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Cloud Computing for on-Demand Resource Provisioning

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Objectives

- Show the benefits of the **separation of resource provisioning from job execution management** for HPC, cluster and grid computing
- Introduce **OpenNEbula** as the Engine for on-demand resource provisioning
- Present **Cloud Computing** as a paradigm for the on-demand provision of virtualized resources as a service
- Describe **Grid as the interoperability technology** for the federation of clouds
- Introduce the **RESERVOIR project** as the infrastructure technology to support the setup and deployment of services and resources on-demand across administrative domains

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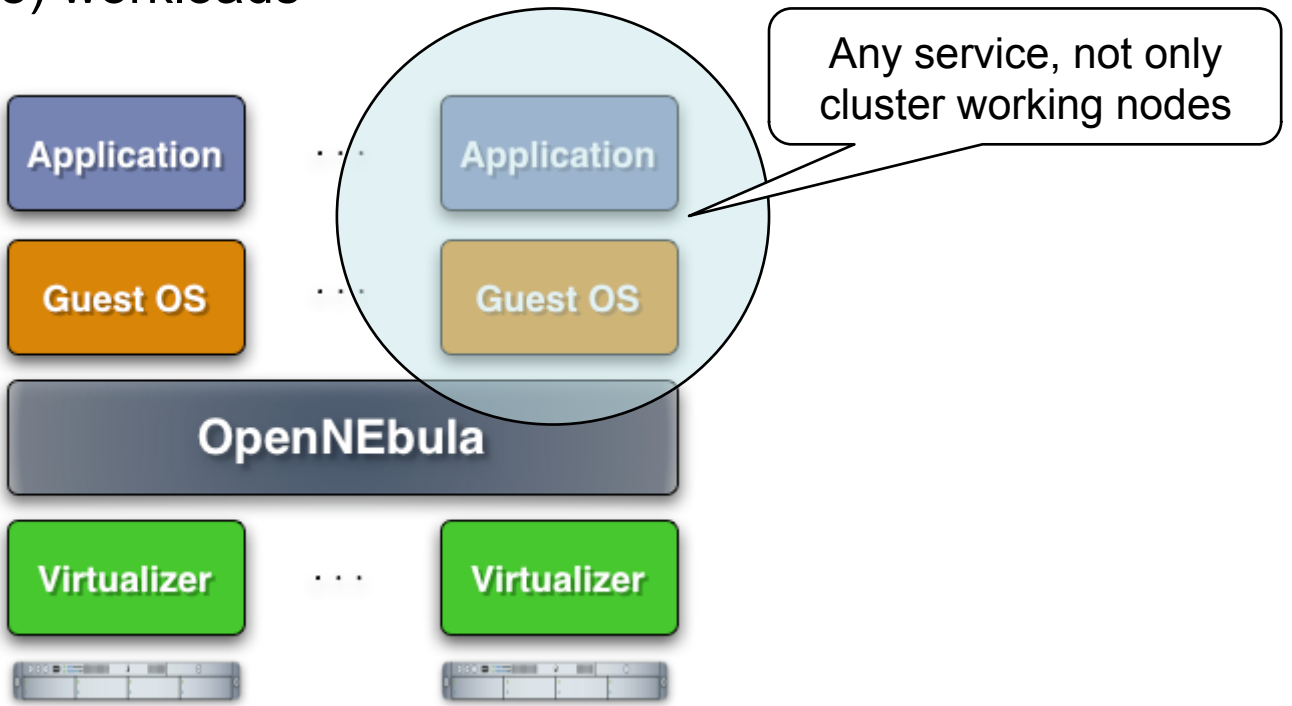
1. Local on-Demand Resource Provisioning

1.1. The Engine for the Virtual Infrastructure

The OpenNEbula Virtual Infrastructure Engine

- OpenNEbula creates a **distributed virtualization layer**
  - Extend the benefits of VM Monitors from one to multiple resources
  - Decouple the VM (service) from the physical location
- Transform a distributed physical infrastructure into a **flexible and elastic virtual infrastructure**, which adapts to the changing demands of the VM (service) workloads

