Cloud/Grid Computing

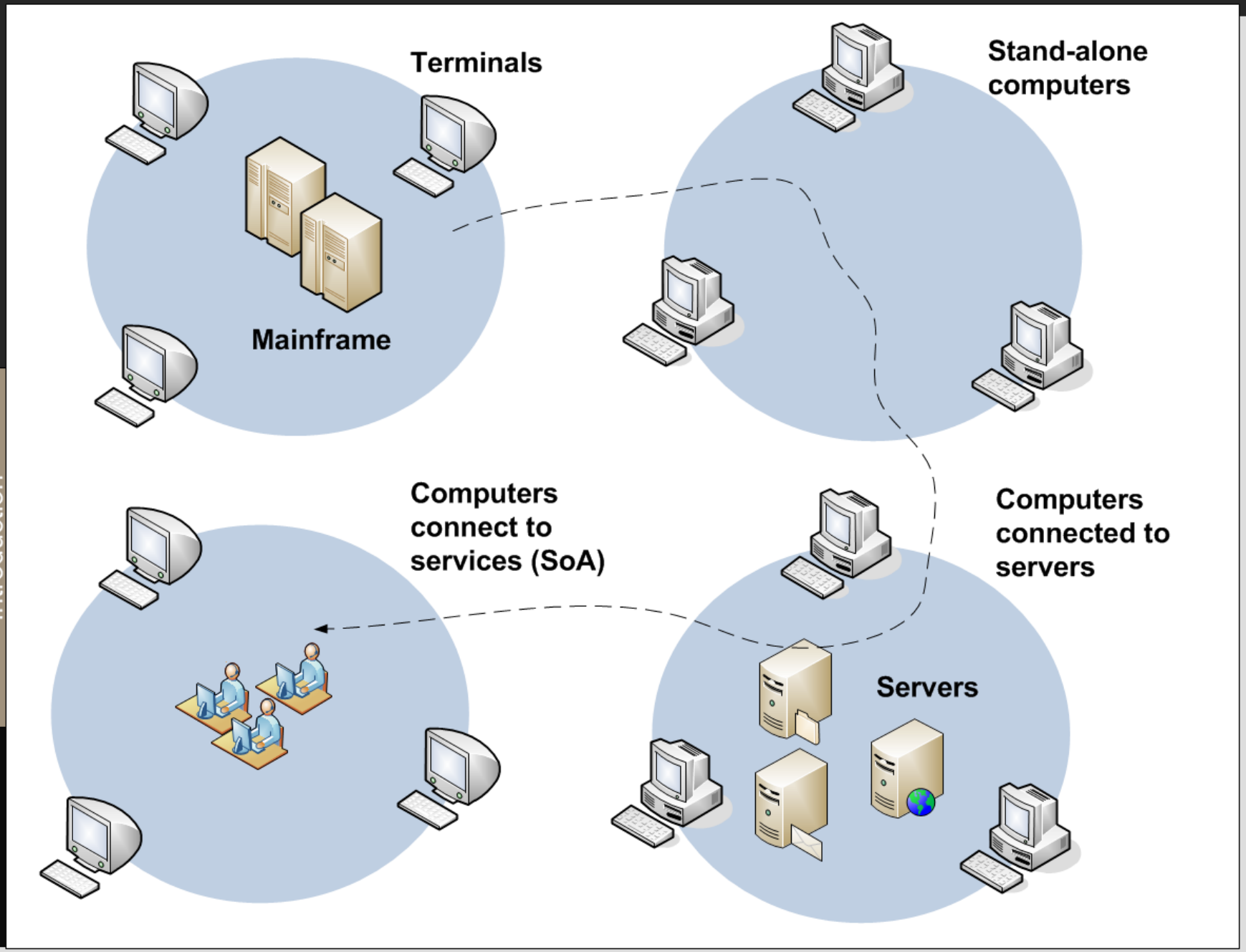
- Provide an introduction to cluster, grid and cloud infrastructures.
- Define an example of grid computing, and its advantages.
- Show an example of using a Cloud Infrastructure.
- Define the usage of Amazon Web Services, including S3 and the EC2 Cloud.
- Outline the usage of RESTful Web Services.

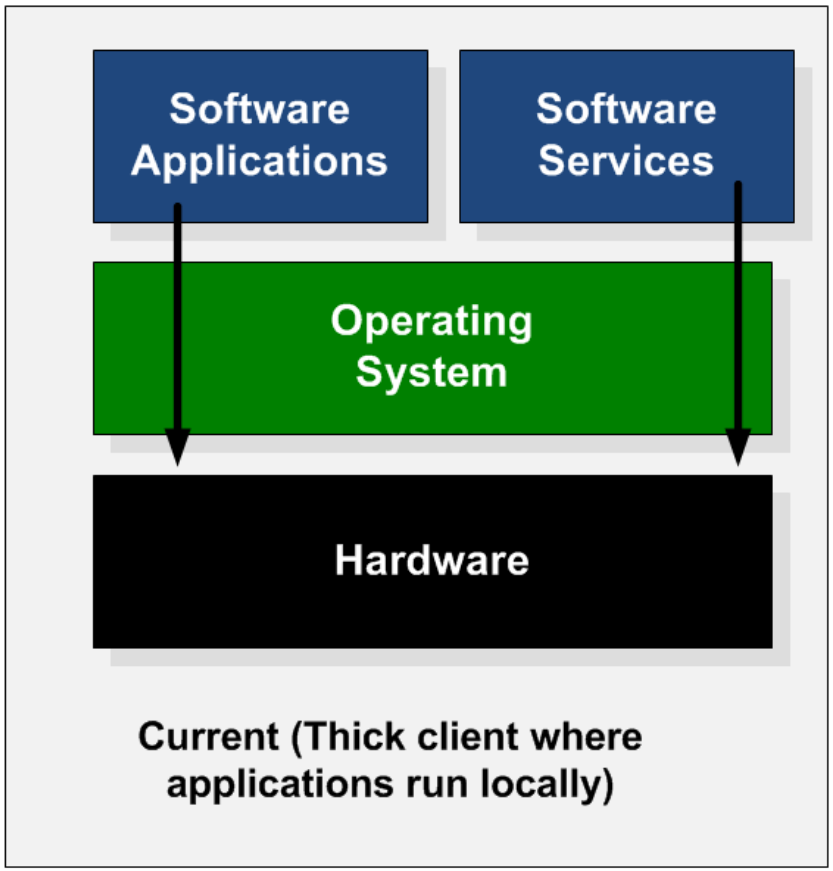
Author: Prof Bill Buchanan

Cloud Computing

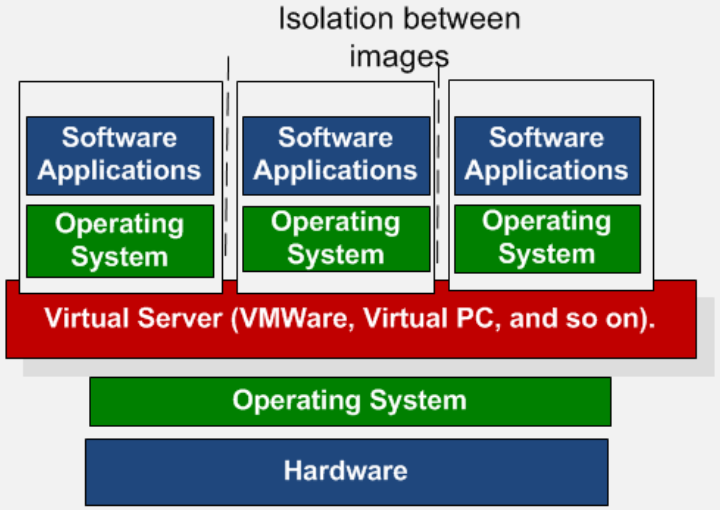
Introduction

Author: Prof Bill Buchanan


Terminals
Mainframe
Stand-alone computers
Computers connect to services (SoA)
Computers connected to servers
Servers

