

Cloud/Grid Computing

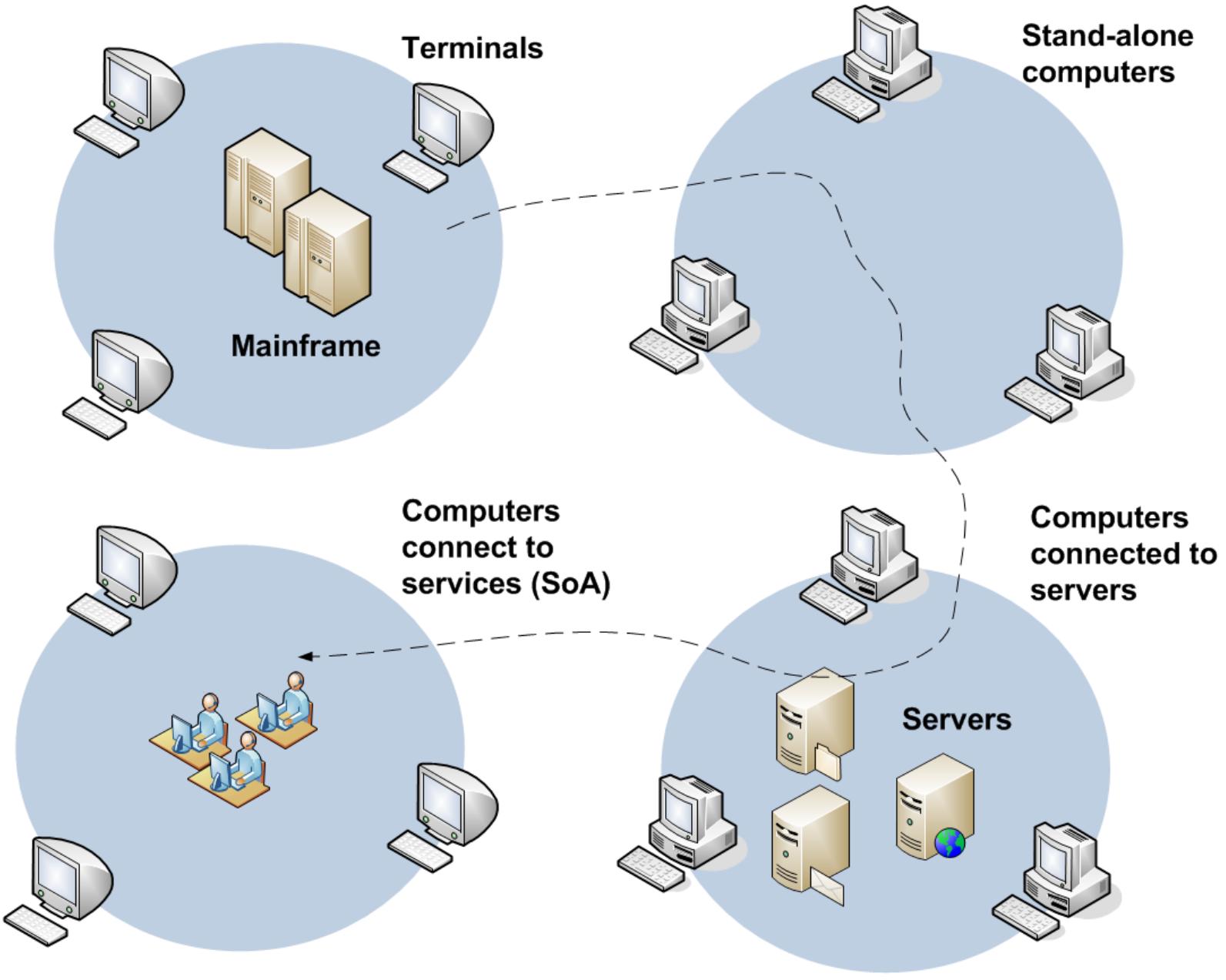
- Provide an introduction to cluster, grid and cloud infrastructures.
- Define an example of grid computing, and its advantages.
- Show an example of using a Cloud Infrastructure.
- Define the usage of Amazon Web Services, including S3 and the EC2 Cloud.
- Outline the usage of RESTful Web Services.

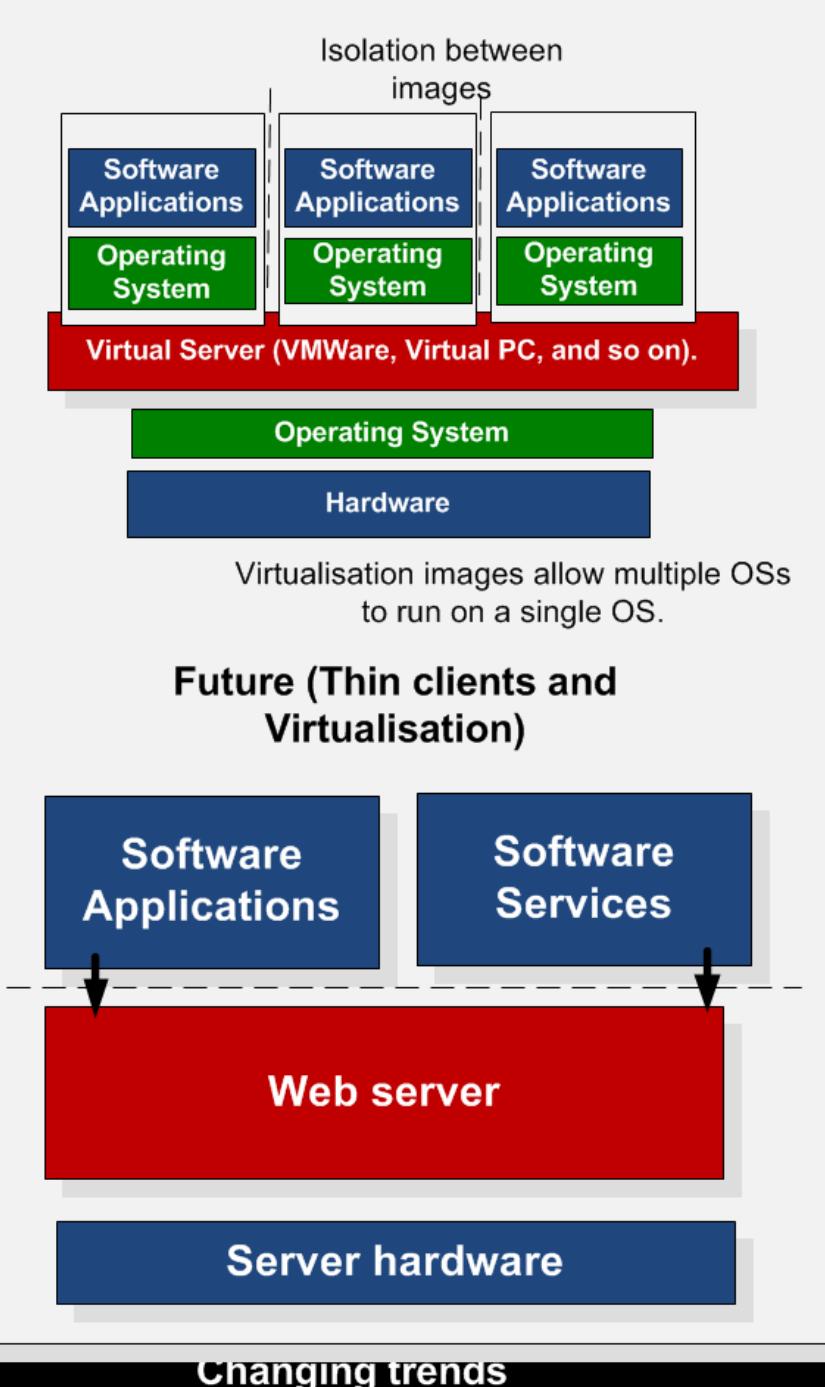
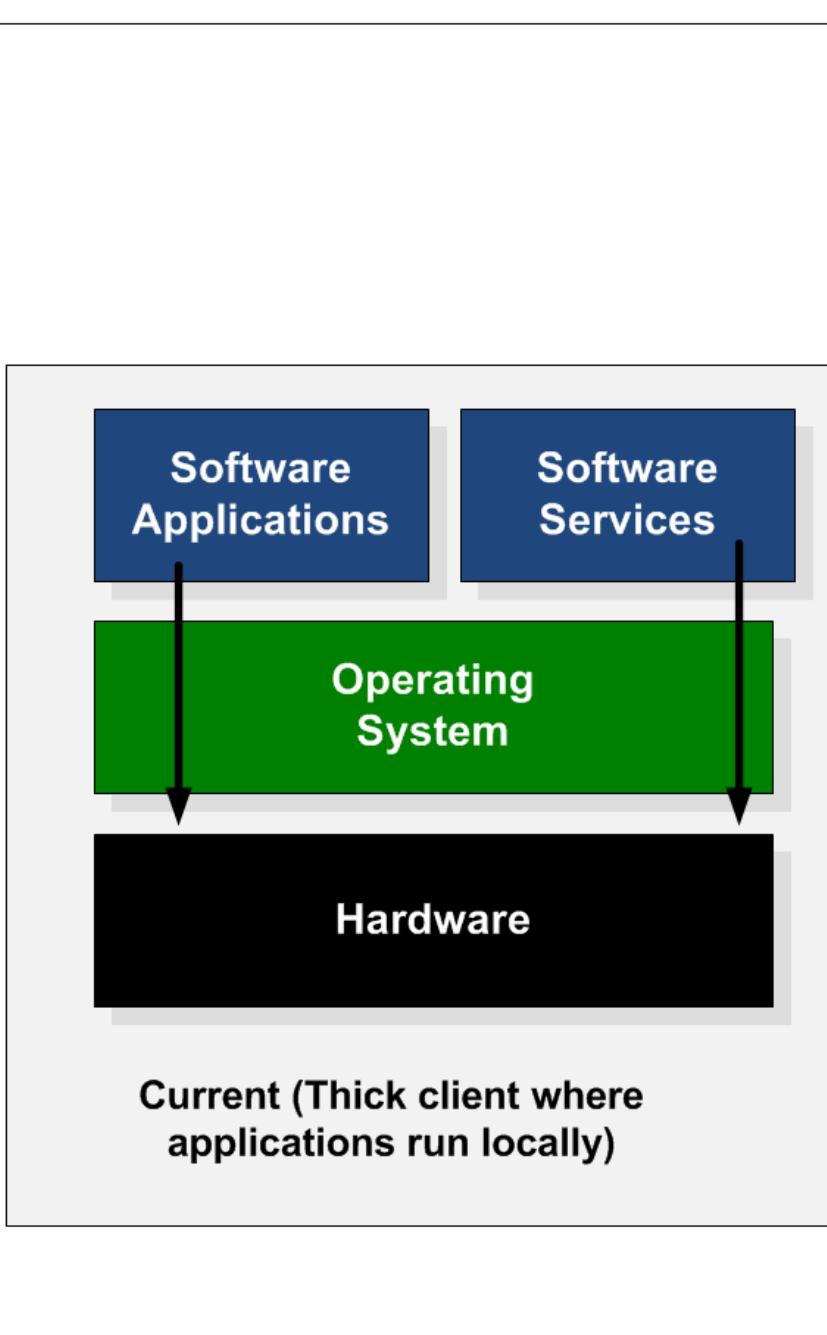


