

CISCO NerdLunch Series

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New resource provision paradigms for Grid Infrastructures: Virtualization and Cloud

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- Brief review of Grids and some limitations of current Grids
- Use of virtual machines in Grids and its use for the dynamic provisioning of virtual clusters
- Grids & Clouds: Scale-out a Grid sites
- Conclusions

Brief Review of Grid Infrastructures

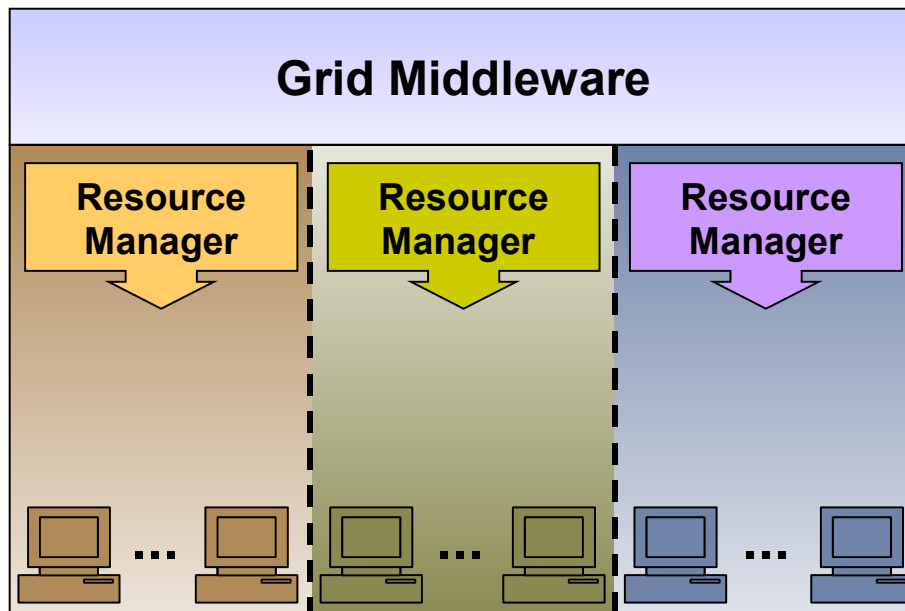
New provision models for Grids: Virtualization and Clouds

"Any problem in computer science can be solved with another layer of indirection... But that usually will create another problem."

David Wheeler

A Grid... a new abstraction layer

"A (computational) Grid is an abstraction layer (middleware) to integrate disparate administration domains (platforms and policies)"



Common Interface for Each Type of Resources: User can access a wide set of resources.

Types of Resources: Computational, storage and network.

A Grid...

“A Grid is system that ...

1. coordinates resources that are **not subject to centralized control**
2. using **standard, open, general-purpose protocols** and interfaces
3. ... to deliver **nontrivial qualities of service.**”

Ian Foster

What is the Grid? A Three Point Checklist (2002)

...Grid technologies and *infrastructures as supporting the sharing and coordinated use of diverse resources in dynamic, distributed “virtual organizations” (Vos)*...We view a Grid as an extensible set of **Grid services** that may be aggregated in various ways to meet the needs of VOs...

Ian Foster, Carl Kesselman, Jeffrey M. Nick y Steven Tuecke

“The Physiology of the Grid: An Open Grid Services Architecture for Distributed Systems Integration” (2002)

Grid Middleware (A computational view)

- **Services in the Grid Middleware layer**

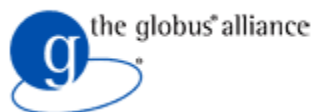
- Security
- Information & Monitoring
- Data Management
- Execution
- Meta-scheduling

- **Open Source Software Distributions**



vdt.cs.wisc.edu

- **Open Source Software Communities**



The Globus Alliance (dev.globus.org)

Some Limitations of Current Grids

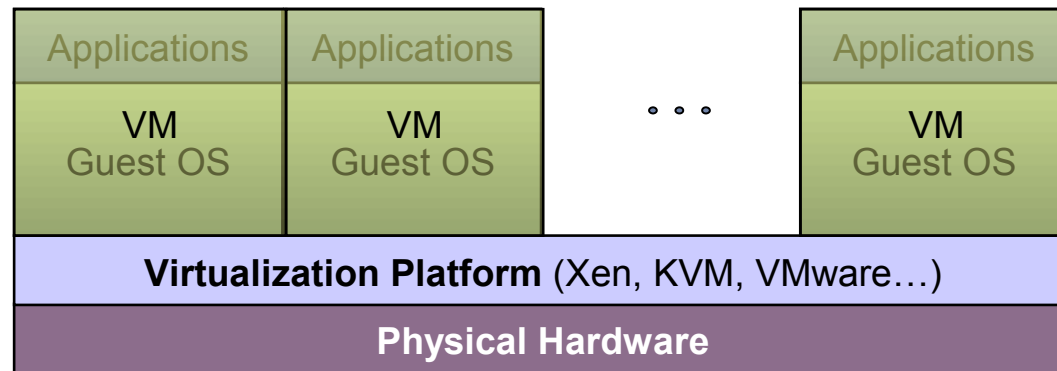
- High degree of heterogeneity (software & hardware)
- High operational costs
- Isolate and partition resources contributed to the Grid
- Specific environment requirements for different VOs



