CS6006 - CLOUD COMPUTING

Module 10 - Cloud and Advanced Technologies

Presented By
Dr. S. Muthurajkumar,
Assistant Professor,
Dept. of CT, MIT Campus,
Anna University, Chennai

CLOUD AND ADVANCED TECHNOLOGIES

- An Architecture for Federated Cloud (Inter-Cloud) Computing
- Inter-Cloud Resource Management
- Introduction to Fog Computing

AN ARCHITECTURE FOR FEDERATED CLOUD (INTER-CLOUD) COMPUTING

- Utility computing, a concept envisioned back in the 1960s, is finally becoming a reality.
- Just as we can power a variety of devices, ranging from a simple light bulb to complex machinery, by plugging them into the wall, today we can satisfy, by connecting to the Internet, many of our computing needs, ranging from full pledge productivity applications to raw compute power in the form of virtual machines.
- Cloud computing enables companies and individuals to lease resources on-demand from a virtually unlimited pool.
- The “pay as you go” billing model applies charges for the actually used resources per unit time.
- This way, a business can optimize its IT investment and improve availability and scalability.

AN ARCHITECTURE FOR FEDERATED CLOUD (INTER-CLOUD) COMPUTING

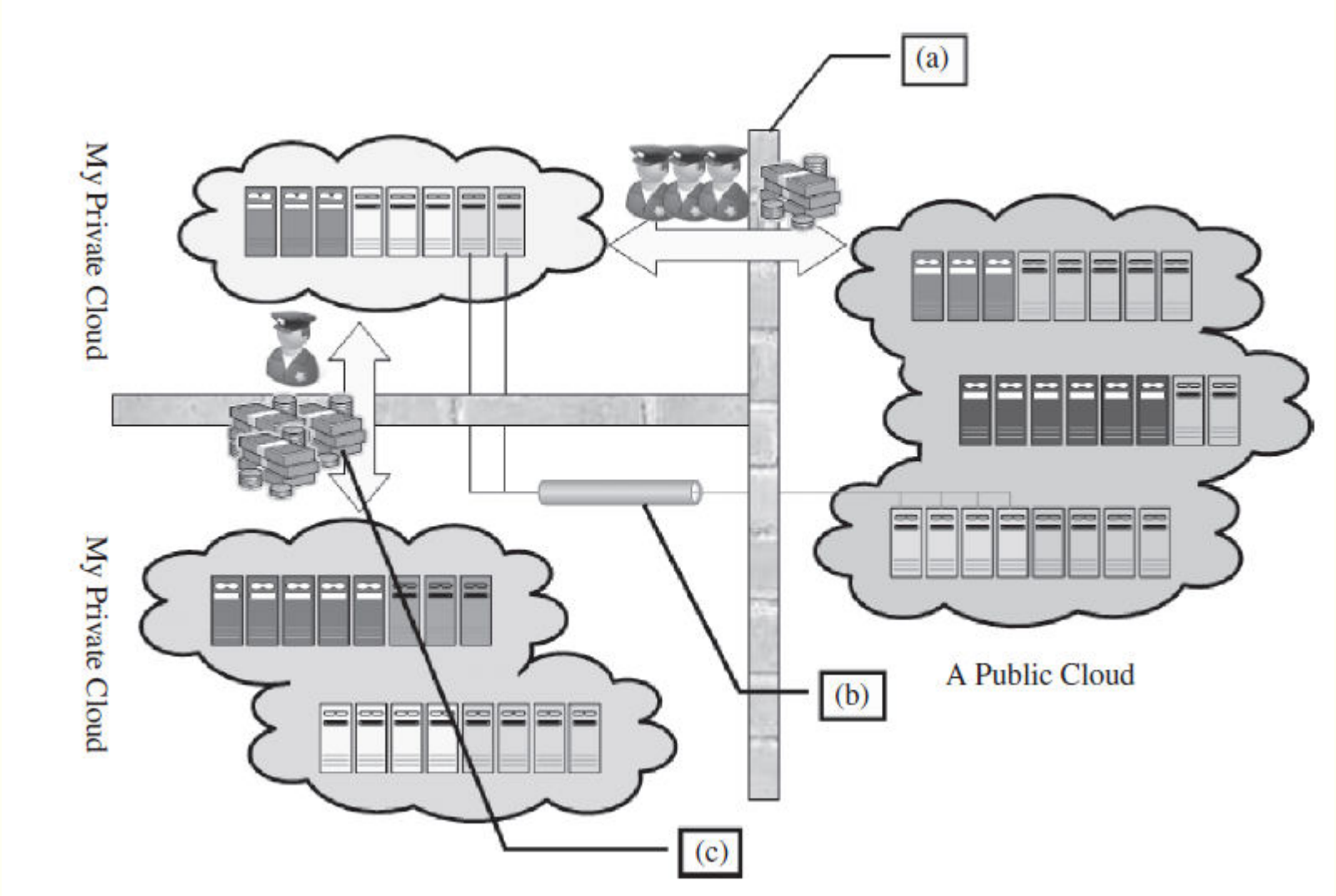
- Inherently Limited Scalability of Single-Provider Clouds
- Lack of Interoperability Among Cloud Providers
- No Built-In Business Service Management Support

AN ARCHITECTURE FOR FEDERATED CLOUD (INTER-CLOUD) COMPUTING

- **A TYPICAL USE CASE**

- As a representative of an enterprise-grade application, we have chosen to analyze SAP systems and to derive from them general requirements that such application might have from a cloud computing provider.

AN ARCHITECTURE FOR FEDERATED CLOUD (INTER-CLOUD) COMPUTING



AN ARCHITECTURE FOR FEDERATED CLOUD (INTER-CLOUD) COMPUTING

- Model for federated cloud computing:

(a) Different cloud providers collaborate by sharing their resources while keeping thick walls in between them; that is, each is an independent autonomous entity.

(b) Applications running in this cloud of clouds should be unaware of location; that is, virtual local networks are needed for the inter-application components to communicate.