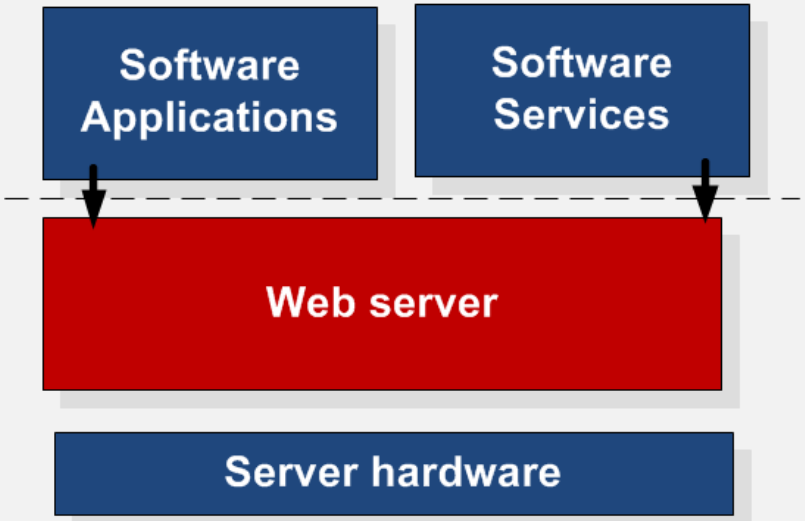


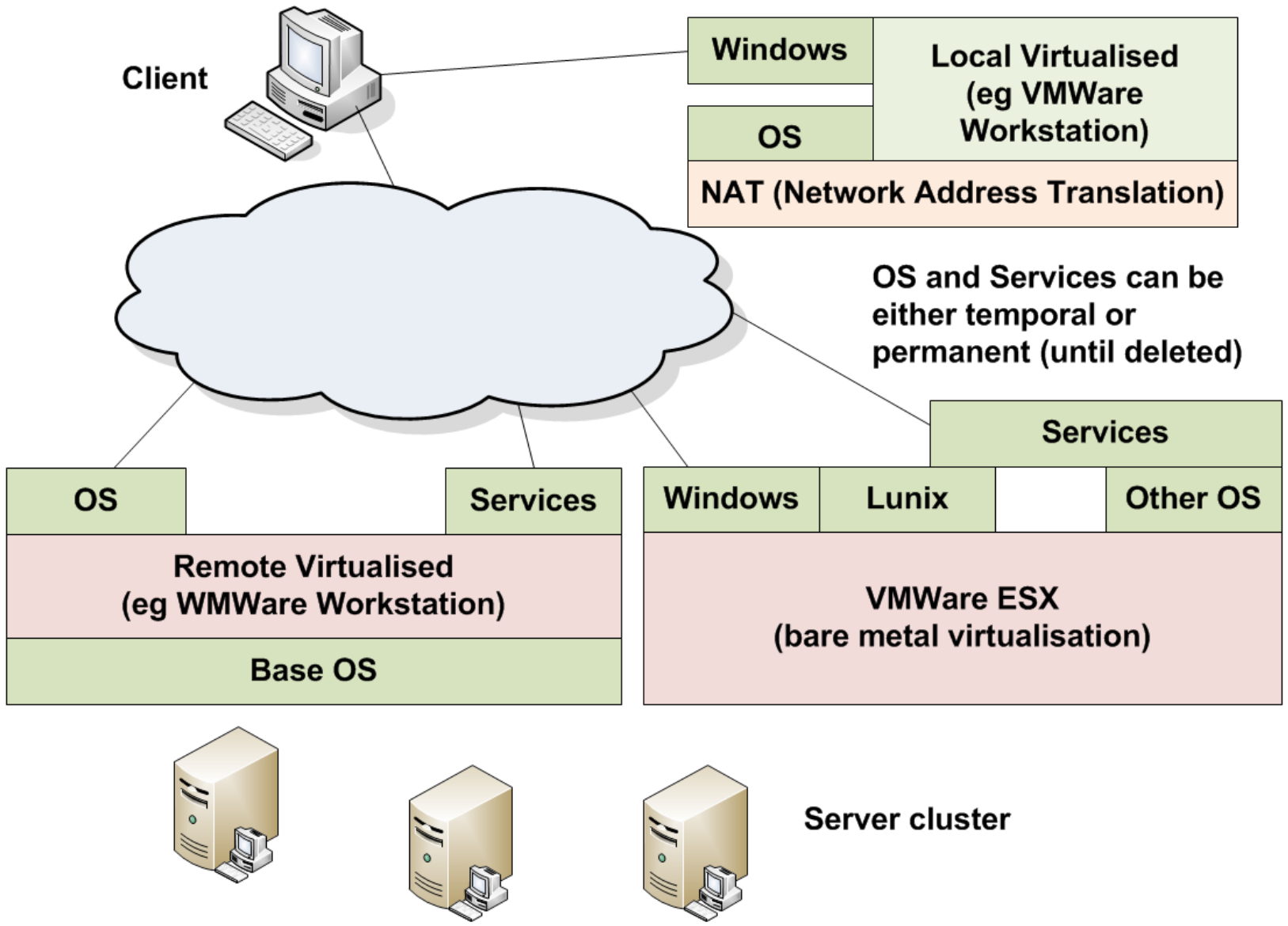
Current (Thick client where applications run locally)

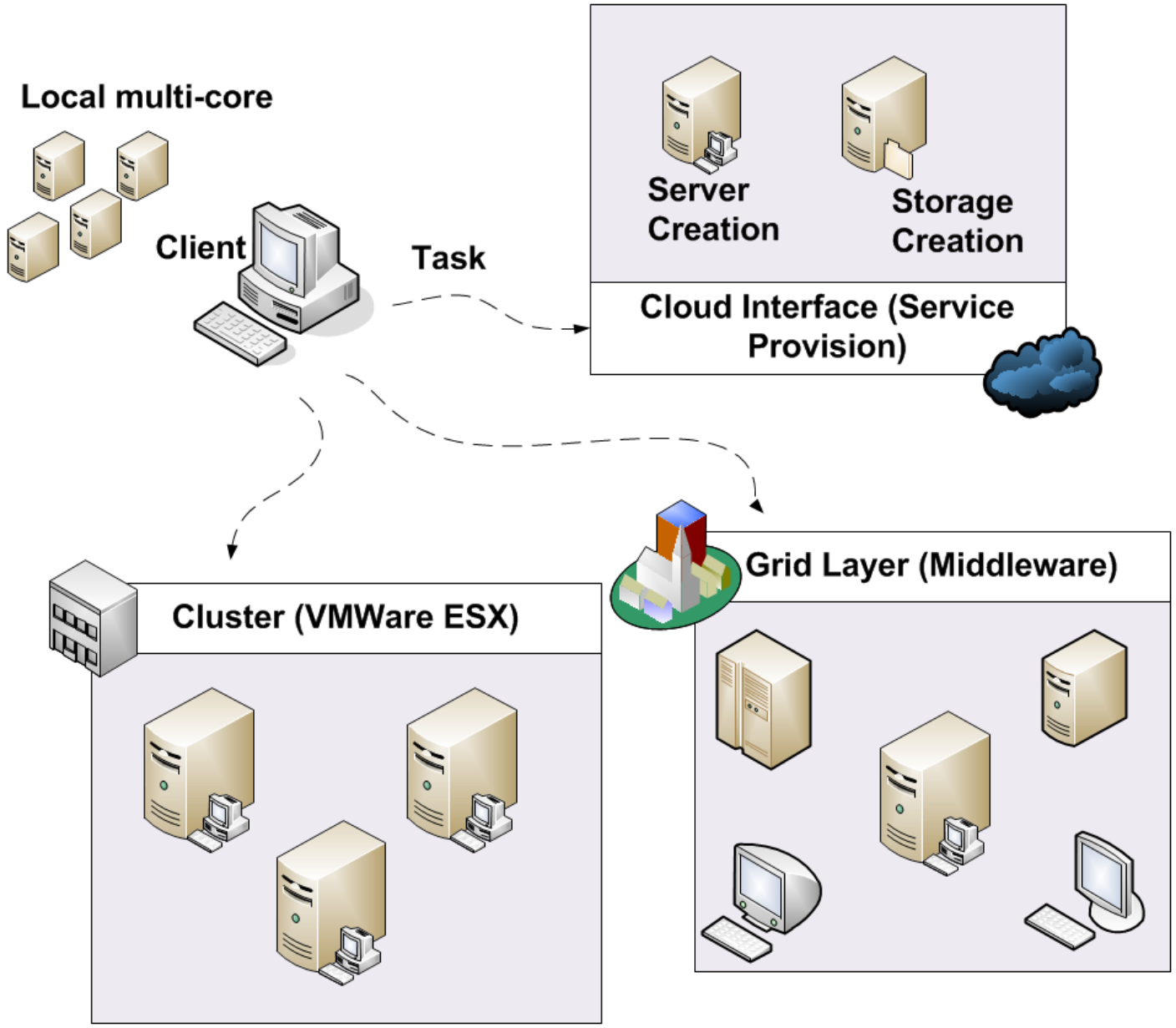


Virtualisation images allow multiple OSs to run on a single OS.

Future (Thin clients and Virtualisation)



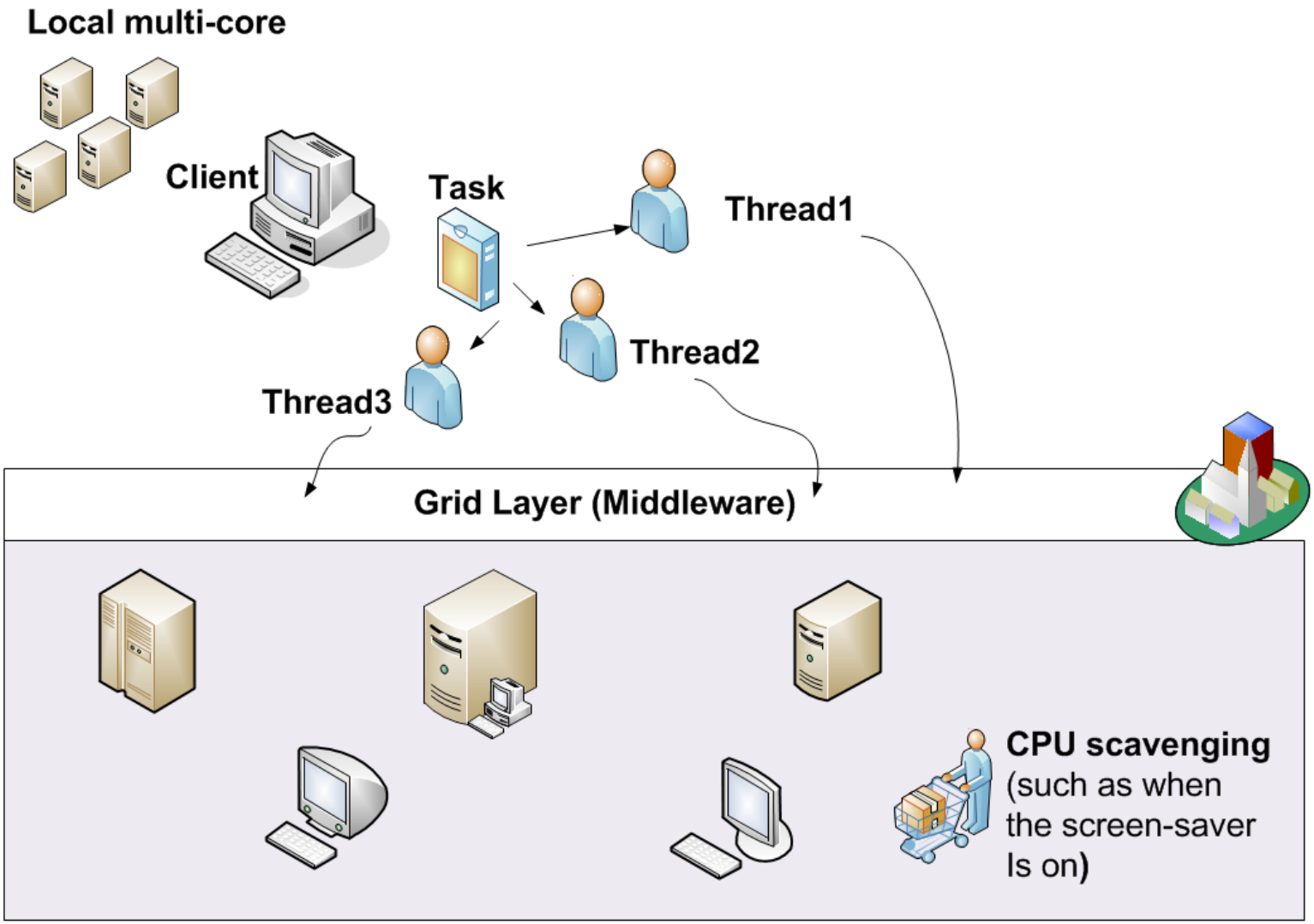

Client
Windows
OS
Local Virtualised
(eg VMWare
Workstation)
NAT (Network Address Translation)
OS and Services can be
either temporal or
permanent (until deleted)
Services
OS
Services
Windows
Lunix
Other OS
Remote Virtualised
(eg WMWare Workstation)
Base OS
VMWare ESX
(bare metal virtualisation)
Server cluster
Virtualisation
Cloud