Grids are difficult to mantain, operate and use

Virtual Machines

- A VM is an isolated runtime environment (guest OS and apps)
- Hypervisors: Full Virtualized, para-virtualization, HW Virtualization

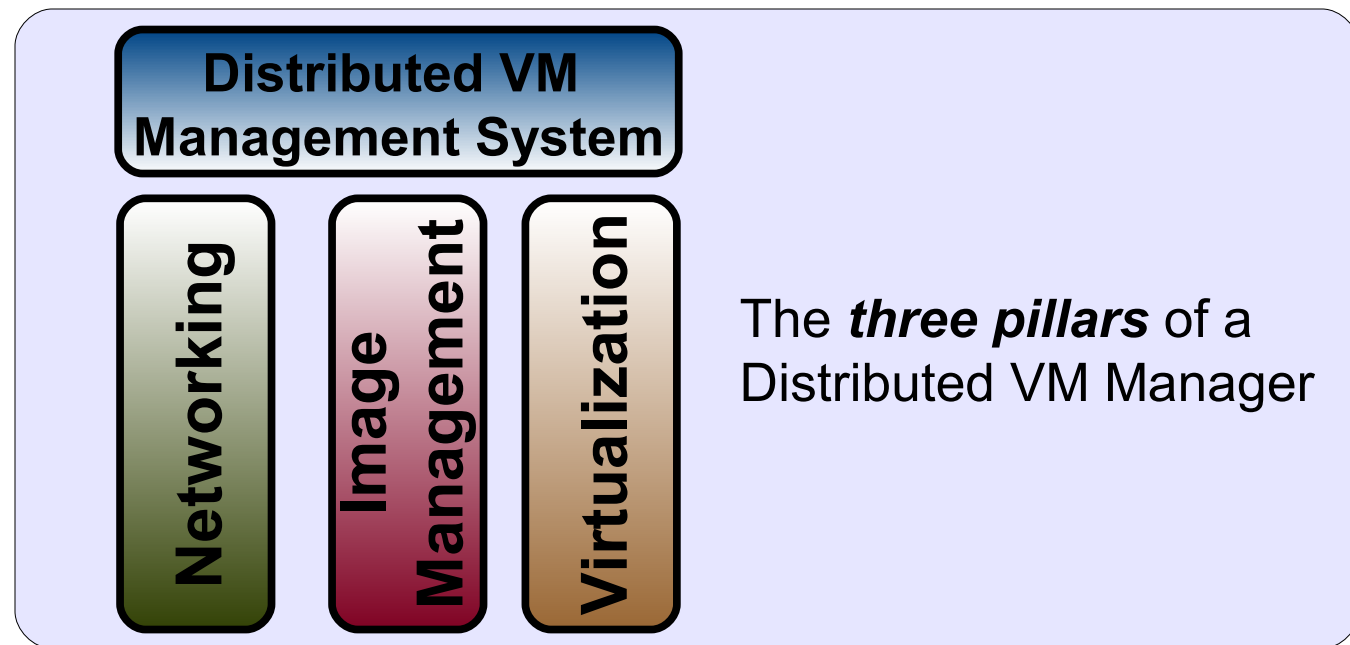


Benefits of Virtualization Platforms

- Natural way to deal with the heterogeneity of the infrastructure
- Allow partitioning and isolating of physical resources
- Execution of legacy applications

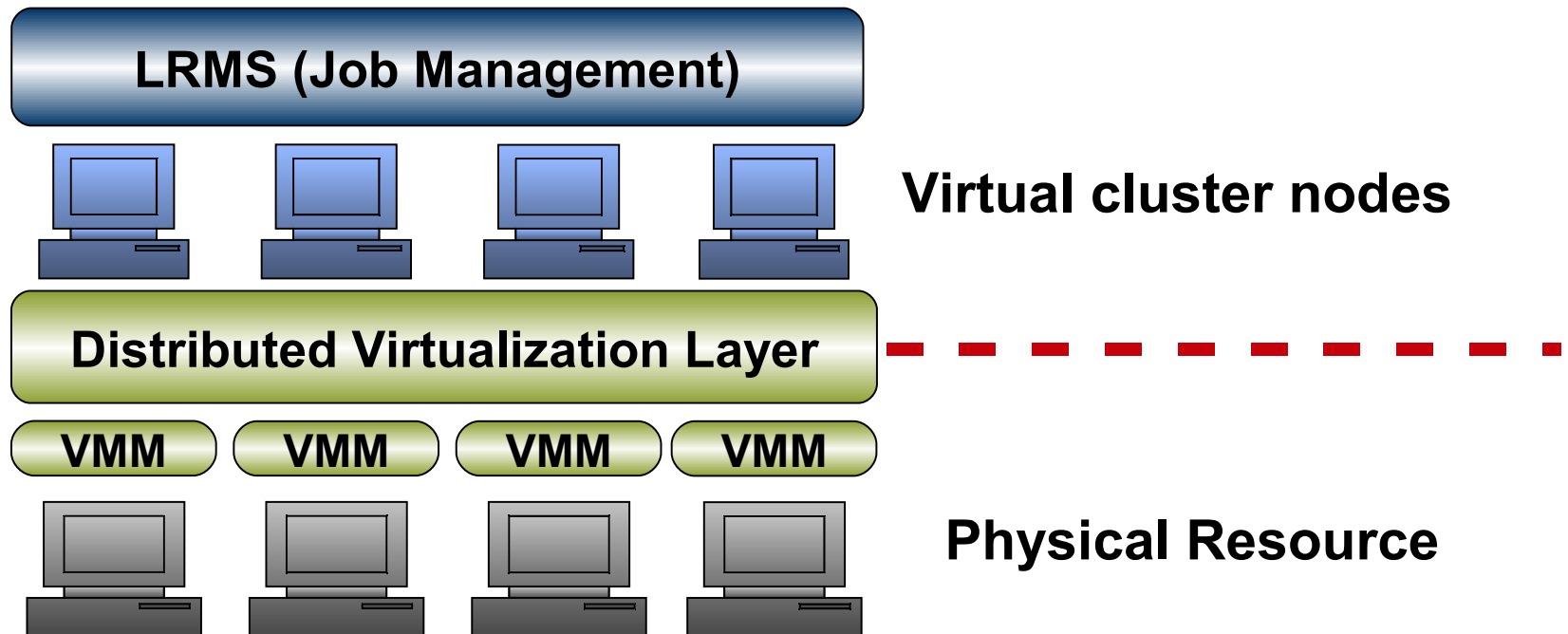
Distributed Virtual Machine Management System