Cloud Computing

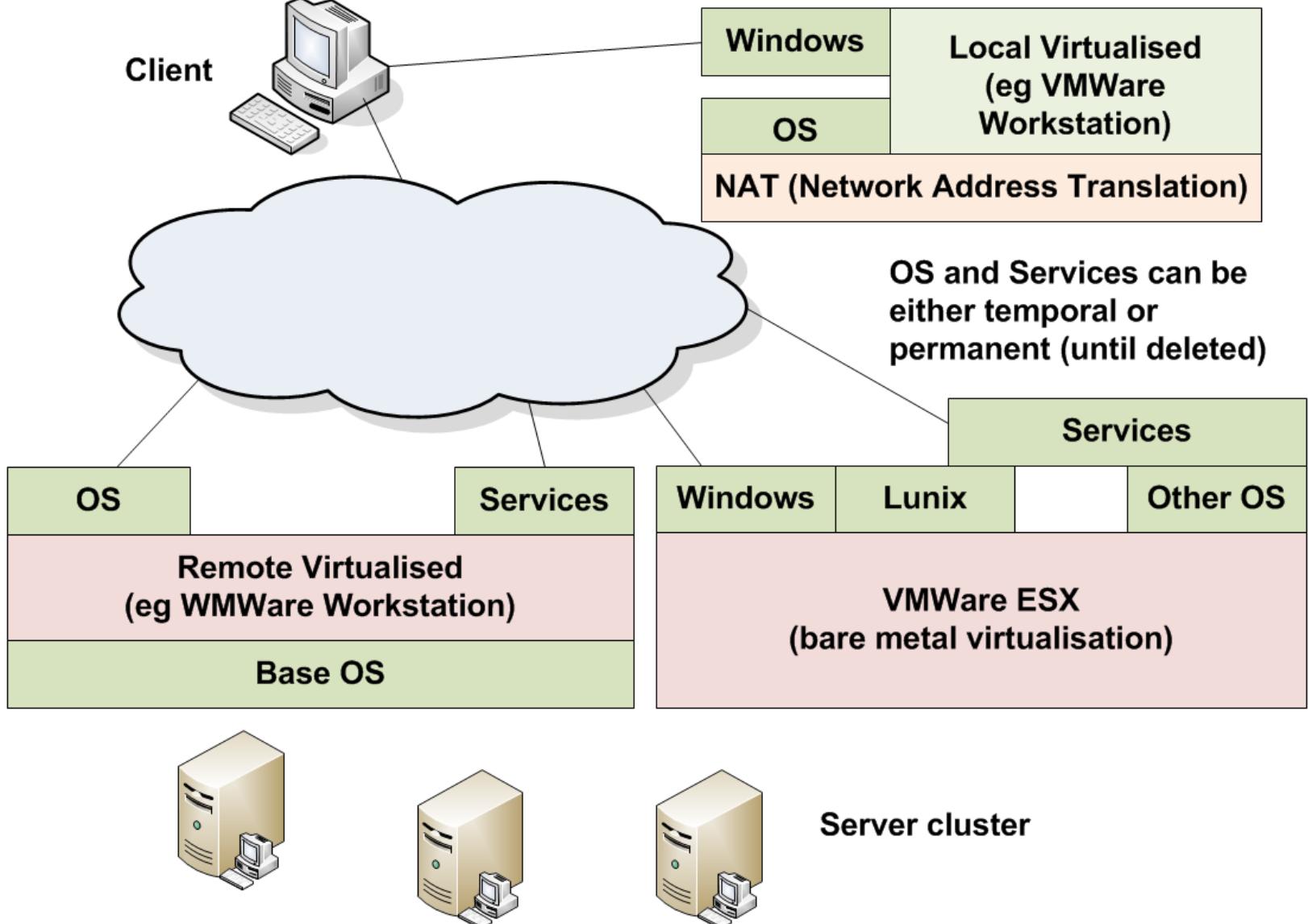


Introduction

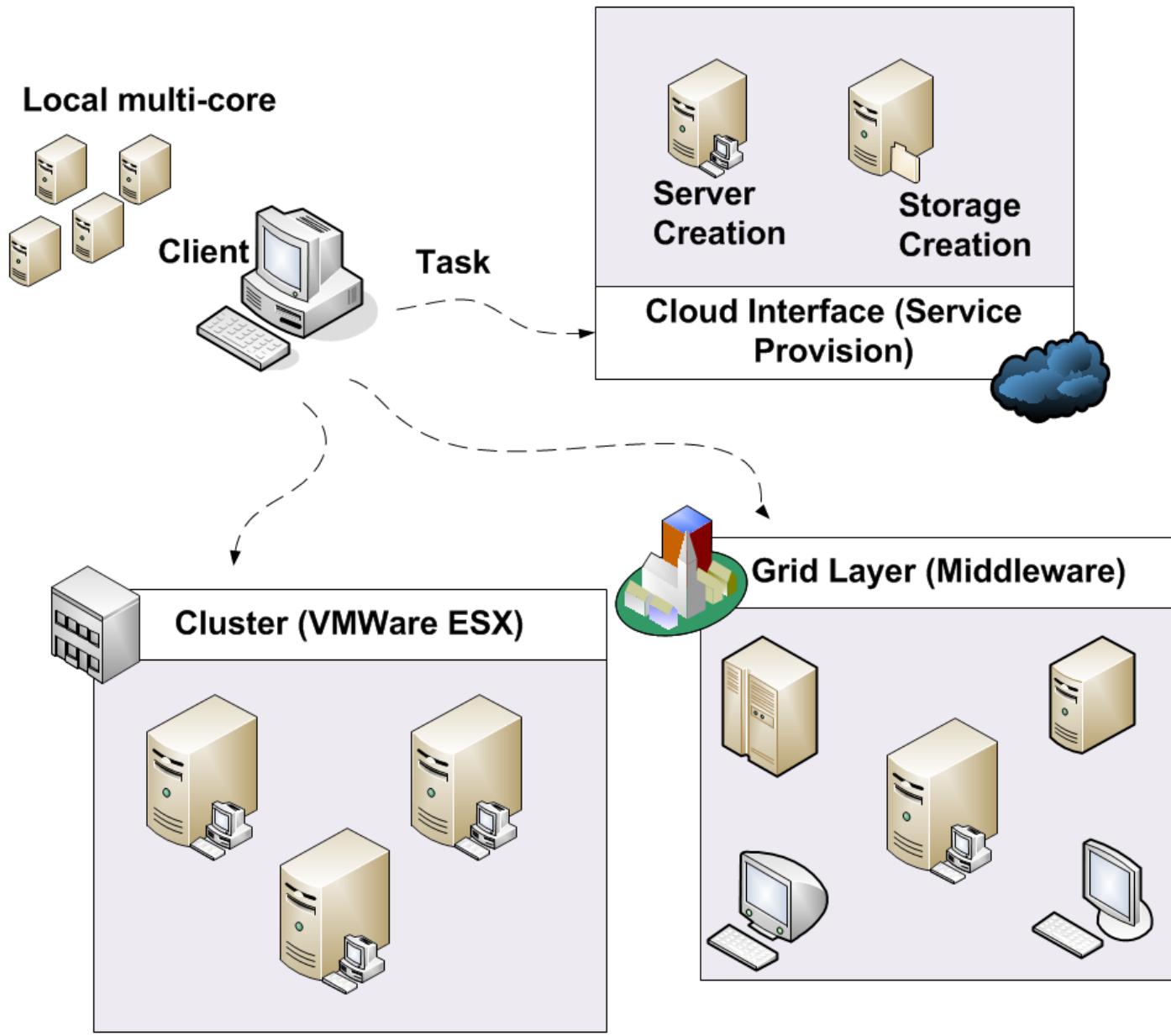




Virtualisation
Cloud



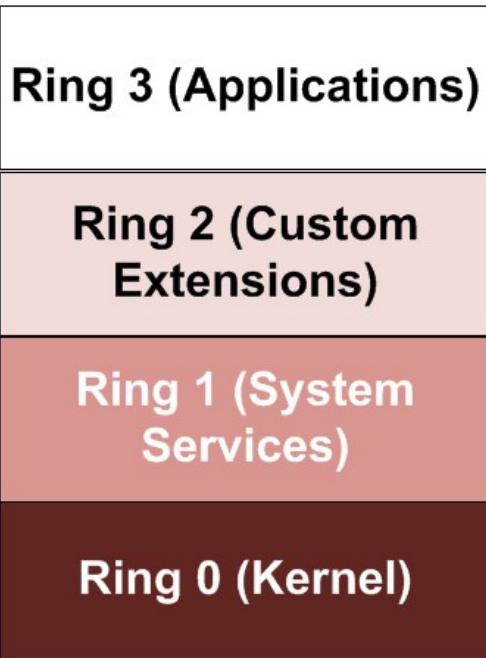
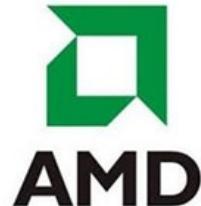
Virtualisation



Cloud Computing



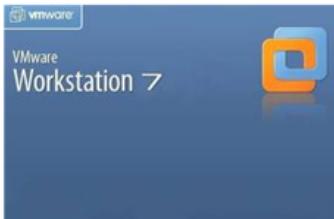
Virtualisation



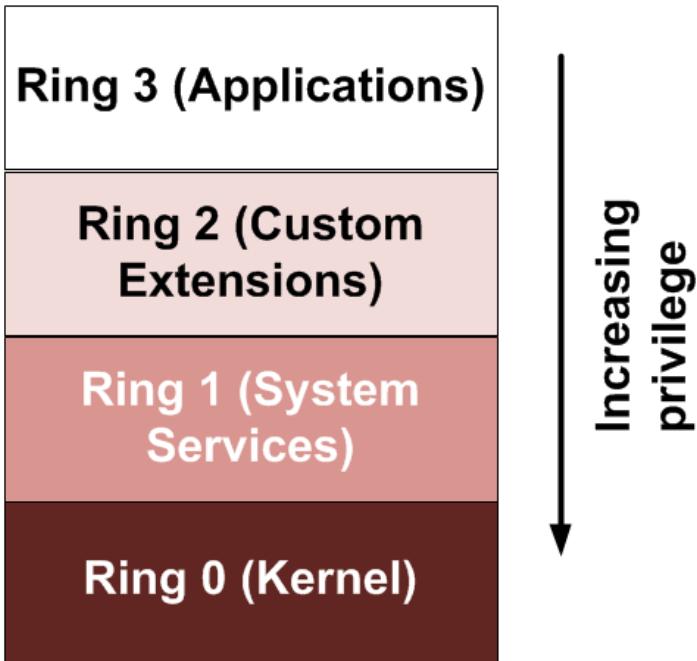
X86 Architecture



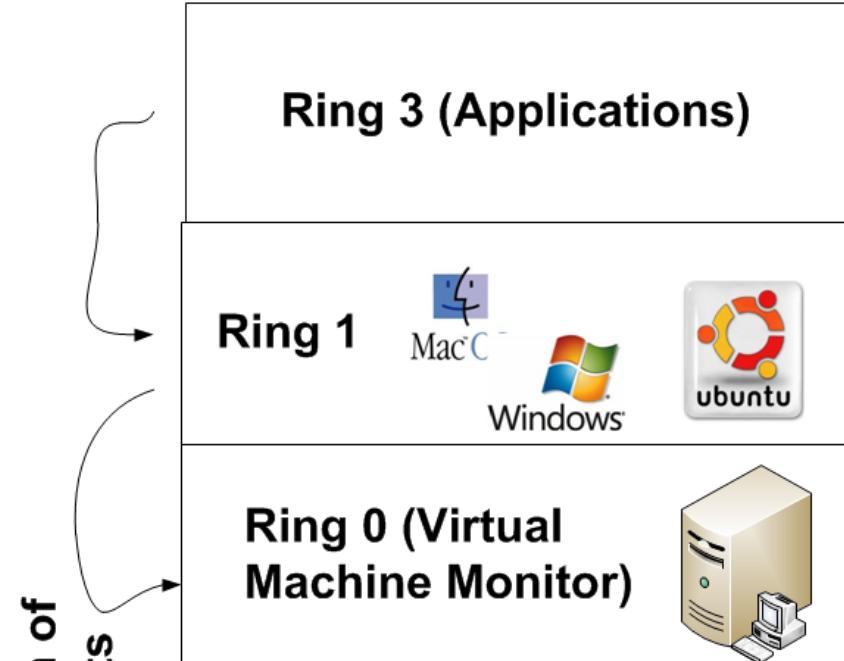
Full Virtualisation



Full virtualisation. OS does not know it is being virtualised. VMM translates requests to Ring 0.



X86 Architecture



Full Virtualisation



Ring 3 (Applications)

Ring 2 (Custom Extensions)

Ring 1 (System Services)

Ring 0 (Kernel)



X86 Architecture

x86

Cloud

Paravirtualisation. Guest OS communicates with a Hypervisor (KVM, Xen, etc). Bare Metal Virtualisation: Vmware ESX/ESXi, Citrix XenServer, Microsoft Hyper-V
Downside: Guest OS requires modification, and makes them least compatible
Upside: Fastest of the methods

Increasing privilege

Hyper calls to the Virtualisation layer

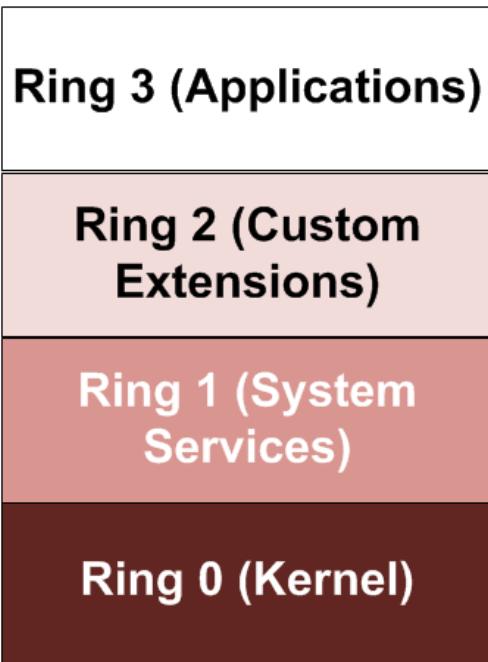
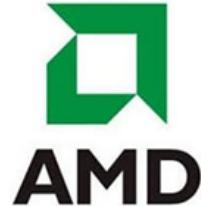
Ring 3 (Applications)

Ring 1 Paravirtualised Guest OS



Ring 0 (Virtual Machine Monitor)

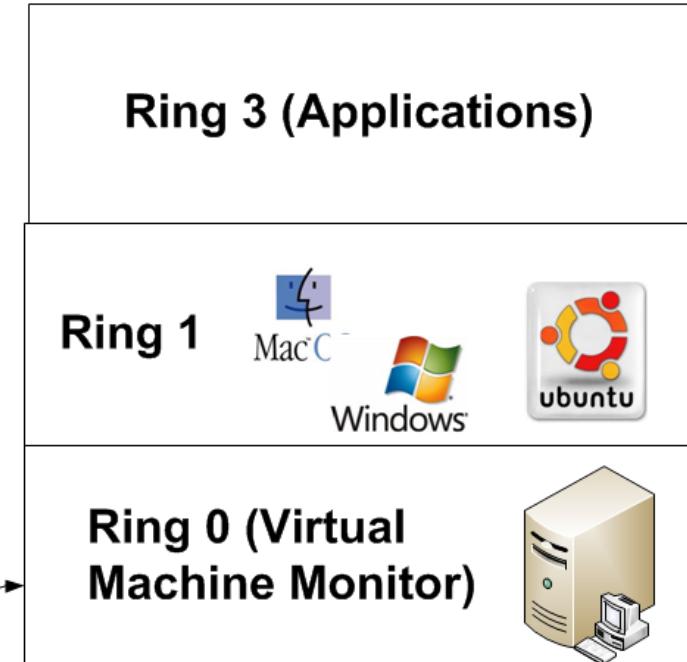




X86 Architecture

Increasing privilege
Hardware traps OS calls from Ring 1 and converts them

Hardware assisted.
Hardware is used to trap Ring 1 calls and converts them into Ring 0. Intel VT or AMD-V are used.