Local multi-core
Client
Task
Server Creation
Storage Creation
Cloud Interface (Service Provision)
Cluster (VMWare ESX)
Grid Layer (Middleware)

Cloud Computing

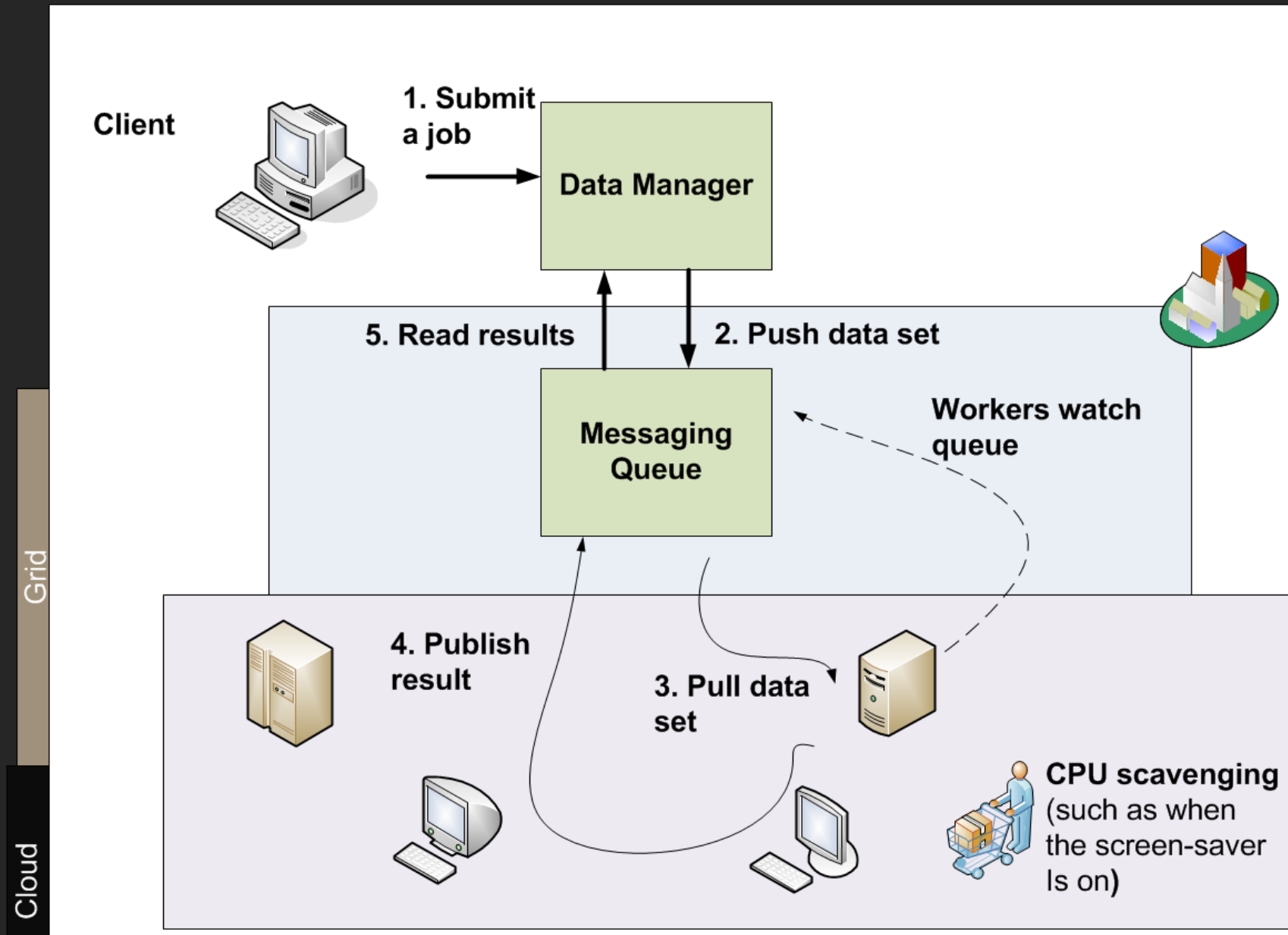
Grid Computing

Author: Prof Bill Buchanan


Local multi-core
Client
Task
Thread1
Thread2
Thread3
Grid Layer (Middleware)
CPU scavenging
(such as when
the screen-saver
Is on)

Grid

Cloud



Separating architecture from data processing nodes

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

18.4 million million million different keys
0000000000000….0000000000000000000
To
1111111111111….1111111111111111111

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

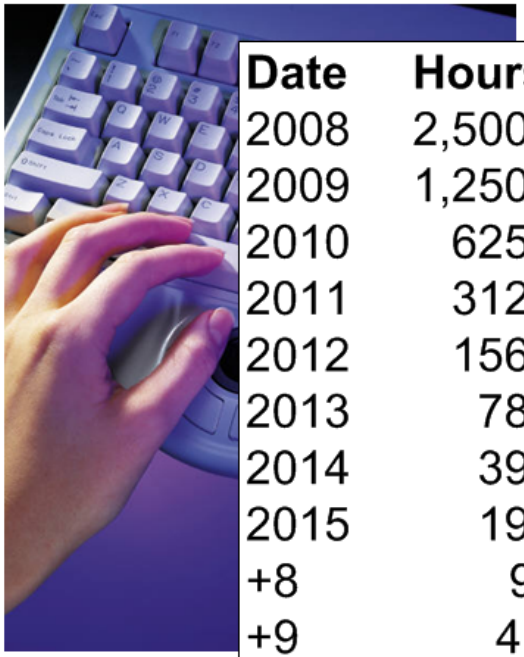
Grid

Cloud

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**

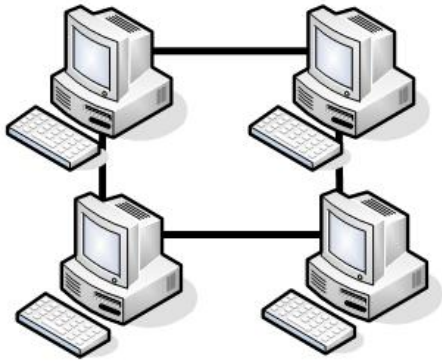
56-bit DES:
Developed
1975
30 years ago!
… now easily
crackable

