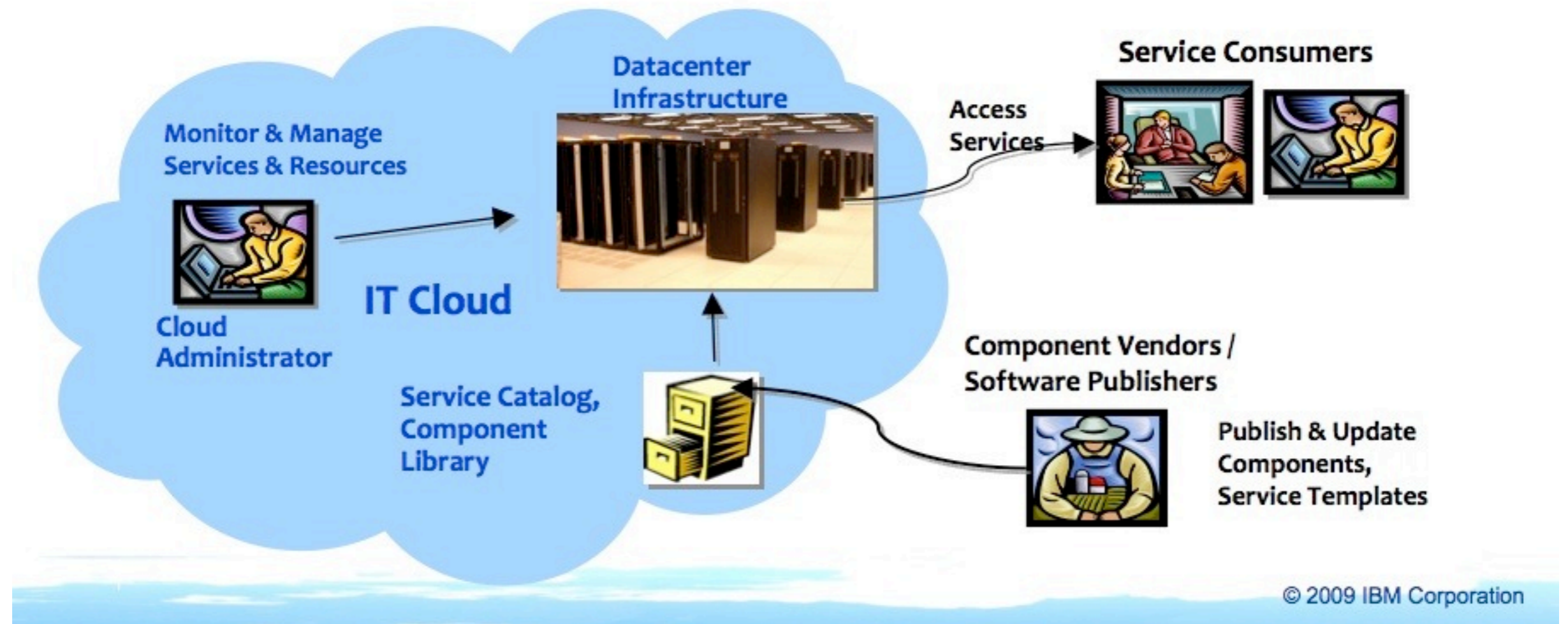
Grid computing

- What is Grid ?
 - «A fully distributed, dynamically reconfigurable, scalable and autonomous infrastructure to provide location independent, pervasive, reliable, secure and efficient access to a coordinated set of services encapsulating and virtualizing resources (computing power, storage, instruments, data, etc.) in order to generate knowledge...» from the CoreGRID NoE



Cloud computing

- What is Cloud ?
 - *An emerging computing paradigm where applications, data and infrastructures are provided as a service that can be ubiquitously accessed from any connected devices over the internet.*



What is behind Cloud



Google cluster 1997



Google Servers today



36 data centers containing > 800K servers

- Datacenters as the reincarnation of the mainframe concept
- The end of the PC/Mac era ?
 - just a web browser is needed
 - «The network is the computer», «thin client», ...

Datacenters : easy to build !

- Based on the LEGO concept - a datacenter in shipping containers



- You do not even need a building, just gather these building blocks together on a parking lot and plug them to the Internet and to the power grid and that's it !
- Energy / Green-IT issues
 - In 25 years from now, Internet will consume the same quantity of energy than the humans today
 - Humans have to be ready to fight against computers to get access to the energy...

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Datacenters : easy to build !

- If local laws matter... Google has a patent for this !



- Just set up offshore datacenter vessels out of territorial seas...

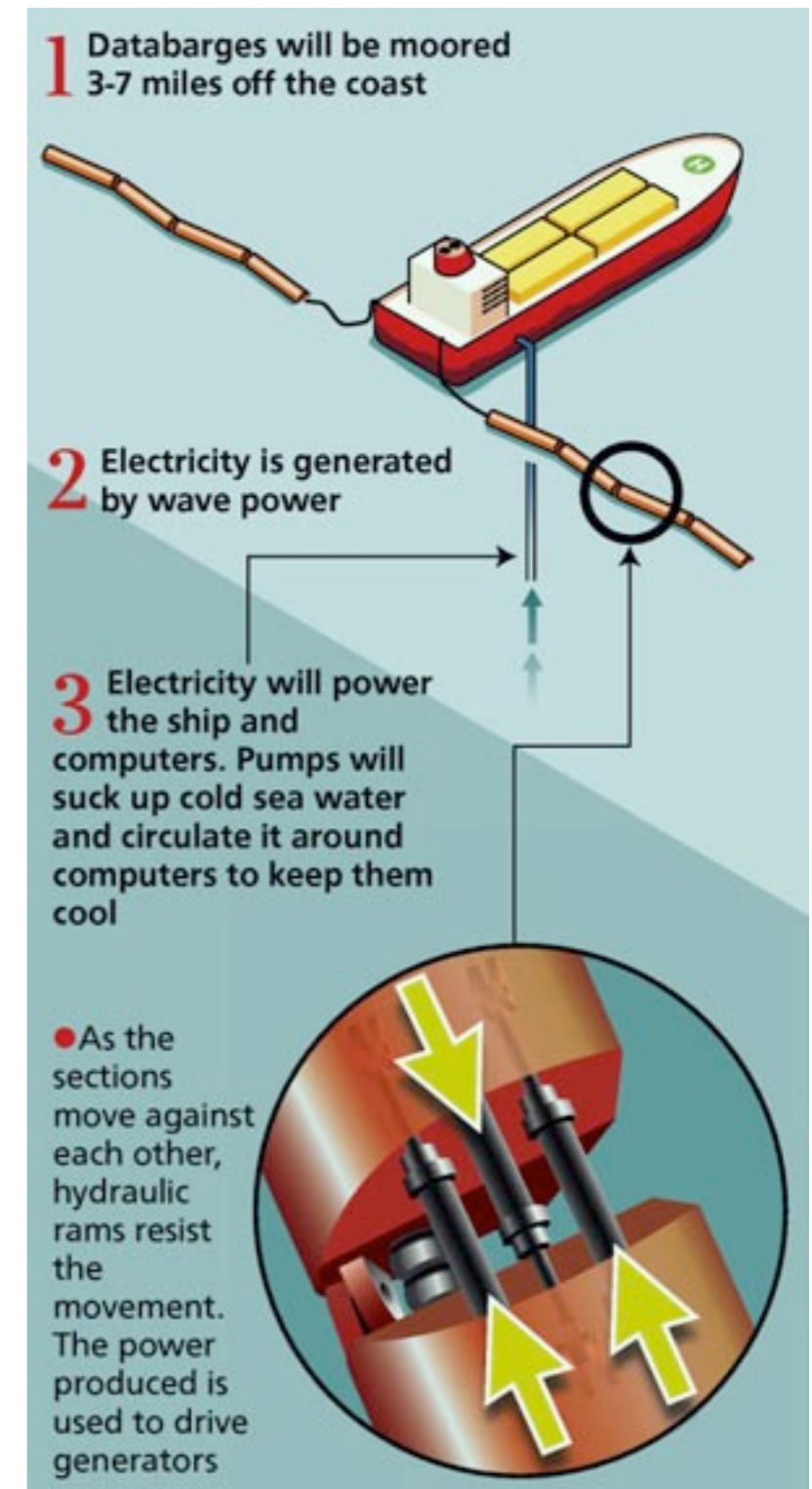


Image:

Why Cloud now and not before ?