Hardware assisted

AWS Management Console - Windows Internet Explorer

https://console.aws.amazon.com/ec2/home?region=us-east-1#s=Instances

vcenter logo

File Edit View Favorites Tools Help

Favorites AWS Management Console

aws.amazon.com AWS Products Developers Community Support Account Welcome, Dr William Buchanan | Settings | Sign Out

Elastic Beanstalk S3 Amazon EC2 Amazon VPC Amazon CloudWatch Amazon Elastic MapReduce Amazon CloudFront Amazon RDS Amazon SNS

Navigation

Region: US East (Virginia)

> EC2 Dashboard

INSTANCES

> Instances

> Spot Requests

IMAGES

> AMIs

> Bundle Tasks

ELASTIC BLOCK STORE

> Volumes

> Snapshots

NETWORKING & SECURITY

> Security Groups

> Placement Groups

> Elastic IPs

> Load Balancers

My Instances

Viewing: All Instances All Instance Types 1 to 21 of 21 Instances

Name	Instance	Type	Status	Public DN	Security G	Key Pair	Monitoring	Virtualizatio	Placen
empty	i-c0af4f	m1.small	running	ec2-50-16-	Windows2008	billwindows	basic	hvm	
empty	i-deaf4f	m1.small	running	ec2-184-72	Windows2008	billwindows	basic	hvm	
empty	i-dcaf4f	m1.small	running	ec2-50-17-	Windows2008	billwindows	basic	hvm	
empty	i-daa4f4	m1.small	running	ec2-50-17-	Windows2008	billwindows	basic	hvm	
empty	i-d8af4f	m1.small	running	ec2-50-17-	Windows2008	billwindows	basic	hvm	
empty	i-cc10f6	m1.small	running	ec2-50-17-	Windows2008	billwindows	basic	paravirtual	

1 EC2 Instance selected

EC2 Instance: i-cc10f6a3

Description Monitoring Tags

AMI ID: ami-eb7f9082 Zone: us-east-1d

Security Groups: Windows2008 Type: m1.small

Status: pending Owner: 103269750866

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Internet | Protected Mode: Off

x86 Rinas

Cloud

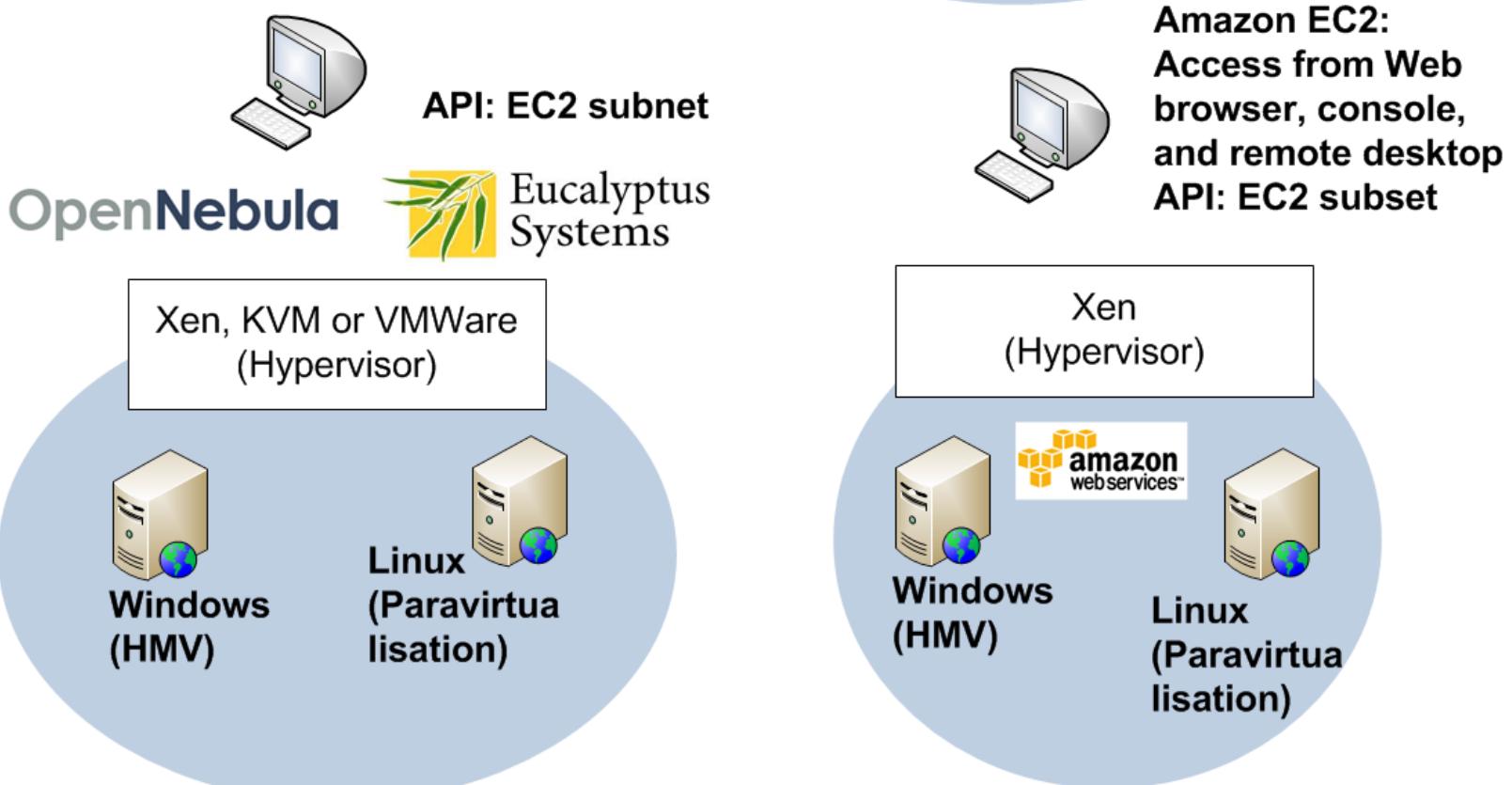
X86 Architecture

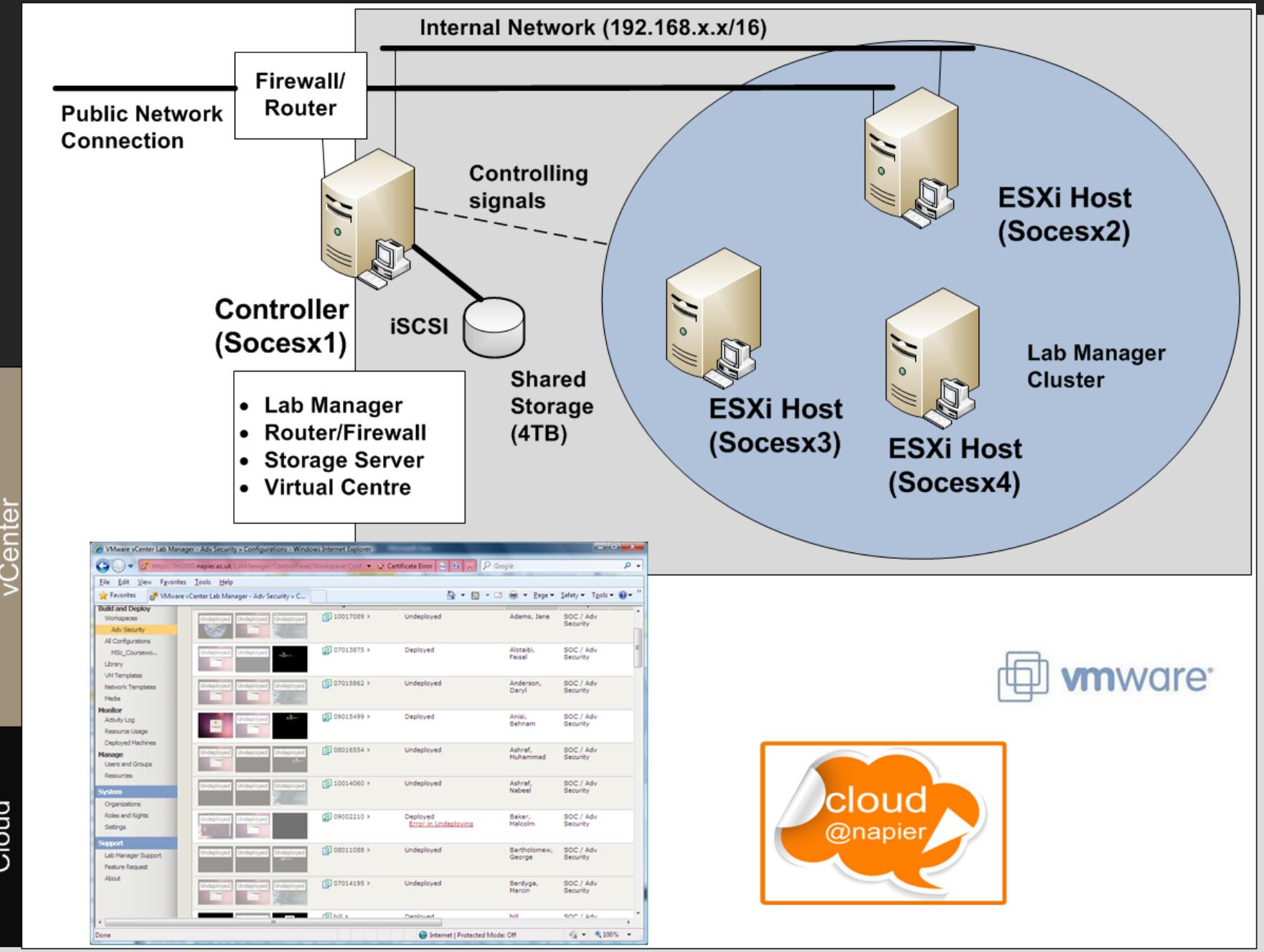
Hard calls and

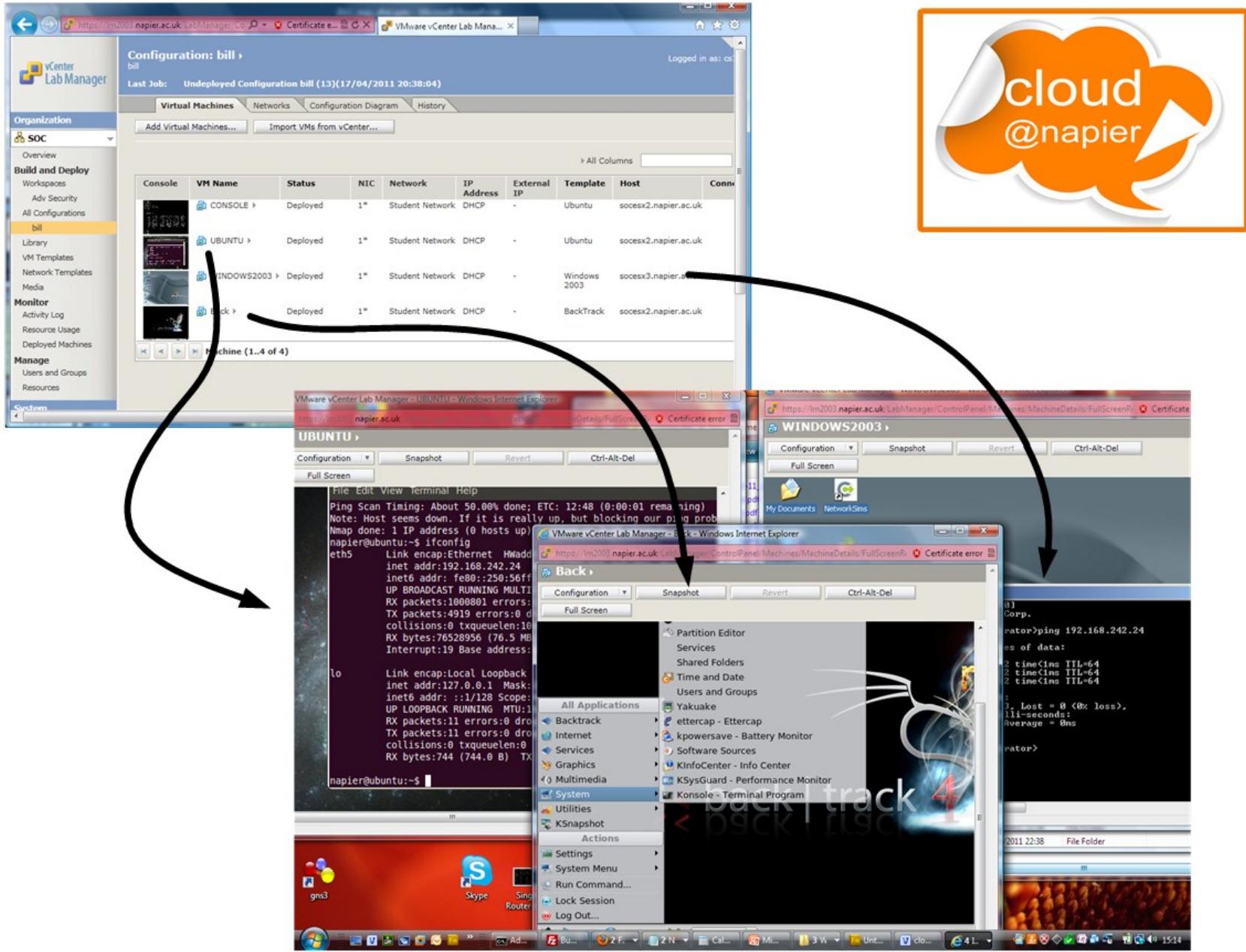
Hardware assisted

ons)