- Provides a uniform view of the resource pool
- Resources organized in a cluster architecture
- **Life-cycle management** and monitoring of VM
- The VM Management System **integrates** Image, Network and Virtualization technologies



A New Infrastructure Layer...

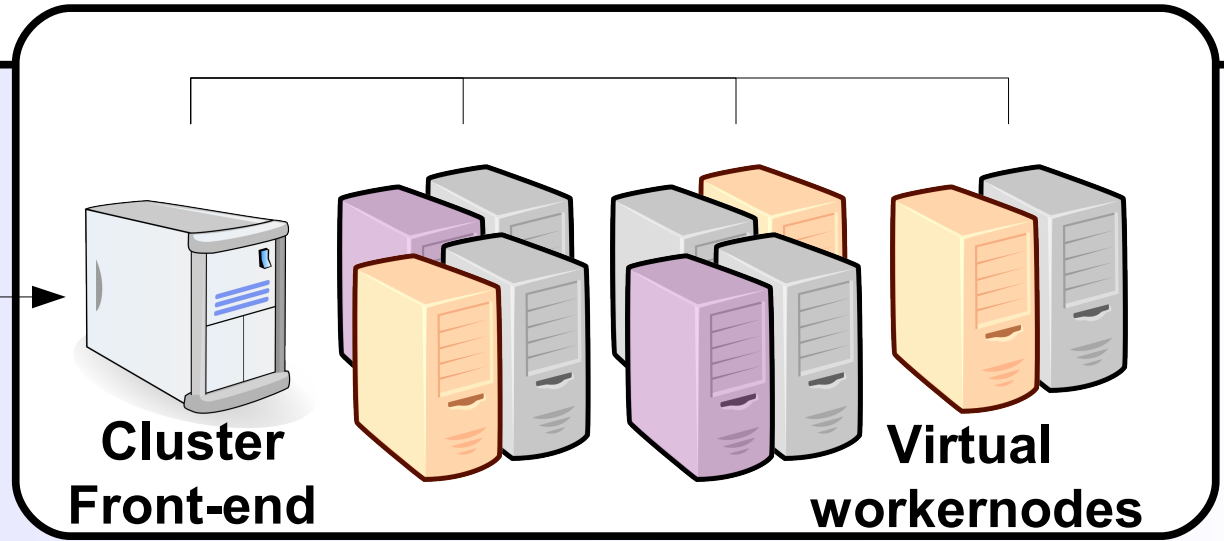
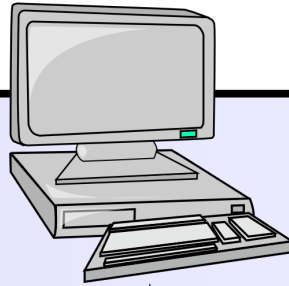
- Separation of Resource Provisioning from Job Management
- Seamless integration with the existing middleware stacks.
- Completely transparent to the computing service and end users



Grids & Virtual Machines

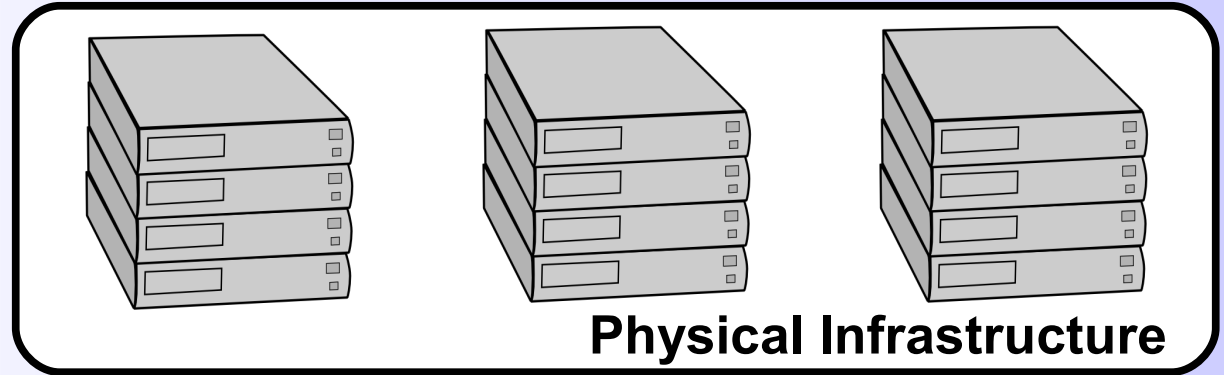
New provision models for Grids: Virtualization and Clouds