- Internet !
 - Network performance has been improved dramatically the last 15 years
 - Nearly always connected to the Internet (anytime, anywhere)
- PC is not anymore the central device for personal computing
 - MP3, SmartPhone, Tablets, Set-top box, PCs, ...
- How to get access to my personal data anywhere/anytime and from any devices ?
- Cost
 - Oversized systems to meet peak demand (both in the private and public sector)
 - Outsourcing (labor cost is much higher that computing cost)

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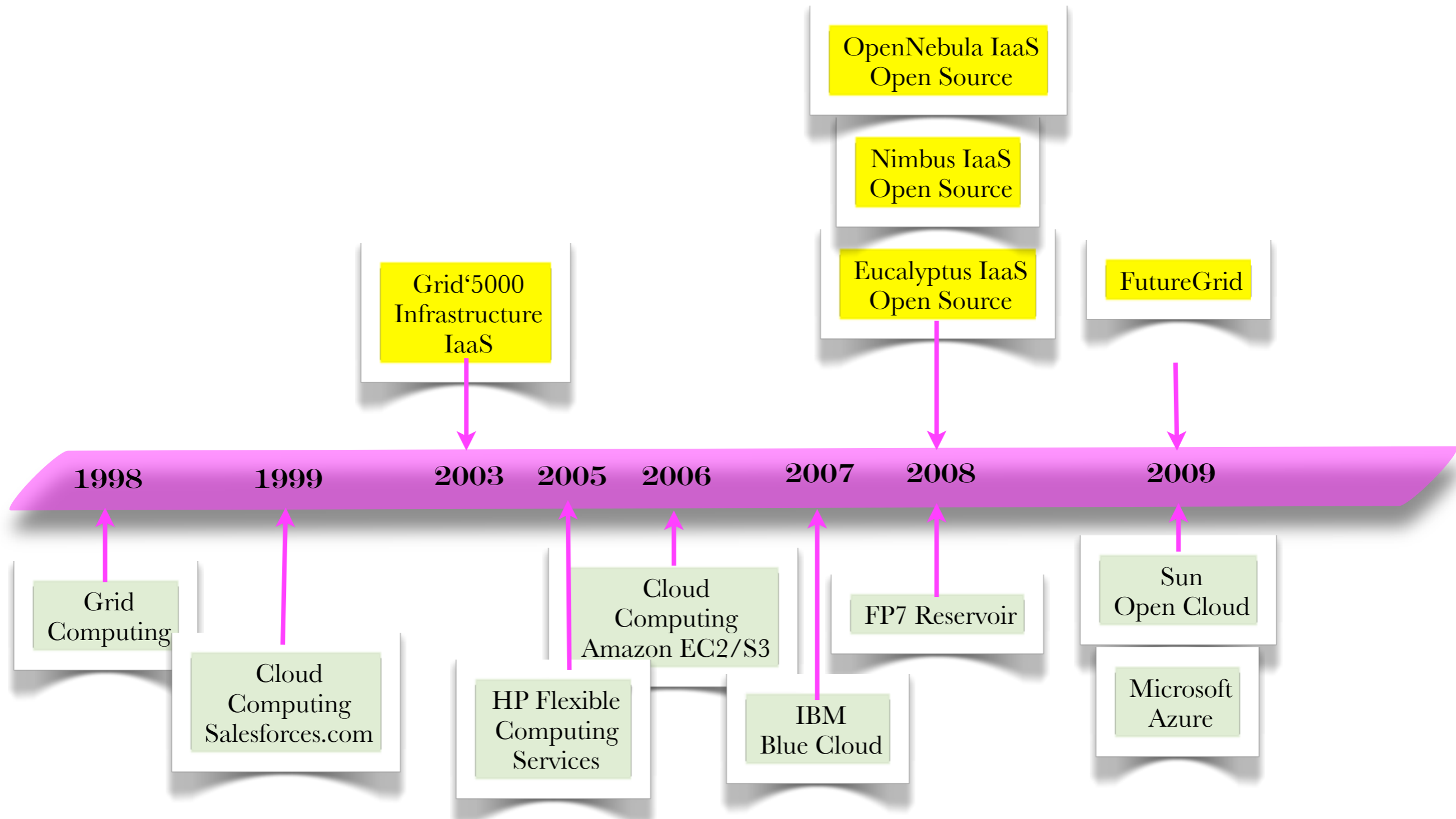


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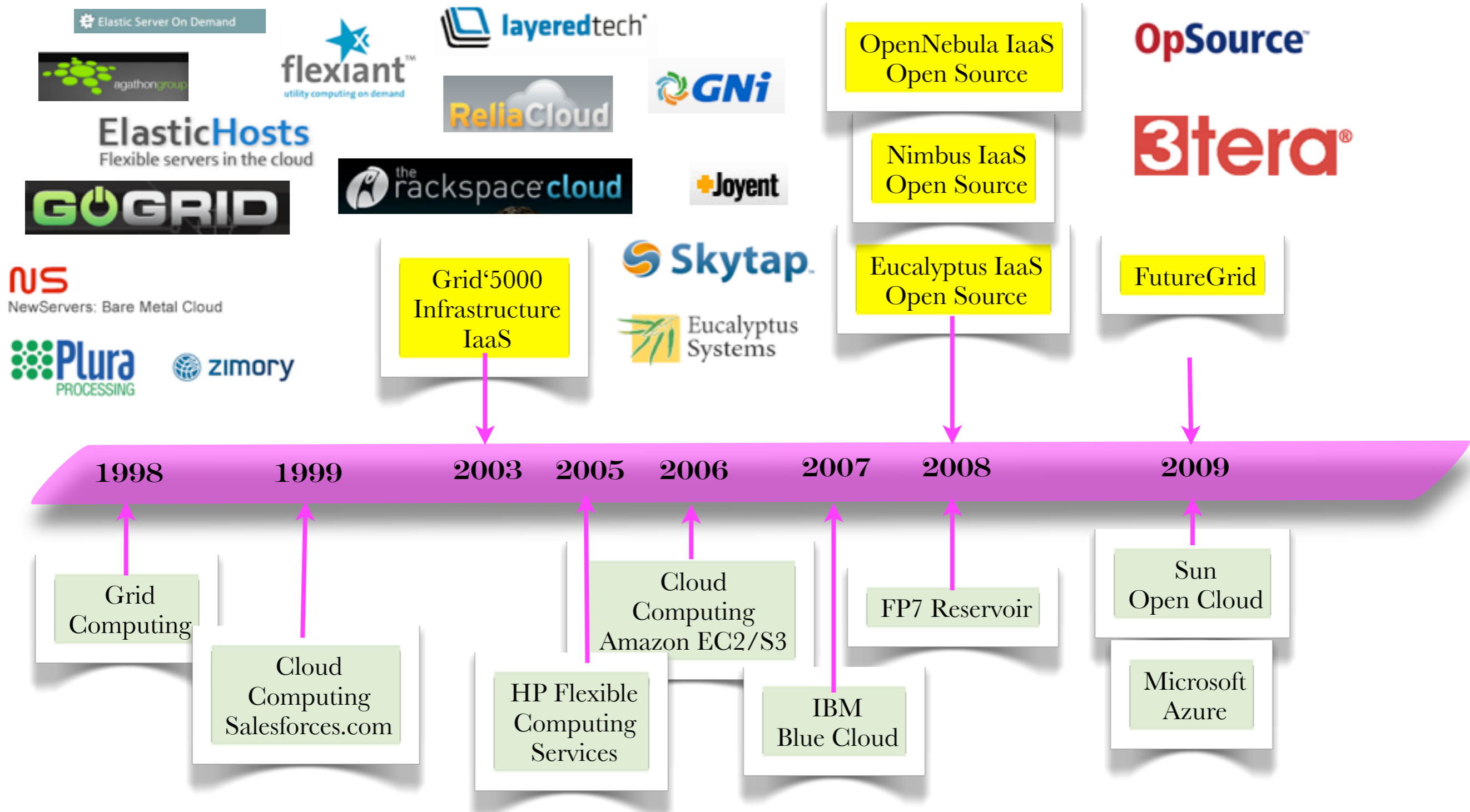
Why Cloud now and not before ?