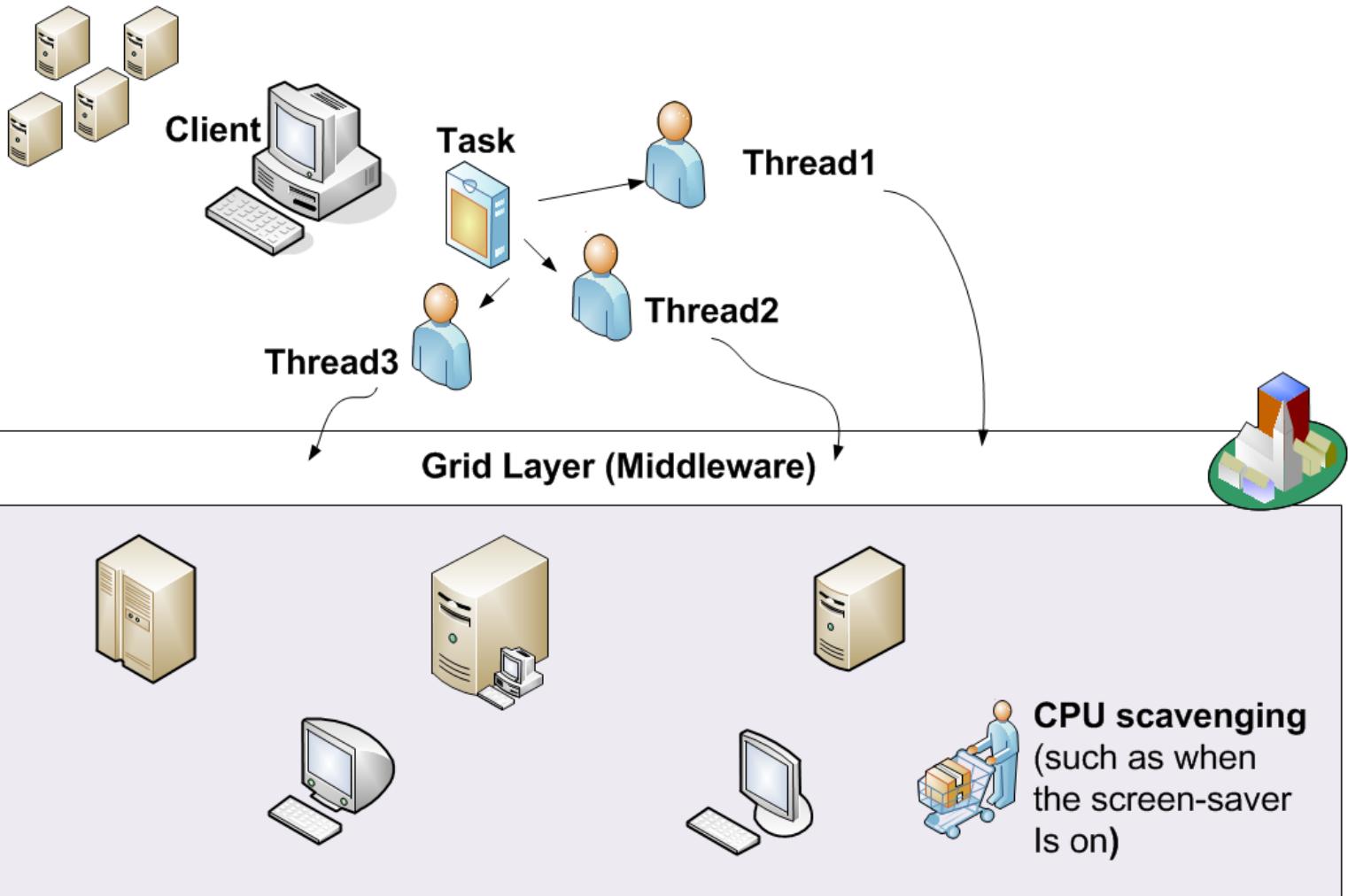
Cloud Computing

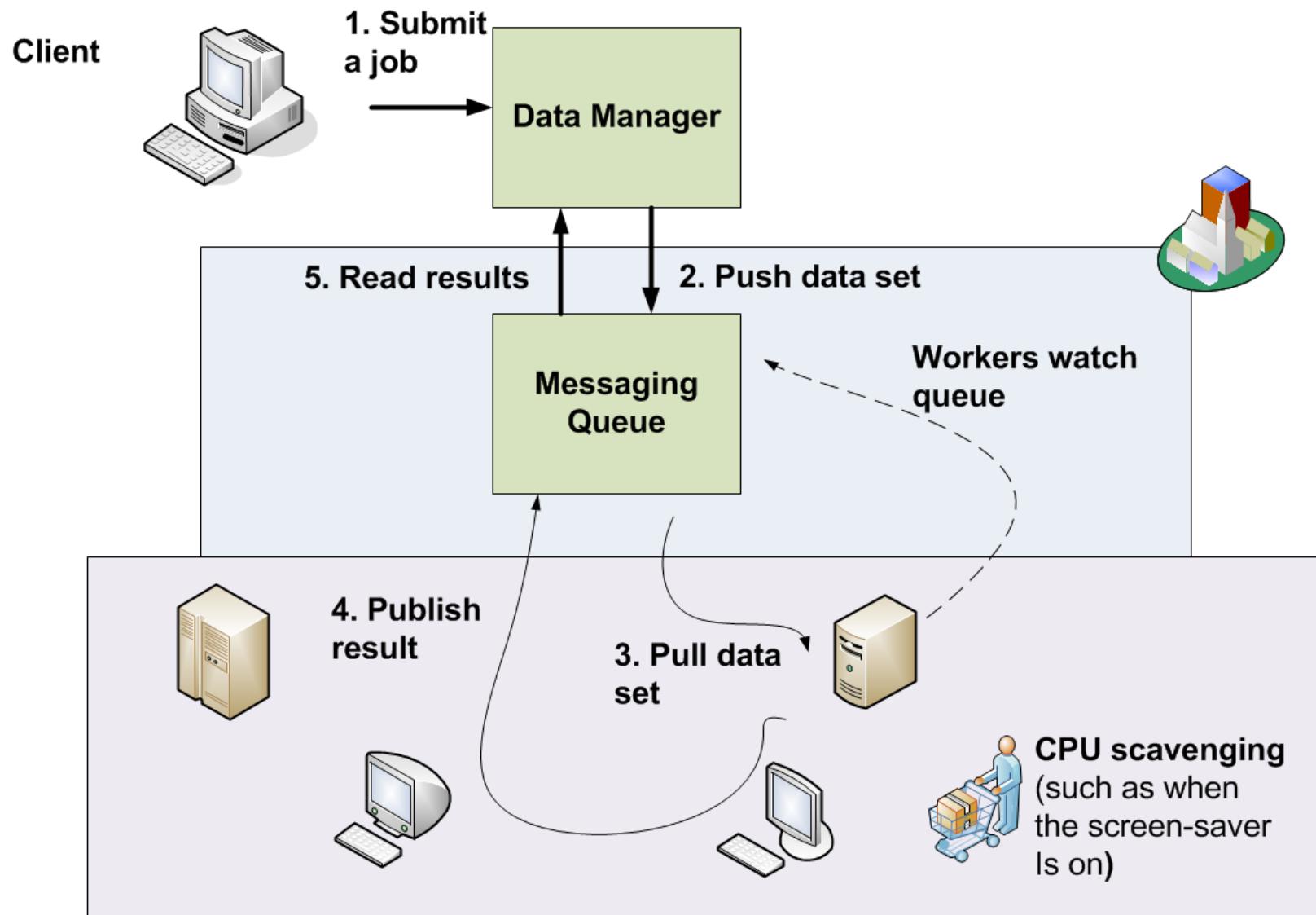


Grid Computing

Cloud Grid

Local multi-core







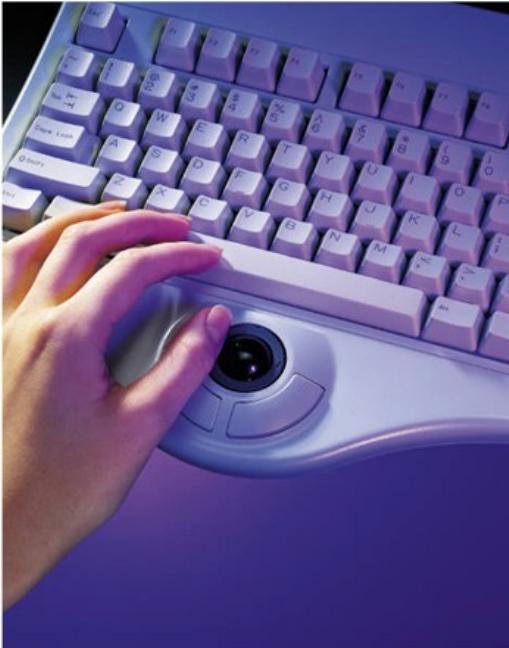
Okay... we select a **64-bit key** ...
which has 1.84×10^{19} combinations



18.4 million million million different keys
000000000000...0000000000000000
To
111111111111...1111111111111111



How long will it take to cracked It by brute-force
(on average)?



A 64-bit key has 1.84×10^{19} combinations and it could be cracked by brute-force in 0.9×10^{19} goes.



If we use a fast computer such as 1GHz clock (1ns), and say it takes one clock cycle to test a code, the time to crack the code will be:



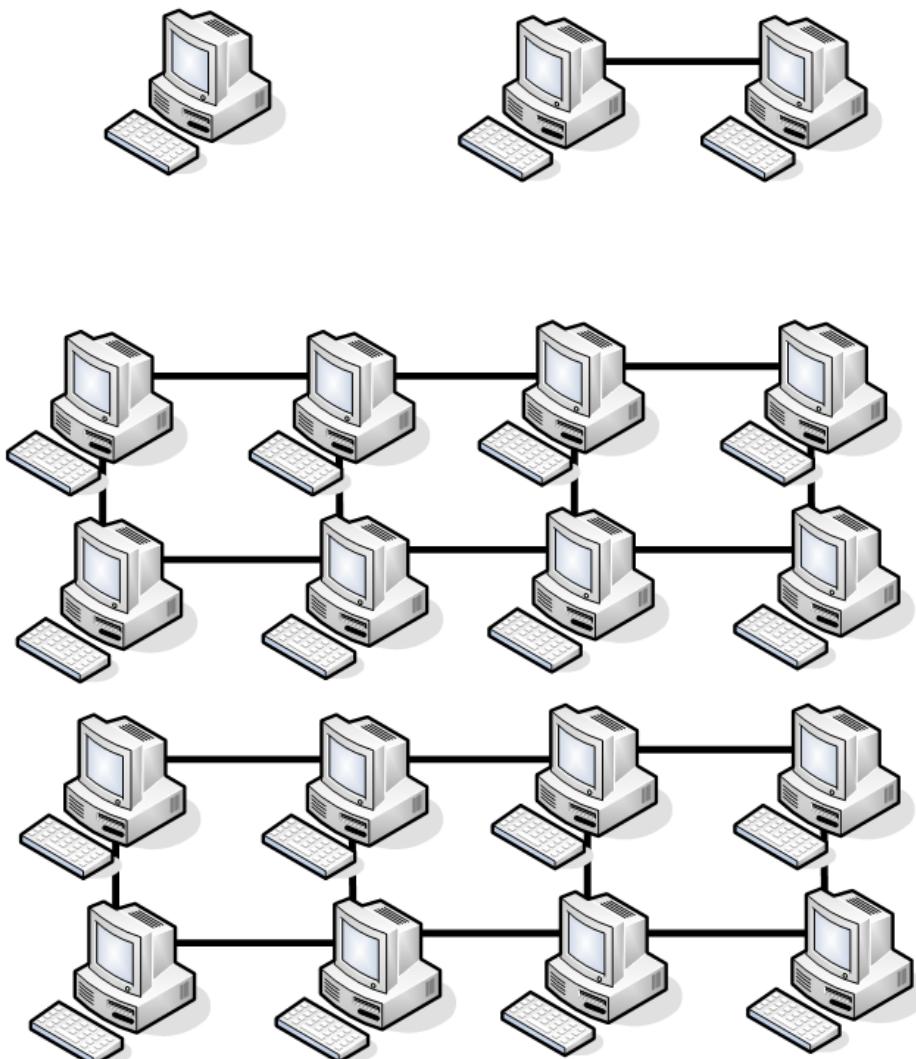
9,000,000,000 seconds (150 million minutes)
... **2.5 million hours** (285 years)



Date	Hours	Days	Years
2008	2,500,000	104,167	285
2009	1,250,000	52,083	143
2010	625,000	26,042	71
2011	312,500	13,021	36
2012	156,250	6,510	18
2013	78,125	3,255	9
2014	39,063	1,628	4
2015	19,532	814	2
+8	9,766	407	1
+9	4,883	203	1
+10	2,442	102	0.3
+11	1,221	51	0.1
+12	611	25	0.1
+13	306	13	0
+14	153	6	0
+15	77	3	0
+16	39	2	0
+17	20	1	0