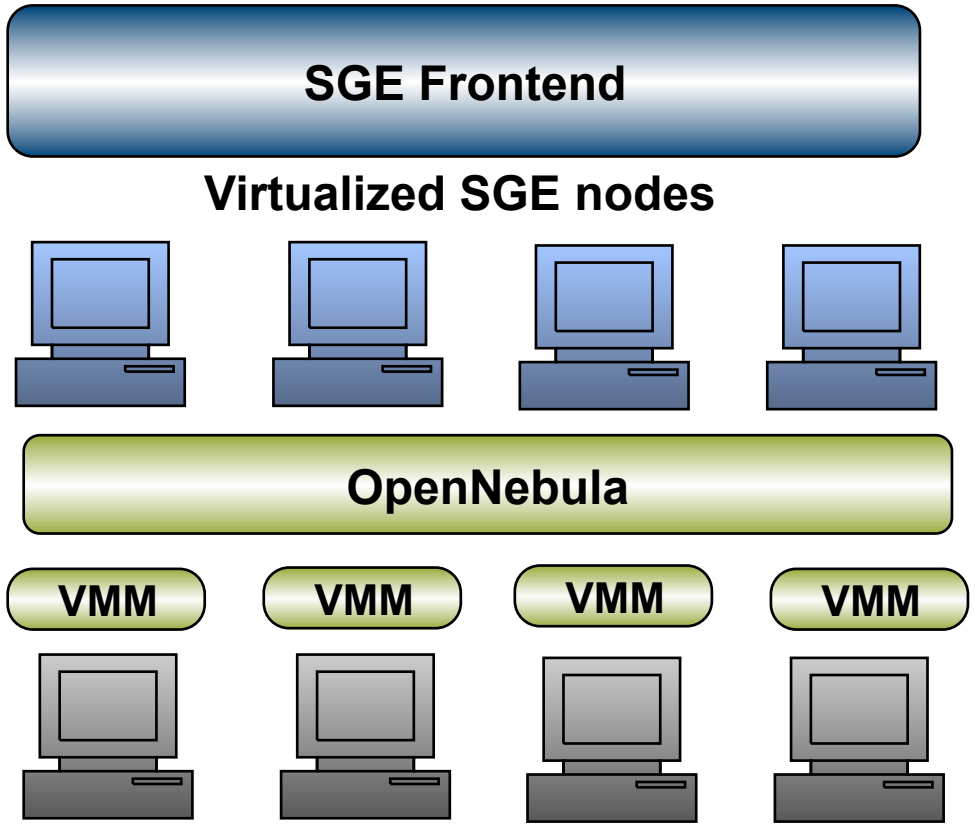


1. Local on-Demand Resource Provisioning

1.2. Virtualization of Cluster and HPC Systems

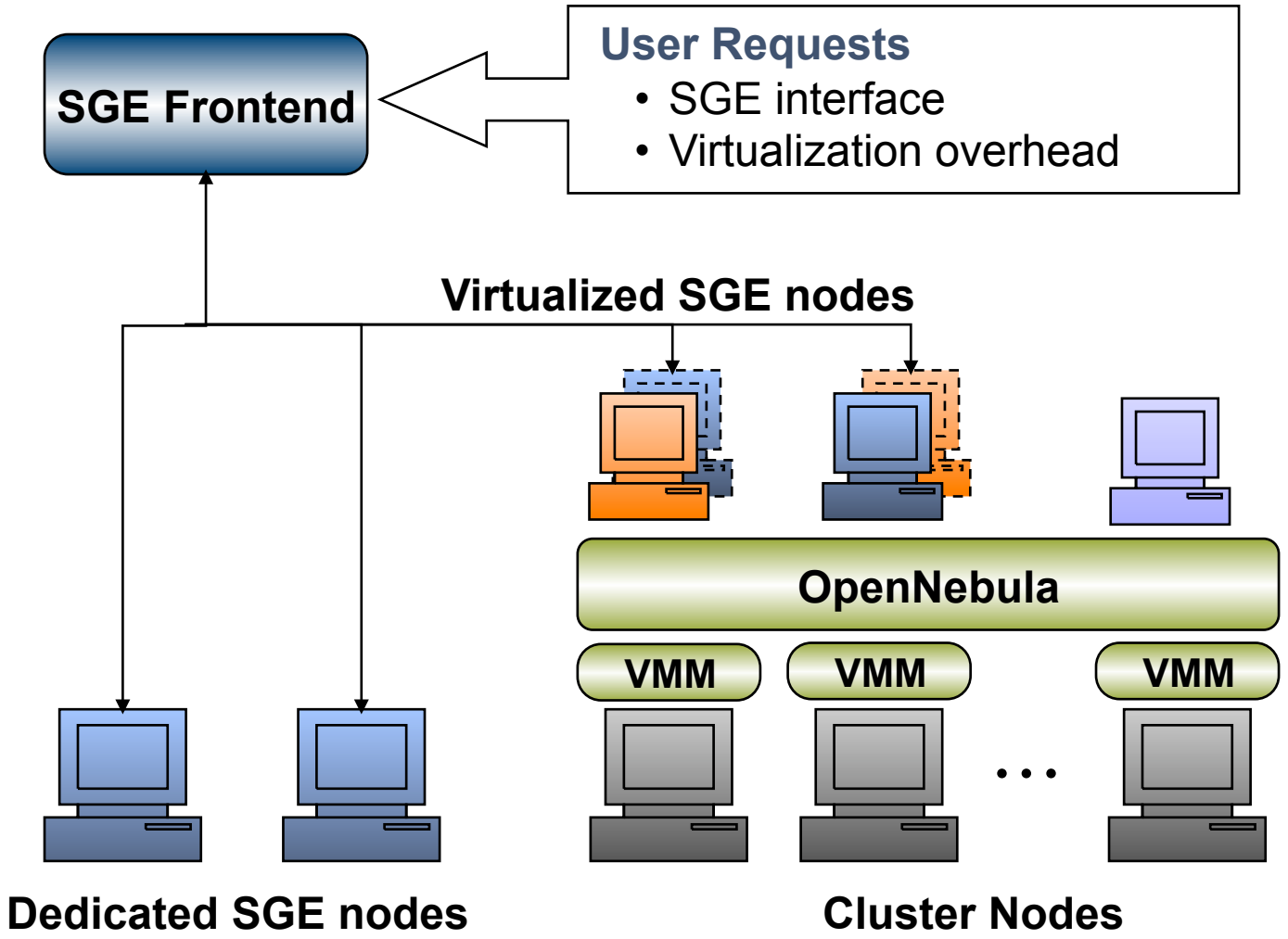
Separation of Resource Provisioning from Job Management

