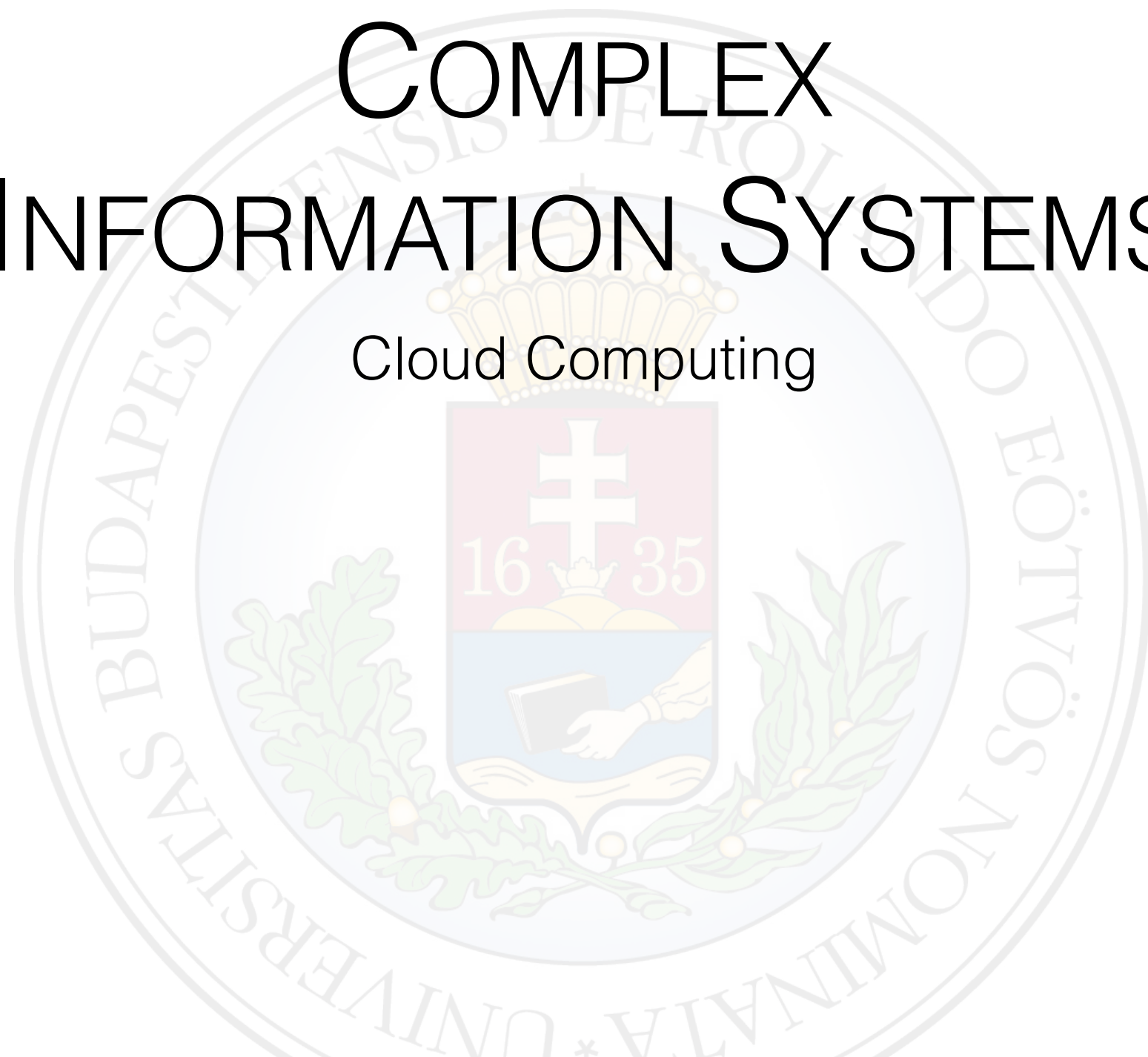# COMPLEX INFORMATION SYSTEMS

Cloud Computing

In this section

- "Cloud computing" is a relatively new term, and it is important to clearly define what we mean

- Cloud computing is a new delivery model for IT but that it uses established IT resources

- Concept of abstraction is critical to the implementation of cloud architectures

Introducing Cloud Computing

What is Cloud Computing?

What is Cloud Computing?