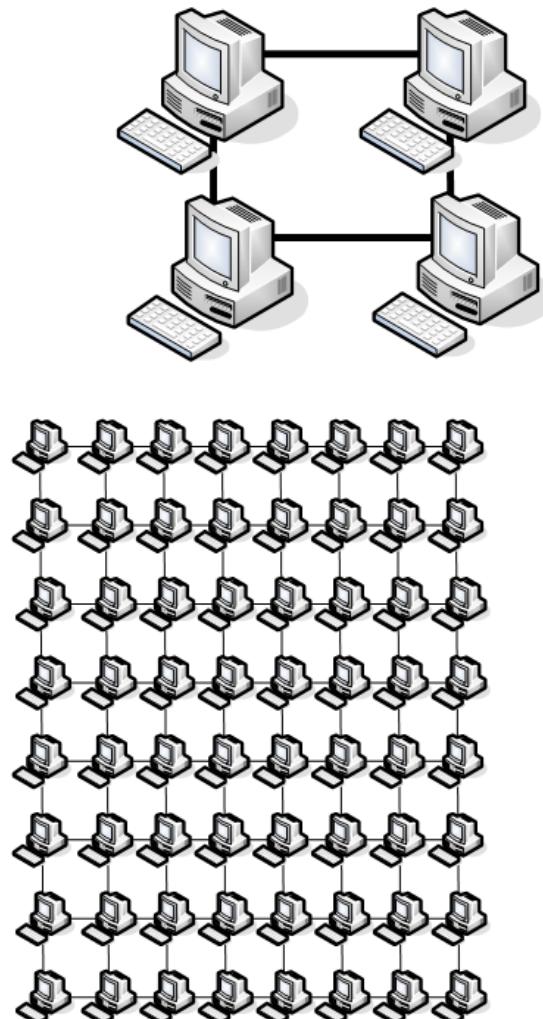
56-bit DES:
Developed
1975
30 years ago!
... now easily
crackable

Cloud Grid



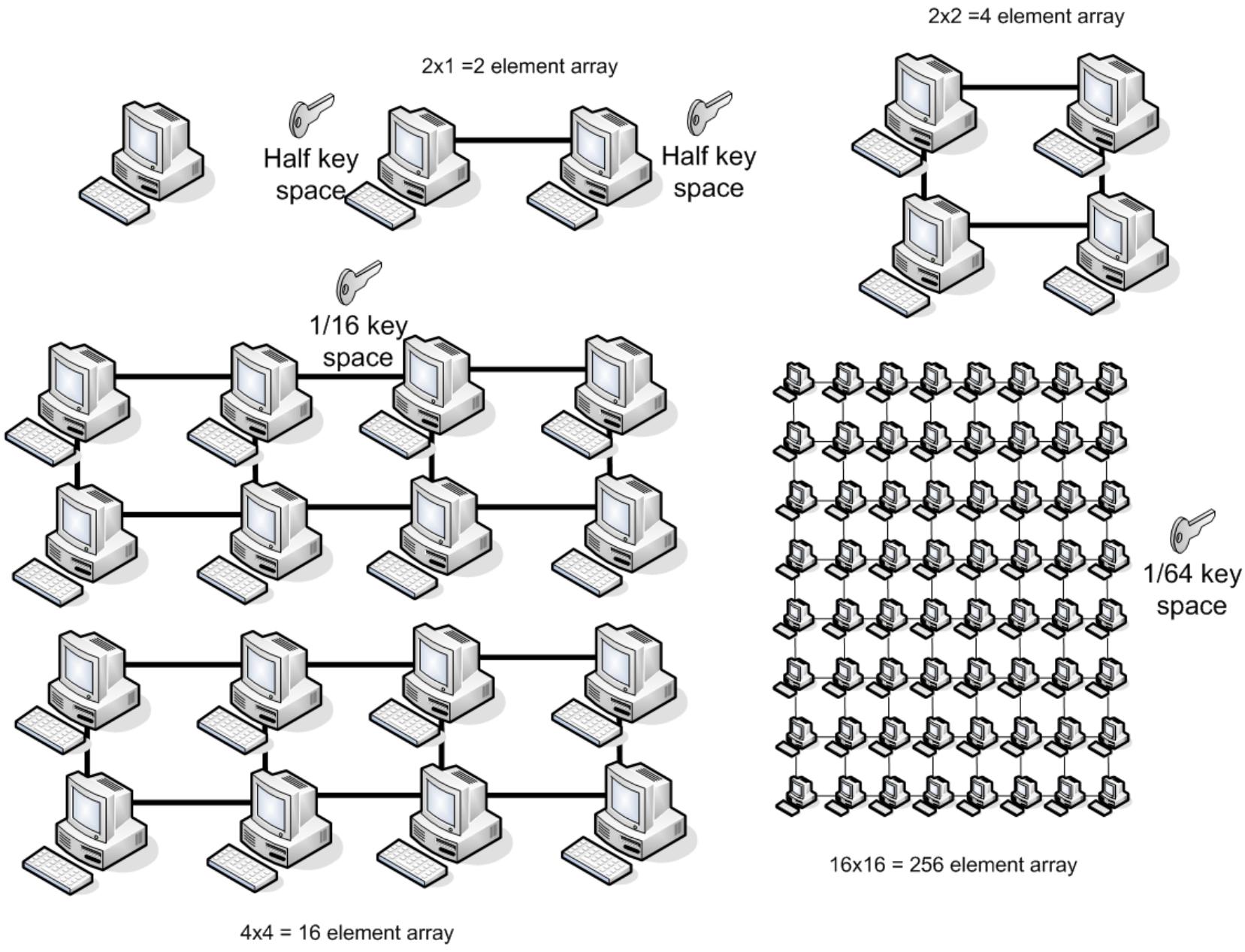
4x4 = 16 element array

2x2 = 4 element array



16x16 = 256 element array

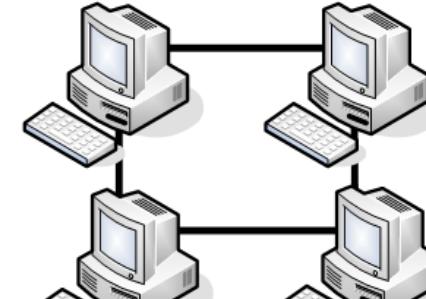
Distributing applications



Processors	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
1	104000 days	52000	26000	13000	6500	3250
4	26000	13000	6500	3250	1625	813
16	6500	3250	1625	813	407	204
64	1625	813	407	204	102	51
256	406	203	102	51	26	13
1024	102	51	26	13	7	4
4096	25	13	7	4	2	1
16,384	152hr	76hr	38hr	19hr	10hr	5hr
65,536	38hr	19hr	10hr	5hr	3hr	2hr
262,144	10hr	5hr	3hr	2hr	1hr	
1,048,576	2hr	1hr				



Half key space



16x16 = 256 element array

4x4 = 16 element array

Author: Prof Bill Buchanan



1997. RSA Lab's 56-bit RC5 Encryption Challenge
- 250 days and 47% of the key space tested) –
distributed.net



1998. RSA Lab's 56-bit DES II-1 Encryption Challenge - 39 days.

1998. RSA Lab's 56-bit DES II-2 Encryption Challenge - 2.5 days.

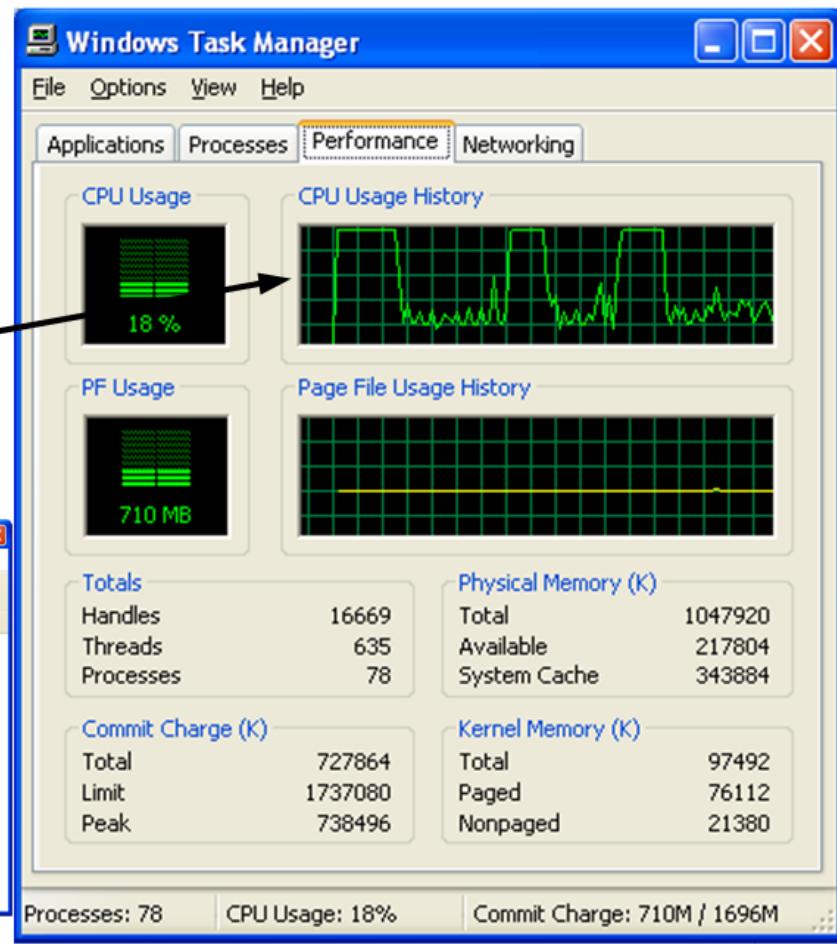


2002. RSA Lab's 64-bit RC5 Encryption Challenge — Completed 14 July 2002 – 1,757 days and 83% of the key space tested.

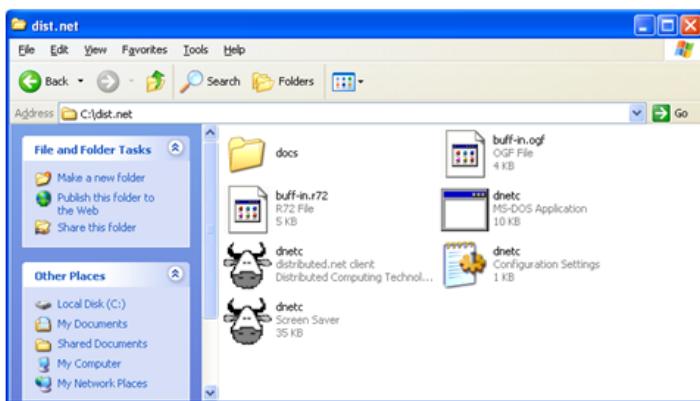
RSA Lab's 72-bit RC5 Encryption Challenge
- In progress.



The screenshot shows a web page from RSA Laboratories titled "The RSA Laboratories Secret-Key Challenge". The page includes a navigation menu with links like "Home", "About RSA", "Products", "Services", "News & Events", "Contact", "Site Map", and "Feedback". The main content area discusses the challenge, mentioning the 72-bit RC5 encryption challenge and its completion date of 14 July 2002. It also notes the 64-bit RC5 challenge completed in 2002 and the 56-bit DES challenges completed in 1998. The page concludes with a statement about the 56-bit DES challenge still in progress.



Distributed.net is starting and stopping (Max CPU when searching for possible keys)



Cloud Computing



Cloud Computing

Rapid elasticity. Consumers can easily scale-up and scale-down, whenever required.

On-demand self-service.

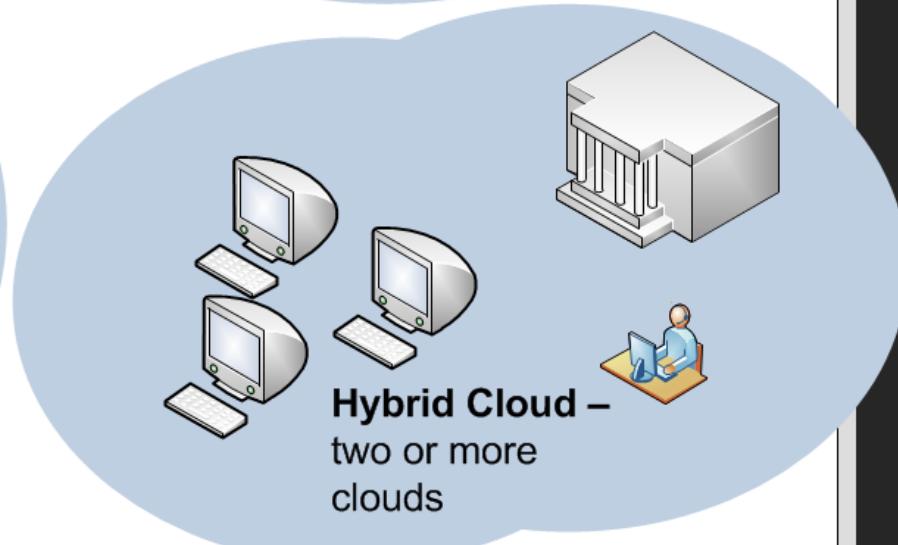
Consumers get server CPU, memory, bandwidth and storage resources whenever required.

Pay per use. All access to resources is monitored, and paid for either by advertising or usage. Payment methods: per users created, per hour usage (service), etc.