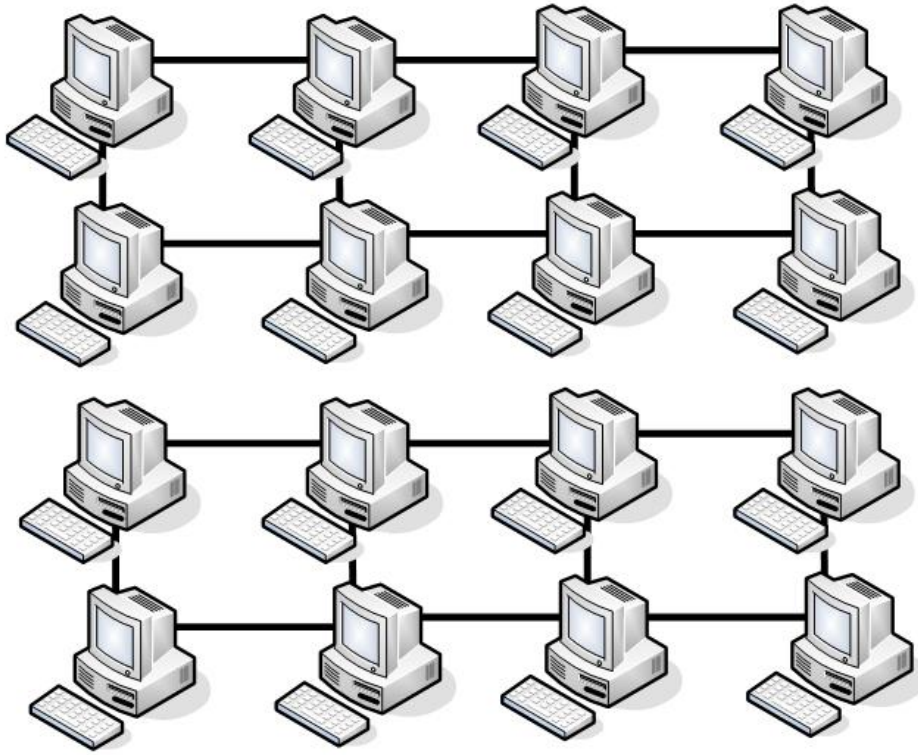
Grid

Cloud

2x1 =2 element array

2x2 =4 element array



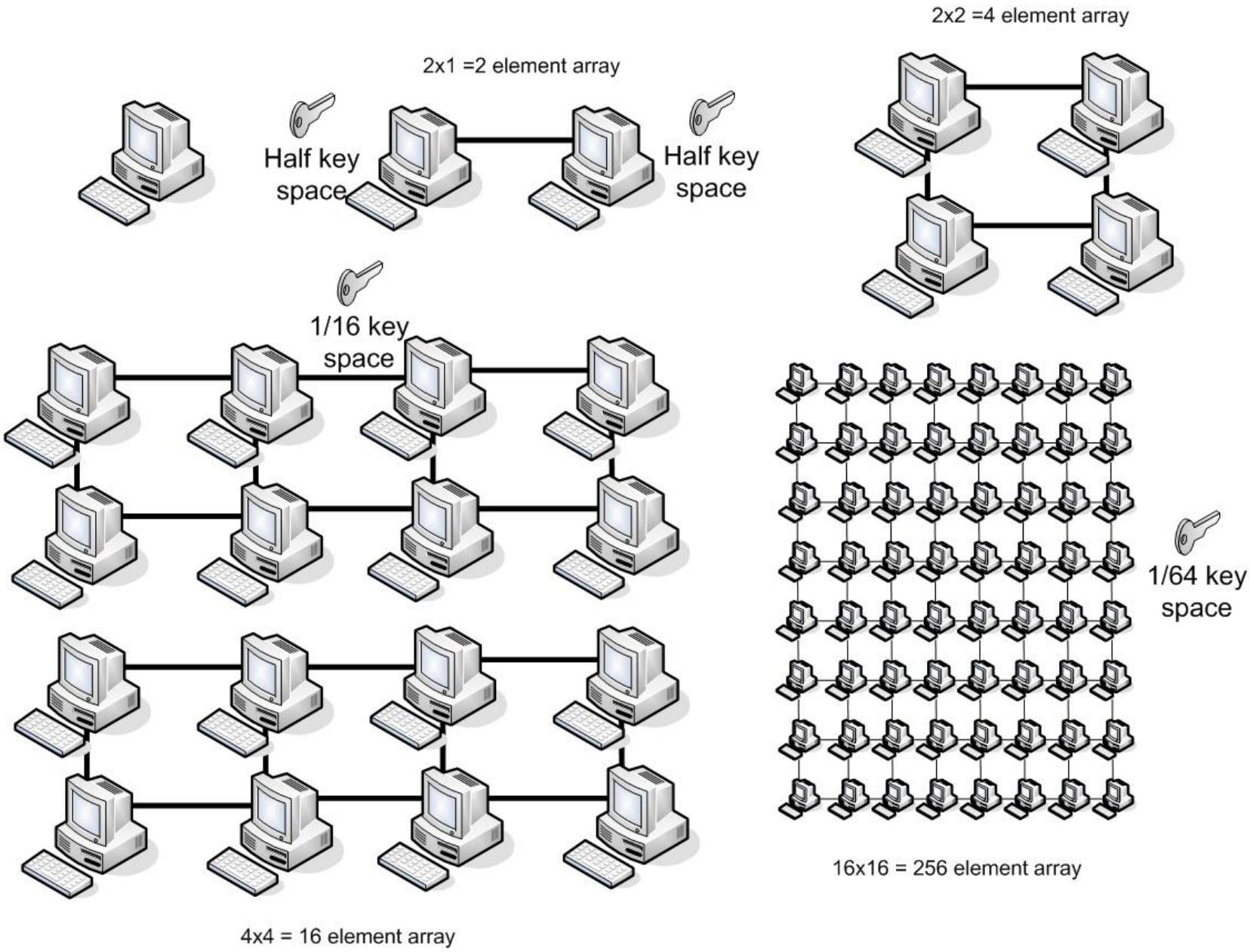


4x4 = 16 element array

16x16 = 256 element array

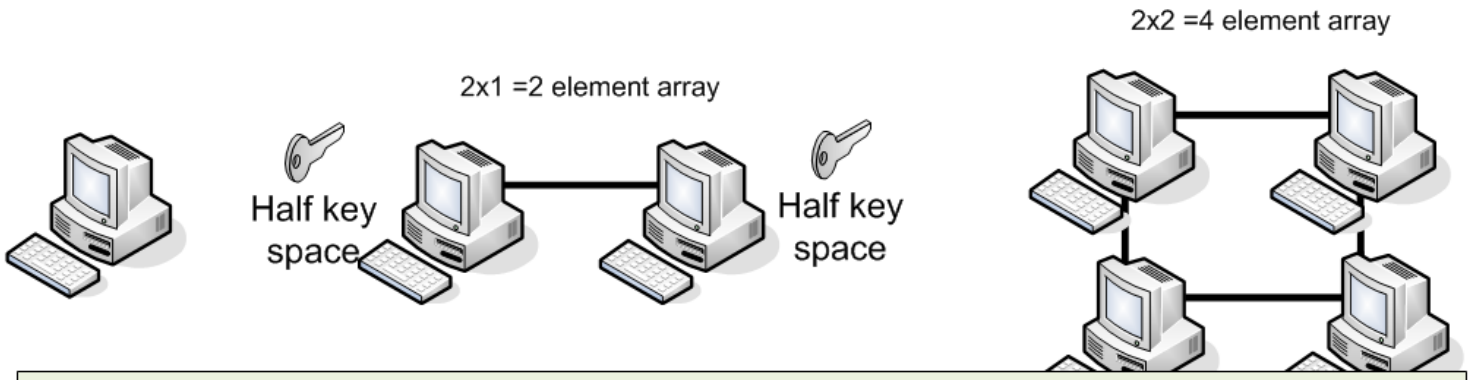
Grid

Cloud

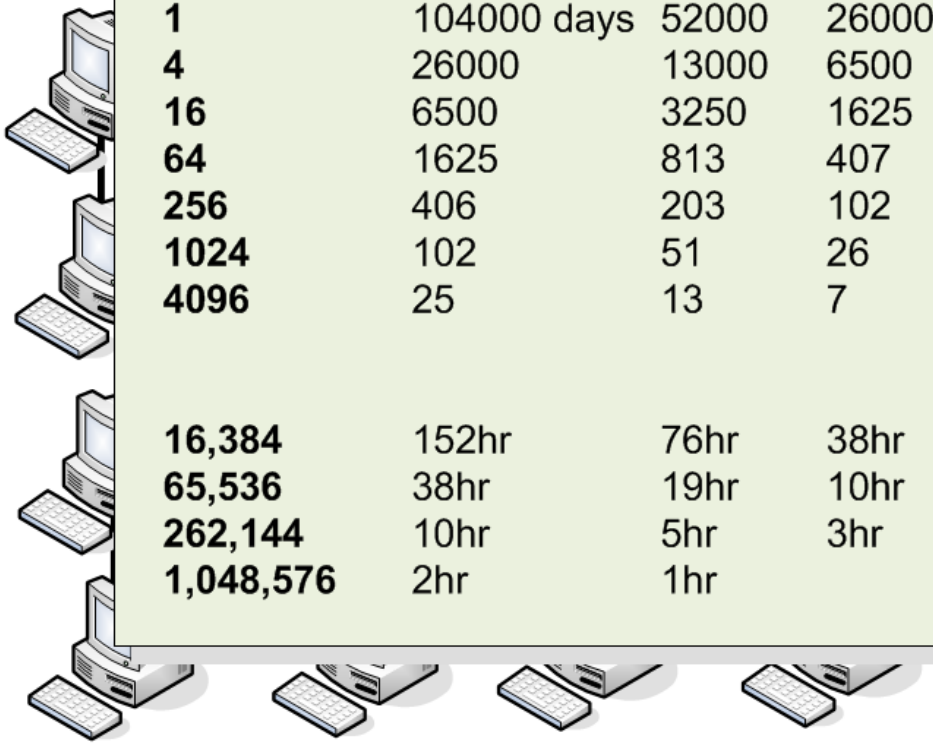

2x1 =2 element array
Half key space
Half key space
2x2 =4 element array
1/16 key space
4x4 = 16 element array
1/64 key space
16x16 = 256 element array

Grid

Cloud



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				



4x4 = 16 element array

16x16 = 256 element array

Author: Prof Bill Buchanan

Grid

Cloud

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.

1999. RSA Lab's 56-bit DES-III Encryption Challenge - after 22.5 hours using EFF's Deep Crack custom DES cracker.

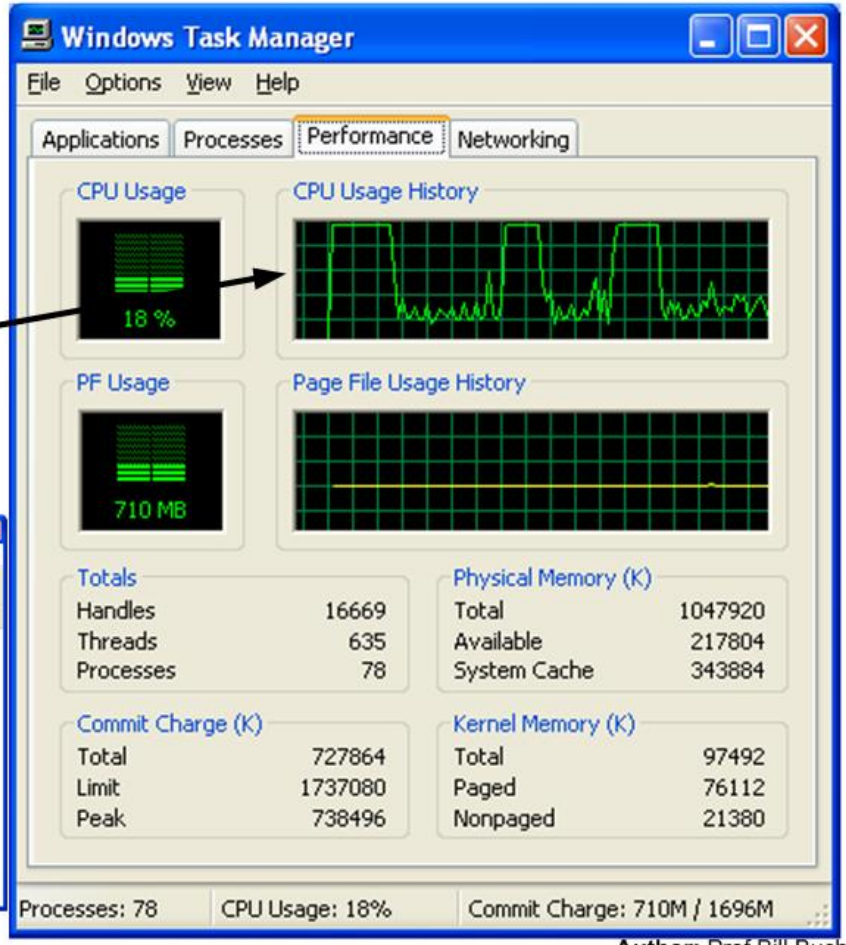
2002. RSA Lab's 64-bit RC5 Encryption Challenge — Completed 14 July 2002 – 1,757 days and 83% of the key space tested.

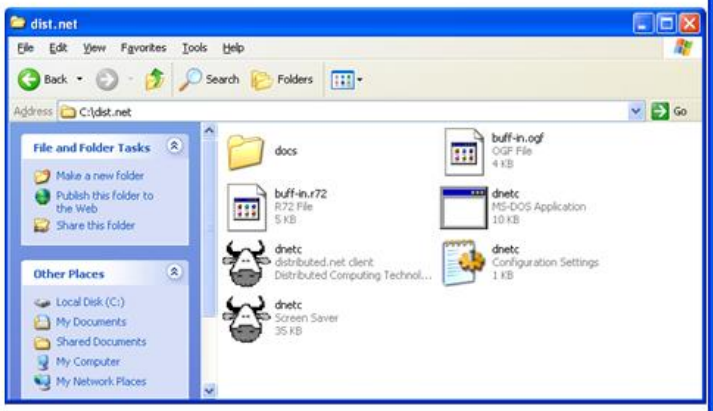
RSA Lab's 72-bit RC5 Encryption Challenge - In progress.