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Computing as a utility : a brief history



Computing as a utility : a brief history



Cloud Acronyms

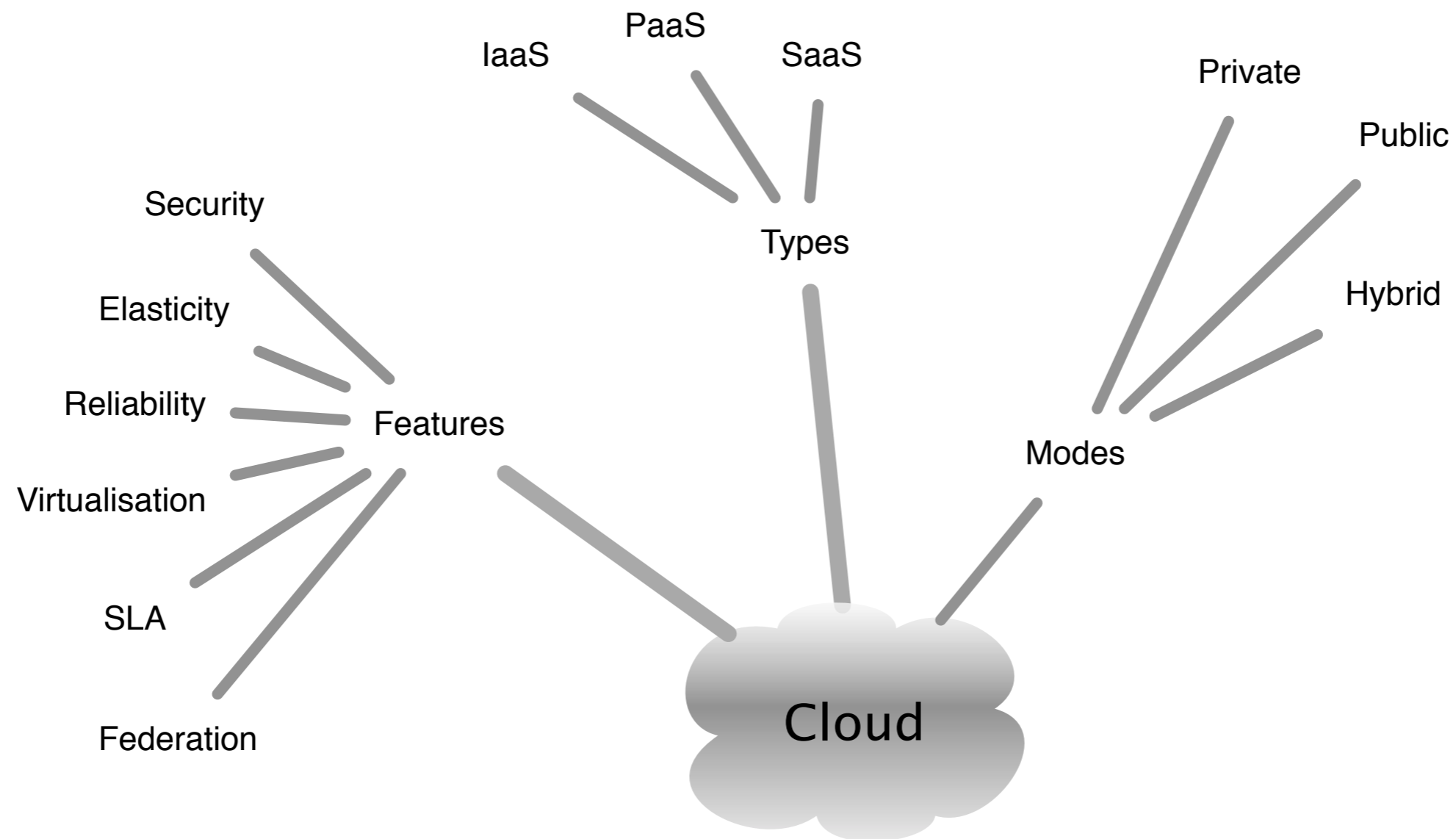
- PaaS - Platform/People as a Service
- SaaS - Software/Search as a Service
- IaaS - Infrastructure as a Service
- DaaS - Data as a Service
- CaaS - (composition/communication /composite) as a Service
- HaaS - Human as a Service ...
just your shared agenda ;-)
- KaaS - Knowledge as a Service
- ...

- AaaS/XaaS - Anything as a Service or X to replace any letter...



IT'S A
JUNGLE OUT
THERE!

Cloud: how to escape from the jungle



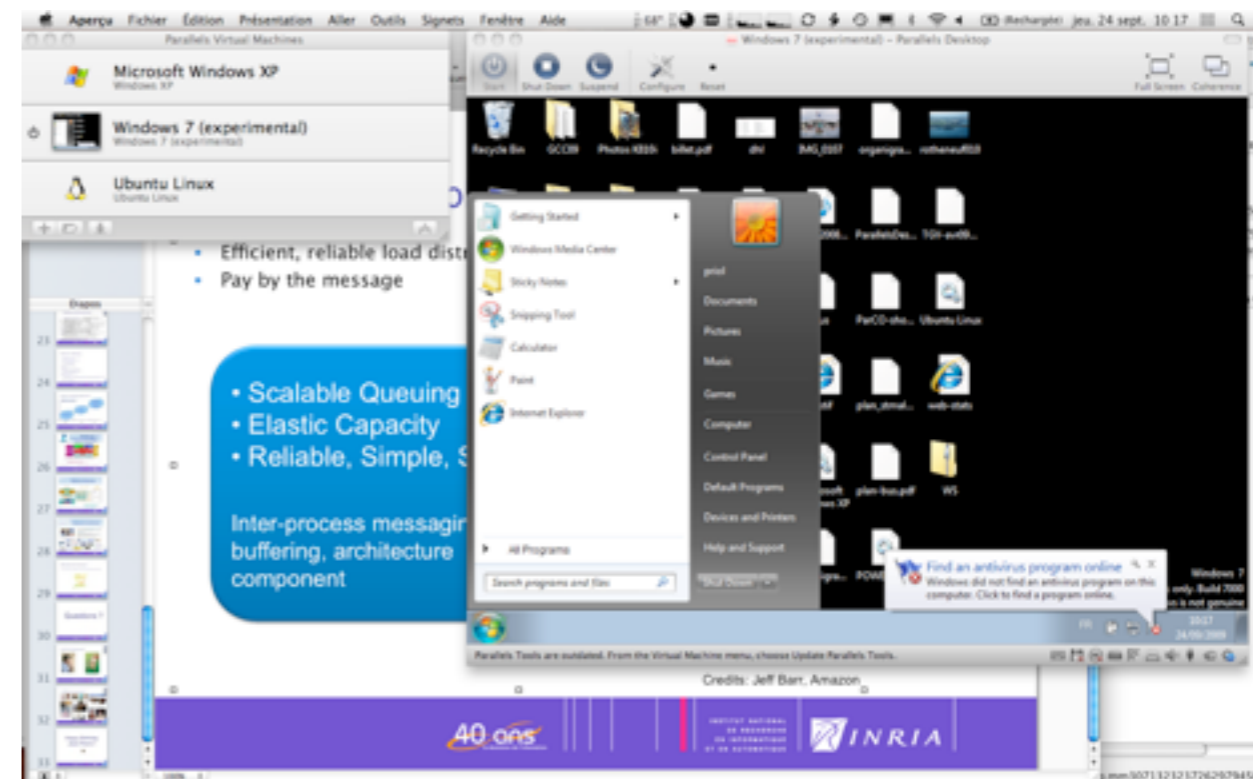
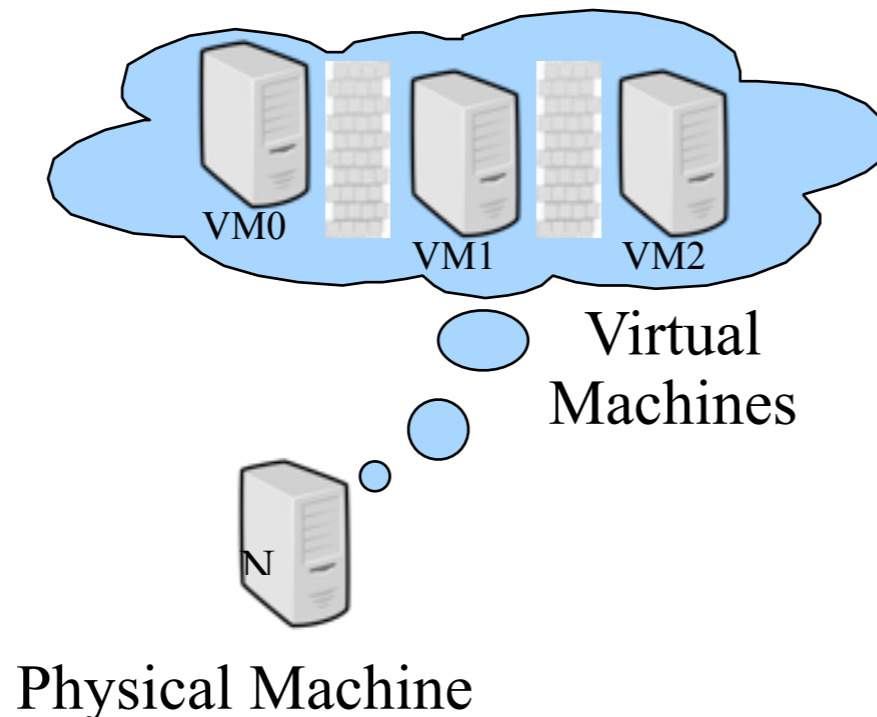
<http://cordis.europa.eu/fp7/ict/ssai/docs/cloud-report-final.pdf>

Infrastructure as a Service

- Get access on demand to a large number of highly virtualized resources
 - Dynamicity, elasticity
- Concept of OS Virtualization
 - OS does not matter anymore !
 - OS are just software libraries and does not play a central role!
 - Concept of virtual machines to host instances of OS
 - Physical resources are shared by several virtual machines

Properties:

- Isolation
- VM portability
- Suspend/restart



Let's take an example... Amazon !