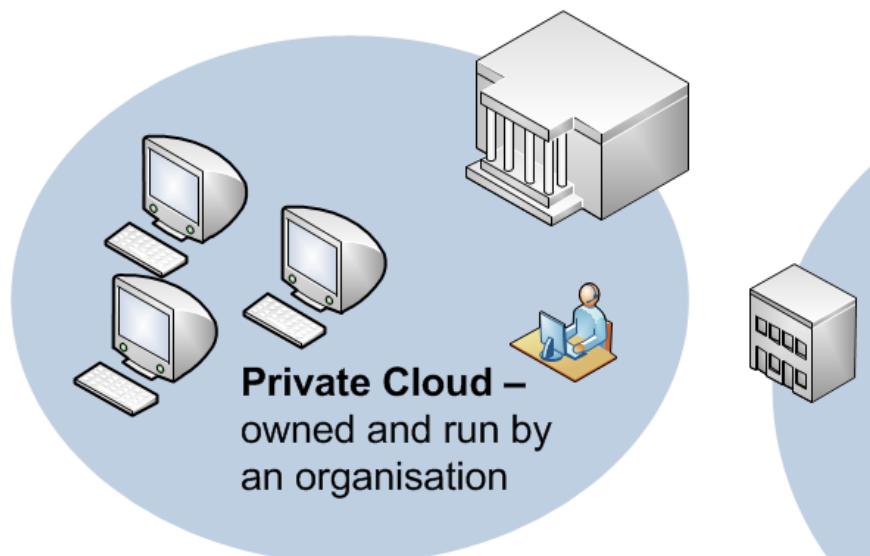
Location independent resource pooling. Multiple customers use shared resources within the provider, without actually knowing where the exact location of these are.



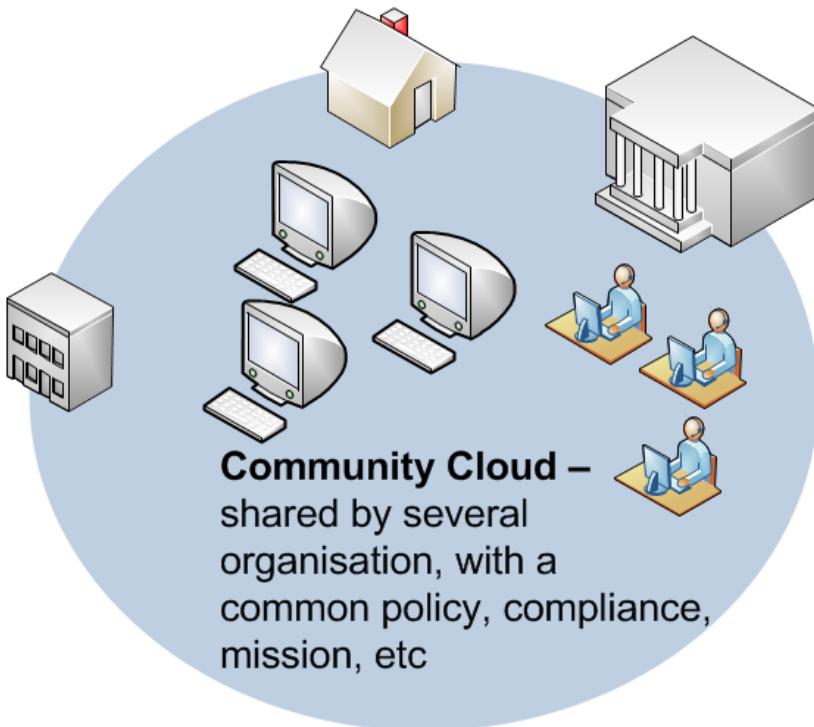
Public Cloud – owned by an organisation selling a cloud infrastructure



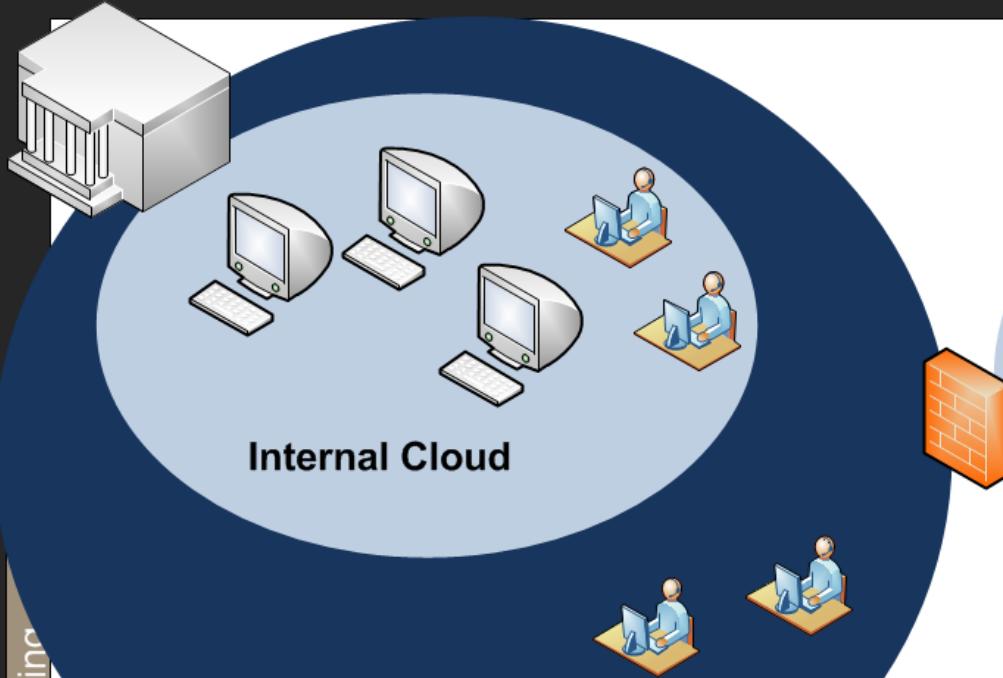
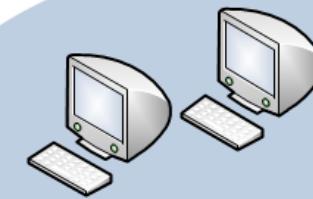
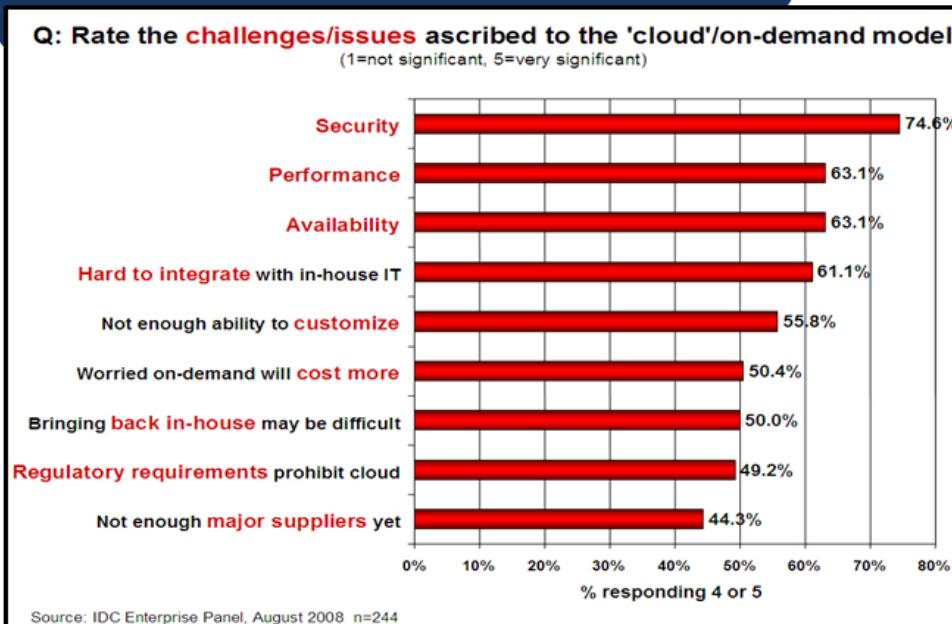
Hybrid Cloud – two or more clouds



Private Cloud – owned and run by an organisation



Community Cloud – shared by several organisation, with a common policy, compliance, mission, etc

**Internal Cloud****External Cloud**

Audit/compliance

Can I be compliant with statutory and regulatory requirements?

- Where is my data stored?
- Who handles breach notifications?
- How long is my data stored for?
- How is eDiscovery handled?



Client

Cloud

Software as a Service (SaaS)

- User interface.
- Machine interface

Platform as a Service (PaaS)

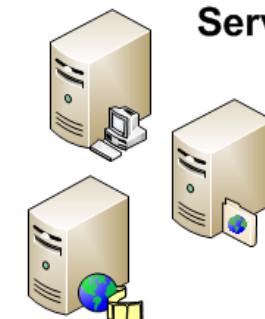
- Service Oriented Architecture (SOA)
- Sophisticated Web Services
- Developing
- Testing
- Deploying
- Hosting
- Service platform providers, e.g. Google GAE, Microsoft Windows Azure

Infrastructure as a Service (IaaS)

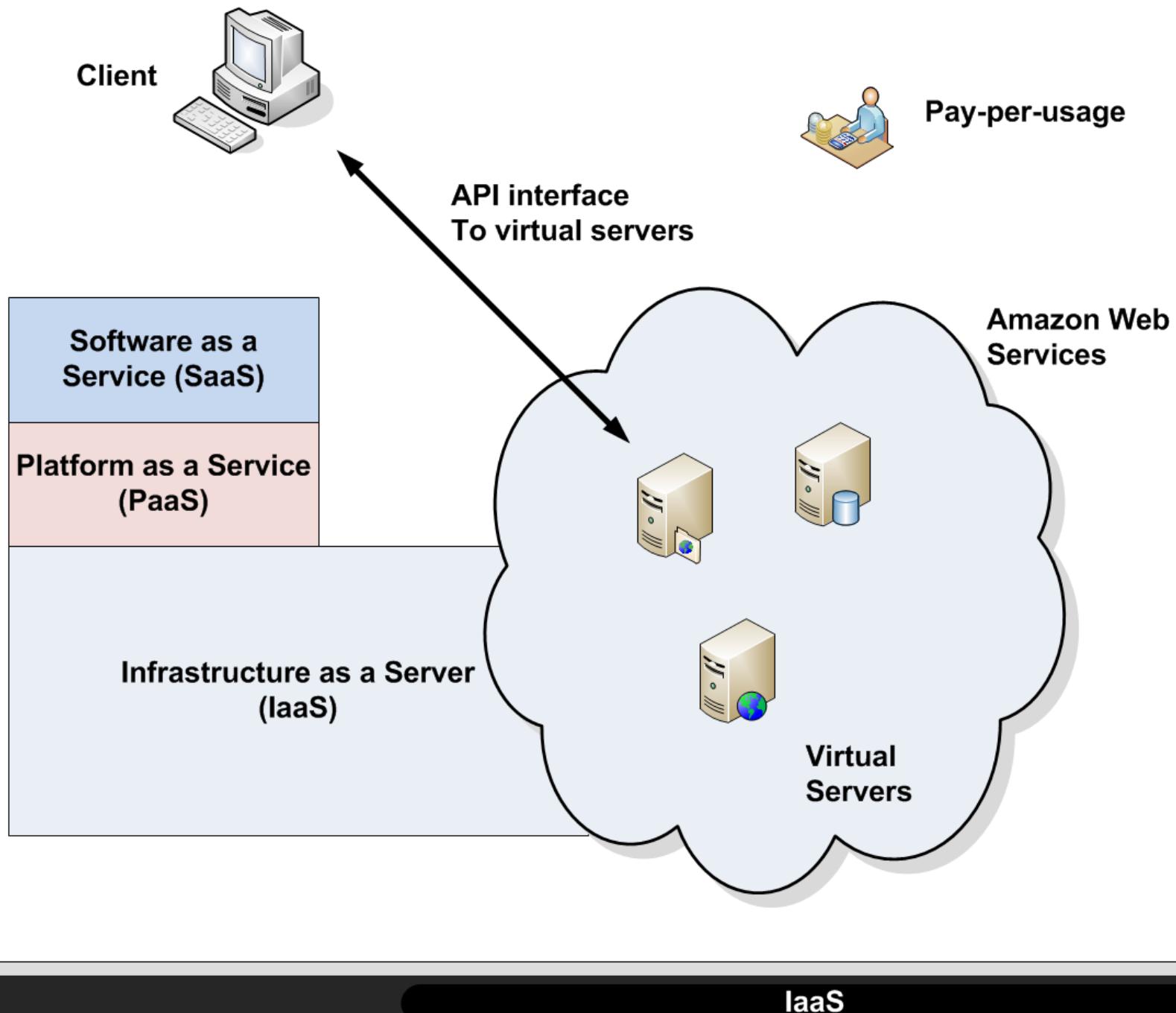
- Resource virtualisation
- Computing power
- Storage capacity
- Network bandwidth
- Usage-based payment scheme
- Cloud enablers, e.g. Amazon EC2 / S3