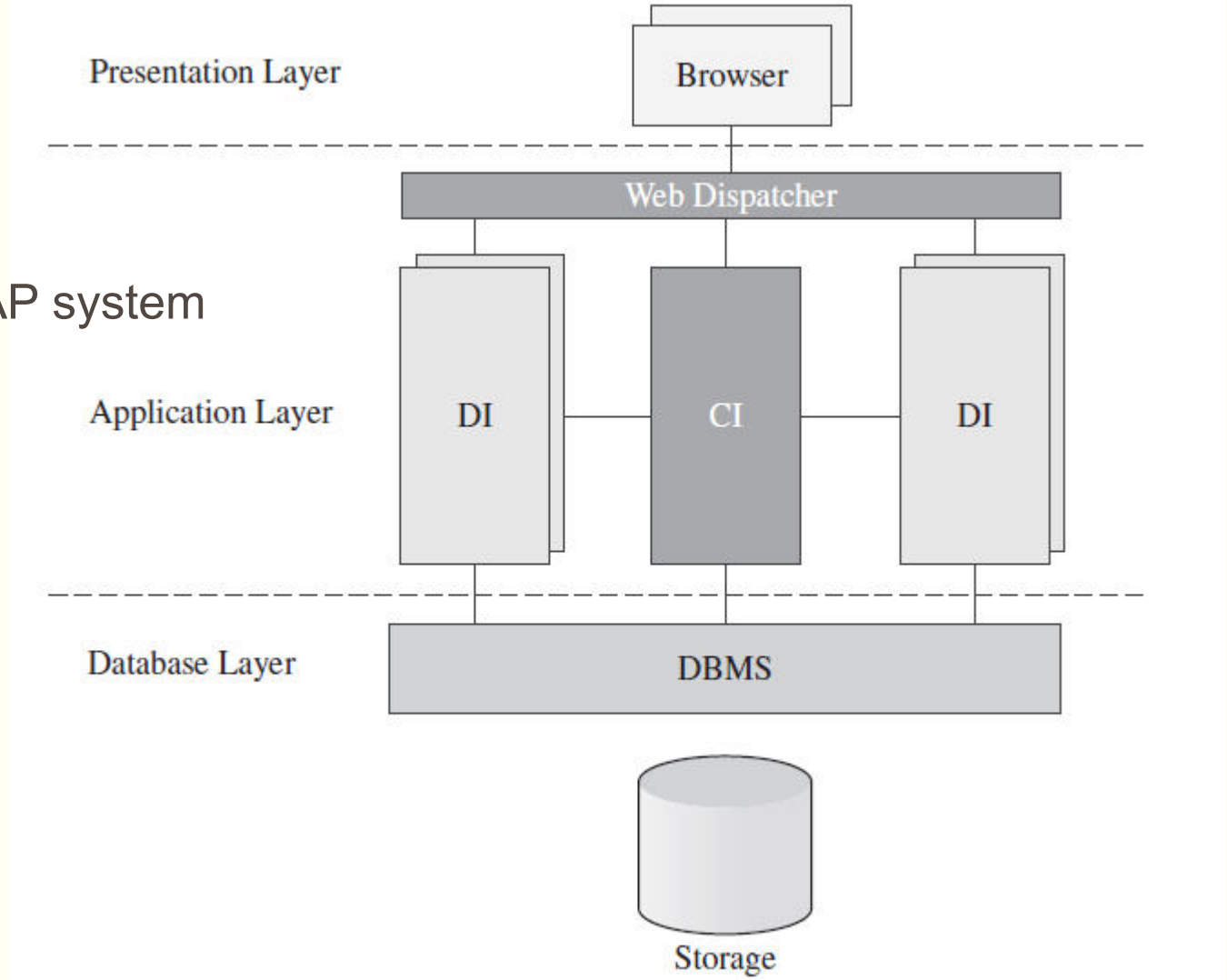
(c) Cloud providers differentiate from each in terms of cost and trust level; for example, while a public cloud maybe cheap, companies will be reluctant to put in there sensitive services.

AN ARCHITECTURE FOR FEDERATED CLOUD (INTER-CLOUD) COMPUTING

- **SAP Systems**
- SAP systems are used for a variety of business applications that differ by version and functionality [such as customer relationship management (CRM) and enterprise resource planning (ERP)].
- For a given application type, the SAP system components consist of generic parts customized by configuration and parts custom-coded for a specific installation.
- Certain SAP applications are composed of several loosely coupled systems.
- Such systems have independent databases and communicate asynchronously by message with each other.