COMPUTE

Provides on-demand processing
Virtual machine images
pay per server hour

Elastic Compute
Cloud Service



MESSAGING

Efficient, reliable comm. layer
Pay by the message

Simple Queue Service



STORAGE

Virtually infinite storage capacity
Objects from 1 byte to 5 gigabytes of data each
pay per GB-month

Simple Storage
Service



to create storage volumes
from 1 GB to 1 TB
pay per GB-month

Database service

highly available, scalable, and flexible
non-relational data store
pay per hour



Amazon Pricing - 2010

US – N. Virginia	US – N. California	EU – Ireland
Standard On-Demand Instances		
	Linux/UNIX Usage	Windows Usage
Small (Default)	\$0.085 per hour	\$0.12 per hour
Large	\$0.34 per hour	\$0.48 per hour
Extra Large	\$0.68 per hour	\$0.96 per hour
High-Memory On-Demand Instances		
	Linux/UNIX Usage	Windows Usage
Extra Large	\$0.50 per hour	\$0.62 per hour
Double Extra Large	\$1.20 per hour	\$1.44 per hour
Quadruple Extra Large	\$2.40 per hour	\$2.88 per hour
High-CPU On-Demand Instances		
	Linux/UNIX Usage	Windows Usage
Medium	\$0.17 per hour	\$0.29 per hour
Extra Large	\$0.68 per hour	\$1.16 per hour

* Data Transfer In will be \$0.10 per GB after June 30, 2010.

There is no Data Transfer charge between Amazon EC2 and other Amazon Web Services within the same region (i.e. between Amazon EC2 US West and Amazon S3 in US West). Data transferred between Amazon EC2 instances located in different Availability Zones in the same Region will be charged Regional Data Transfer. Data transferred between AWS services in different regions will be charged as Internet Data Transfer on both sides of the transfer.

Data Transfer In	
All Data Transfer	Free through June 30, 2010*

Data Transfer Out	
First 10 TB per Month	\$0.15 per GB
Next 40 TB per Month	\$0.11 per GB
Next 100TB per Month	\$0.09 per GB
Over 150 TB per Month	\$0.08 per GB

Amazon Pricing - 2010

US – N. Virginia

US – N. California

EU – Ireland

Amazon EBS Volumes

- \$0.10 per GB-month of provisioned storage
- \$0.10 per 1 million I/O requests

Amazon EBS Snapshots to Amazon S3 (priced the same as Amazon S3)

- \$0.15 per GB-month of data stored
- \$0.01 per 1,000 PUT requests (when saving a snapshot)
- \$0.01 per 10,000 GET requests (when loading a snapshot)

US – N. Virginia

US – N. California

EU – Ireland

Amazon EC2 Monitoring

- \$0.015 per instance-hour (or partial hour)

US – N. Virginia

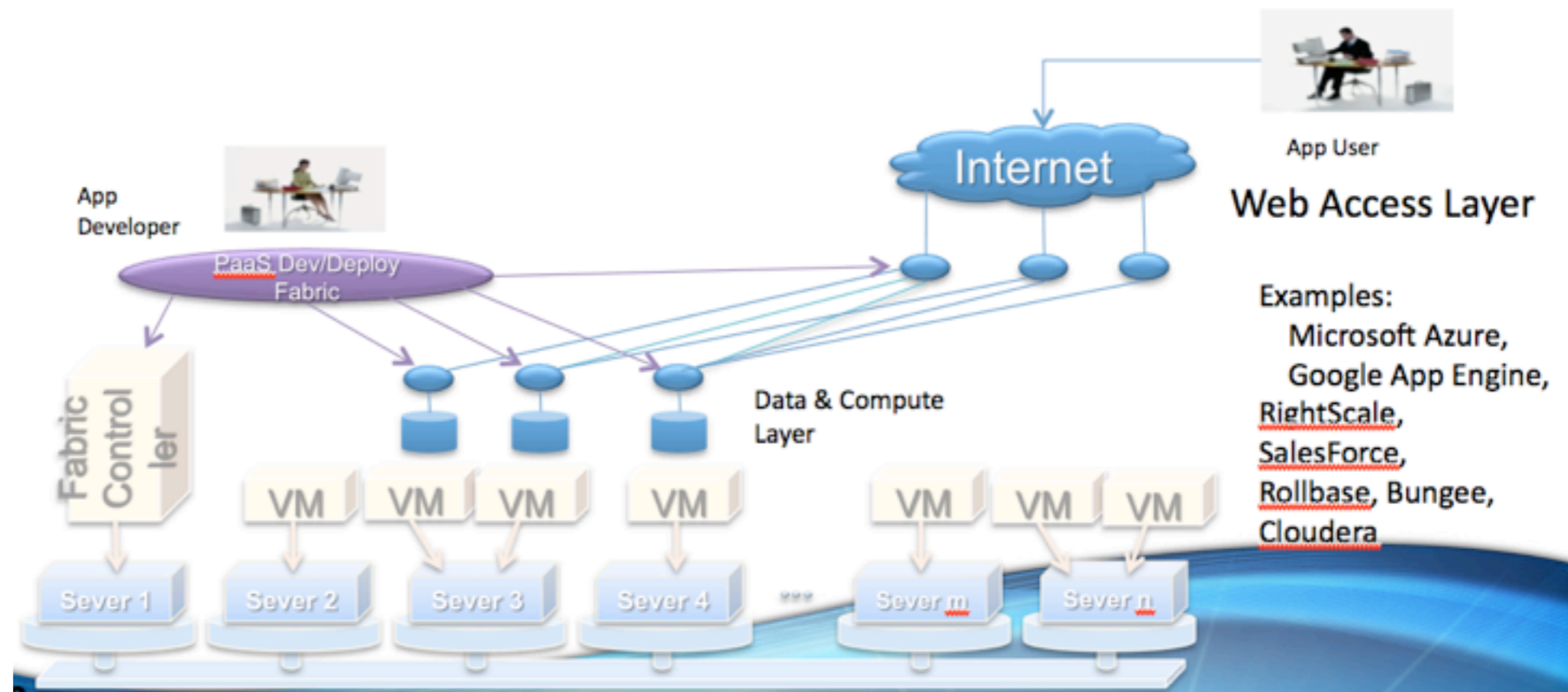
US – N. California

EU – Ireland

- \$0.025 per Elastic Load Balancer-hour (or partial hour)
- \$0.008 per GB of data processed by an Elastic Load Balancer

Platform as a Service

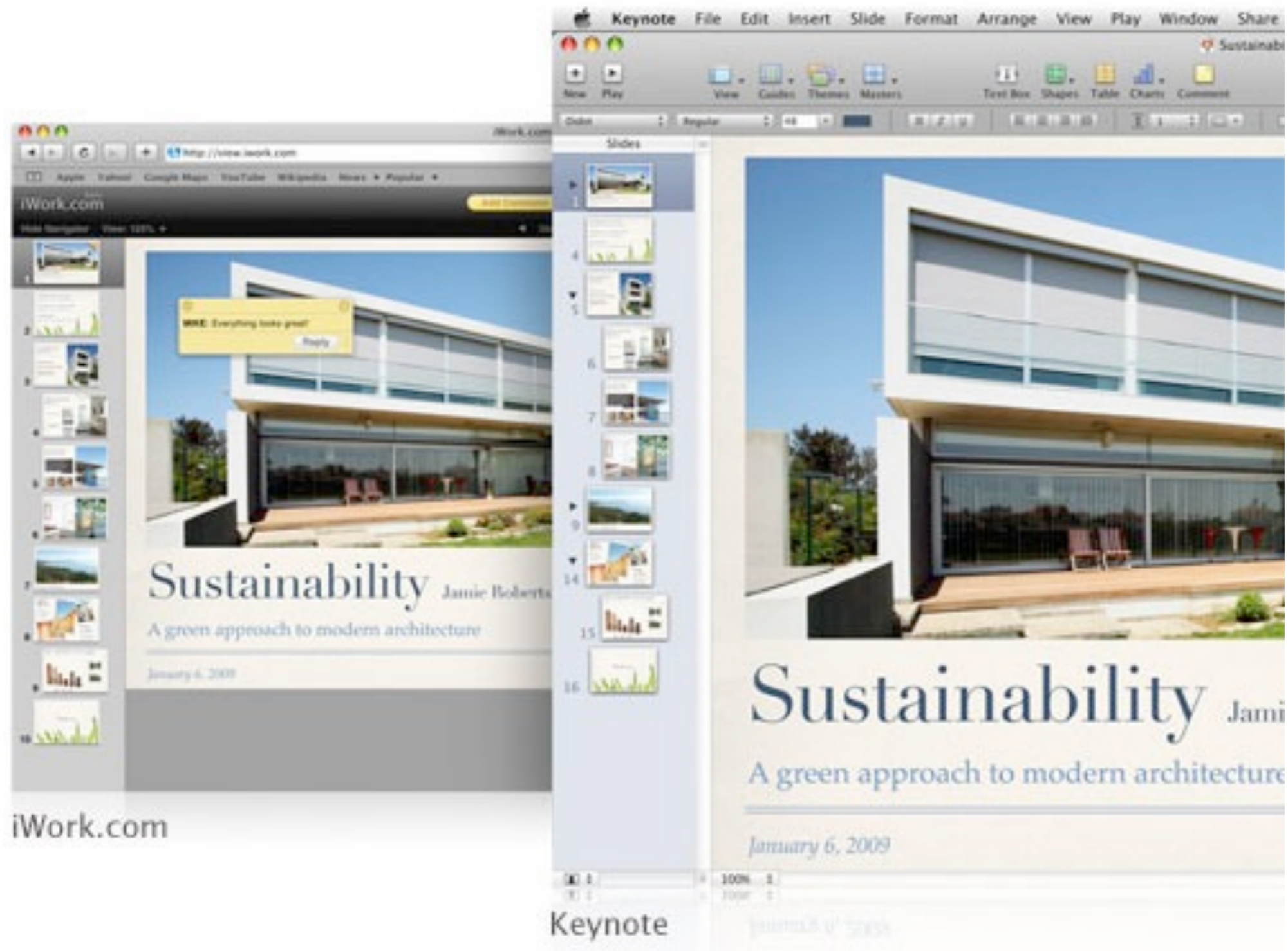
- An application development, deployment and management fabric.
- User programs web service front end and computational & Data Services
- Framework manages deployment and scale out
- No need to manage VM images