Examining cloud computing from historical, theoretical and practical perspectives

Important to know:

what to use,

in *which* situation,

and *when* it will be most appropriate.

What is Cloud Computing?

In a nutshell, cloud computing is a means by which computational power, storage, collaboration infrastructure, business processes and applications can be delivered as a utility, that is, a service or collection of services that meet your demands.

What is Cloud Computing?

In the need of extra processing power, it is available in an instant.

No need to invest a lot of hardware to cater for peak usage.

This aspect of the cloud is referred to as *elasticity* and is an extremely important concept within cloud computing.

Utility Computing

Utility computing was discussed by John McCarthy in the 1960s

The concept was thoroughly expanded by Douglas Parkhill in 1966

The nature of utilities such as water, natural gas and electricity in the way they are provided to create an understanding of the characteristics that computing would require if it was truly a utility

Service Orientation

The term *service orientation* refers to the clear demarcation of a function that operates to satisfy a particular goal.

Concept of abstraction, combined with object-oriented principles such as encapsulation and cohesion, that helps define services within an organization.

Service-oriented architecture (SOA) utilizes the principle of service orientation to organize the overall technology architecture of an enterprise.
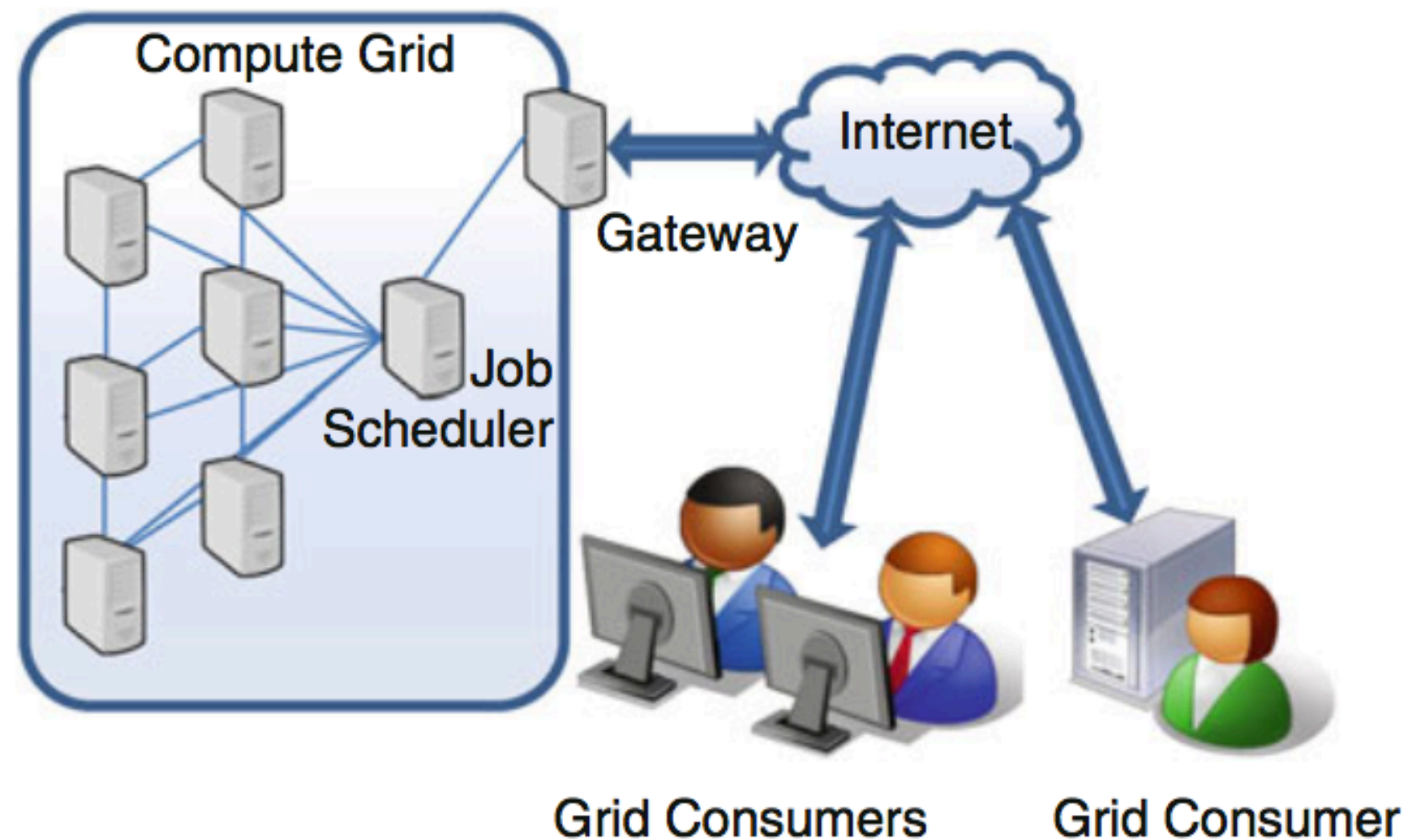
Grid Computing