Cluster users



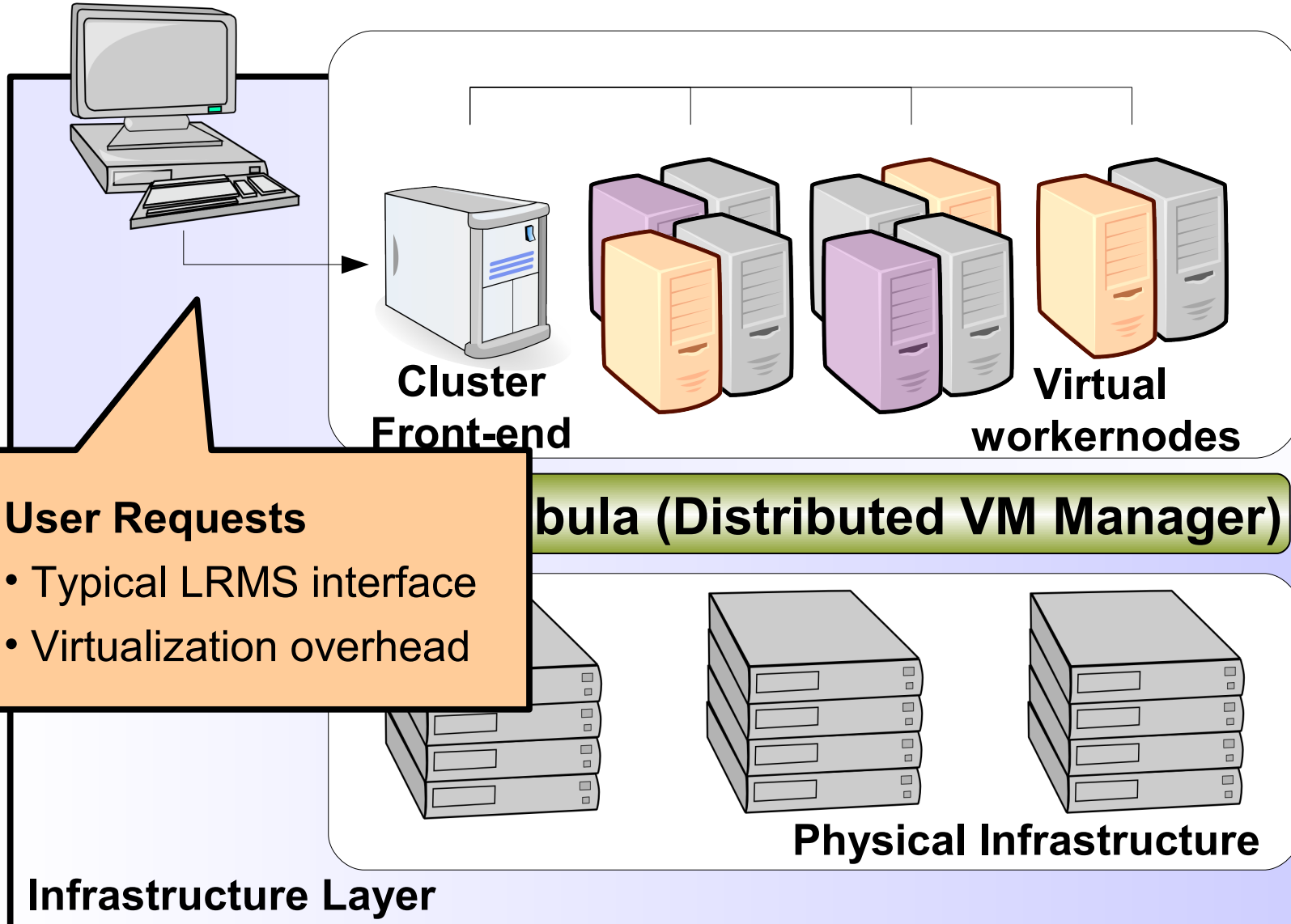
Service Layer

Distributed Virtualizer



Infrastructure Layer

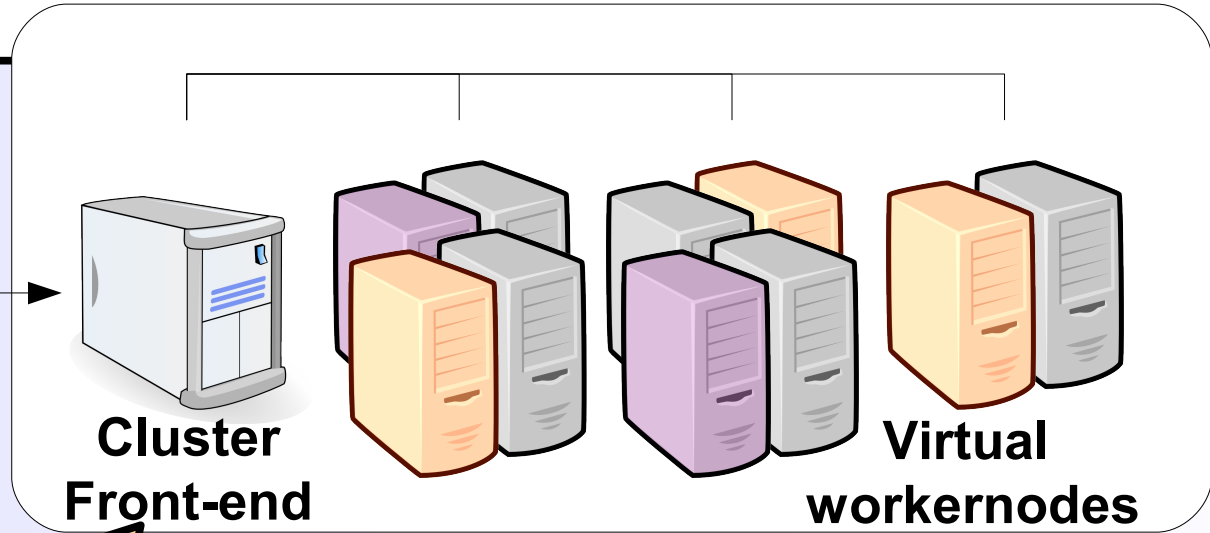
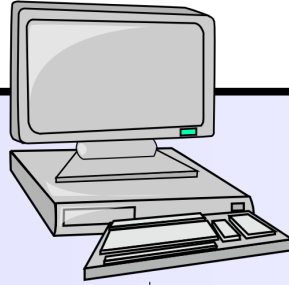
Cluster users



Grids & Virtual Machines

New provision models for Grids: Virtualization and Clouds

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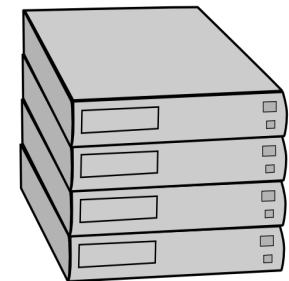


Service Layer

anNebula (Distributed VM Manager)

Cluster Consolidation

- Multiple worker nodes in a single resource
- Dynamic provision rules (inf. adaptation)
- VMM functionality (e.g. live migration)