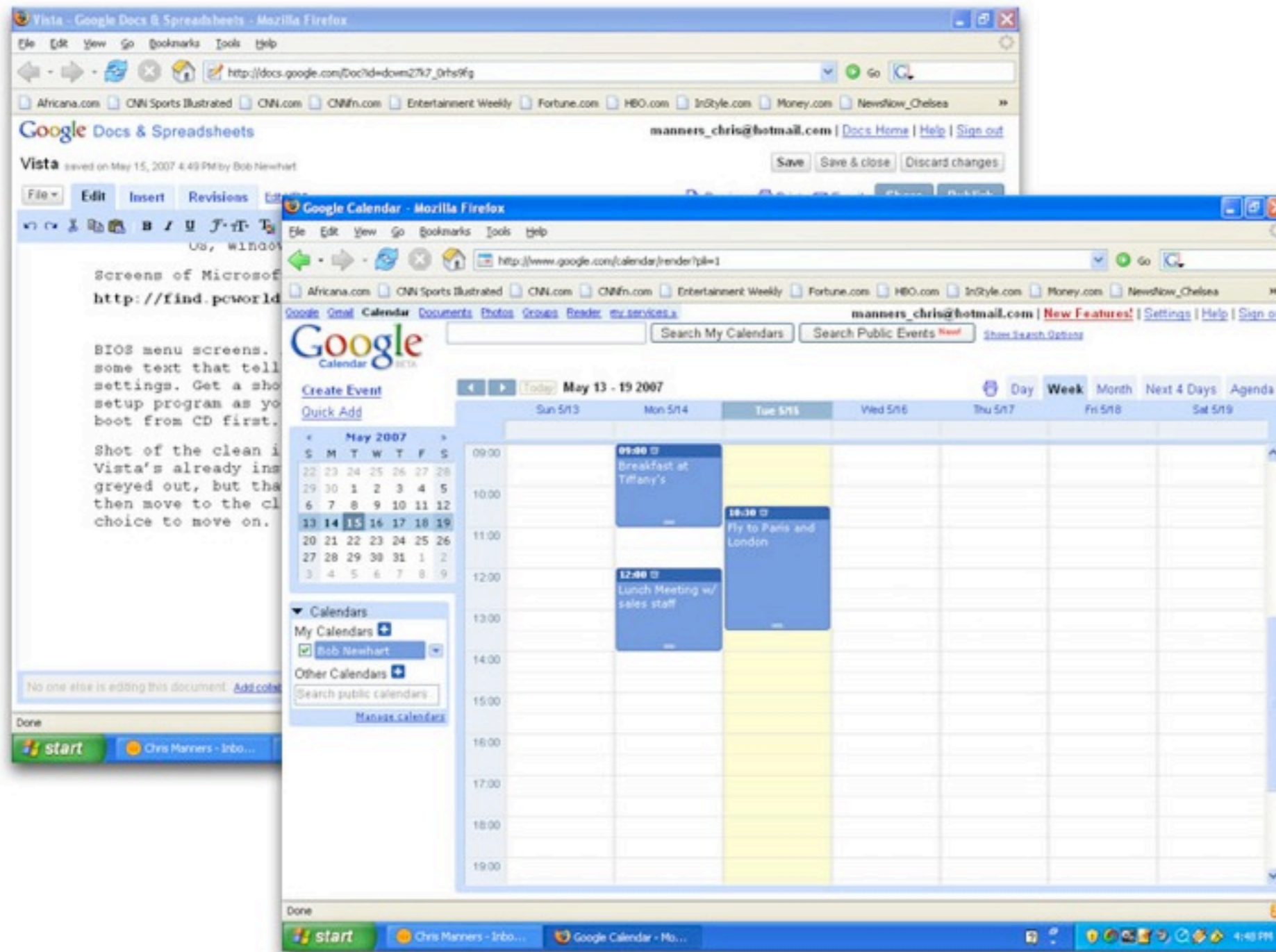
(c)

Software as a Service

Software as a Service



Software as a Service



Software as a Service

The screenshot displays a web browser window with a Microsoft Excel Web App. The address bar shows the file path: Contoso > ... Research Folder > LA Location Analysis Origina.xlsx. The user is identified as Frank Martinez. The ribbon includes Home, Insert, and View tabs. The active sheet is 'Sheet 1'.

The spreadsheet content includes a title 'Location Analysis' and a list of locations in Los Angeles with various attributes. The data is as follows:

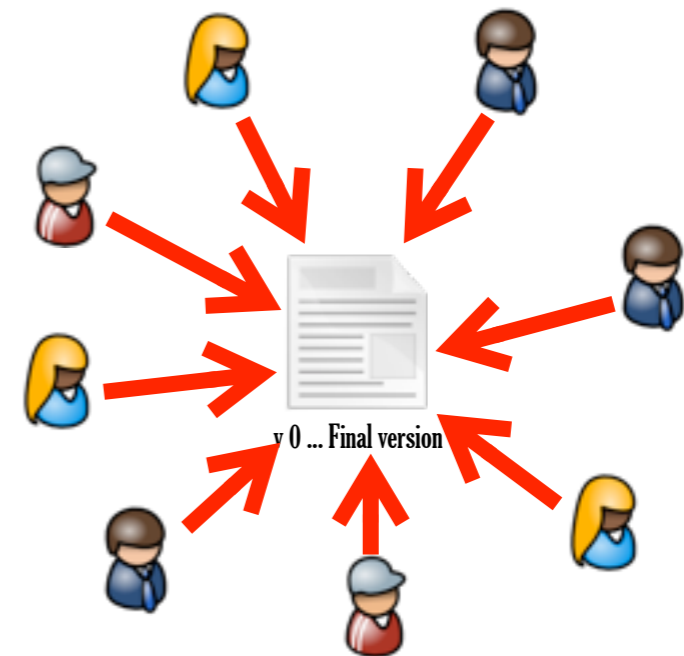
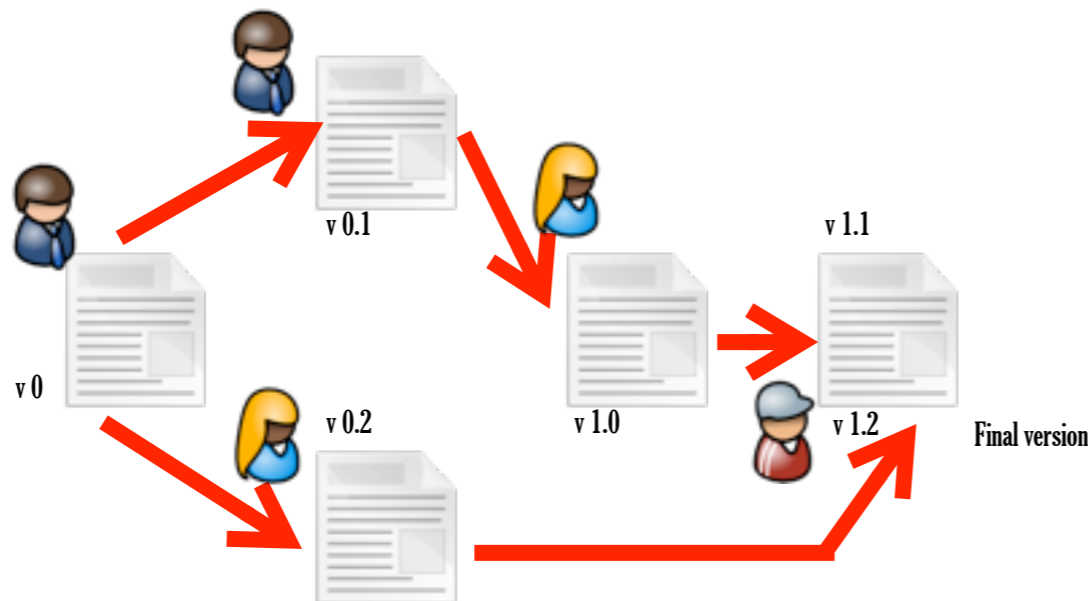
Location	Score	Price	Support	Nat. Light	Sq. Ft.	Staff	Distance	Pow	Noise (db)	Contact	Comment
LACMA	1	\$ 12,000.00	Excellent	<input type="radio"/>	6000	3	3.8	1500	32.8	Joe	
LA Coliseum	194	\$ 12,000.00	Excellent	<input type="radio"/>	18000	2	3.57	1500	35.1	Chris	
LACC	183	\$ 12,000.00	Very Good	<input type="radio"/>	30000	2	5	1500	47.2	Dan	
Caltech	266	\$ 10,000.00	Excellent	<input type="radio"/>	60000	4	3	1500	26.7	Manpratap	
LA Forum	188	\$ 9,000.00	Good	<input checked="" type="radio"/>	9000	1	3	1400	28.8	Joe	
Central Market	181	\$ 8,000.00	Good	<input checked="" type="radio"/>	3500	1	3	1200	25.8	Steve	
Olvera Street	157	\$ 5,000.00	Very Good	<input type="radio"/>	2500	2	6.56	1000	45.1	Eran	
Philippe's	121	\$ 5,000.00	Very Good	<input type="radio"/>	1800	1	4.8	1200	48.8	Chris	
Garment District	137	\$ 2,000.00	Good	<input checked="" type="radio"/>	3000	0	5	800	52.6	Manpratap	
Union Station	223	\$ 1,000.00	Good	<input checked="" type="radio"/>	15000	2	2.1	1200	26.8	Dan	