Supercomputers that could process large data sets were prohibitively expensive for many areas of research.

Alternative:

the connection and coordination of many separate personal computers (PC) as a grid would facilitate the scaling up of computational resources under the guise of a virtual organization (VO).

Grid Computing

Hardware Virtualization

Hardware virtualization is a developing technology

Enabling 'virtual' instances of hardware to execute on disparate physical infrastructure

Virtualization layer allows data centre management to create and instantiate new instances of virtual hardware irrespective of the devices running underneath it

New hardware can be added to the pool of resource and commissioned without affecting the virtualized layer

Hardware Virtualization
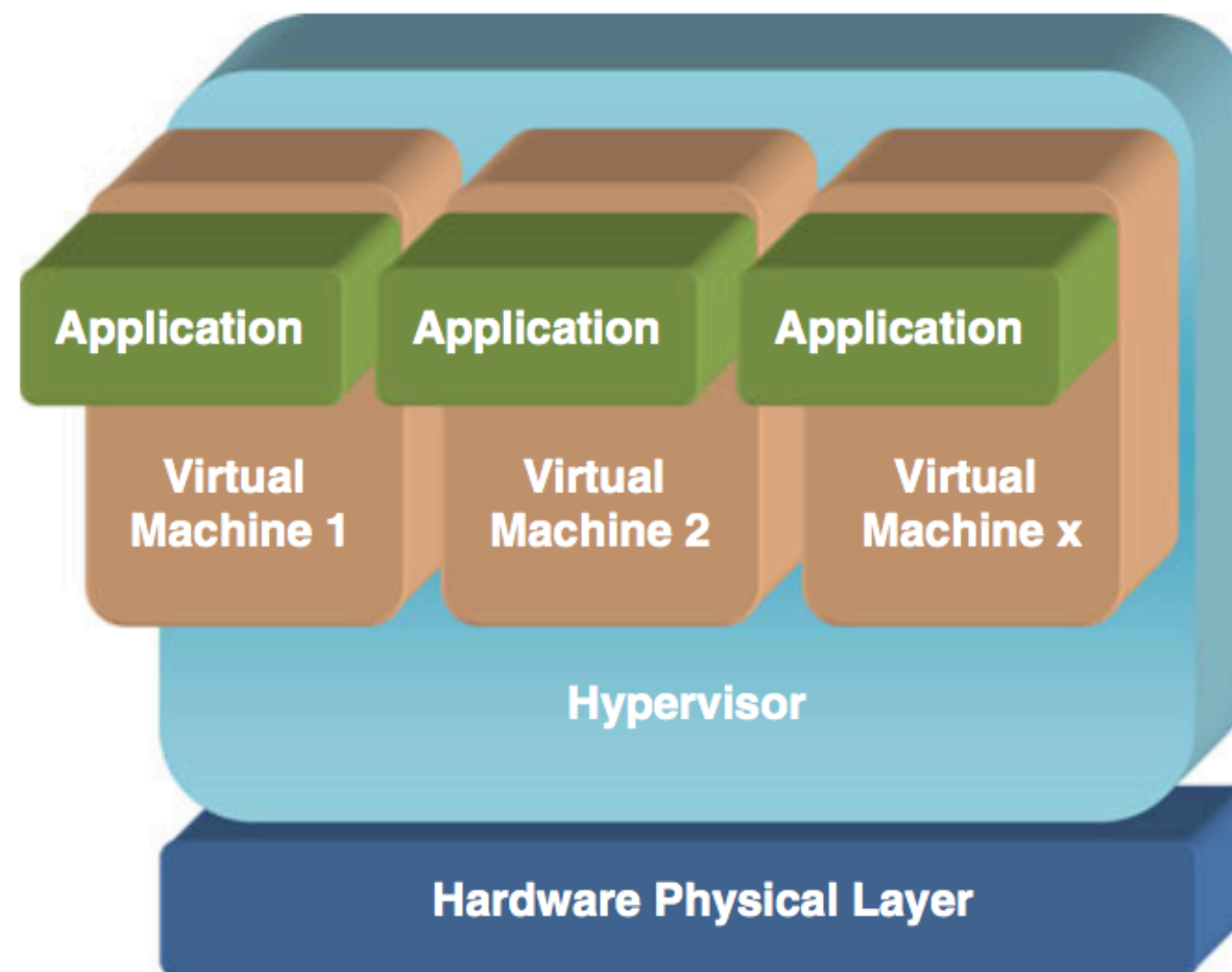
Autonomic Computing