- New virtualization layer **between the service and the infrastructure layers**
- **Seamless integration** with the existing middleware stacks.
- **Completely transparent** to the computing service and so end users



1. Local on-Demand Resource Provisioning

1.3. Benefits

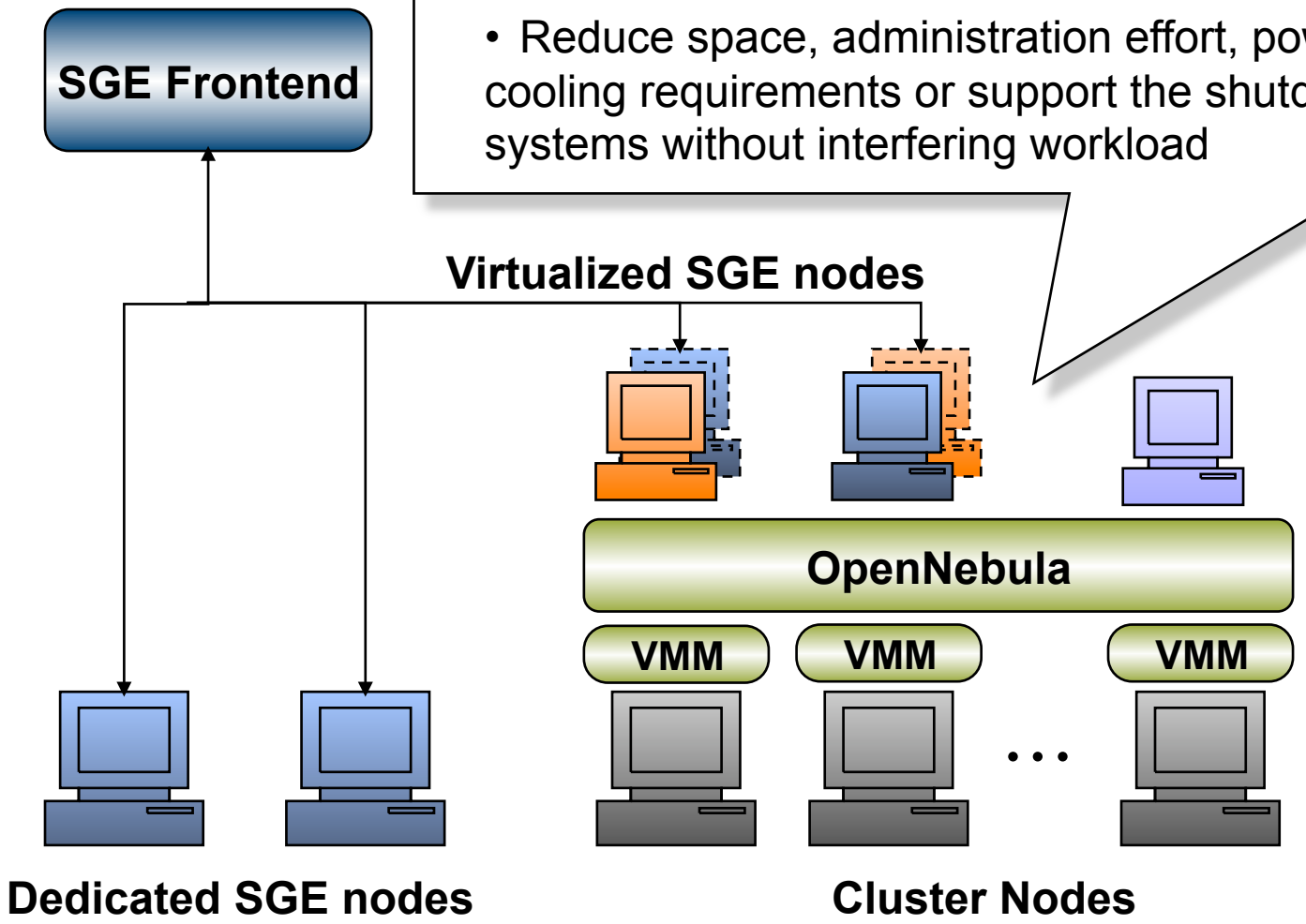


1. Local on-Demand Resource Provisioning

1.3. Benefits

Cluster Consolidation

- Heuristics for dynamic capacity provision leveraging VMM functionality (e.g. live migration)
- Reduce space, administration effort, power and cooling requirements or support the shutdown of systems without interfering workload