What are the benefits of a SaaS approach

- Avoid managing/installing/deploying new software / patches / update



- Facilitating collaboration between users
 - No more versions to be merged with potential incoherencies



We have only seen the virtuous side !



What is the dark side of Cloud Computing ?

We have only seen the virtuous side !



What is the dark side of Cloud Computing ?

Some research issues with Cloud Computing

- Reliability / Resilience / Fault-tolerance
- Trust, Security and Privacy
- New economical models for computing
- Service Level Agreement / Quality of Service - *From Best Effort to SLA*
- Building cloud-aware applications from legacy applications
- Energy management
- Data management
- Cloud federation
- Autonomic behaviors / Self-*
- Brokering / Scheduling
- Programming models (MapReduce, ...)
- Interactions between legal aspects (laws) and computer science
 - privacy and liability

Reliability / Resilience / Fault-tolerance



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Reliability / Resilience / Fault-tolerance



The screenshot shows a CNET News article from December 21, 2005. The article is titled "Salesforce outage angers customers" and is written by Alorie Gilbert. It reports on a major outage of Salesforce.com that occurred on Tuesday, December 20, 2005. The article mentions that the outage lasted nearly a day and affected many of the company's customers, cutting off access to critical business data. It also includes quotes from Charlie Crystle, CEO of Mission Research, and Bruce Francis, a Salesforce spokesman, regarding the impact and cause of the outage.

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December 21, 2005 2:11 PM PST

Salesforce outage angers customers

By Alorie Gilbert
Staff Writer, CNET News

17 comments

Related Stories

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December 12, 2005
- Salesforce.com to launch software marketplace
September 12, 2005
- Salesforce CEO: Deal is a thumbs-up for on-demand
September 12, 2005
- Salesforce.com's new gamble
July 26, 2005
- Will computing flow like electricity?
June 17, 2005

A Salesforce.com outage lasting nearly a day cut off access to critical business data for many of the company's customers on Tuesday in what appears to be Salesforce's most severe service disruption to date.

Salesforce stores customer information for thousands of businesses, delivering data "on-demand" via the Web. The lack of that data interfered with some customers' sales and customer service activities on a critical pre-holiday business day.

"This is not just an inconvenience. We're losing sales," said Charlie Crystle, CEO of Mission Research, a software company in Lancaster, Pa. "It's a busy time of the year."

Bruce Francis, a Salesforce spokesman, said he doesn't know how many of Salesforce's 18,700 customers were affected by the outage, which began at about 6:30 a.m. PST. The cause was a faulty database, which was repaired by about 2 p.m., he said.

"We apologize to any customer who was inconvenienced by this," Francis said. "We take that very, very seriously."

Reliability / Resilience / Fault-tolerance



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**TROUVEZ LAQUELLE EST
COMPATIBLE AVEC VOTRE PC**
Economique, prix direct fabricant

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Lightning strikes Amazon cloud (honest)
The dangers of sky-high computing
By **Cade Metz** • [Get more from this author](#)
Posted in [Servers](#), 12th June 2009 19:38 GMT
[Free whitepaper – Get application aware with your Cisco network devices](#)

Amazon's cloud was struck by lightning earlier this week. And that's the truth.

On Wednesday evening at about 6:30pm Pacific time, some Amazon cloud sitters saw their floating servers disappear - and yes, the company blamed the temporary outage on a lightning strike.

Reliability / Resilience / Fault-tolerance

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The New York Times
Thursday, September 24, 2009

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Bits


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February 24, 2009, 9:47 AM

Four Hours Without Gmail

By SAUL HANSELL

Update | 7:21 p.m. Modified to include Google's explanation of the cause of the failure.

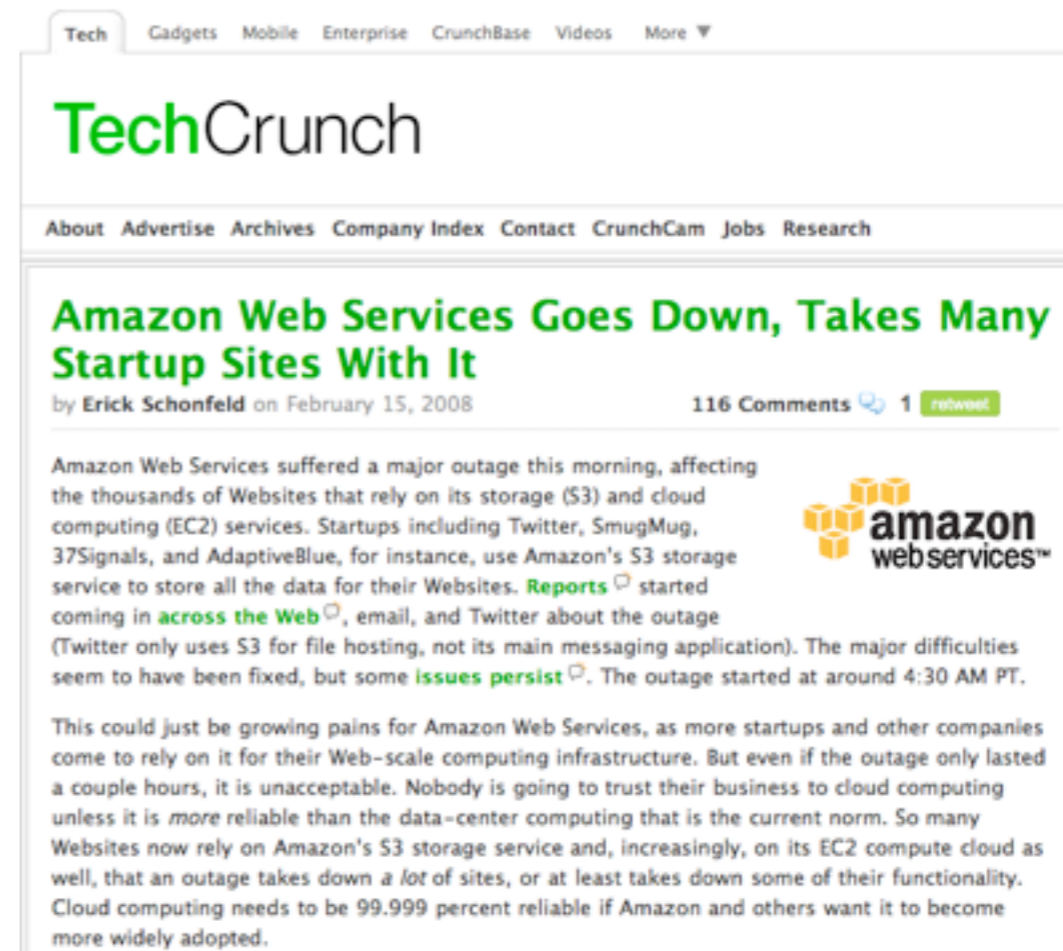


Google's Gmail service froze Tuesday at 9:30 a.m. London time, leaving millions of users in Europe without access to e-mail for four prime working hours. (The service was also out for after-work e-mailers in Asia and night owls in the Americas.)