Grid

Cloud

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





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Cloud Computing

Cloud Computing

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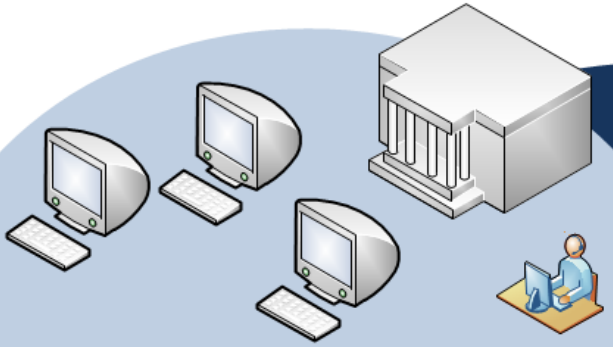
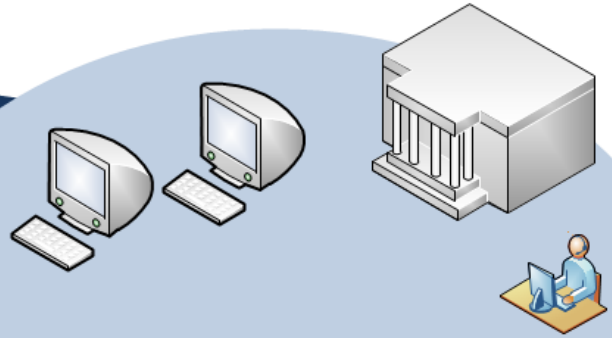
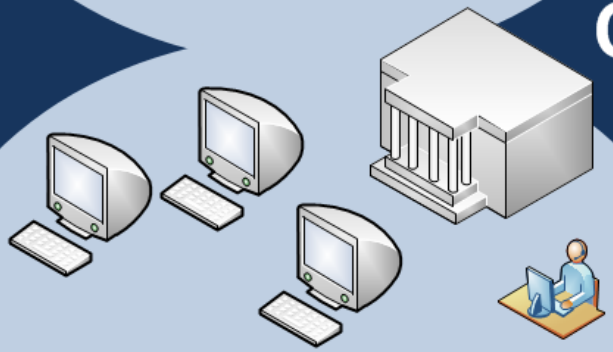


On-demand self-service. Consumers get server CPU, memory, bandwidth and storage resources whenever required.

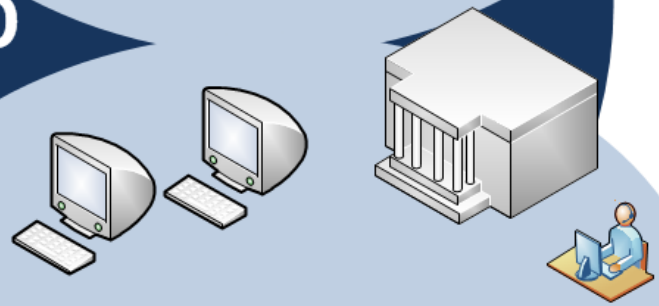


Location independent resource pooling. Multiple customers use shared resources within the provider, without actually knowing where the exact location of these are.

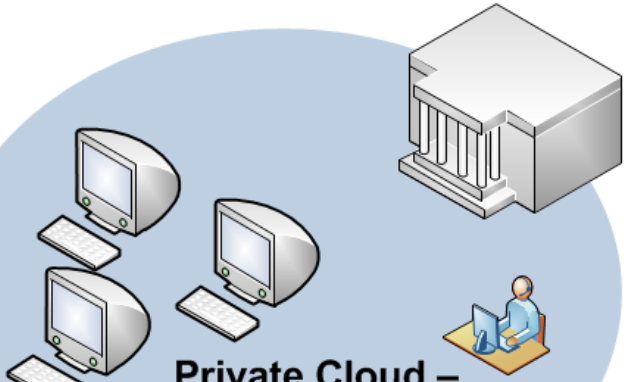
CLOUD



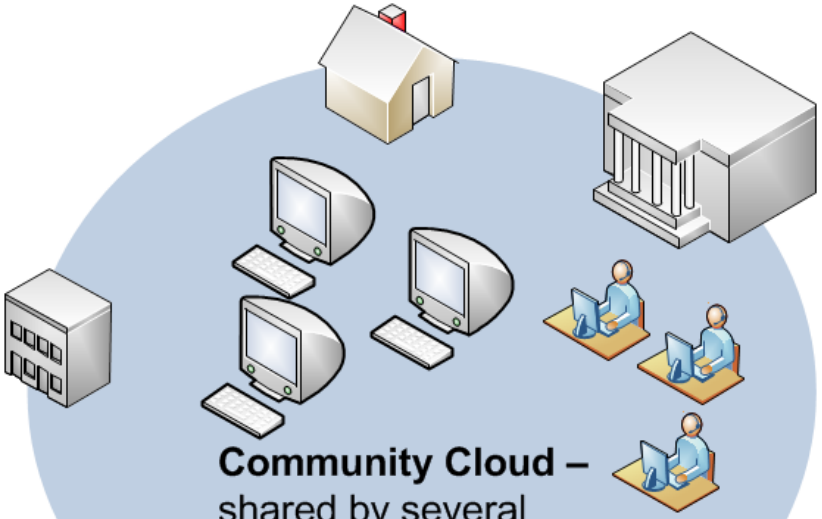
Rapid elasticity. Consumers can easily scale-up and scale-down, whenever required.



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.

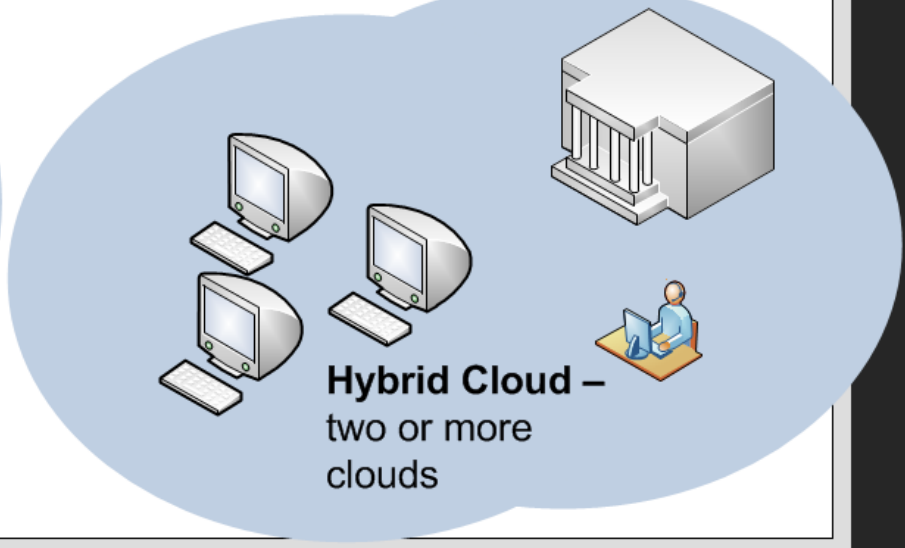


Private Cloud – owned and run by an organisation

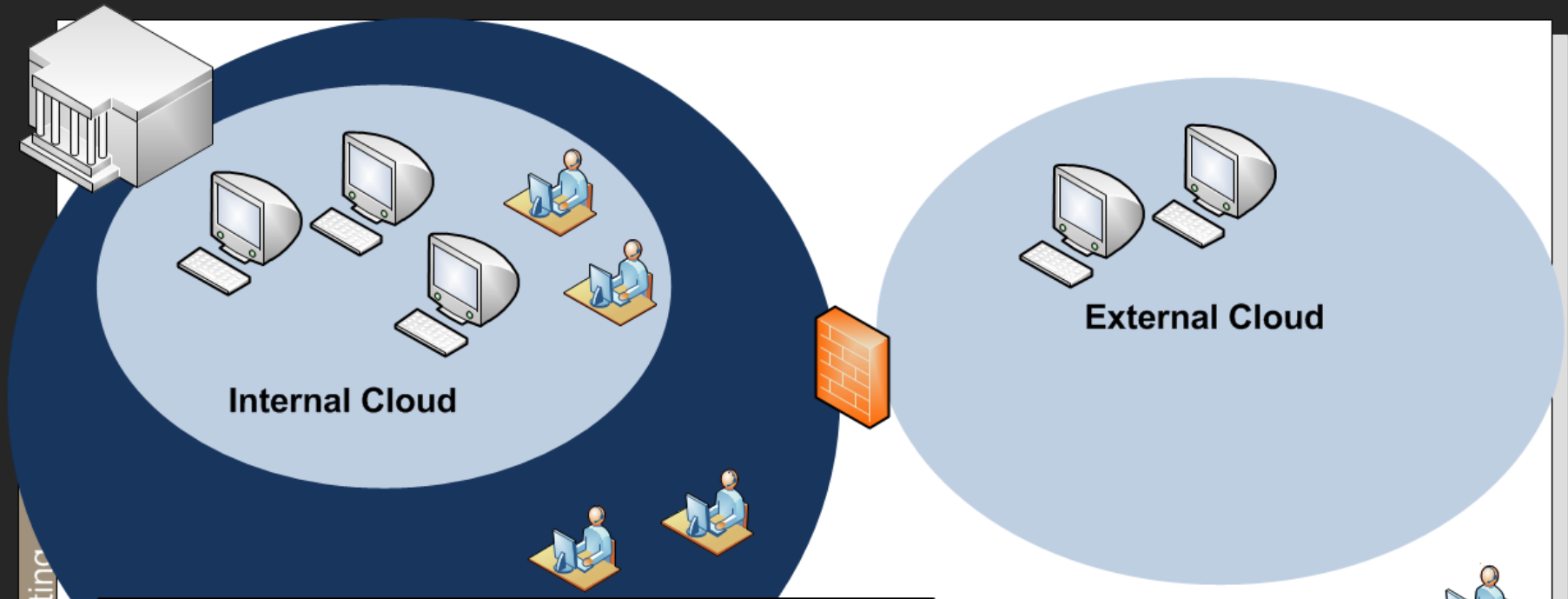


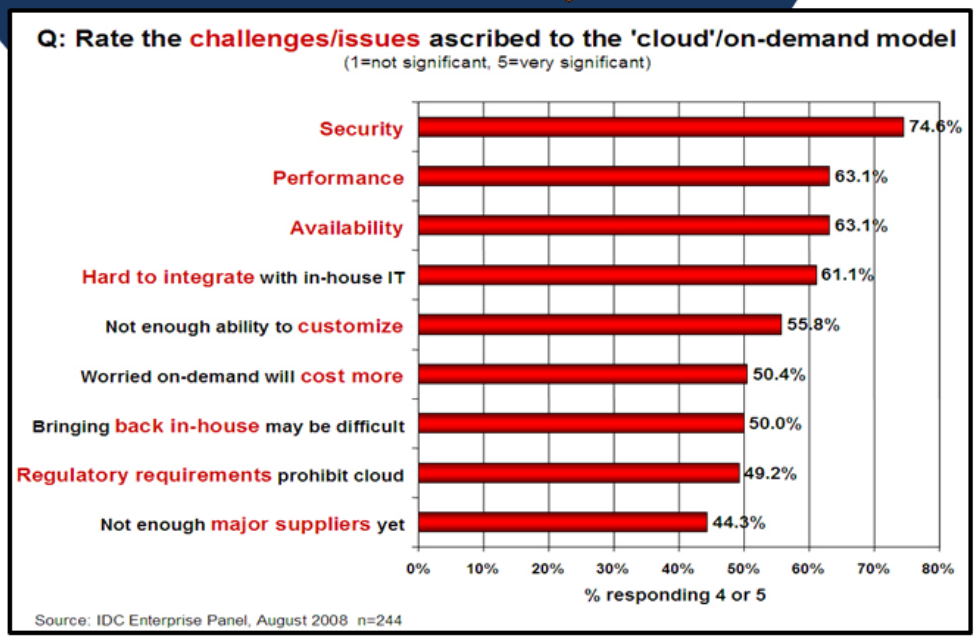
Community Cloud – shared by several organisation, with a common policy, compliance, mission, etc

Public Cloud – owned by an organisation selling a cloud infrastructure



Hybrid Cloud – two or more clouds





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?