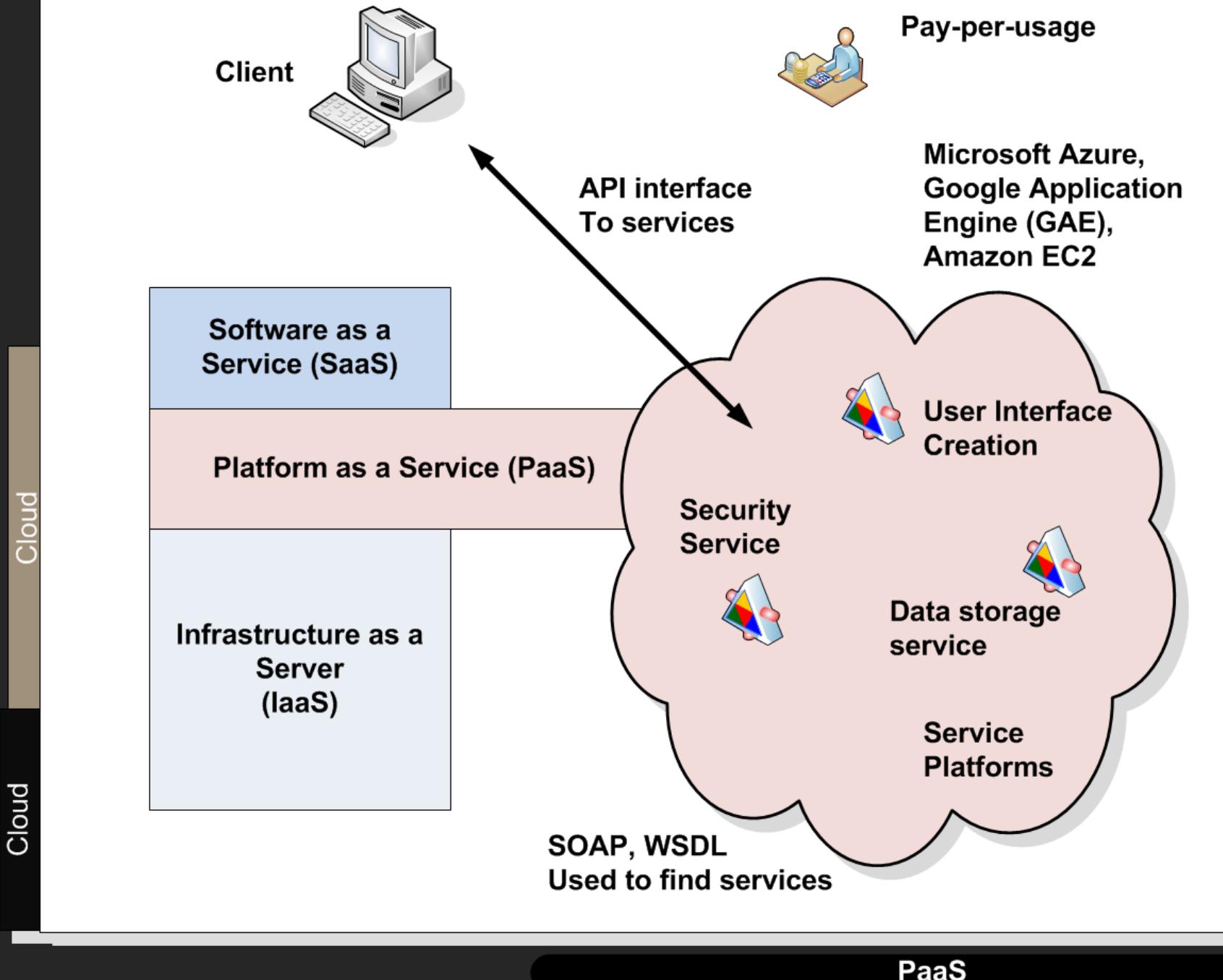
Hardware as a Service (HaaS)

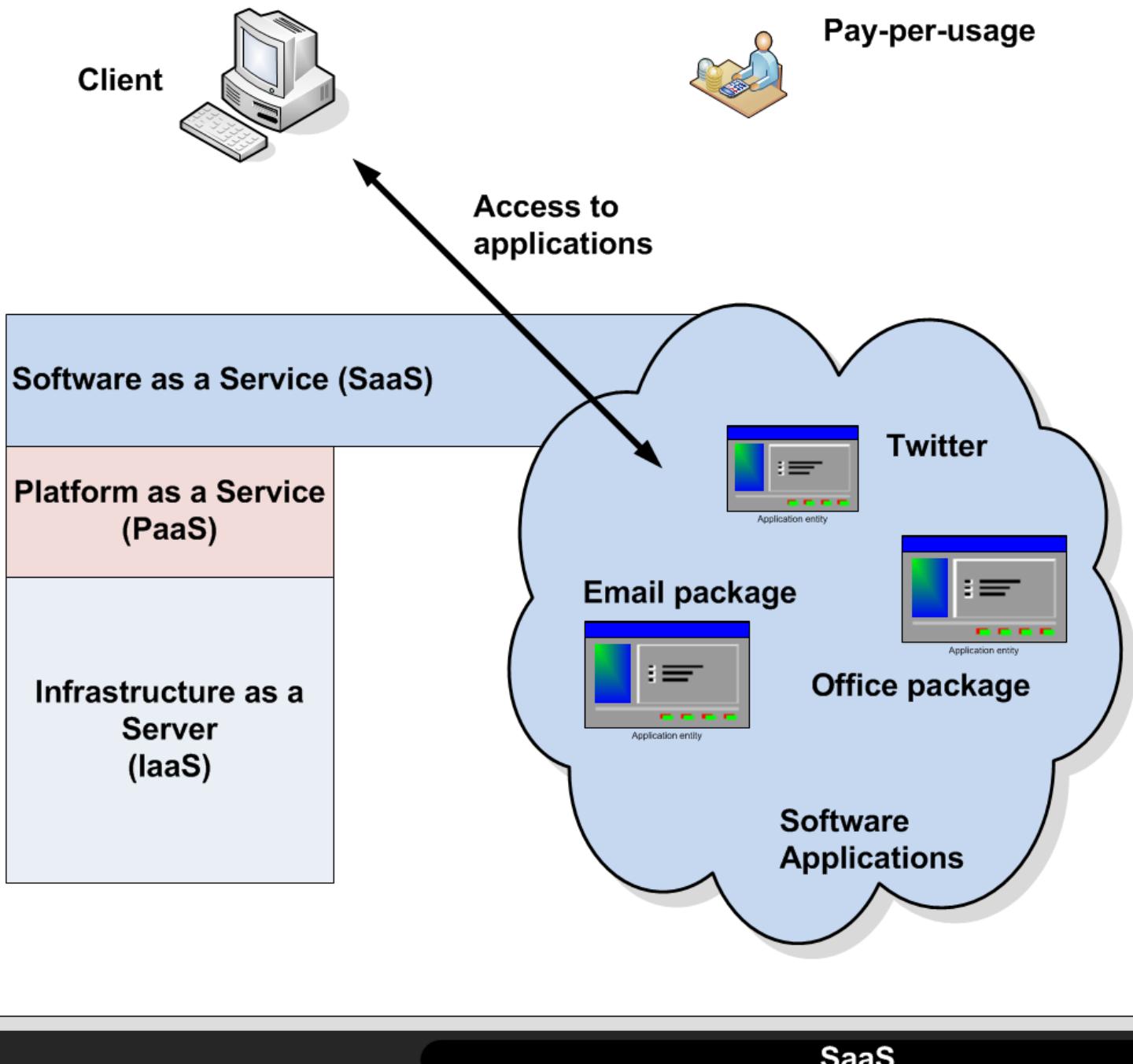
- Cluster & data centre providers
- Reduction of capital & operation investments
- Enhanced reliability – redundancy, replication & failover
- Enhanced scalability
- Enhanced load-balancing



Servers







Cloud Computing



Amazon EC2

Client**Amazon CloudFront**

This allows content to be placed close to the places where it is to be consumed, the content thus gets moved to the edge of the cloud to support rapid delivery of content.

Amazon Simple Queue Service (Amazon SQS).

This supports a grid infrastructure, where message can be passed to a queue, and then consumed by any subscribers.

Amazon SimpleDB

This produces a mixture of structured data storage with the reliability of a traditional database.

Amazon Elastic Cloud Compute (Amazon EC2)

This is the core of the Amazon Cloud, and provides a Web services API to create, manage and delete virtual servers within the Amazon Cloud. This includes US, Asia (Japan and Singapore) and European data centres (Ireland), and uses the Xen hypervisor for the management of the servers.

Amazon Virtual Private Cloud (VPC)

This allows for complete network infrastructures to be built, which are isolated from other network infrastructures

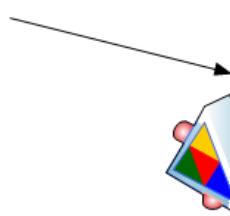
**Pay-per-usage****Amazon Simple Storage Service (Amazon S3).**

This provides data storage with web services through APIs. It differs from normal filesystems in that it does not have a hierarchical structure. Instead it uses buckets, which are unique namespaces across all of the Amazon customers. It is thus not a filesystem, and is a Web service, thus applications need to be written which specifically store data into the S3 Cloud.



Client

GET /login.html?name=Fred



GET /resource/myservice

Resource is identified by a URI

GET /resource/myservice

List members in a collection

POST /resource/myservice

CREATE a new member in a collection

GET /resource/myservice/elem111

READ a member in a collection

PUT /resource/myservice/elem111

UPDATE a member in a collection

DELETE /resource/myservice/elem111

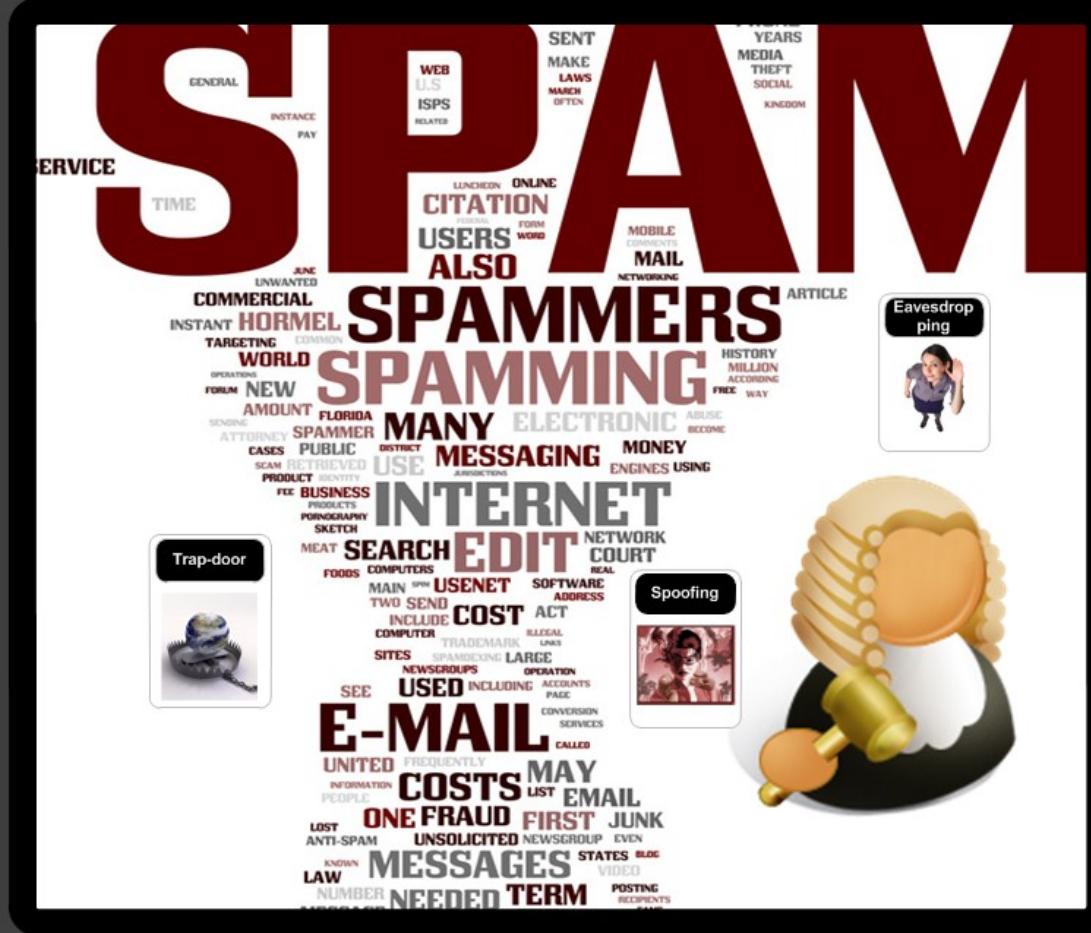
DELETE a member in a collection

- REST defines a set of architectural principles that focus on a system's resources.
- Is stateless, and focuses on how to define states using HTTP.
- Used by Yahoo, Facebook, Amazon, Microsoft Azure, etc.
- A lightweight alternative to SOAP/WSDL.

Web Service

C
R
U
D
e
a
p
e
l
e
t

Cloud Computing



Amazon E3

Client

Amazon Simple Storage Service (Amazon S3).

This provides data storage with web services through APIs. It differs from normal filesystems in that it does not have a hierarchical structure. Instead it uses buckets, which are unique namespaces across all of the Amazon customers. It is thus not a filesystem, and is a Web service, thus applications need to be written which specifically store data into the S3 Cloud.

**Pay-per-usage**

\$0.150 per GB - first 50 TB / month of storage used

```
s3cmd mb s3://bill.bucket
s3cmd put myfile.mp3 s3://bill.bucket/myfile.mp3
s3cmd get s3://bill.bucket/myfile.mp3 myfile.mp3

s3cmd ls
s3cmd ls s3://bill.bucket/

s3cmd delete s3://bill.bucket/myfile.mp3
s3cmd mb s3://bill.bucket
```

```
napier@ubuntu:~$ s3cmd ls
2010-03-08 20:44    s3://akiaiwumttazyst2i2aa-test-bucket12083
2010-03-09 08:17    s3://akiaiwumttazyst2i2aa-test-bucket13695
2010-03-09 08:18    s3://akiaiwumttazyst2i2aa-test-bucket17966
2010-03-08 20:42    s3://akiaiwumttazyst2i2aa-test-bucket25165
2010-03-08 20:43    s3://akiaiwumttazyst2i2aa-test-bucket27774
2010-03-08 20:44    s3://akiaiwumttazyst2i2aa-test-bucket31130
2010-03-08 20:42    s3://akiaiwumttazyst2i2aa-test-bucket39674
2010-03-09 12:16    s3://bill.bucket
napier@ubuntu:~$ s3cmd mb s3://bill.bucket2
Bucket 's3://bill.bucket2' created
napier@ubuntu:~$ s3cmd put test.txt s3://bill.bucket2/test.txt
test.txt -> s3://bill.bucket2/test.txt [1 of 1]
  15 of 15 100% in   0s   25.08 B/s done
napier@ubuntu:~$ s3cmd ls s3://bill.bucket2
2010-03-09 18:06      15    s3://bill.bucket2/test.txt
napier@ubuntu:~$ s3cmd ls s3://bill.bucket2
2010-03-09 18:06      15    s3://bill.bucket2/test.txt
napier@ubuntu:~$ s3cmd get s3://bill.bucket2/test.txt 1.txt
s3://bill.bucket2/test.txt -> 1.txt [1 of 1]
  15 of 15 100% in   0s   24.16 B/s done
napier@ubuntu:~$ s3cmd del s3://bill.bucket2/test.txt
File s3://bill.bucket2/test.txt deleted
napier@ubuntu:~$ s3cmd rb s3://bill.bucket2
Bucket 's3://bill.bucket2' removed
napier@ubuntu:~$ s3cmd ls
2010-03-08 20:44    s3://akiaiwumttazyst2i2aa-test-bucket12083
2010-03-09 08:17    s3://akiaiwumttazyst2i2aa-test-bucket13695
2010-03-09 08:18    s3://akiaiwumttazyst2i2aa-test-bucket17966
2010-03-08 20:42    s3://akiaiwumttazyst2i2aa-test-bucket25165
2010-03-08 20:43    s3://akiaiwumttazyst2i2aa-test-bucket27774
2010-03-08 20:44    s3://akiaiwumttazyst2i2aa-test-bucket31130
2010-03-08 20:42    s3://akiaiwumttazyst2i2aa-test-bucket39674
2010-03-09 12:16    s3://bill.bucket
```



Amazon Simple Storage Service (Amazon S3).