Tuesday evening, Google posted an [explanation](#) of the problem on its blog. It appears to be the digital equivalent of the rolling blackouts that happen when some minor glitch at a power plant short-circuits the power grid for half the country. In this case, Google shut down one data center for a software update, which overburdened other data centers that were supposed to cover for it.

This morning, there was a routine maintenance event in one of our European data centers. This typically causes no disruption because accounts are simply served out of

Reliability / Resilience / Fault-tolerance



The screenshot shows a TechCrunch article from February 15, 2008, by Erick Schonfeld. The article discusses a major outage of Amazon Web Services (AWS) that affected thousands of websites, including startups like Twitter, SmugMug, 37Signals, and AdaptiveBlue. The text explains that these startups rely on AWS's S3 storage and EC2 cloud computing services. The outage started at 4:30 AM PT, and while some issues were fixed, others persisted. The article also notes that this highlights the growing reliance on cloud computing infrastructure and the need for high reliability in such services.


TechCrunch

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Amazon Web Services Goes Down, Takes Many Startup Sites With It

by Erick Schonfeld on February 15, 2008 116 Comments 1 reblog

Amazon Web Services suffered a major outage this morning, affecting the thousands of Websites that rely on its storage (S3) and cloud computing (EC2) services. Startups including Twitter, SmugMug, 37Signals, and AdaptiveBlue, for instance, use Amazon's S3 storage service to store all the data for their Websites. [Reports](#) started coming in [across the Web](#), email, and Twitter about the outage (Twitter only uses S3 for file hosting, not its main messaging application). The major difficulties seem to have been fixed, but some [issues persist](#). The outage started at around 4:30 AM PT.



This could just be growing pains for Amazon Web Services, as more startups and other companies come to rely on it for their Web-scale computing infrastructure. But even if the outage only lasted a couple hours, it is unacceptable. Nobody is going to trust their business to cloud computing unless it is *more* reliable than the data-center computing that is the current norm. So many Websites now rely on Amazon's S3 storage service and, increasingly, on its EC2 compute cloud as well, that an outage takes down a *lot* of sites, or at least takes down some of their functionality. Cloud computing needs to be 99.999 percent reliable if Amazon and others want it to become more widely adopted.

Reliability / Resilience / Fault-tolerance



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Trust, Security and Privacy



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Macworld » Security

Sep 4, 2009 12:34 am | 0 Comments | + 4 Recommendations | Digg submit | ShareThis

Researchers find a new way to attack the cloud

by Robert McMillan, IDG News Service

Amazon and Microsoft have been pushing cloud-computing services as a low-cost way to outsource raw computing power, but the products may introduce new security problems that have yet to be fully explored, according to researchers at the University of California, San Diego, and the Massachusetts Institute of Technology.

Trust, Security and Privacy



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HSBC  Partager :

Twitter piraté, Google mis en cause

[17/07/09 - 09H36 - actualisé à 09:41:00]

Le site de micro-blogs, qui utilise les services de dématérialisation informatique de Google, a retrouvé toute sa stratégie divulguée sur internet.

Le géant de l'internet **Google**, promoteur le plus en pointe de l'informatique dématérialisée, est mis en cause depuis que le site de micro-blogs **Twitter**, client de ses applications pour entreprises, a retrouvé toute sa stratégie divulguée sur internet.

L'affaire, qui met en émoi la Silicon Valley, a été révélée par le co-fondateur du site Biz Stone avec un message au titre humoristique sur le blog de sa société: "**Twitter**, encore plus ouvert que nous ne le souhaitions". Un blogueur français, Korben, et le site spécialisé TechCrunch ont eu accès à des centaines de documents, et toute la stratégie de **Twitter**, telle qu'elle se présentait en février du moins, s'est retrouvée divulguée.

Biz Stone a eu beau dédouaner **Google** - "Cette attaque n'avait rien à voir avec une vulnérabilité des applications **Google**, que nous continuons d'utiliser" - l'affaire a suscité des doutes. Suspensions d'autant plus gênantes pour **Google** que celui-ci multiplie les initiatives pour pénétrer le marché des entreprises. L'informatique dématérialisée ("cloud computing"), qui consiste pour une entreprise à utiliser la puissance de calcul et de stockage disponible sur l'internet pour réduire ses dépenses en matériels informatiques, est le nouvel enjeu de la guerre que se livrent **Google** et les groupe de hautes technologies.

Trust, Security and Privacy



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Security experts: China hacked Google to steal U.S. industrial secrets

BY DIANE MOY SCHAEFER
DAILY NEWS STAFF WRITER

Thursday, January 14th 2010, 2:33 PM



Jin/Getty

A Chinese flag flies over the company logo outside the Google China headquarters in Beijing Thursday.

Security experts say Google, along with dozens of other major companies, was the victim of a concerted espionage effort that they say came from within China and exploited flaws in e-mail attachments to get into networks of major financial and technology firms.

At least 34 companies, including Adobe, Symantec, Yahoo and Dow Chemical, were attacked, according to industry sources. On Tuesday, Google revealed that hackers broke into the G-mail accounts of Chinese human rights advocates in the United States, Europe and China, and the search-engine company threatened to pull out of operations in China in response.

RELATED NEWS

ARTICLES

- Google may ax China service, end search censoring after hackers launch human rights cyber attack
- Google gets even bigger! Investment arm grows partner ranks

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Trust, Security and Privacy

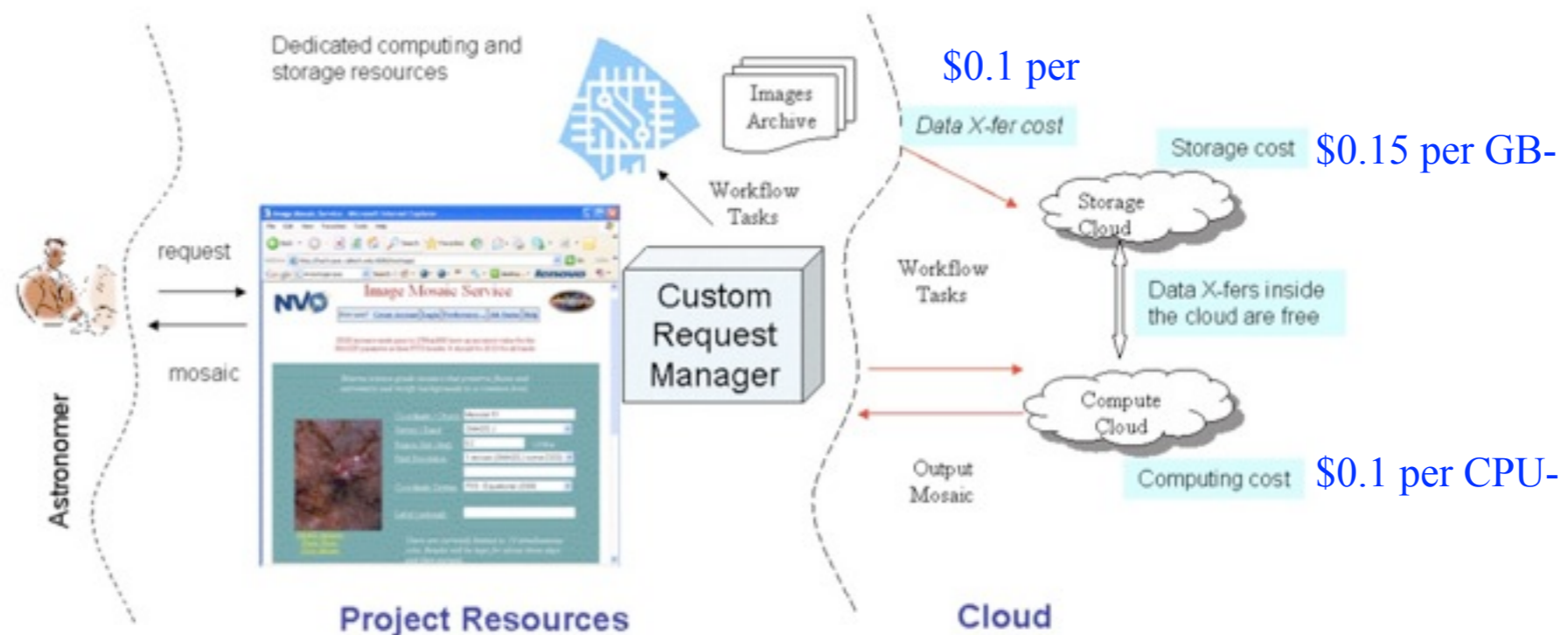
- Cloud will introduce new vulnerabilities and threats by allowing a physical infrastructure to be shared thanks to virtualisation technologies
 - The provider is not the only one that could have a malicious behavior...
 - Several VMs from different customers will share the same processor
 - Are we confident that virtualisation can provide 100% isolation across VMs ?
- Have a look on this very interesting paper:
 - ***Hey, You, Get Off of My Cloud: Exploring Information Leakage in Third-Party Compute Clouds***
Thomas Ristenpart, Eran Tromer†, Hovav Shacham, Stefan Savage*, *University of California, †Massachusetts Institute of Technology. Published in the proceedings of CCS'09.*
 - The paper is about how a cloud customer can «attack» another customer of the same cloud infrastructure
 - It just costs a few \$\$\$ to have a reasonable chance to observe what a cloud user is doing...
 - It has not been fully experimented but the paper gives some indications especially for Amazon EC2
- The threat model
 - Determine where is the VM that hosts a service to be attacked
 - Determine if the attacker's VM co-resides with the VM to be attacked
 - If not, try to launch new VMs until you are co-resident with the VM to be attacked
 - Exploit cross-VM information leakage once co-resident (CPU caches, branch target buffers, network queues, ...)