Cloud Computing

Cloud

Client

Software as a Service (SaaS)

- User interface.
- Machine interface

Platform as a Service (PaaS)

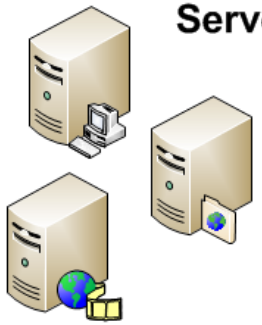
- Service Oriented Architecture (SOA)
- Sophisticated Web Services
- Developing
- Testing
- Deploying
- Hosting
- Service platform providers, e.g. Google GAE, Microsoft Windows Azure

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)

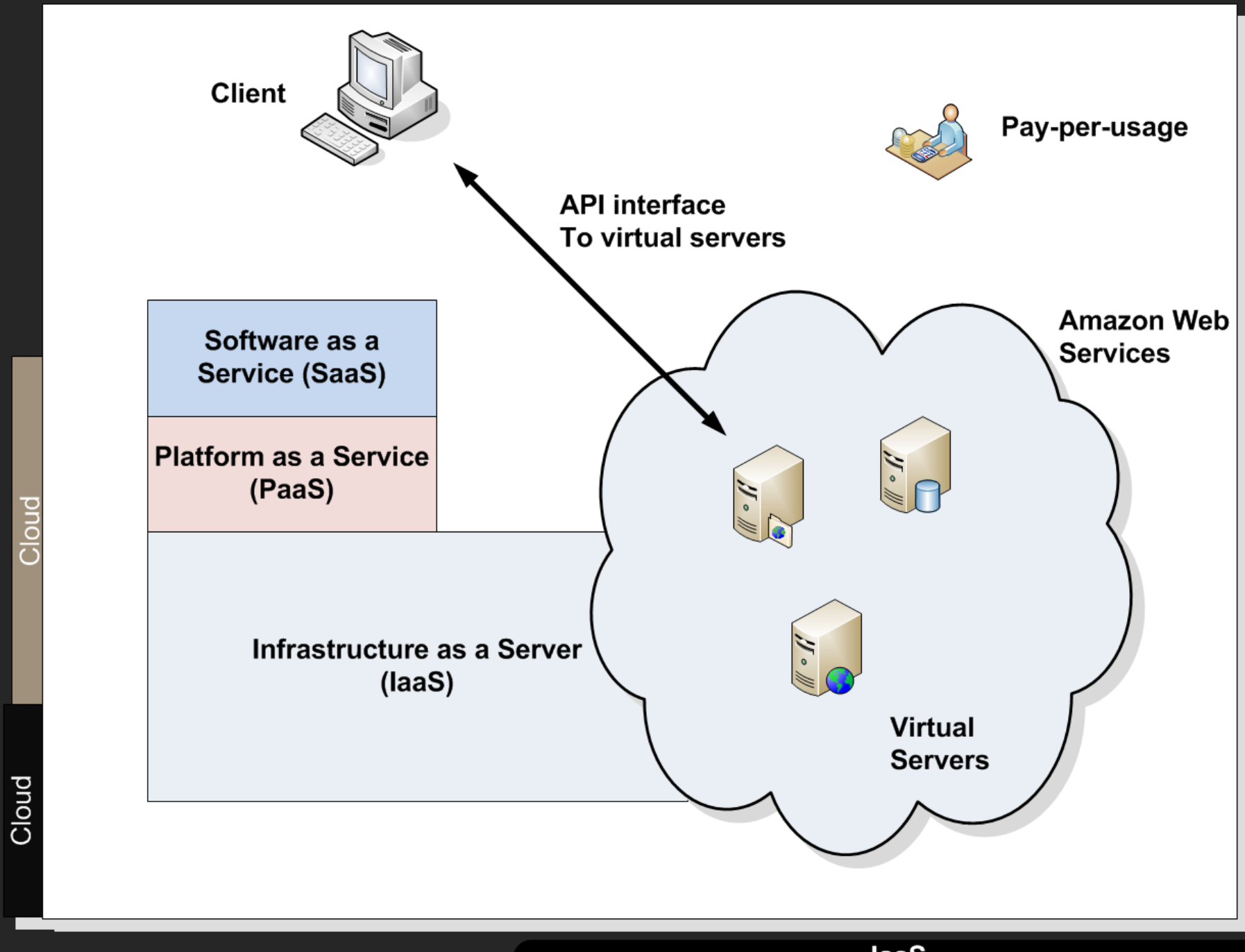
- Cluster & data centre providers
- Reduction of capital & operation investments
- Enhanced reliability – redundancy, replication & failover
- Enhanced scalability
- Enhanced load-balancing