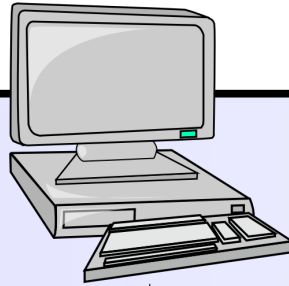
Physical Infrastructure

Infrastructure Layer

Grids & Virtual Machines

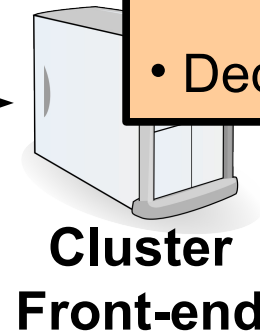
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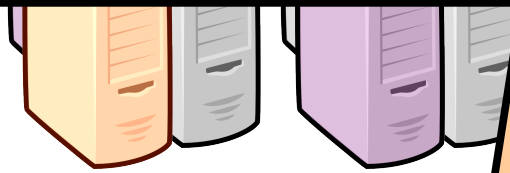


Cluster Partitioning

- Performance partitioning (dedicated nodes)
- Isolate cluster workload
- Dedicated HA partitions



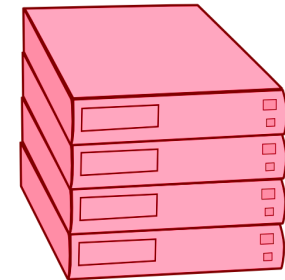
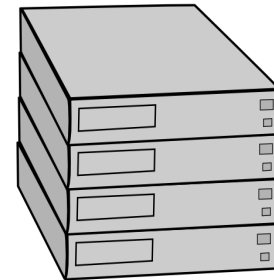
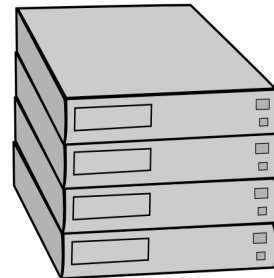
**Cluster
Front-end**



Backend nodes

Service Layer

OpenNebula (Distributed Virtual Machine Manager)