AN ARCHITECTURE FOR FEDERATED CLOUD (INTER-CLOUD) COMPUTING

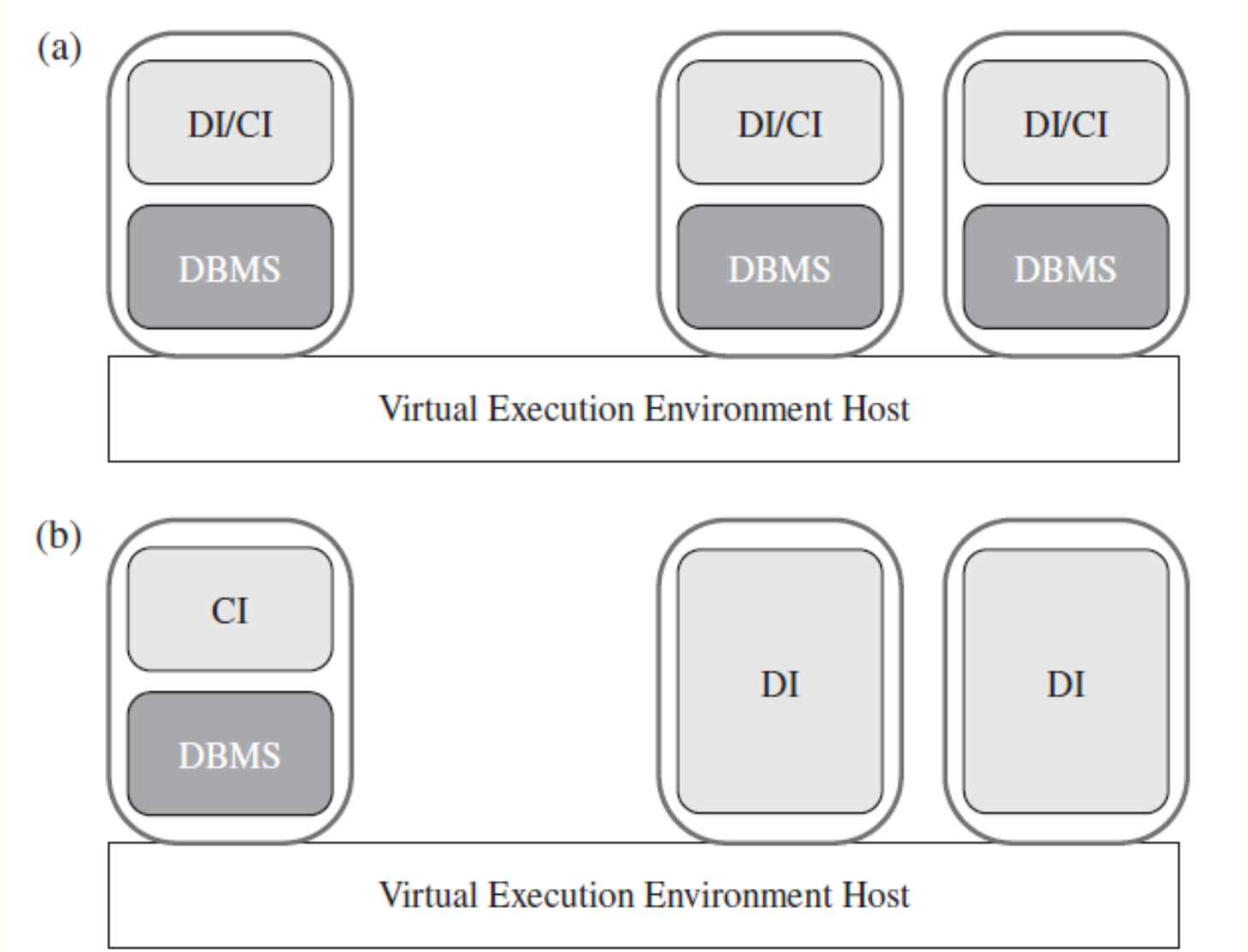
Abstraction of an SAP system



AN ARCHITECTURE FOR FEDERATED CLOUD (INTER-CLOUD) COMPUTING

- The Virtualized Data Center Use Case
- Consider a data center that consolidates the operation of different types of SAP applications and all their respective environments (e.g., test, production) using virtualization technology.

AN ARCHITECTURE FOR FEDERATED CLOUD (INTER-CLOUD) COMPUTING



AN ARCHITECTURE FOR FEDERATED CLOUD (INTER-CLOUD) COMPUTING

- Sample SAP system deployments.

(a) All components run in the same virtual execution environment (represented as rounded rectangles)

(b) The large components (CI and DBMS) run each on a dedicated virtual execution environment.

- The virtual execution environment host refers to the set of components managing the virtual environments.

AN ARCHITECTURE FOR FEDERATED CLOUD (INTER-CLOUD) COMPUTING

- Primary Requirements
- Automated and Fast Deployment
- Dynamic Elasticity
- Automated Continuous Optimization

INTER-CLOUD RESOURCE MANAGEMENT

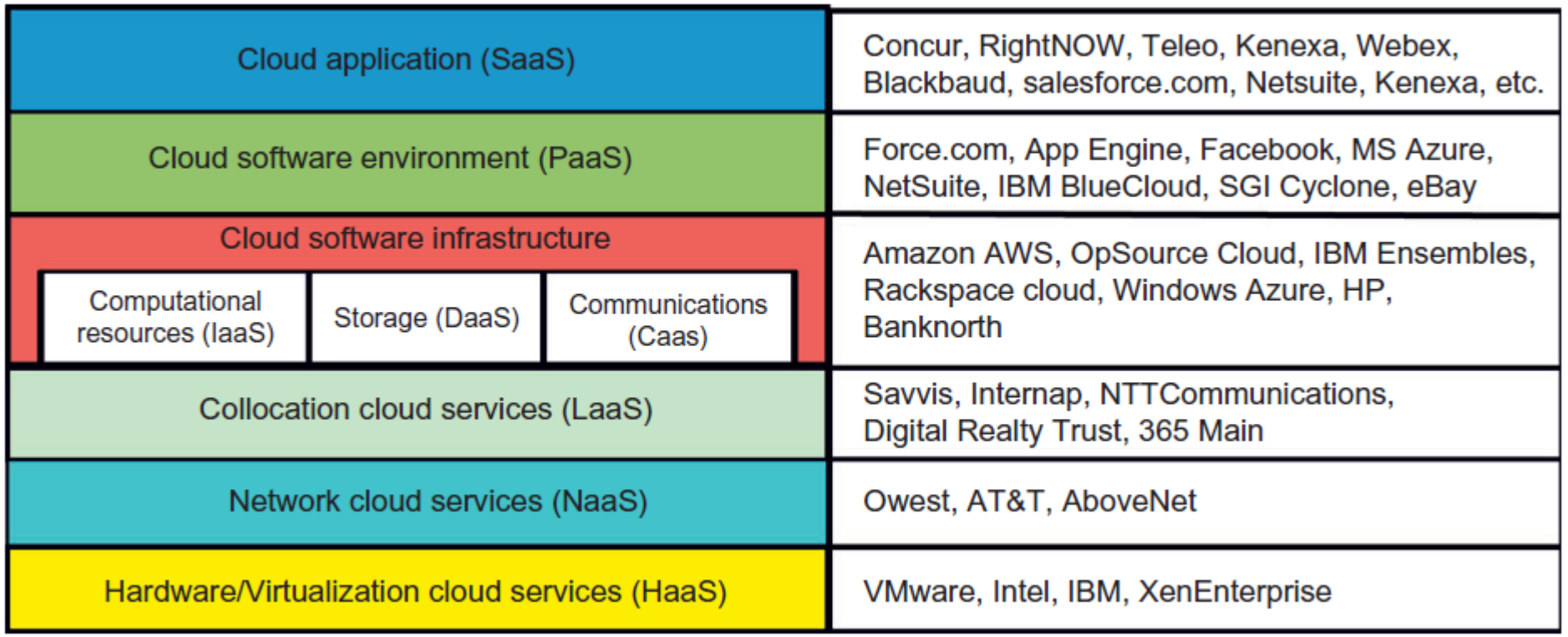
- The cloud service trends are outlined. Cloud resource management and inter-cloud resource exchange schemes are reviewed.
  - Extended Cloud Computing Services
  - Resource Provisioning and Platform Deployment
  - Virtual Machine Creation and Management
  - Global Exchange of Cloud Resources

INTER-CLOUD RESOURCE MANAGEMENT

- **Extended Cloud Computing Services**
- Six layers of cloud services, ranging from hardware, network, and collocation to infrastructure, platform, and software applications.
- We already introduced the top three service layers as SaaS, PaaS, and IaaS, respectively.
- The cloud platform provides PaaS, which sits on top of the IaaS infrastructure.
- The top layer offers SaaS.
- These must be implemented on the cloud platforms provided.