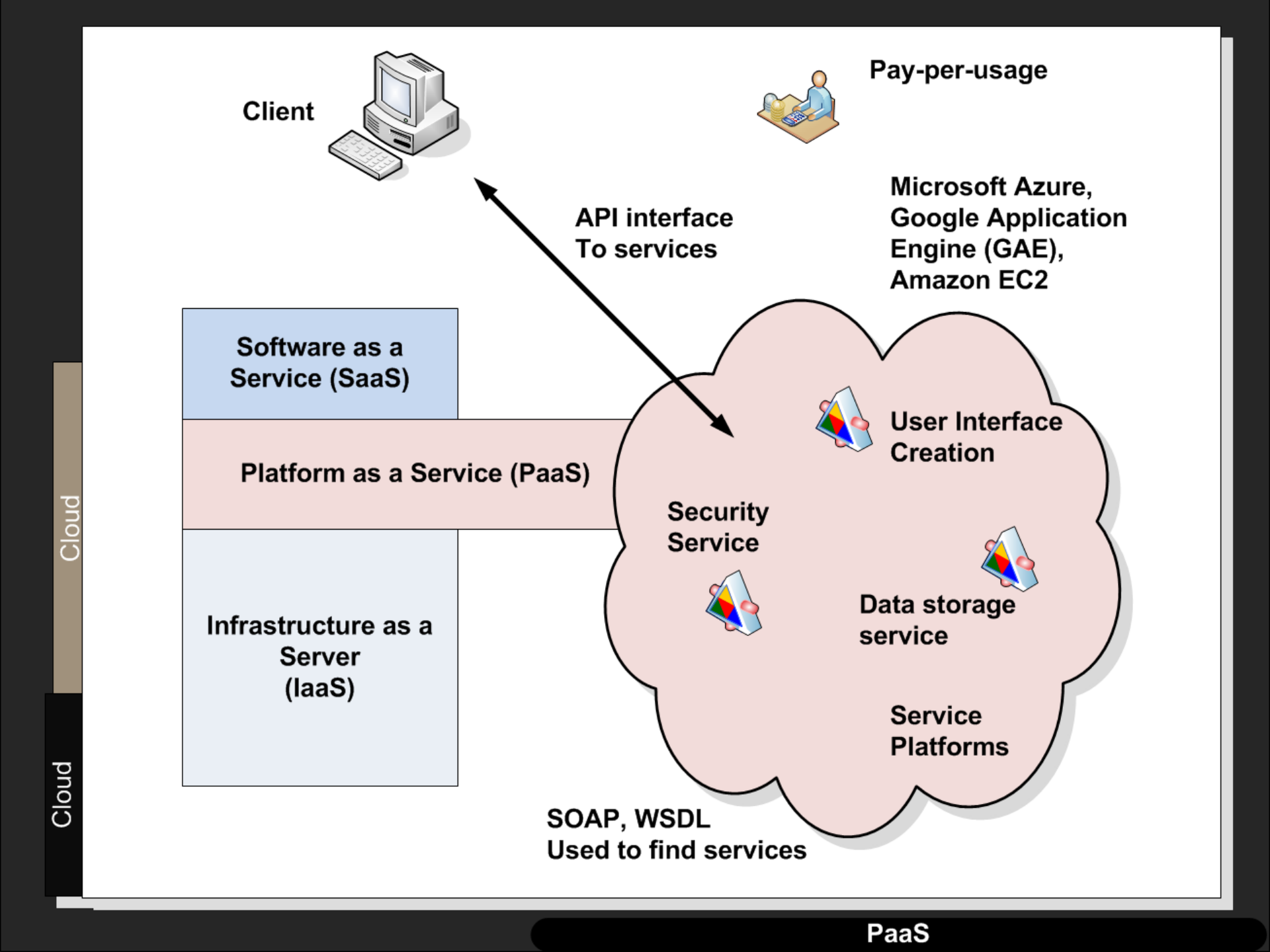


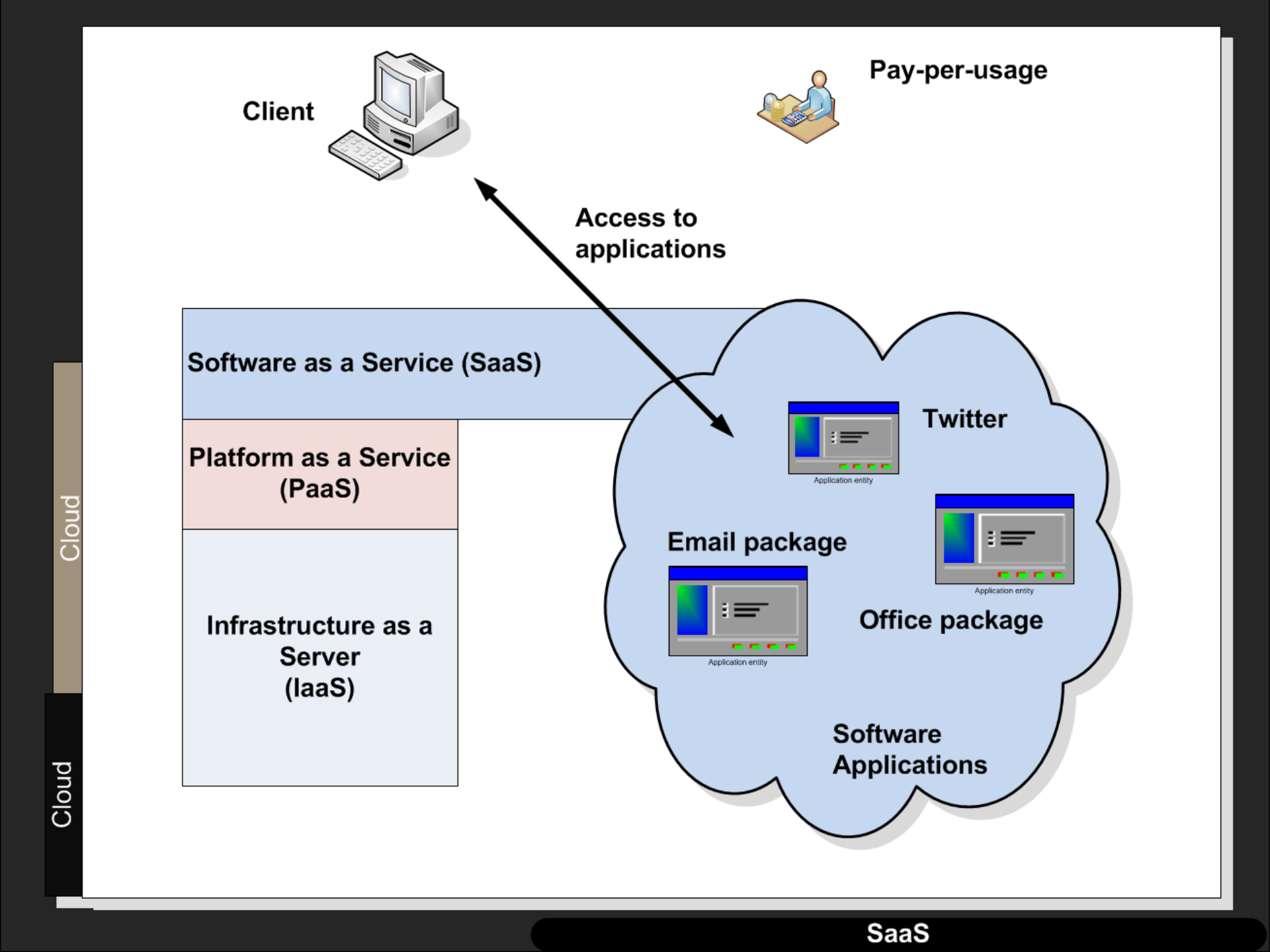
Servers

Cloud

Cloud


Client
Pay-per-usage
API interface
To virtual servers
Software as a Service (SaaS)
Platform as a Service (PaaS)
Infrastructure as a Server (IaaS)
Amazon Web Services
Virtual Servers
Cloud
Cloud
IaaS


Client
Pay-per-usage
API interface
To services
Microsoft Azure,
Google Application
Engine (GAE),
Amazon EC2
Software as a
Service (SaaS)
Platform as a Service (PaaS)
Infrastructure as a
Server
(IaaS)
User Interface
Creation
Security
Service
Data storage
service
Service
Platforms
SOAP, WSDL
Used to find services
Cloud
Cloud
PaaS


Client
Pay-per-usage
Access to applications
Software as a Service (SaaS)
Platform as a Service (PaaS)
Infrastructure as a Server (IaaS)
Cloud
Cloud
Twitter
Application entity
Email package
Application entity
Application entity
Office package
Software Applications
SaaS

Cloud Computing

Amazon EC2

Author: Prof Bill Buchanan

Client

amazon web services

Pay-per-usage

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

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 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 and European data centres, and uses the Xen hypervisor for the management of the servers.

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 hierarchal 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.

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.

AWS Cloud

Amazon Web Services

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

Create
Read
Update
Delete

AWS Cloud

RESTful Web Services (REST -Representational state transfer)

Cloud Computing

Amazon E3

Author: Prof Bill Buchanan

Client

amazon web services

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 hierarchal 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.