Physical Infrastructure

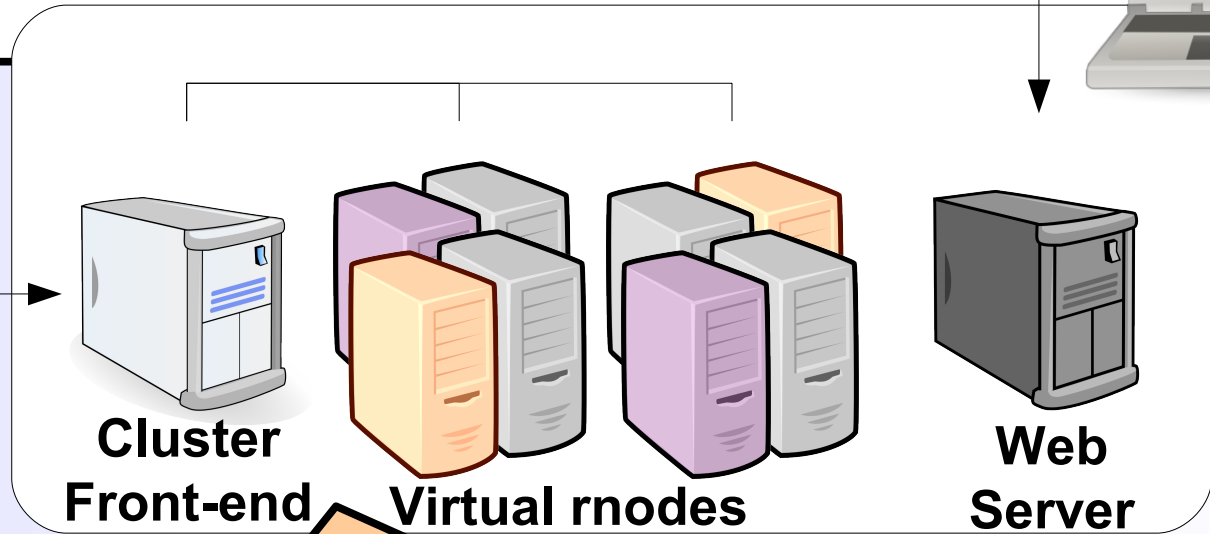
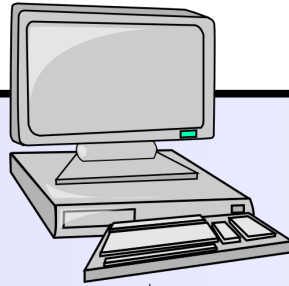
Infrastructure Layer

Grids & Virtual Machines

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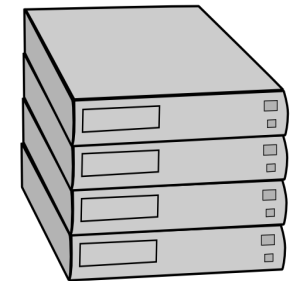
HTTP clients



Service Layer

OpenNebula (distributed VM Manager)

- Heterogenous Workloads**
- Dynamic provision of cluster configurations
 - Simultaneous support of different services
 - E.g. on-demand VO workernodes in Grids



Physical Infrastructure

Infrastructure Layer

A Complete Grid Middleware Stack

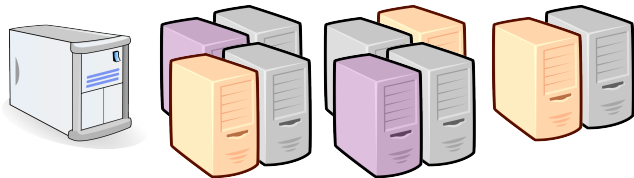
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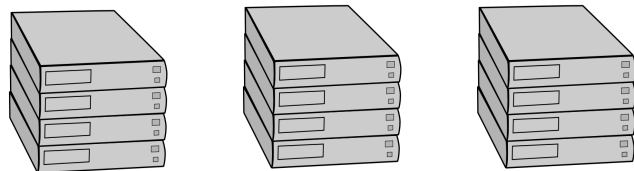
**Meta-schedulers
(GridWay, Condor/G...)**

gLite, UNICORE, Globus...

Cluster Frontend (SGE...)



Distributed VM Manager



- Unmodified Applications (Grid or local)
- Interfaces preserved (qsub, DRMAA..)

Applications

- Virtual resources are exposed by GT
- Dynamic scheduling
- Fault detection & recovery

Grid Middleware Layer

- WNs register to different queues
- Multiple VO-specific clusters

Computing Service Layer

- Infrastructure consolidation
- Infrastructure partitioning
- Infrastructure adaptation

Infrastructure Layer

A Complete Grid Middleware Stack

New provision models for Grids: Virtualization and Clouds



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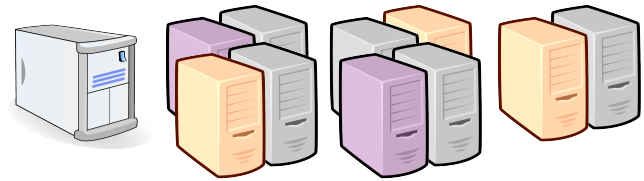
Grid Middleware Layer



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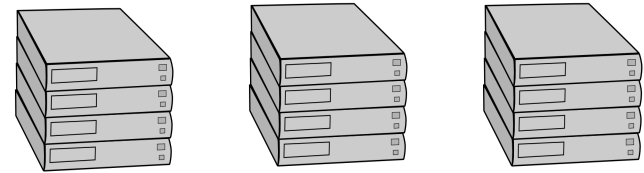
Computing Service Layer