INTER-CLOUD RESOURCE MANAGEMENT

- **Extended Cloud Computing Services**



A stack of six layers of cloud services and their providers

INTER-CLOUD RESOURCE MANAGEMENT

- **Extended Cloud Computing Services**

Table 4.7 Cloud Differences in Perspectives of Providers, Vendors, and Users

Cloud Players	IaaS	PaaS	SaaS
IT administrators/cloud providers	Monitor SLAs	Monitor SLAs and enable service platforms	Monitor SLAs and deploy software
Software developers (vendors)	To deploy and store data	Enabling platforms via configurators and APIs	Develop and deploy software
End users or business users	To deploy and store data	To develop and test web software	Use business software

INTER-CLOUD RESOURCE MANAGEMENT

- **Extended Cloud Computing Services**
  - Cloud Service Tasks and Trends
  - Software Stack for Cloud Computing
  - Runtime Support Services

INTER-CLOUD RESOURCE MANAGEMENT

- **Cloud Service Tasks and Trends**
- Cloud services are introduced in five layers. The top layer is for SaaS applications, as further subdivided into the five application areas, mostly for business applications.
- For example, CRM is heavily practiced in business promotion, direct sales, and marketing services.
- CRM offered the first SaaS on the cloud successfully.

INTER-CLOUD RESOURCE MANAGEMENT

- **Software Stack for Cloud Computing**
- Despite the various types of nodes in the cloud computing cluster, the overall software stacks are built from scratch to meet rigorous goals.
- Developers have to consider how to design the system to meet critical requirements such as high throughput, HA, and fault tolerance.

INTER-CLOUD RESOURCE MANAGEMENT

- **Runtime Support Services**
- As in a cluster environment, there are also some runtime supporting services in the cloud computing environment.
- Cluster monitoring is used to collect the runtime status of the entire cluster.

INTER-CLOUD RESOURCE MANAGEMENT

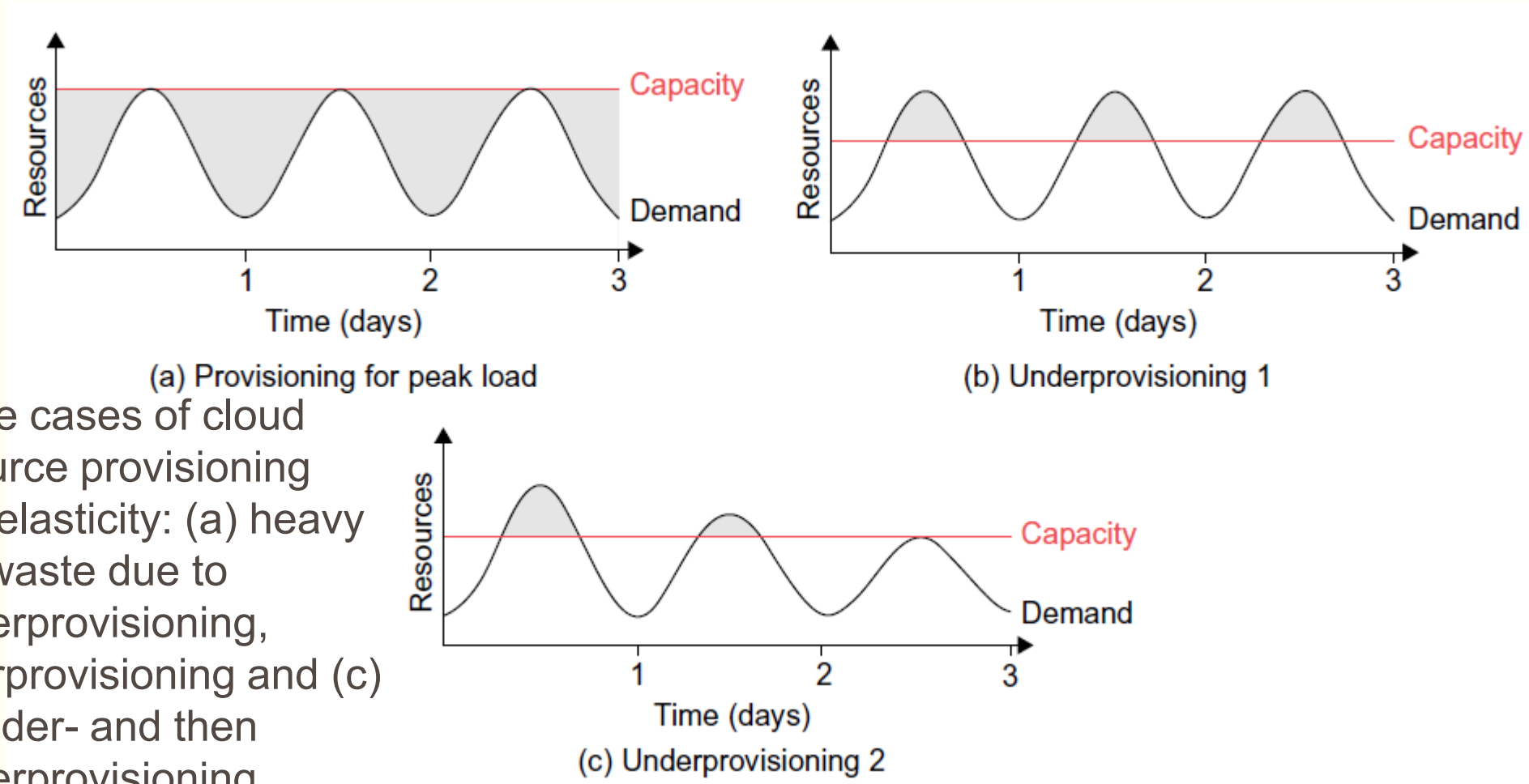
- **Resource Provisioning and Platform Deployment**
- The emergence of computing clouds suggests fundamental changes in software and hardware architecture.
- Cloud architecture puts more emphasis on the number of processor cores or VM instances.
- Parallelism is exploited at the cluster node level.
- We will discuss techniques to provision computer resources or VMs.
- Then we will talk about storage allocation schemes to interconnect distributed computing infrastructures by harnessing the VMs dynamically.