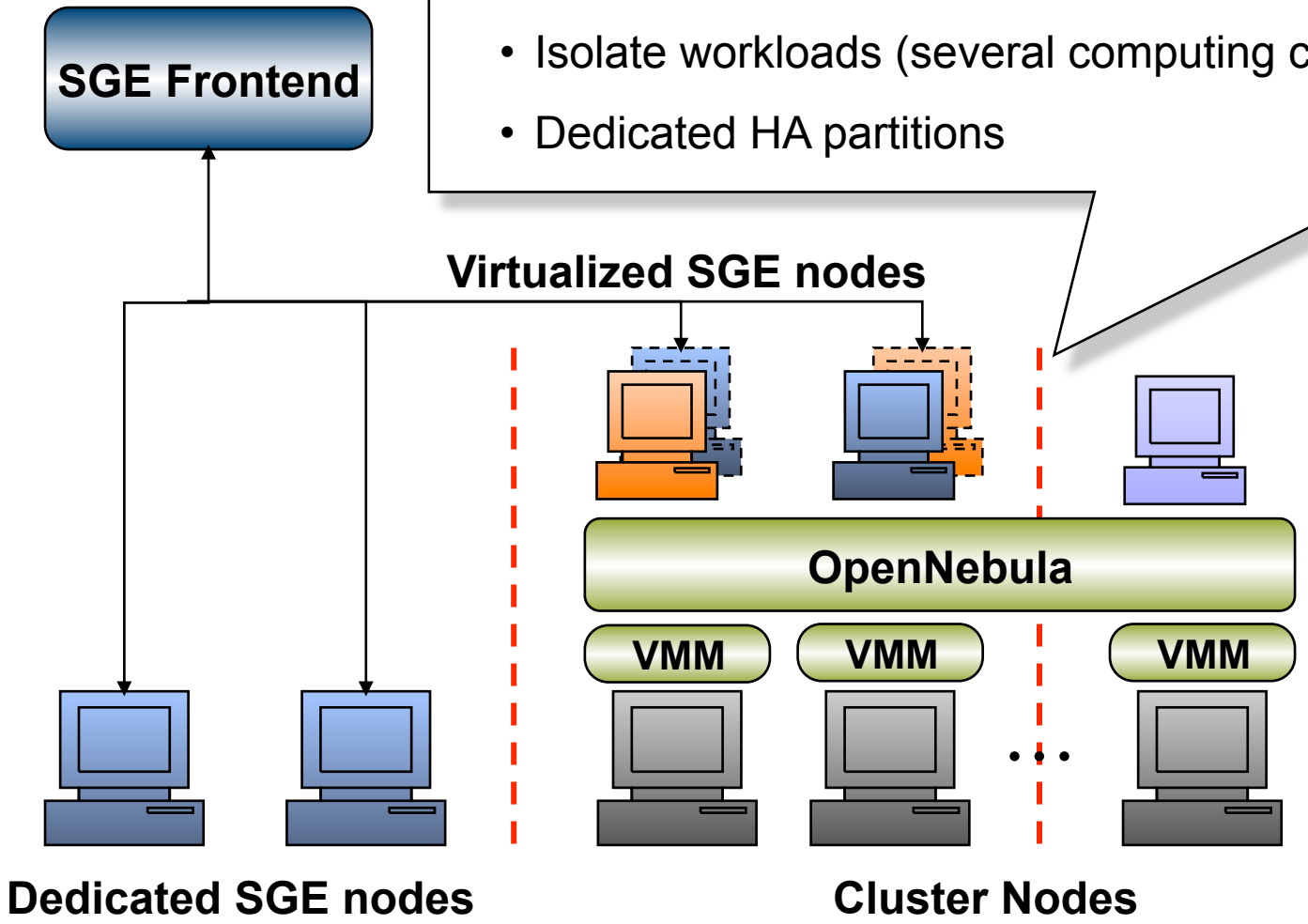


1. Local on-Demand Resource Provisioning

1.3. Benefits

Cluster Partitioning

- Dynamic partition of the infrastructure
- Isolate workloads (several computing clusters)
- Dedicated HA partitions