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Infrastructure Layer

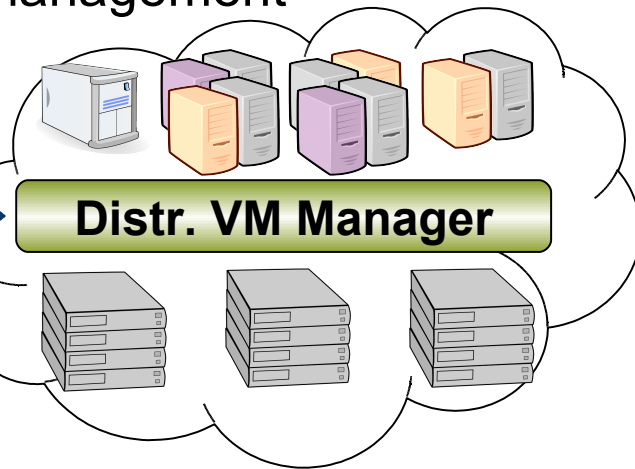


A Service to Provide Hardware on Demand (IaaS)

- Cloud systems provide **virtualized resources as a service**
- Provide remote **on-demand access to infrastructure** (through Vms)
- Main components of a **Cloud architecture**:
 - **Front-end**: Remote interface
 - **Back-end**: Local VM, image & network management

Simple Interfaces

- VM Management
- Image Management



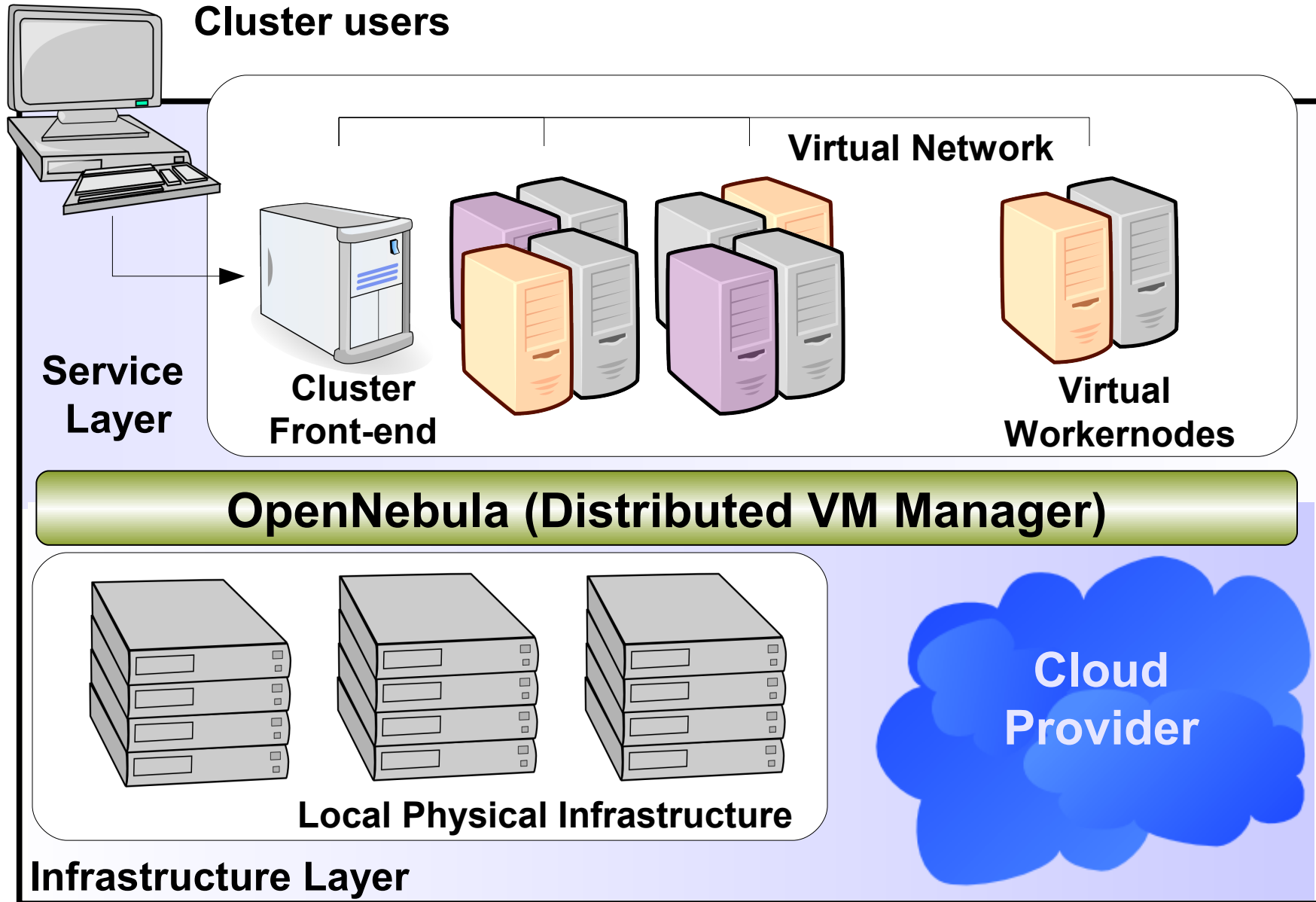
Infrastructure Cloud Services

- Commercial Cloud: Amazon EC2, GoGrid...
- Scientific Cloud: Nimbus (University of Chicago)