INTER-CLOUD RESOURCE MANAGEMENT

- **Resource Provisioning and Platform Deployment**
  - Provisioning of Compute Resources (VMs)
  - Resource Provisioning Methods
  - Demand-Driven Resource Provisioning
  - Event-Driven Resource Provisioning
  - Popularity-Driven Resource Provisioning
  - Dynamic Resource Deployment
  - Provisioning of Storage Resources

INTER-CLOUD RESOURCE MANAGEMENT

- **Resource Provisioning and Platform Deployment**

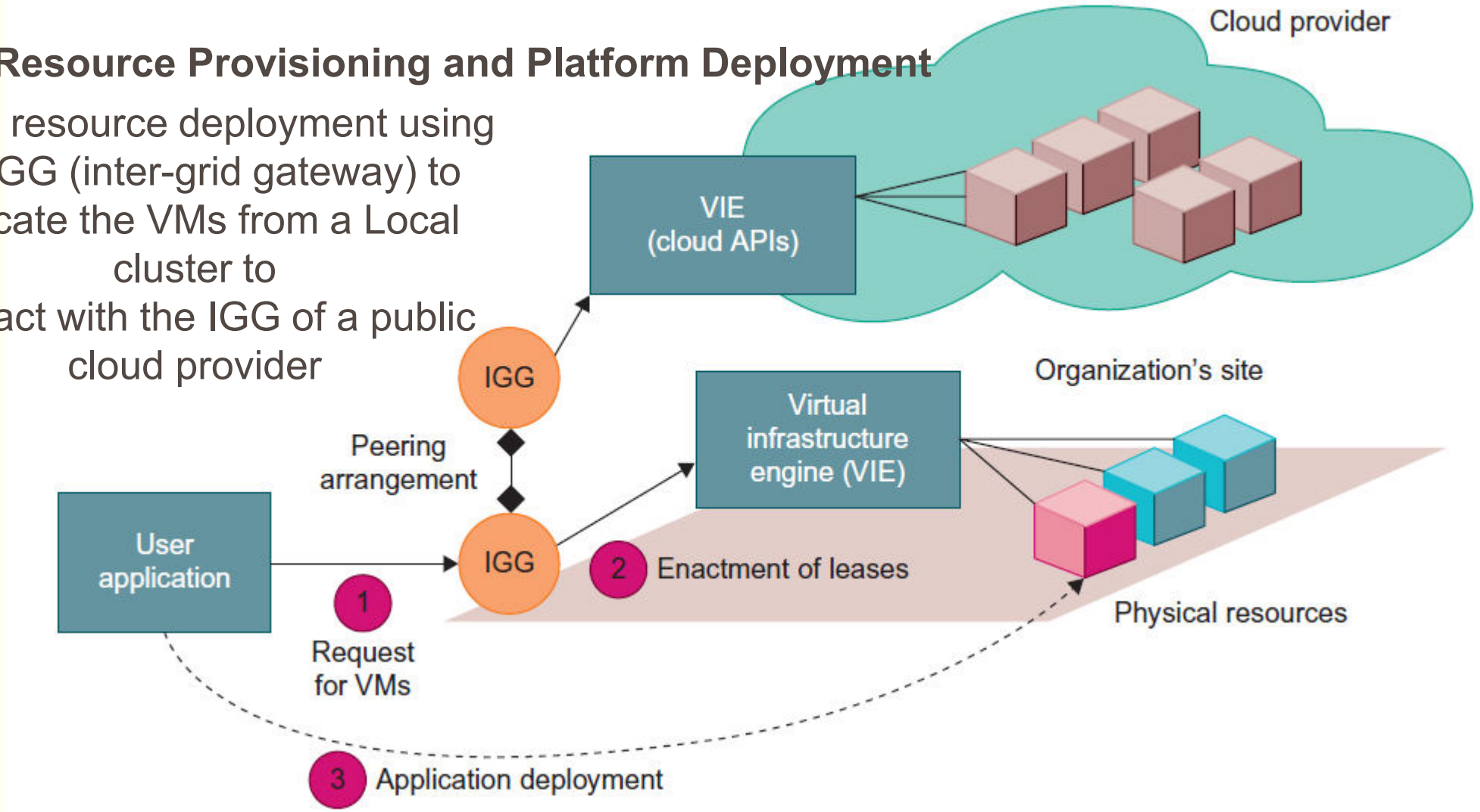


Three cases of cloud resource provisioning without elasticity: (a) heavy waste due to overprovisioning, (b) underprovisioning and (c) under- and then overprovisioning.

INTER-CLOUD RESOURCE MANAGEMENT

- **Resource Provisioning and Platform Deployment**

Cloud resource deployment using an IGG (inter-grid gateway) to allocate the VMs from a Local cluster to interact with the IGG of a public cloud provider