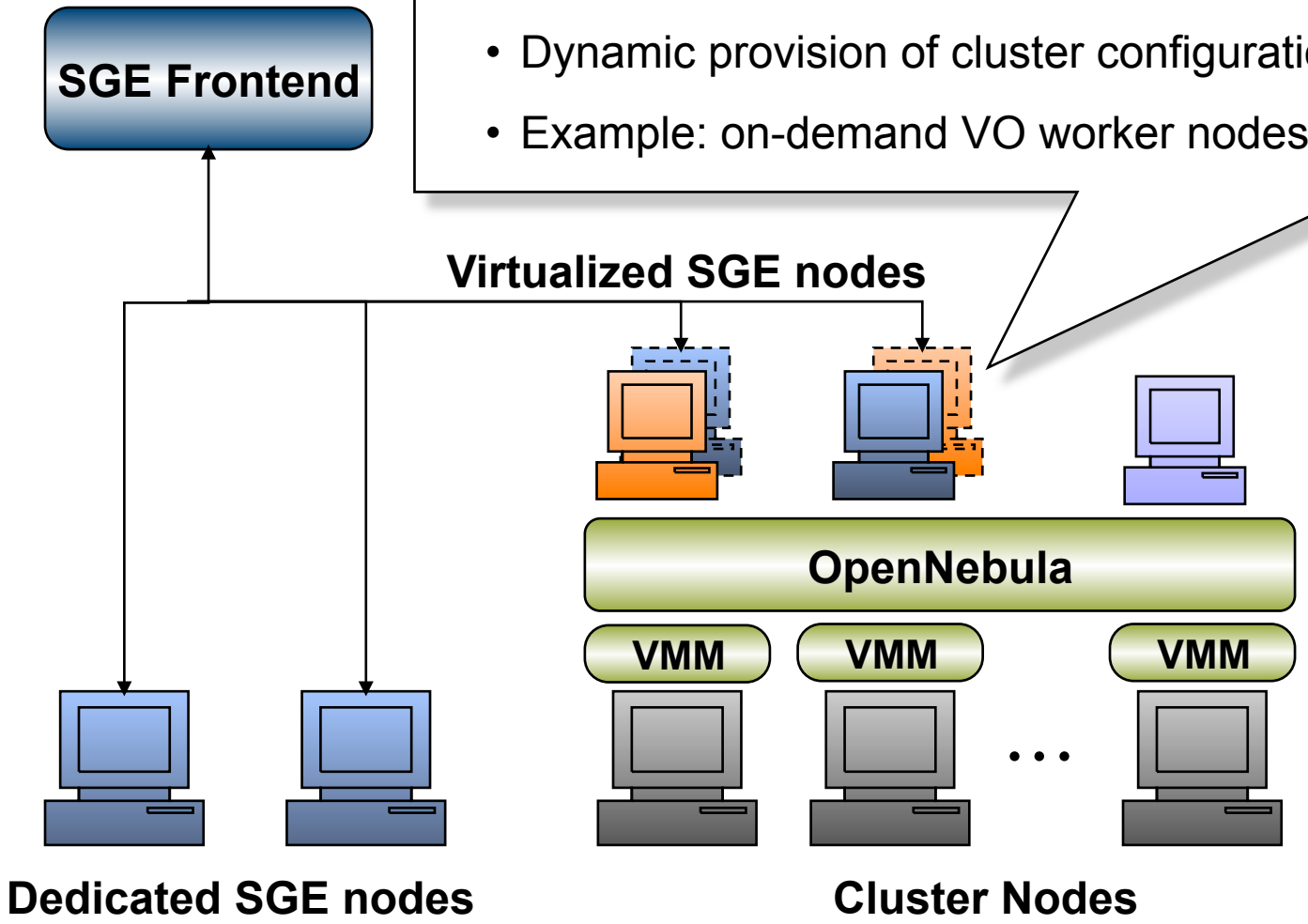


1. Local on-Demand Resource Provisioning

1.3. Benefits

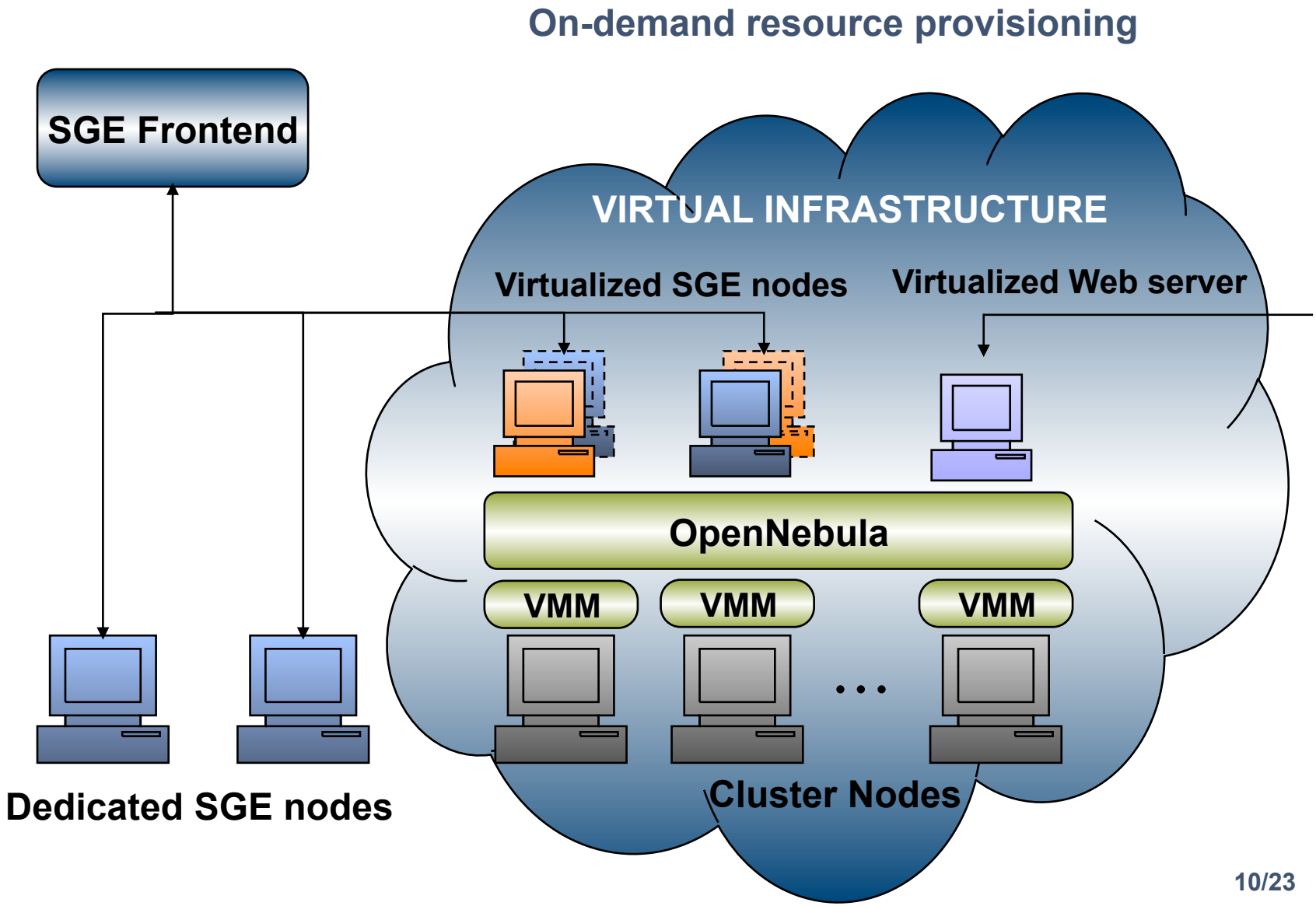
Support of Heterogeneous Workloads

- Custom worker-node configurations (queues)
- Dynamic provision of cluster configurations
- Example: on-demand VO worker nodes in Grids