Cloud Computing, An Infrastructure View

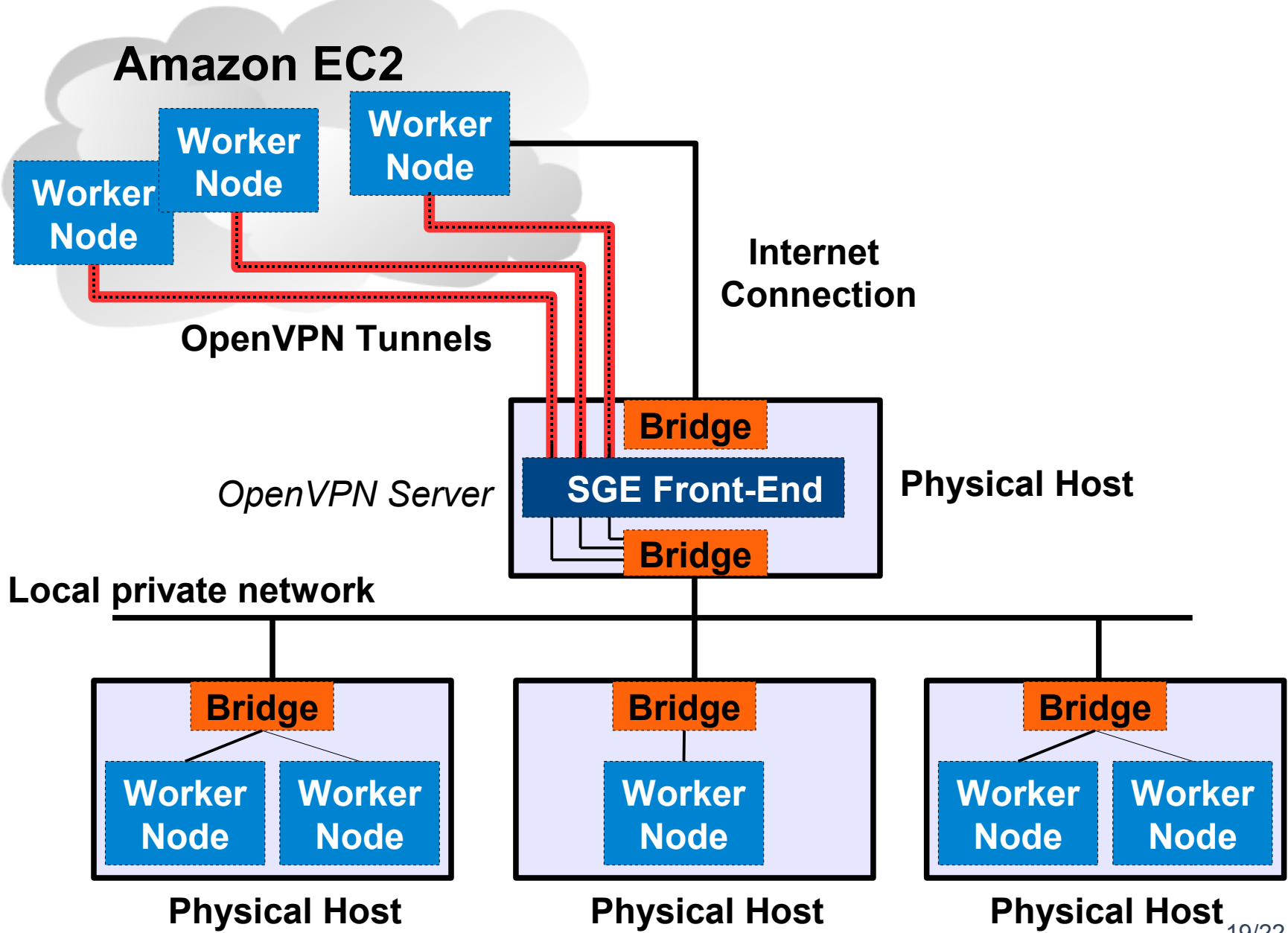
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Cloud Computing, An Infrastructure View

New provision models for Grids: Virtualization and Clouds



Benefits of Virtualization for Existing Grid Infrastructures

- Easy support for VO-specific worker nodes
- Reduce *gridification* cycles
- Dynamic balance of resources between VO's
- Fault tolerance of key infrastructure components
- Easier deployment and testing of new middleware distributions
- Cheaper development nodes
- Simplified training machines deployment
- Performance partitioning between local and grid services



Solve many obstacles for Grid adoption

About the Coexistence of Grid and Clouds

- Virtualization, cloud, grid and cluster are complementary technologies and will coexist and cooperate at different levels of abstraction
- Virtualization and cloud do NOT require any modification within service layers from both the administrator and the end-user perspectives
- Separation between service and infrastructure layers will allow the application of the utility model to Grid/cluster/HPC computing

THANK YOU FOR YOUR ATTENTION!!!

More info, downloads, mailing lists at
www.OpenNebula.org

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www.reservoir-fp7.eu/

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