Are Cloud infrastructures less secure than non-Cloud ones ?

- **«one of the fastest and easiest ways to access corporate data is through unprotected PDAs that are lost or stolen, as they contain business names and addresses, spreadsheets and other corporate documents»** http://www.theregister.co.uk/2004/09/01/pda_sec
- **«60% of corporate data resides unprotected on PC desktops and laptops»** (IDC analyst Cynthia Doyle, Business Continuity in 2002: It's Not Business as Usual, April 2002)
- Read from <http://www.nationalpost.com/>
 - 10% of laptop computers will be stolen within the first 12 months of purchase.
 - 90% of stolen laptops are never recovered.
 - 49% of companies have had laptops stolen with the last 12 months.
 - 57% of corporate crimes are linked to stolen laptops.
 - 80% of computer crime consists of "inside jobs" by disgruntled employees.
 - 73% of companies had no specific security policies for their laptops in 2003.
- **66 % of USB thumb drive owners report losing them, over 60 % with private corporate data on them!**

New economic/business model for computing

- Considering a Cloud cost model (such as the Amazon one), what are the impacts on how we design / produce software ?
- Have a look on this very interesting paper:
 - ***The cost of Doing Science on the Cloud: The Montage Example***
Ewa Deelman, Gurmeet Singh, Miron Livny, Bruce Berriman, John Good, Published in the proceedings of SC'08.
 - The paper is about to find the right balance between cost and performance considering a cost model
 - Based on an astronomy (data-intensive) application (workflow) to deliver on-demand a science-grade mosaic of the sky



What are the findings ?

- Several implementation data management models are possible !
 - Remote I/O : stage in/stage out files at each step of the workflow
 - Regular: intermediate files produced by the execution of the workflow are stored using the cloud storage service (S3 for Amazon). Files are deleted when the workflow execution is completed
 - Dynamic cleanup: files are deleted when they have outlived their usefulness
- How many processors should be used, what will be the cost ?

	Small	Medium	Large
1 proc	5.5h / 0.60\$	20.5h / 2.25\$	85h / 9\$
128 proc	18mn / 4 \$	40mn / 8\$	1h / 14\$

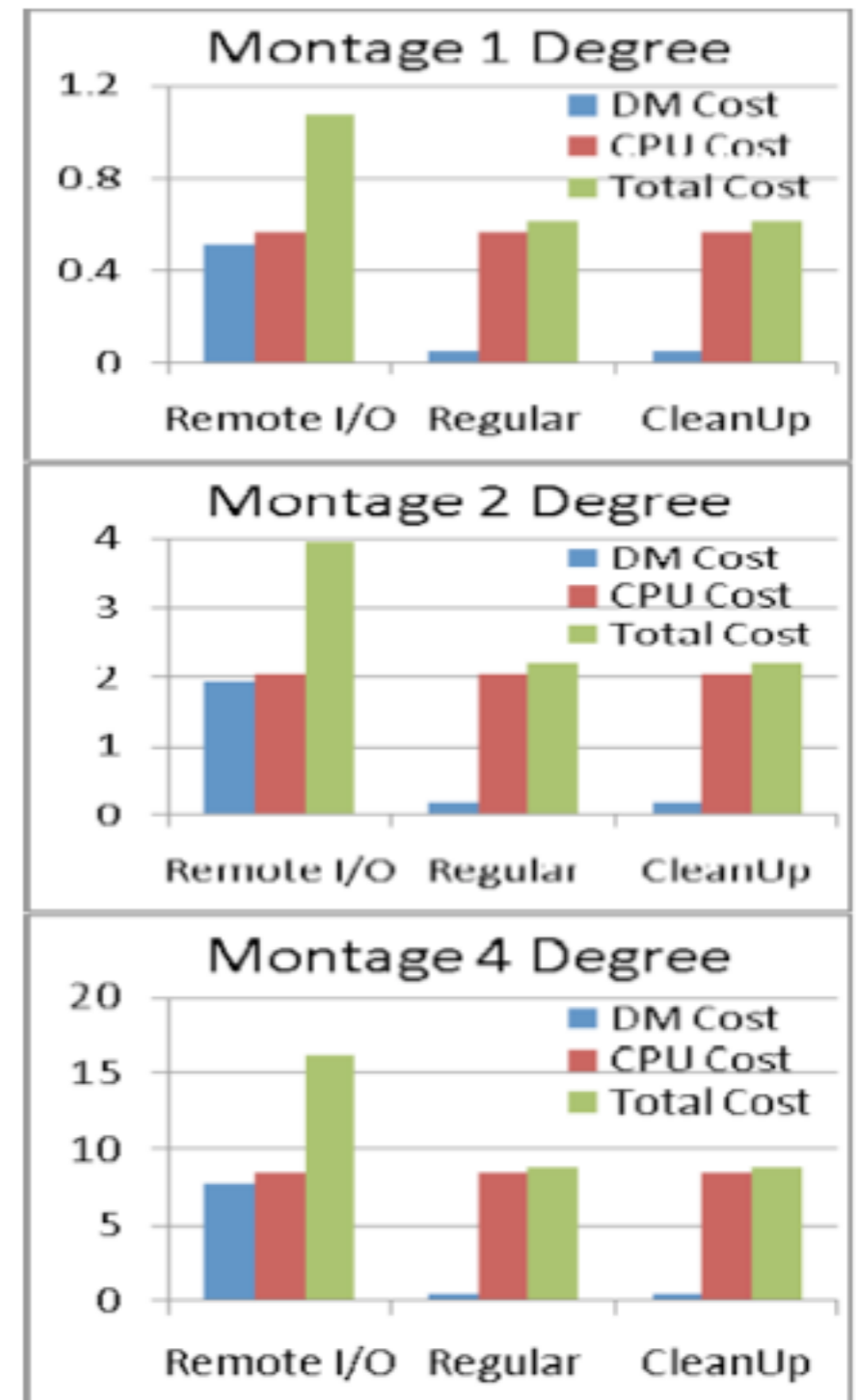
- Does it make sense to archive the generated popular mosaics in the cloud instead of always generating them on demand from the basic input data ?
 - For a small mosaic (173.46 Gbytes), CPU cost to generate it is 0.56\$
 - For this cost, you can archive it for 21.52 months
 - For a large mosaic (2.229 Tbytes), CPU cost to generate it is \$8.40
 - For this cost, you can archive it for 25.12 months
 - Conclusion: if there will be a similar request coming within two years, then it would be cost effective to save popular mosaics of the sky in the cloud...

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Conclusions

- Cloud is becoming a buzzword... a lot of hype around it
 - Not the swiss knife for distributed computing (as the grid was supposed to be...)
 - More an evolution than a revolution
 - Less ambitious than Grid but there is an increasing public and business demand
- But there are new opportunities for research:
 - Reliability / Resilience / Fault-tolerance
 - Trust, Security and Privacy
 - New economical models for computing
 - Service Level Agreement / Quality of Service - *From Best Effort to SLA*
 - Building cloud-aware applications from legacy applications
 - Energy management
 - Cloud federation
 - Autonomic behaviors / Self-*
 - Brokering / Scheduling (performance, energy, ...)
 - Programming models (MapReduce, ...)
 - Interactions between legal aspects (laws) and computer science - *privacy and liability*

Questions ?



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