1. Local on-Demand Resource Provisioning

1.3. Benefits



3. Conclusions

1.3. Benefits

Benefits for Existing Grid Infrastructures (EGEE, TeraGrid…)

- The **virtualization of the local infrastructure** supports a virtualized alternative to contribute resources to a Grid infrastructure
  - Simpler deployment and operation of new middleware distributions
  - Lower operational costs
  - Easy provision of resources to more than one infrastructure or VO
  - Easy support for VO-specific worker nodes
  - Performance partitioning between local and grid clusters

=> Solve many obstacles for Grid adoption

Integration of Job Execution Managers with Virtualization

- **VMs to Provide pre-Created Software Environments for Jobs**
  - Extensions of job execution managers to create per-job basis VMs so as to provide a pre-defined environment for job execution
  - Those approaches still **manage jobs**
  - The VMs are bounded to a given PM and only exist during job execution
  - Condor, SGE, MOAB, Globus GridWay…
- **Job Execution Managers for the Management of VMs**
  - Job execution managers enhanced to allow submission of VMs
  - Those approaches **manage VMs as jobs**
  - Condor, “pilot” backend in Globus VWS…

Differences between Job and VM Management

- **Differences between VMs and Jobs as basic Management Entities**
  - **VM structure**: Images with fixed and variable parts for migration…
  - **VM life-cycle**: Fixed and transient states for contextualization, live migration…
  - **VM duration**: Long time periods (“forever”)
  - **VM groups (services)**: Deploy ordering, affinity, rollback management…
  - **VM elasticity**: Changing of capacity requirements and number of VMs
- **Different Metrics in the Allocation of Physical Resources**
  - **Capacity provisioning**: Probability of SLA violation for a given cost of provisioning including support for server consolidation, partitioning…
  - **HPC scheduling**: Turnaround time, wait time, throughput…

Other Tools for VM Management

- VMware DRS, Platform Orchestrator, IBM Director, Novell ZENworks, Enomalism, Xenoserver…
- **Advantages**:
  - Open-source (Apache license v2.0)
  - Open and flexible architecture to integrate new virtualization technologies
  - Support for the definition of any scheduling policy (consolidation, workload balance, affinity, SLA…)
  - LRM-like CLI and API for the integration of third-party tools

2. Remote on-Demand Resource Provisioning

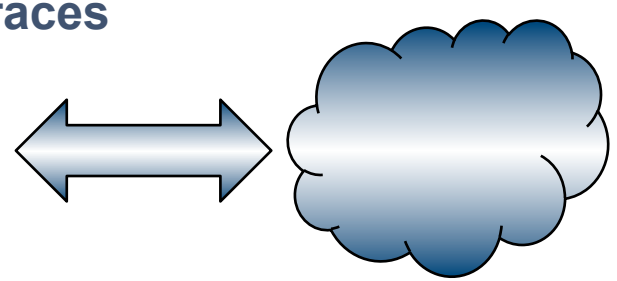
2.1. Access to Cloud Systems

What is Cloud Computing?