Autonomic computing attempts to specify behaviors that enable the self-management of systems

Self-configuration, self-healing, self-optimizing and self-protection (self-CHOP) are the four principles defined by IBM's autonomic computing initiative
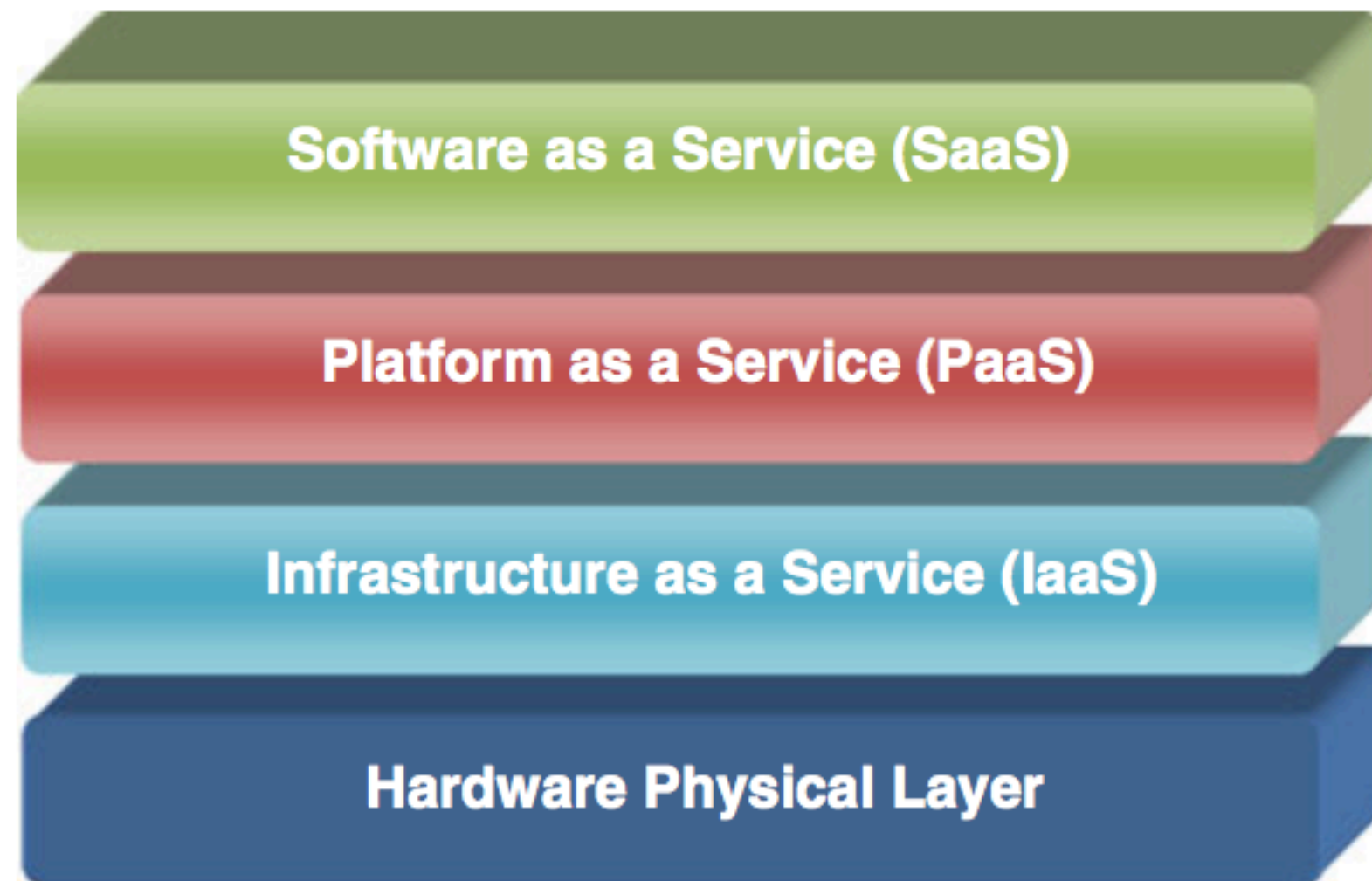
Cloud Computing: A definition