INTER-CLOUD RESOURCE MANAGEMENT

- **Resource Provisioning and Platform Deployment**

Table 4.8 Storage Services in Three Cloud Computing Systems

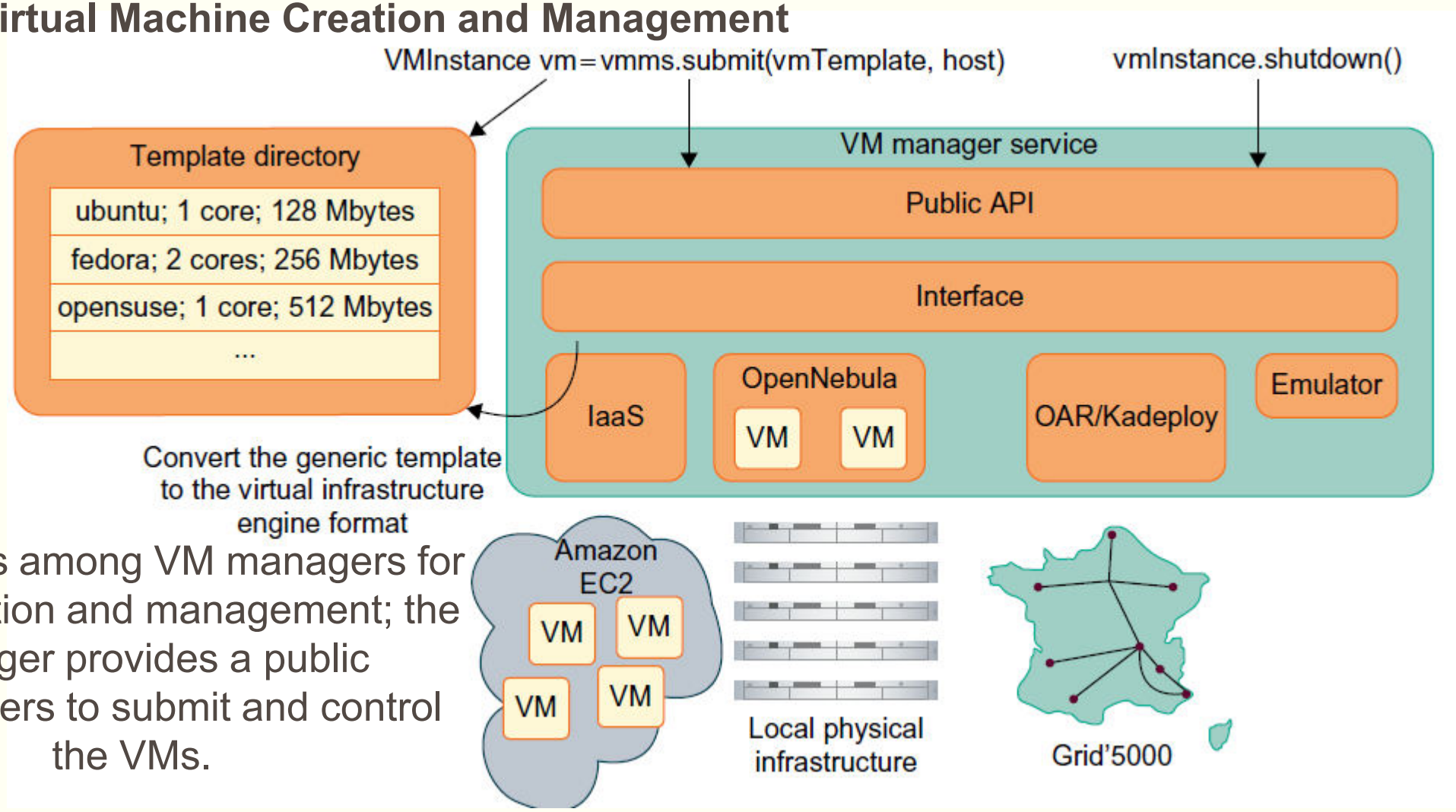
Storage System	Features
GFS: Google File System	Very large sustainable reading and writing bandwidth, mostly continuous accessing instead of random accessing. The programming interface is similar to that of the POSIX file system accessing interface.
HDFS: Hadoop Distributed File System	The open source clone of GFS. Written in Java. The programming interfaces are similar to POSIX but not identical.
Amazon S3 and EBS	S3 is used for retrieving and storing data from/to remote servers. EBS is built on top of S3 for using virtual disks in running EC2 instances.

INTER-CLOUD RESOURCE MANAGEMENT

- **Virtual Machine Creation and Management**
- We will consider several issues for cloud infrastructure management.
- First, we will consider the resource management of independent service jobs.
- Then we will consider how to execute third-party cloud applications.
- Cloud-loading experiments are used by a Melbourne research group on the French Grid'5000 system.
- This experimental setting illustrates VM creation and management.

INTER-CLOUD RESOURCE MANAGEMENT

- **Virtual Machine Creation and Management**



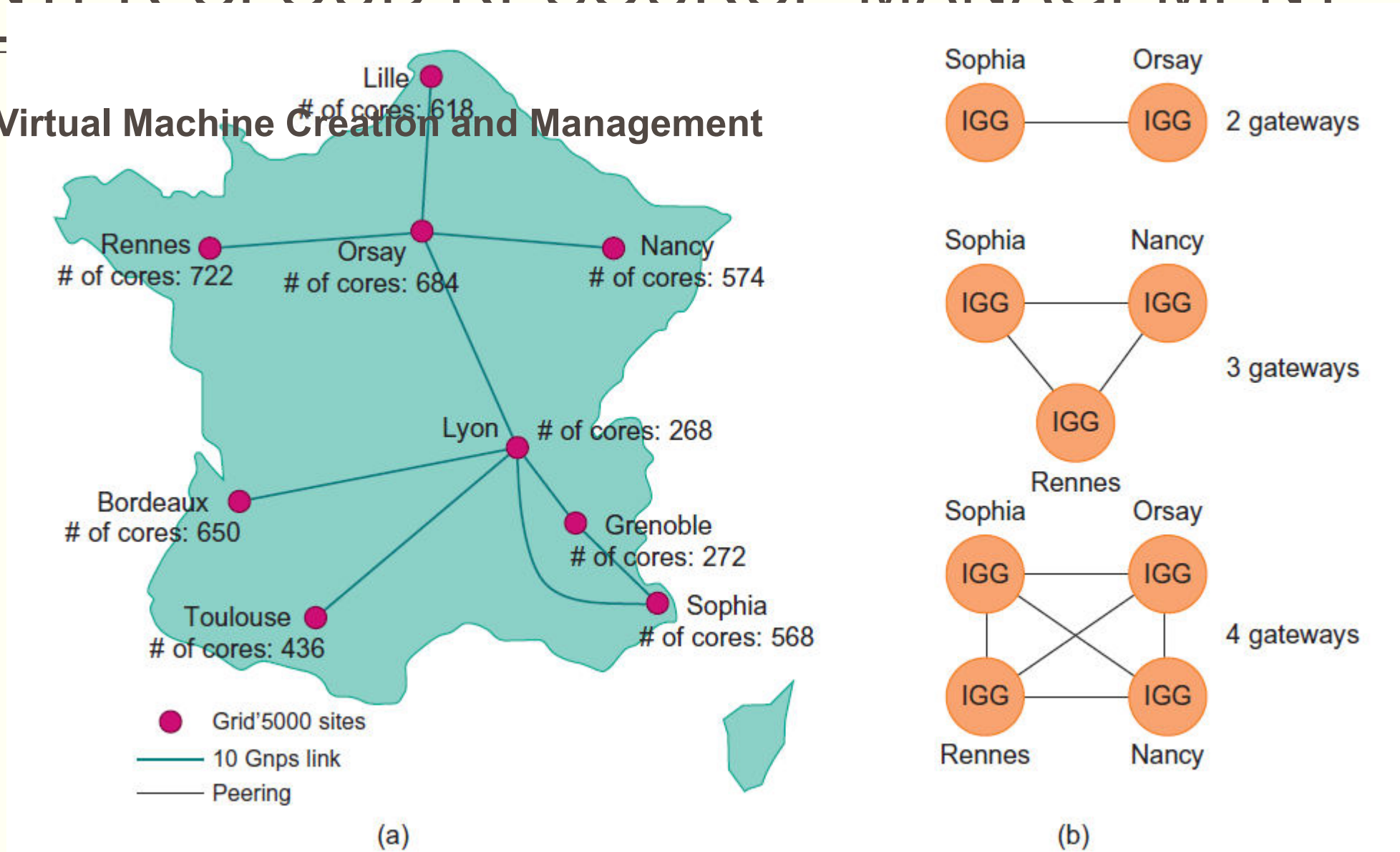
Interactions among VM managers for cloud creation and management; the manager provides a public API for users to submit and control the VMs.