- Provision of virtualized resources as a service

VM Management Interfaces

- Submission
- Control
- Monitoring



Infrastructure Cloud Computing Solutions

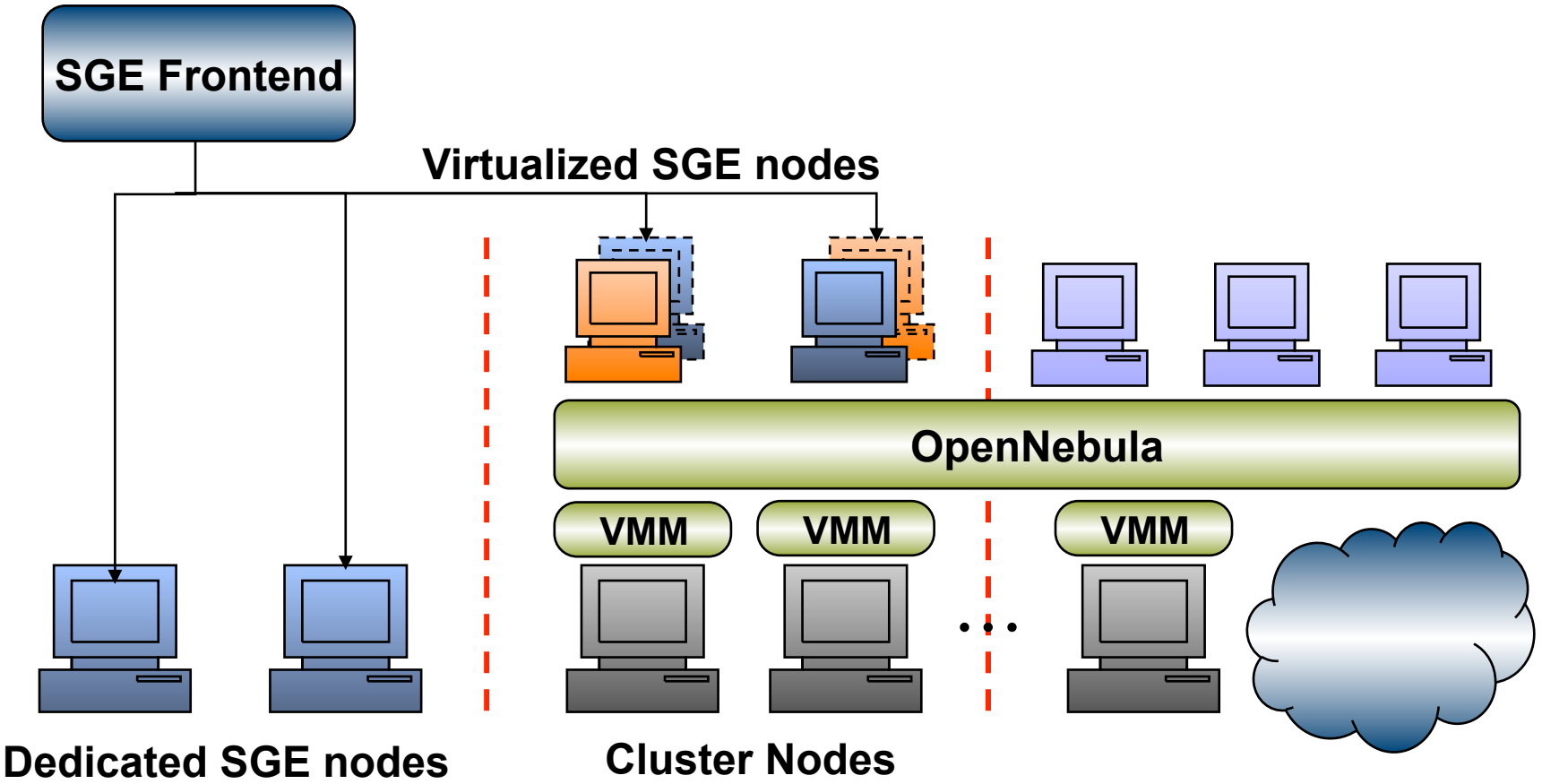
- **Commercial Cloud**: Amazon EC2
- **Scientific Cloud**: Nimbus (University of Chicago)
- **Open-source Technologies**
  - Globus VWS (Globus interfaces)
  - Eucalyptus (Interfaces compatible with Amazon EC2)
  - OpenNEbula (Engine for the Virtual Infrastructure)

2. Remote on-Demand Resource Provisioning

2.1. Access to Cloud Systems

On-demand Access to Cloud Resources

- Supplement local resources with cloud resources to **satisfy peak or fluctuating demands**

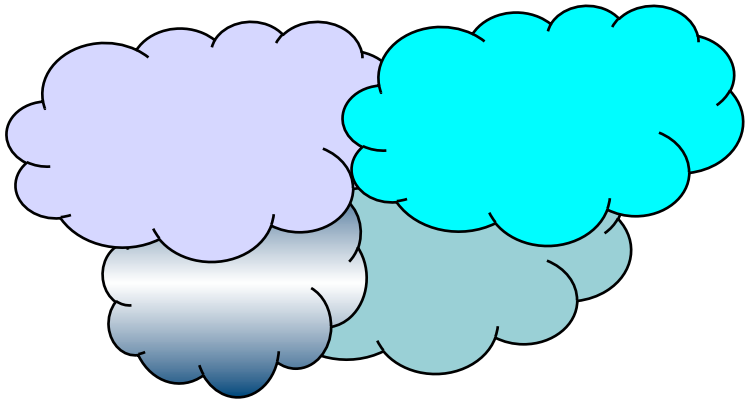


2. Remote on-Demand Resource Provisioning

2.2. Federation of Cloud Systems

Grid and Cloud are Complementary

- Grid interfaces and protocols enable the **interoperability between the clouds or infrastructure providers**
- Grid as technology for **federation of administrative domains** (***not as infrastructure for job computing***)



- **Grid infrastructures for computing** are one of the service use cases that could **run on top of the cloud**

2. Remote on-Demand Resource Provisioning

2.3. RESERVOIR Project

RESERVOIR

Who?

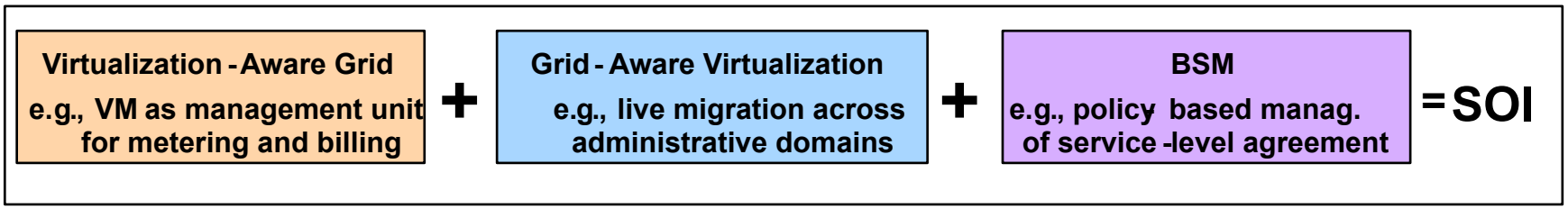
- IBM (coordinator), Sun, SAP, ED, TID, UCM, UNIME, UMEA, UCL, USI, CETIC, Thales and OGF-Europe
- 17-million and 3-year project partially funded by the European Commission (NESSI Strategic Project)

What?

- The Next Generation Infrastructure for Service Delivery, where resources and services can be **transparently and dynamically managed, provisioned and relocated like utilities** – virtually "without borders"

How?