National Institute of Standards and Technology (NIST):

Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models.

Cloud Computing Service Models

Software as a Service (SaaS)

Platform as a Service (PaaS)

Infrastructure as a Service (IaaS)

Hardware Physical Layer

Cloud Computing Service Models

Infrastructure as a Service (IaaS) - lowest level service

   virtual infrastructure, operating systems and application software can
   be deployed

Platform as a Service (PaaS) - sits atop IaaS

   ready for applications to be deployed

Software as a Service (SaaS)

   abstracts the consumer away from any infrastructure or platform level
   detail

Cloud Computing Deployment Models

A *public cloud*, as its name implies, is available to the general public and is managed by an organization

A *private cloud* has an exclusive purpose for a particular organization, a private cloud has an exclusive purpose for a particular organization

Community clouds are a model of cloud computing where the resources exist for a number of parties who have a shared interest or cause

> very similar to the single-purpose grids that collaborating research and academic organizations have created to conduct large-scale scientific experiments

Beyond the Three Service Models

Business drivers

Service models

    for cloud adoption

+ issues

Business Perspective

Grid computing a

massive benefits

problem: large distributed systems perform were inaccessible

SOA

"reduce your business costs"

Cloud computing

rapid provisioning of new compute resources without capital expenditure

cost-effective to experiment with new products and services

new requests merely become additional demands upon the systems

When Can the Service Models Help?

Infrastructure as a Service

IaaS is about servers, networking and storage delivered as a service

Virualized

Form of computing rental where the billing is related to actual usage

Suited to organizations who want to retain control over the whole platform and software stack and who need extra infrastructure quickly and cheaply

Platform as a Service

PaaS has parallels with web hosting

Enables the complete application development life cycle within a cloud

Tools for development and testing

Resources are dynamically scaled

Software as a Service

SaaS is the easiest way into cloud computing

The software automatically scales to the number of users, data is backed up

SaaS is useful if you are in the situation whereby a legacy application you own has been replicated by a SaaS provider or if a particular SaaS application offers a capability that you don't currently have but can see the business benefit of having it

  e.g., Customer Relationship Management (CRM)

Issues of Cloud Computing

Where are the users "data" stored?

>Delegating the location of the data along with the management processes that go with it

Legislation, where the data is physically stored

Software bugs, undocumented features

Data transfer bottlenecks

Business Adoption Models

	Public	Private
Network	Internet	Private network
Server and data centre location	Global	In company
Costing	By usage or free	Internal mechanism, often by capacity and processor
Tenancy	Multiple	Single
Scale orientation	Vertical (i.e. user focused)	Horizontal (i.e. application focused)
Key selection rationale	Cost	Security

Public Cloud

The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services

Provider	Estimated users (millions, as of 2010)
Hotmail	330
Yahoo	302
Gmail	193
Others	200

Private Cloud

The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.

Hybrid Cloud

The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

Community Cloud

The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.

Legal Aspects of Cloud Computing

Law about cloud computing is largely uncertain

Some elements are clear

Worldwide Issue

    2010, USA ITIF → Digital Due Process (DDP)

    The guarantees are usually expressed in measurable terms, some examples of which include:

- Availability of the service

- Minimum performance benchmarks

- Minimum help-desk response time

Cloud Technology

Cloud applications are accessed via the web

Virtualization

  provide the elasticity required to offer cloud
  computing as a utility

MapReduce Programming model

Web Technology

HTTP is a key to building cloud systems

at low level, each interaction in a cloud application uses HTTP

- HEAD which asks the server for information about a resource

- PUT which stores data in a resource

- POST which sends data to a program to be processed on the server

- DELETE which deletes the specified resource

Web Technology

HTML, CSS

XML

JSON (JavaScript Object Notation)