INTER-CLOUD RESOURCE MANAGEMENT

- **Virtual Machine Creation and Management**
- Independent Service Management
- Running Third-Party Applications
- Virtual Machine Manager
- Virtual Machine Templates
- Distributed VM Management

INTER-CLOUD RESOURCE MANAGEMENT

- **Virtual Machine Creation and Management**



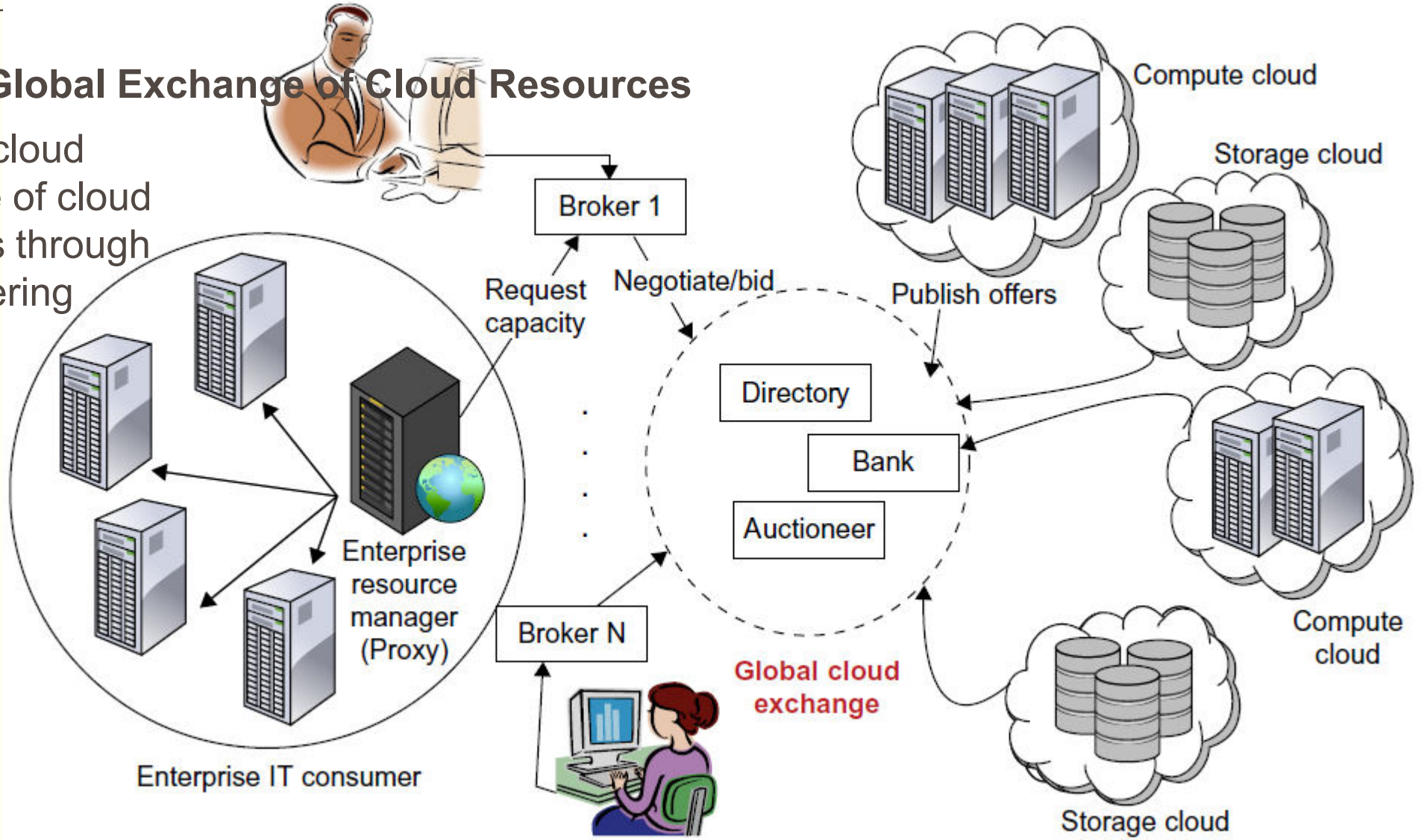
INTER-CLOUD RESOURCE MANAGEMENT

- **Global Exchange of Cloud Resources**
- In order to support a large number of application service consumers from around the world, cloud infrastructure providers (i.e., IaaS providers) have established data centers in multiple geographical locations to provide redundancy and ensure reliability in case of site failures.
- For example, Amazon has data centers in the United States (e.g., one on the East Coast and another on the West Coast) and Europe.