Provides data storage in web services through buckets. It differs from normal systems in that it does not have a hierarchical structure. Instead it uses buckets, which are unique namespaces across all of Amazon customers. It is not a filesystem, and is a Web service, thus applications need to be written which specifically write data into the S3 Cloud.

Cloud Computing



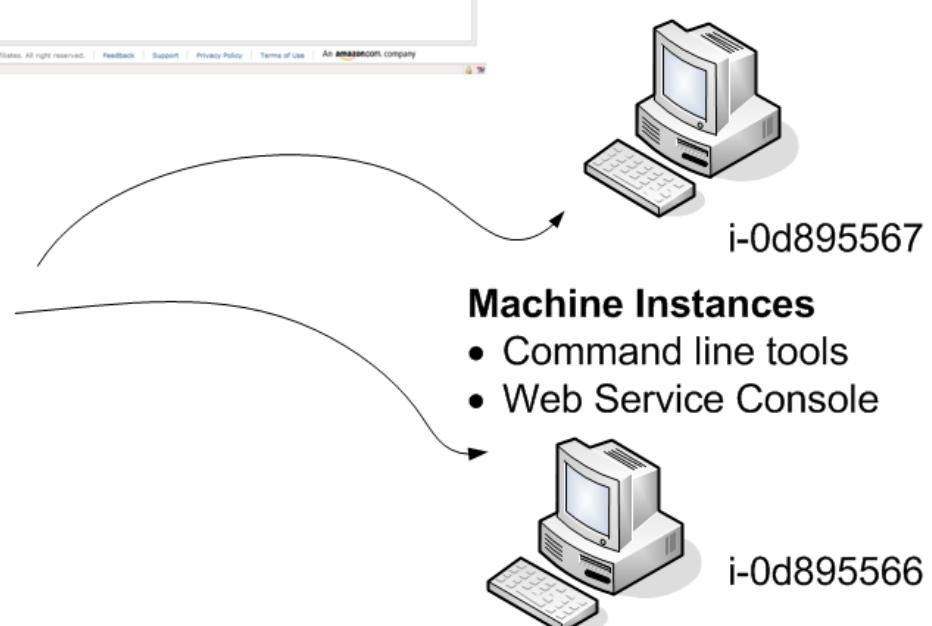
Amazon EC2

AWS Management Console - Mozilla Firefox
https://console.aws.amazon.com/ec2/home?region=US_EAST_1
 AWS Management Console | Mail Folder
www.amazon.com AWS Products Developers Community Support Account
 Welcome, Dr William Buchanan Settings Sign Out
 Amazon EC2 Amazon Simple Queue Service Amazon CloudFront
 Navigation Region: US East (Virginia)
EC2 Dashboard
 Instances 1 Instances 1 Launch Instance
 Images 0 AMIs 0 Bundle Tasks
 Volumes 2 Snapshots 0
 Networking & Security 0 Elastic IPs 2 Security Groups 0 Key Pairs 0 Load Balancers
 Service Health Current Status Details Service is operating normally View complete service health details
 My Resources You are using the following Amazon EC2 resources in the US East (Virginia) region.
 1 Running Instance 0 Elastic IPs
 2 EBS Volumes 0 EBS Snapshots
 1 Key Pair 2 Security Groups
 0 Load Balancers
 Related Links Documentation All EC2 Resources Forums Feedback Report an Issue



Amazon Machine Images (AMI)

e2-204-236-198-170.compute-1.amazonaws.com - Remote Desktop Done
 Administrator
 Computer
 Network
 Internet Explorer
 Control Panel
 Server Manager
 File Action View Help
 Roles
 Roles Summary View the health of the roles installed on your server and add or remove roles and features.
 Roles: 1 of 17 installed
 Web Server (IIS)
 Provides a reliable, manageable, and scalable Web application infrastructure.
 Role Status Message: None
 System Services: 3 Running, 1 Stopped
 Events: 1 informational in the last 24 hours
 Role Services: 20 installed
 Role Service Status
 Basic Web Server Uninstalled
 Common HTTP Features Uninstalled
 Static Content Installed



```
$ ec2-describe-images -o AKIAIWUMTTAZYST2I2AA
$ ec2-describe-images
IMAGE ami-45c22e2c powerdns/image.manifest.xml 495219933132 available private
$ ec2-run-instances i-0d895566
```



Client

Amazon Elastic Cloud Compute (Amazon EC2)

This is the core of the Amazon Cloud,

AWS Management Console - Mozilla Firefox
File Edit View History Bookmarks Tools Help
amazon.com https://console.aws.amazon.com/ec2/home#c=EC2&s=Instances

AWS Management Console
aws.amazon.com AWS | Products | Developers | Community | Support | Account
Welcome, Dr William Buchanan | Settings | Sign Out

Amazon EC2 Amazon Elastic MapReduce Amazon CloudFront

Navigation
Region: US East
EC2 Dashboard
INSTANCES
Instances (selected)
Spot Requests
IMAGES
AMIs
Bundle Tasks
ELASTIC BLOCK STORE
Volumes
Snapshots
NETWORKING & SECURITY
Elastic IPs
Security Groups
Key Pairs
Load Balancers

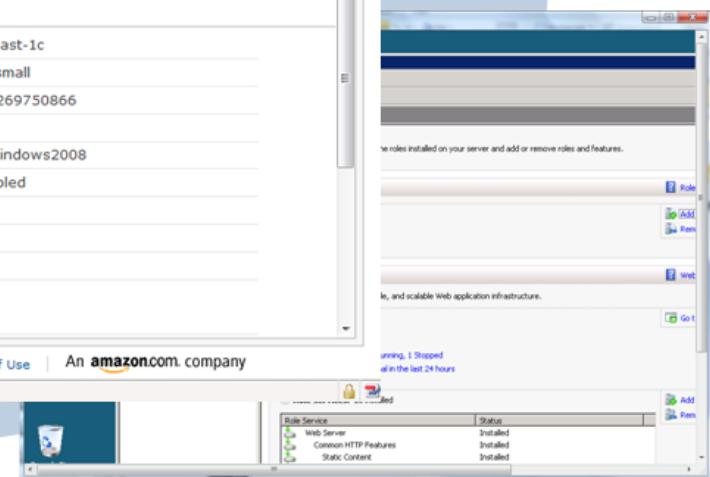
My Instances
Viewing: All Instances All Instance Types
Instance AMI ID Root Device Type Type Status Lifecycle Public DNS Security Groups Key Pair Name
i-0d895566 ami-45c22e2c ebs m1.small running normal ec2-204-236-199-96.compute-1.amazonaws.com bill billwindows2

EC2 Instance: i-0d895566
Description Monitoring
AMI ID: ami-45c22e2c Zone: us-east-1c
Security Groups: bill Type: m1.small
Status: running Owner: 103269750866
Reservation: r-fcd18794 Ramdisk ID: -
Platform: windows Key Pair Name: billwindows2008
Kernel ID: - Monitoring: enabled
AMI Launch Index: 0 Elastic IP: -
Root Device: /dev/sda1 Root Device Type: ebs
Block Devices: /dev/sda1=vol-49e43920:attached:2010-03-07T19:58:20.000Z:true
Lifecycle: normal
Public DNS: ec2-204-236-199-96.compute-1.amazonaws.com

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on
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usage



Cloud

Client

The diagram shows a Client computer connected to an Amazon Elastic Cloud Compute (Amazon EC2) instance. The Client is represented by a computer monitor, keyboard, and mouse. The Amazon EC2 instance is shown as a rectangular box labeled "Amazon Elastic Cloud Compute (Amazon EC2)". A blue arrow points from the Client to the Amazon EC2 instance. To the right of the Client, there is a "Remote Desktop Connection" window. The window title is "Remote Desktop Connection". Inside the window, the "Computer:" field contains the IP address "ec2-204-236-199-96.compute-1.amazonaws.com" and the "Username:" field contains "Administrator". Below the window, the text "amazon web servers" is visible.

AWS Management Console - Mozilla Firefox

Amazon EC2

Security Groups

Region: US East

Instances

EC2 Dashboard

Images

Networking & Security

Elastic IPs

Security Groups

Key Pairs

Load Balancers

Navigation

Viewing: All Security Groups

Name	Description
bill	bill
default	default group

1 Security Group selected

Group Name: bill
Description: bill

Allowed Connections:

Connection Method	Protocol	From Port	To Port	Source (IP or group)	Actions
RDP	tcp	3389	3389	0.0.0.0/0	Remove
HTTP	TCP	80	80	0.0.0.0/0	Save

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Untitled Document - Mozilla Firefox

Untitled Document

This is a simple page.

Done

Amazon Web Services

Cloud Computing



Amazon EC2 Programming

Amazon Elastic Compute Cloud - Mozilla Firefox
 File Edit View History Bookmarks Tools Help
 http://docs.amazonwebservices.com/AWSEC2/latest/CommandLineReference/index.html?Api
 Amazon Elastic Compute Cloud

Amazon Elastic Compute Cloud
 Command Line Tools Reference (API Version 2009-11-30)

- Welcome
- What's New
- Getting the Command Line Tools
- AMI Tools Reference**
- API Command Line Tools Reference
 - Common Options for API Tools
 - List of Command Line Operations by Function
 - ec2-add-group
 - ec2-add-keypair
 - ec2-allocate-address
 - ec2-associate-address
 - ec2-attach-volume
 - ec2-authorize
 - ec2-bundle-instance
 - ec2-cancel-bundle-task
 - ec2-cancel-spot-instance-requests
 - ec2-confirm-product-instance
 - ec2-create-image
 - ec2-create-snapshot
 - ec2-create-

Documentation Feedback

ec2-describe-images

Description

Returns information about AMIs, AKIs, and ARIs. This includes image type, product codes, architecture, and kernel and RAM disk IDs. Images available to you include public images, private images that you own, and private images owned by other users for which you have explicit launch permissions.

Launch permissions fall into three categories:

Launch Permission	Description
public	The owner of the AMI granted launch permissions for the AMI to the <code>all</code> group. All users have launch permissions for these AMIs.
explicit	The owner of the AMI granted launch permissions to a specific user.
implicit	A user has implicit launch permissions for all AMIs he or she owns.

The list of AMIs returned can be modified by specifying AMI IDs, AMI owners, or users with launch permissions. If no options are specified, Amazon EC2 returns all AMIs for which the user has launch permissions.

If you specify one or more AMI IDs, only AMIs that have the specified IDs are returned. If you specify an invalid AMI ID, a fault is returned. If you specify an AMI ID for which you do not have access, it will not be included in the returned results.

If you specify one or more AMI owners, only AMIs from the specified owners and for which you have access are returned. The results can include the account IDs of the specified owners, `amazon` for AMIs owned by Amazon or `self` for AMIs that you own.

If you specify a list of executable users, only users that have launch permissions for the AMIs are returned. You can specify account IDs (if you own the AMI(s)), `self` for AMIs for which you own or have explicit permissions, or `all` for public AMIs.

Done

Roles: 1 of 17 installed

- Web Server (IIS)

Web Server (IIS)
 Provides a reliable, manageable, and scalable Web application infrastructure.

Role Status

Message: None
 System Services: 3 Running, 1 Stopped

Events: 1 Informational in the last 24 hours

Role Services: 20 installed

Role Service	Status
Web Server	Uninstalled
Common HTTP Features	Uninstalled
Static Content	Installed

Return images owned by a specific owner

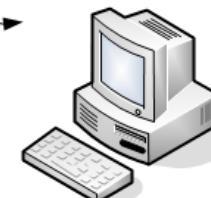
```
$ ec2-describe-images -o AKIAIWUMTTAZYST2I2AA
IMAGE ami-45c22e2c powerdns/image.manifest.xml 495219933132 available private
$ ec2-run-instances ami-45c22e2c -n 10
```



i-0d895567

Machine Instances

- Command line tools
- Web Service Console



i-0d895566

Cloud/Grid Computing

- Provide an introduction to cluster, grid and cloud infrastructures.
- Define an example of grid computing, and its advantages.
- Show an example of using a Cloud Infrastructure.
- Define the usage of Amazon Web Services, including S3 and the EC2 Cloud.
- Outline the usage of RESTful Web Services.