JavaScript and AJAX

MVC

Virtualization

Virtual Machine

many virtual components:

- *'Virtual processors'* which share time with other virtual machines on the physical
  processors

- *'Virtual memory'* which are normally implemented as a slice of physical RAM on the host machine (not to be confused with common use of 'virtual memory'
  referring to the combination of various types of storage media)

- *'Virtual hard disk'* which is typically one or more large files on the physical disk

- '*Virtual network*' based on a network interface controller (NIC)

Virtualization

Desktop Virtualization

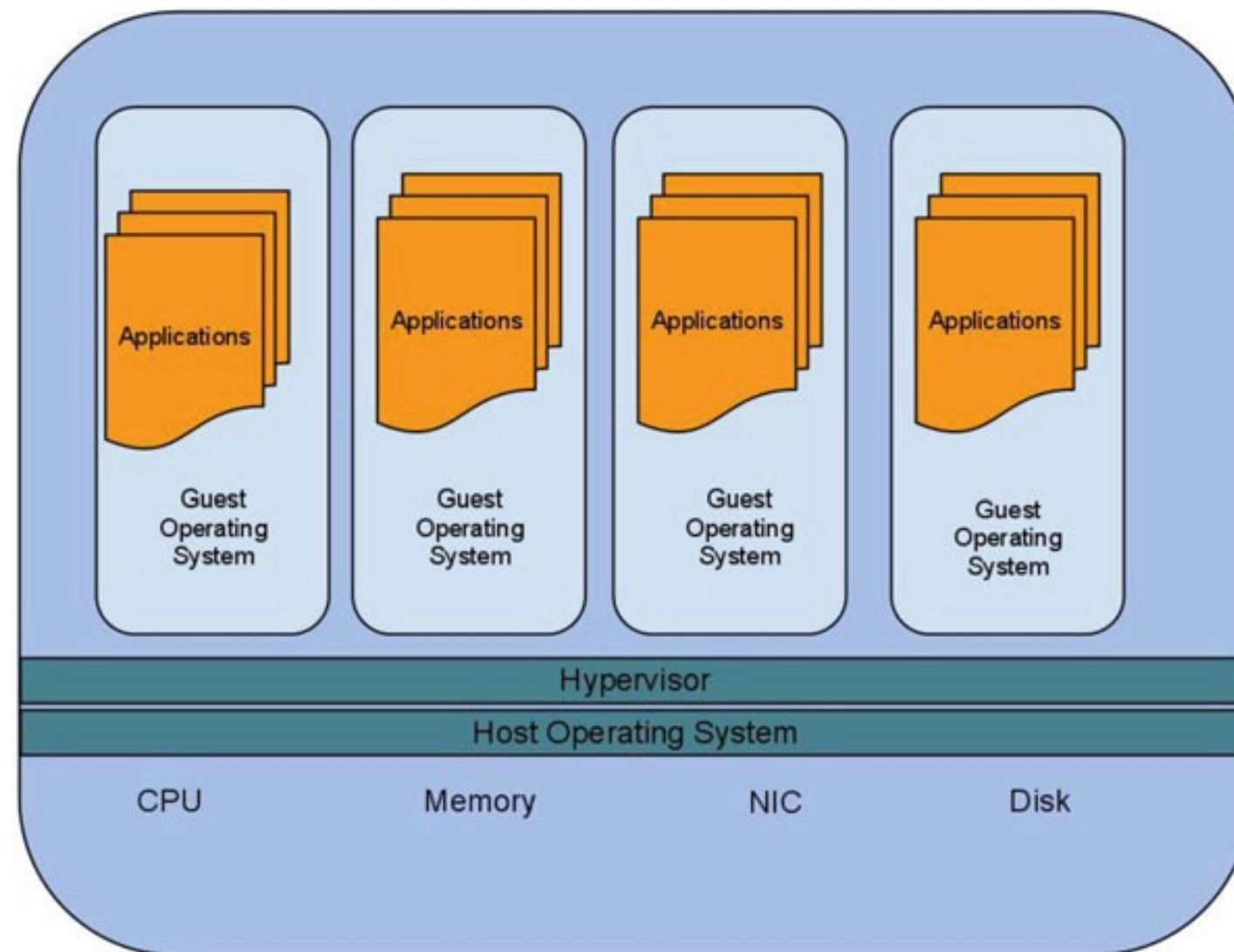Server Virtualization

Efficiency

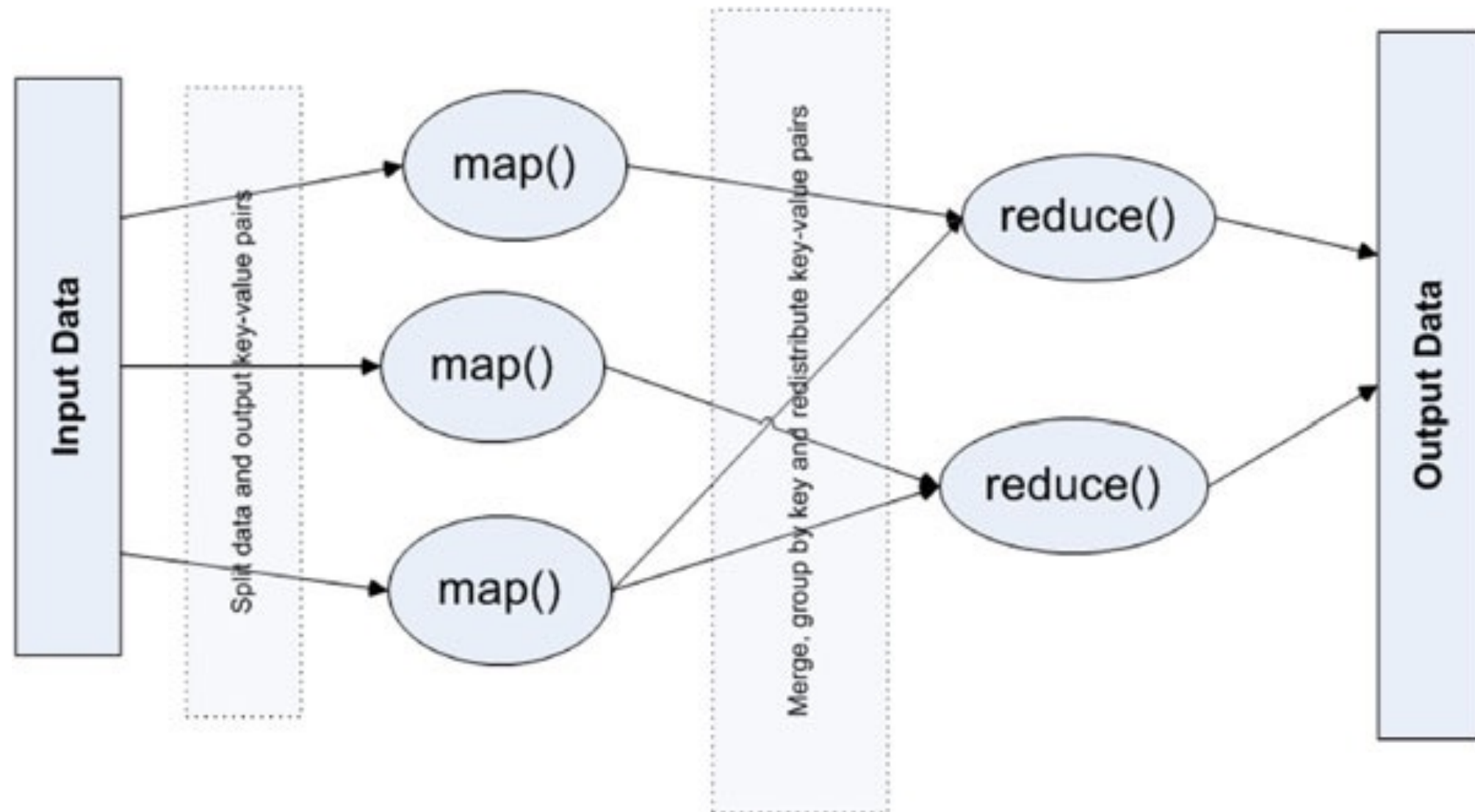Isolation

Mobility

Storage Virtualization

Virtualization

Implementing Virtualization

Hypervisor

MapReduce

Cloud Services

The delivery of computing as a service rather than a product, whereby shared resources, software, and information are provided to computers and other devices as a metered service over a network (typically the Internet)