INTER-CLOUD RESOURCE MANAGEMENT

- **Global Exchange of Cloud Resources**

Inter-cloud exchange of cloud resources through brokering

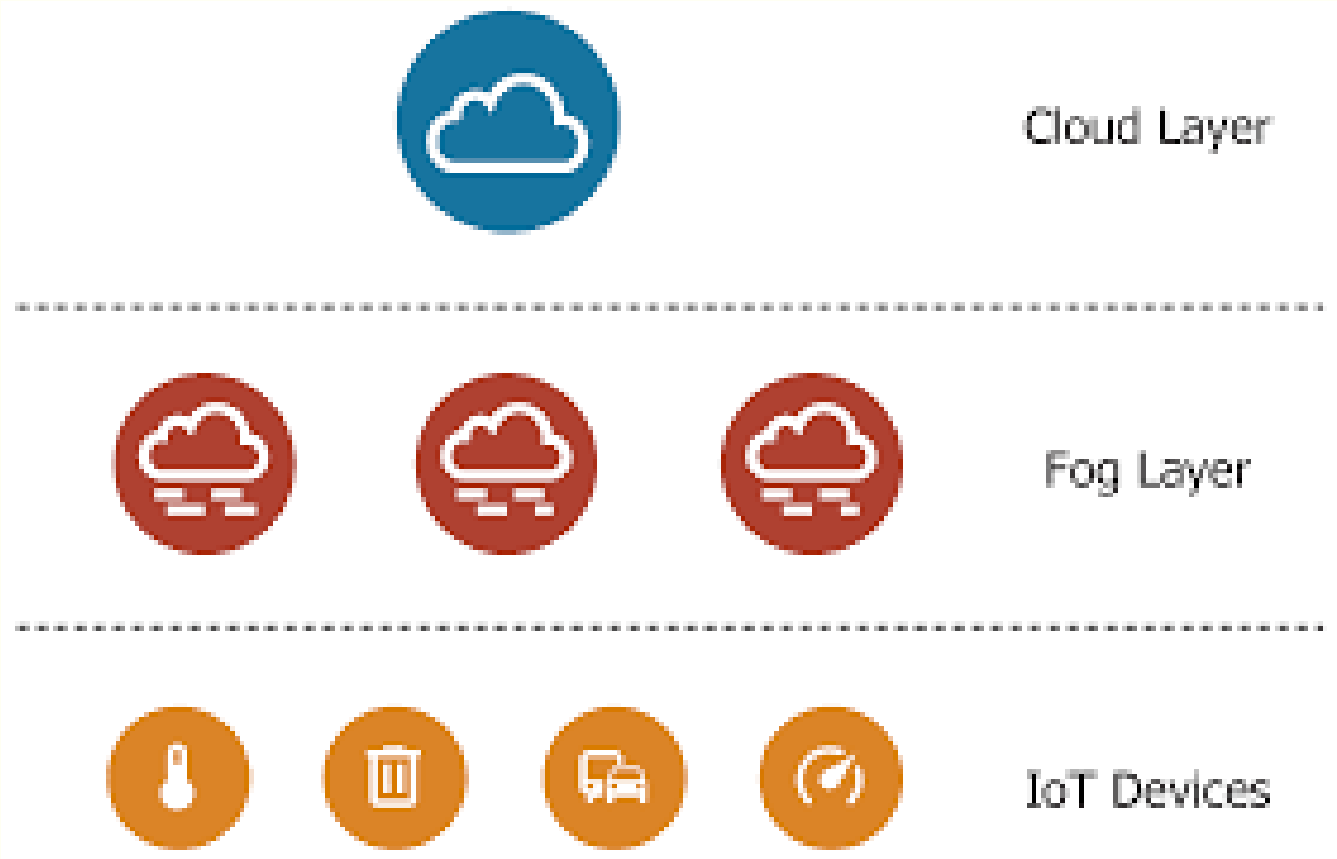


INTRODUCTION TO FOG COMPUTING

- Fog computing, also called fog networking or fogging, describes a decentralized computing structure located between the cloud and devices that produce data.
- This flexible structure enables users to place resources, including applications and the data they produce, in logical locations to enhance performance.

INTRODUCTION TO FOG COMPUTING

- **Architecture of Fog Computing**



INTRODUCTION TO FOG COMPUTING

- **Benefits of fog computing**
- Bandwidth conservation
- Improved response time
- Network-agnostic

INTRODUCTION TO FOG COMPUTING

- **Advantages**
- Minimize latency
- Conserve network bandwidth
- Reduce operating costs
- Enhance security
- Improve reliability
- Deepen insights, without sacrificing privacy
- Boost business agility

INTRODUCTION TO FOG COMPUTING

- **Disadvantages**
- Physical location
- Potential security issues
- Startup costs
- Ambiguous concept

INTRO

Fog Computing

Pros	Cons
Reduces amount of data sent to the cloud	Physical location takes away from the anytime, anywhere, any data benefit of the cloud
Conserves network bandwidth	Security issues: IP address spoofing, man-in-the-middle attacks
Improves system response time	Privacy issues
Improves security by keeping data close to the edge	Availability/cost of fog equipment/hardware
Supports mobility	Trust and authentication concerns
Minimizes network and internet latency	Wireless network security concerns

REFERENCES

1. Kai Hwang, Geoffrey C Fox and Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
2. Barrie Sosinky,"Cloud Computing Bible", Wiley Publishing Inc,2011
3. Buyya R., Broberg J. and Goscinski A., "Cloud Computing: Principles and Paradigm", First Edition, John Wiley & Sons, 2011.
4. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi,"Mastering the Cloud Computing", Morgan Kaufmann,2013
5. John W. Rittinghouse and James F. Ransome, "Cloud Computing: Implementation "Management, and Security", CRC Press, 2016.
6. David Bernstein, "Containers and Cloud: From LXC to Docker to Kubernetes", IEEE Cloud Computing, Volume: 1 , Issue: 3 , 2014.
7. VMware (white paper),"Understanding Full Virtualization, Paravirtualization, and Hardware Assist ":www.vmware.com/files/pdf/VMware_paravirtualization.pdf.

Thank You…