$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
```

AWS

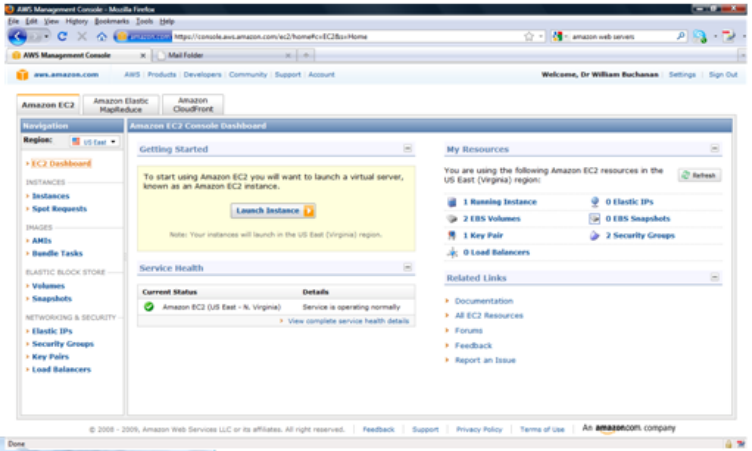
Cloud

Cloud Computing

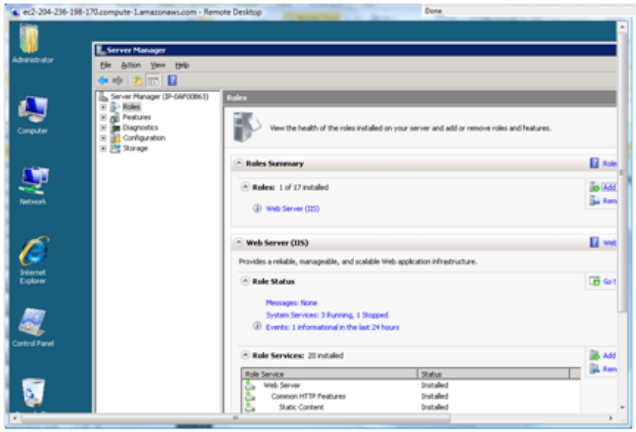
Amazon EC2

Author: Prof Bill Buchanan

Amazon Machine Images (AMI)



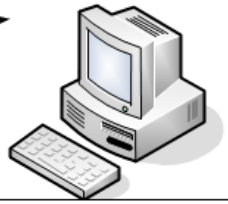
amazon web services



i-0d895567

Machine Instances

- Command line tools
- Web Service Console



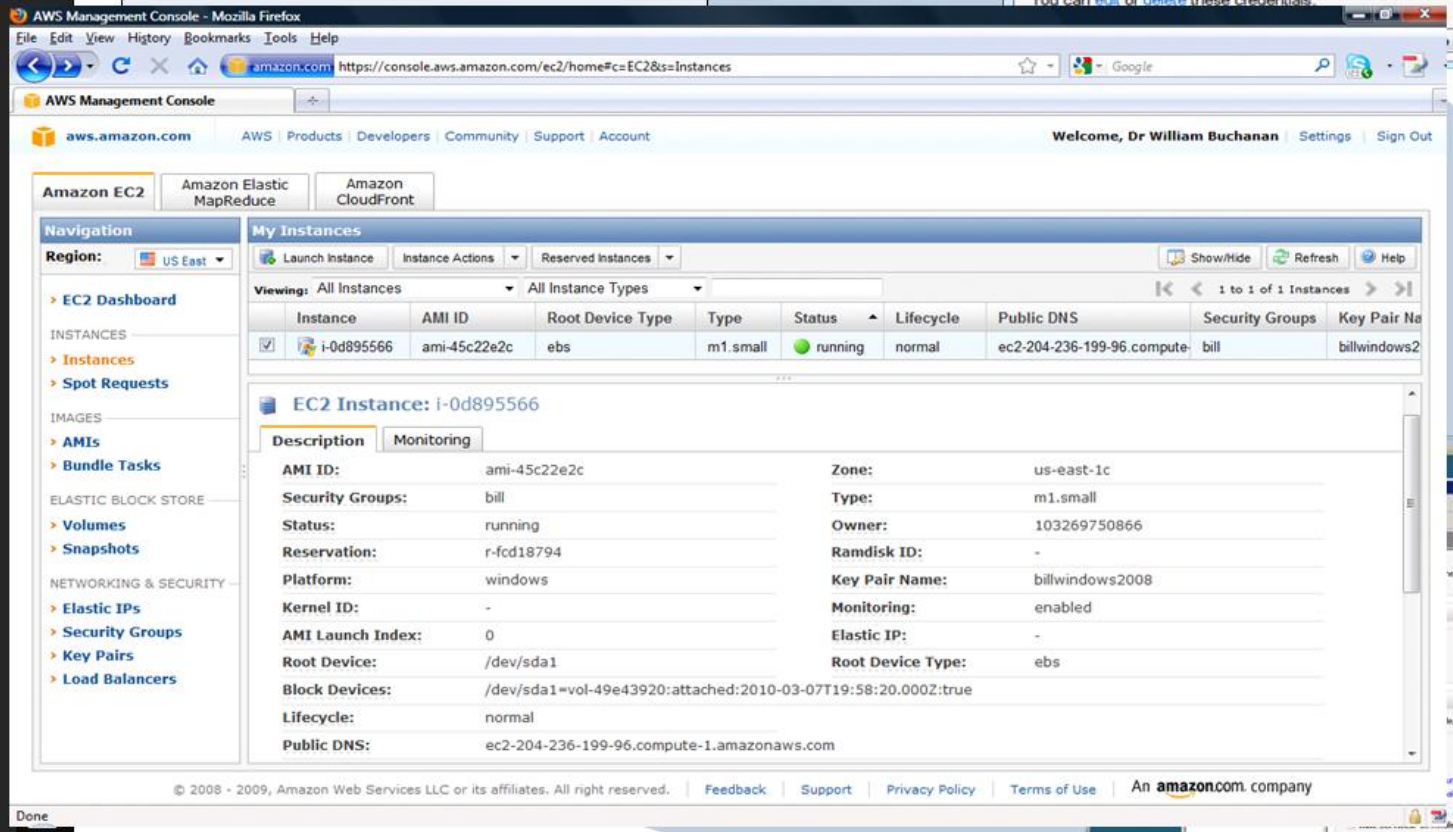
i-0d895566

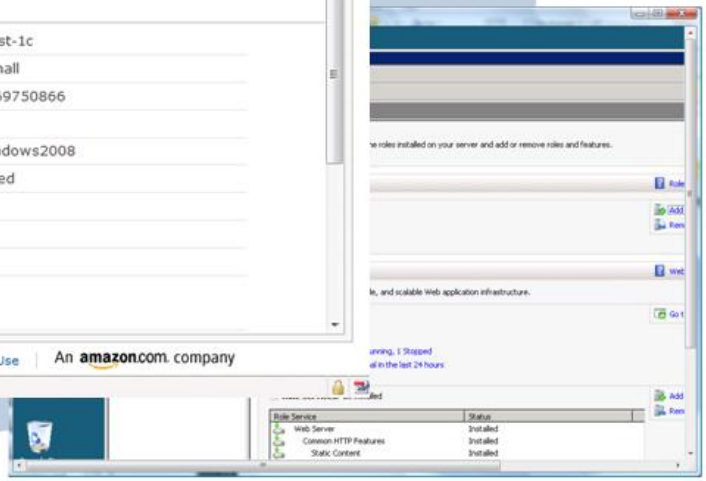
```
$ ec2-describe-images -o AKIAIWUMTTAZYST2I2AA
$ ec2-describe-images
IMAGE ami-45c22e2c powerdns/image.manifest.xml 495219933132 available private
$ ec2-run-instances i-0d895566
```

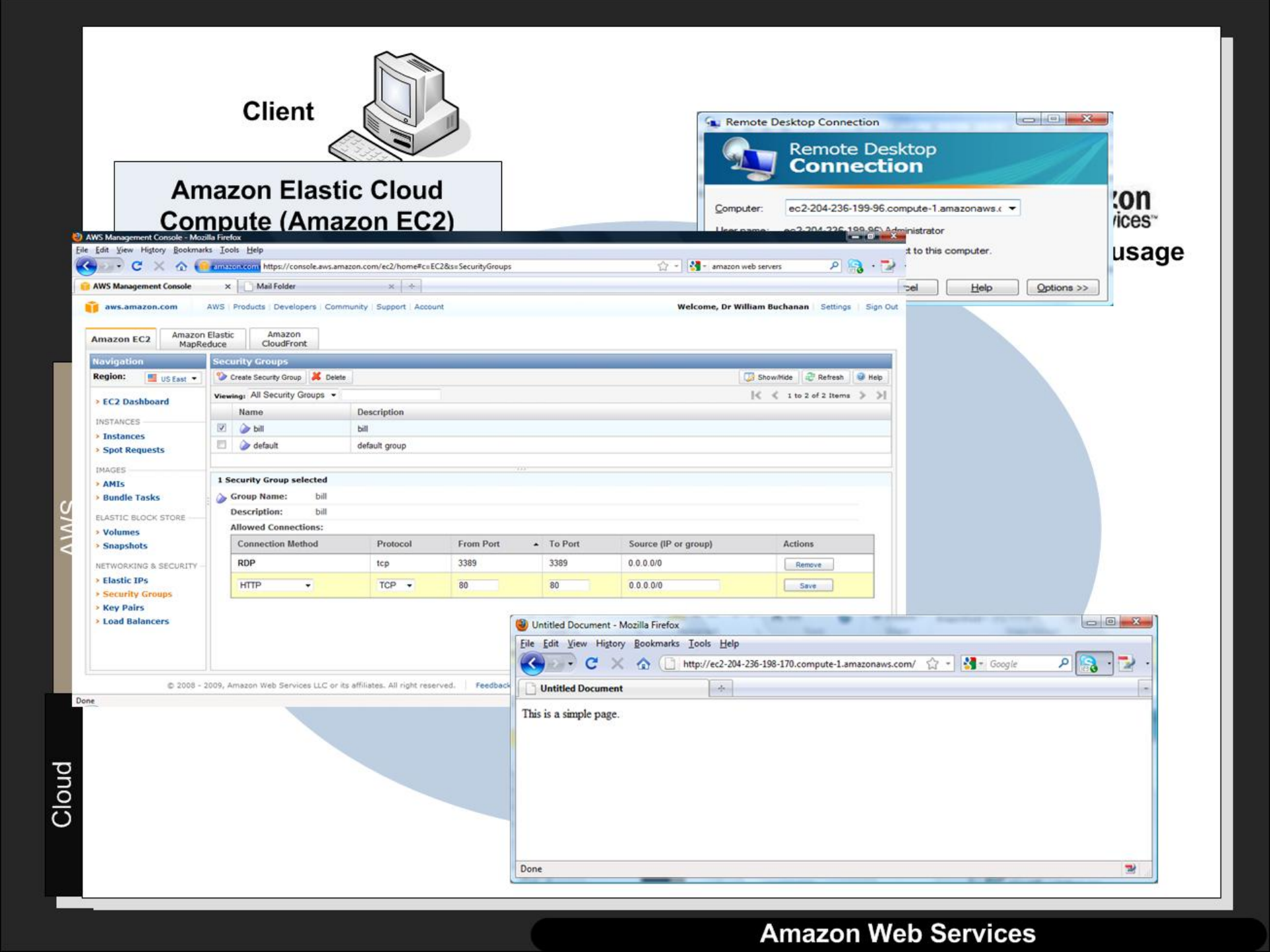
Client

Amazon Elastic Cloud Compute (Amazon EC2)

This is the core of the Amazon Cloud,






Client
Amazon Elastic Cloud Compute (Amazon EC2)
Remote Desktop Connection
Remote Desktop Connection
Computer:
ec2-204-236-199-96.compute-1.amazonaws.c
Administrator
t to this computer.
Help
Options >>
AWS Management Console - Mozilla Firefox
File Edit View History Bookmarks Tools Help
https://console.aws.amazon.com/ec2/home#c=EC2&s=SecurityGroups
amazon web servers
AWS Management Console
Mail Folder
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
Spot Requests
IMAGES
AMIs
Bundle Tasks
ELASTIC BLOCK STORE
Volumes
Snapshots
NETWORKING & SECURITY
Elastic IPs
Security Groups
Key Pairs
Load Balancers
Security Groups
Create Security Group
Delete
Show/Hide
Refresh
Help
Viewing: All Security Groups
1 to 2 of 2 Items
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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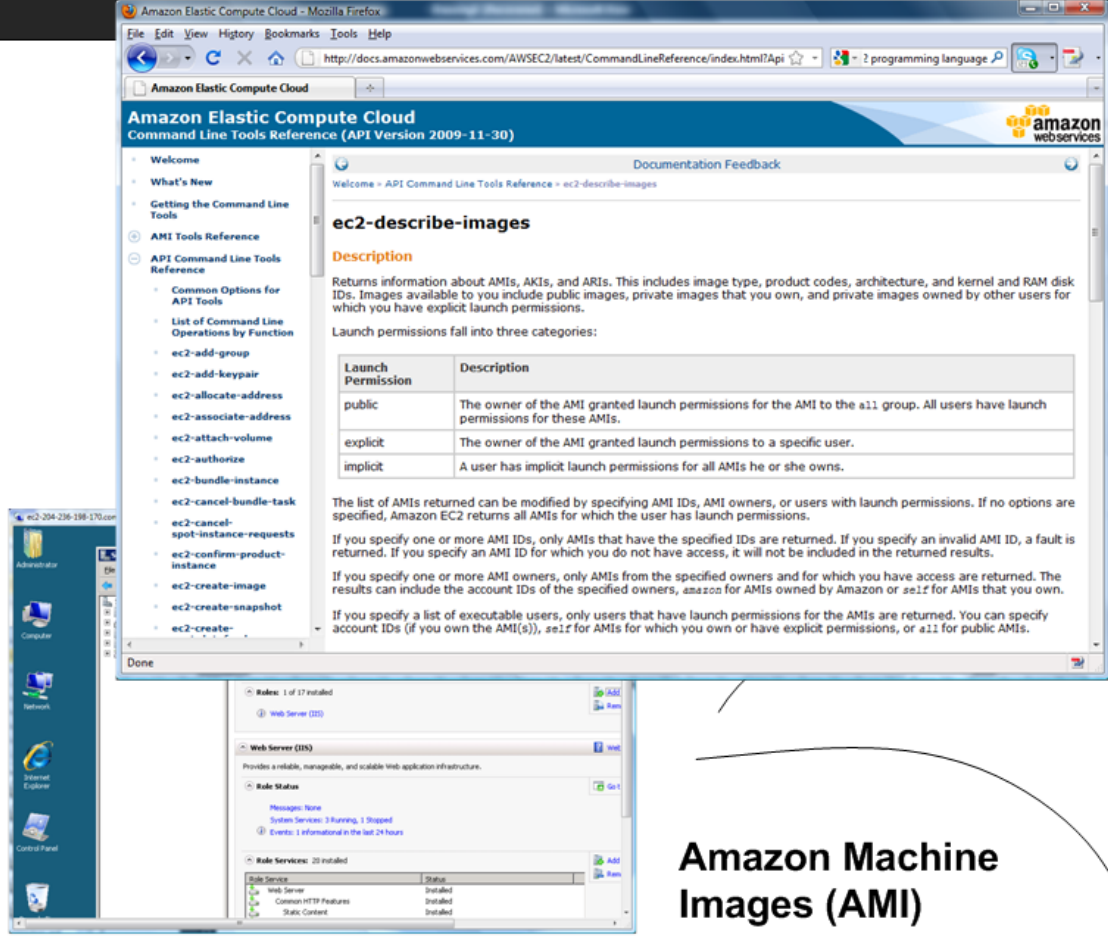
Feedback
Done
Untitled Document - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://ec2-204-236-198-170.compute-1.amazonaws.com/
Google
Untitled Document
This is a simple page.
Done
AWS
Cloud
Amazon Web Services

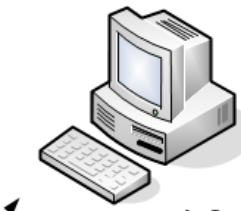
Cloud Computing

Amazon EC2 Programming

Author: Prof Bill Buchanan



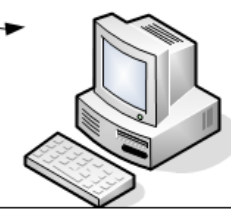
Amazon Machine Images (AMI)



i-0d895567

Machine Instances

- Command line tools
- Web Service Console



i-0d895566

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
```

AWS

Cloud

EC2 configuration

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.

Author: Prof Bill Buchanan