- Integration of **virtualization technologies** with **grid computing** driven by new techniques for **business service management**



2.3. RESERVOIR Project

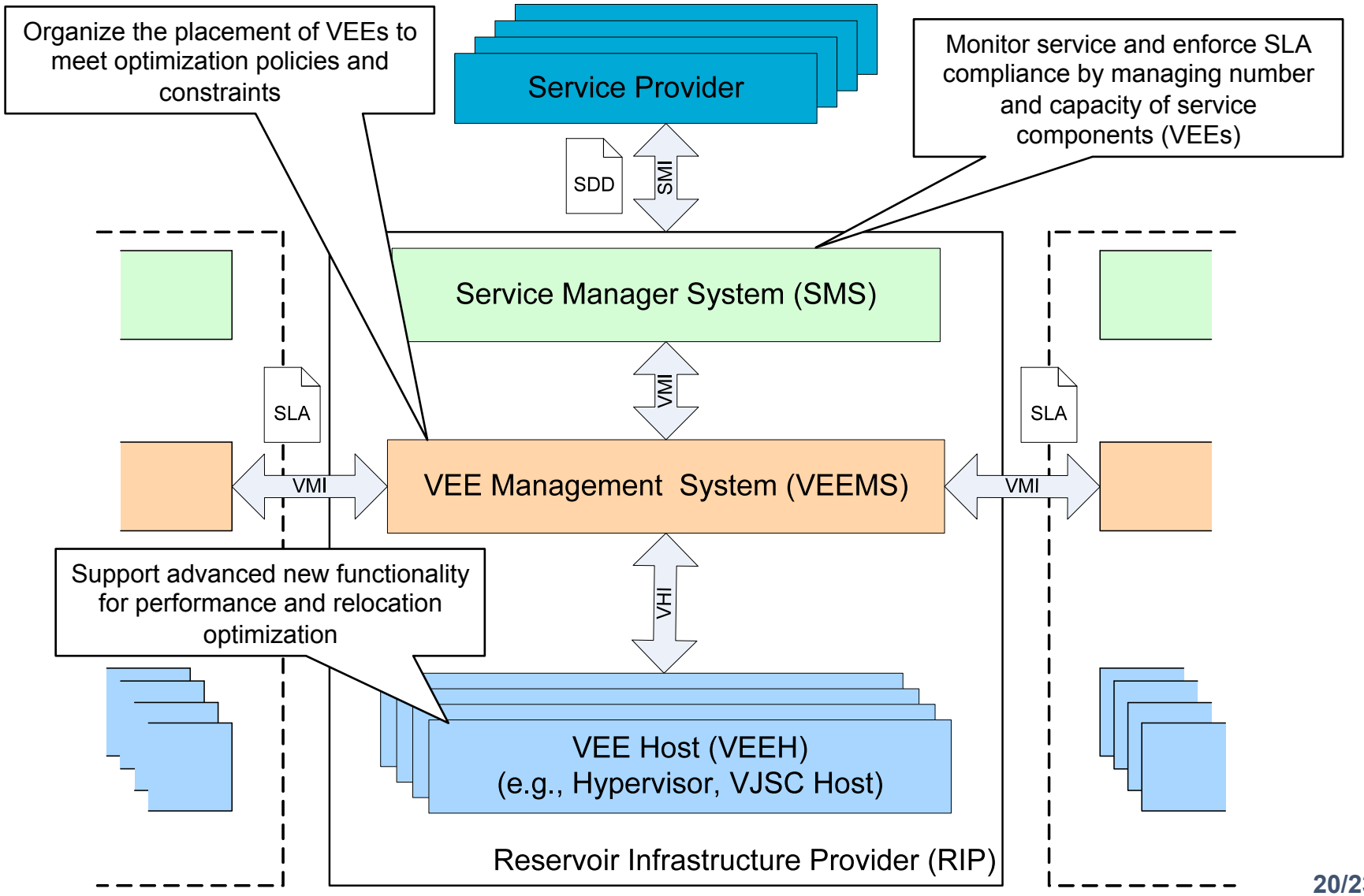
A Project Driven by Business Use Cases

- **Scenario 1: SAP business application (SAP)**
  - Business application oriented use cases and the opportunities to execute them on a flexible infrastructure.
- **Scenario 2: Telco application (TID)**
  - Hosting web sites that deals with massive access (e.g., the Olympics games)
- **Scenario 3: Utility computing (Sun)**
  - Deploy arbitrary operating system and application stacks on remote resources
- **Scenario 4: eGov application (Thales)**
  - Automatic adjustment of resources and domains cooperation

2. Remote on-Demand Resource Provisioning

2.3. RESERVOIR Project

The Architecture, main Components and Interfaces



The VEE Manager (OpenNEbula based)

- **Generic and independent** of the underlying virtualization technology
- **Open source** and based on **standards** (**Grid & Virtualization OGF WG**)
- **Automatic provision** of VEEs to meet pre-defined infrastructure site policies for **SLA commitment**
- **VEE groups** (forming a single service) with affinity rules, deployment ordering rules, rollback policies, elasticity management…
- Access to remote grid sites, supporting **on-demand access and federation of data-centers** (**GT4 Interfaces are being evaluated**)

3. Conclusions

- Show the benefits of the **separation of resource provisioning from job execution management** for HPC, cluster and grid computing
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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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