

Resource Management for Virtual Clusters

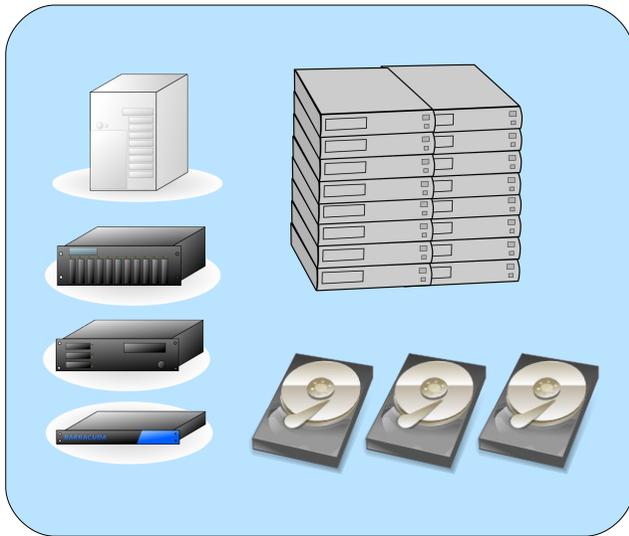
Borja Sotomayor
DSL Seminar
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Index

- ▶ Problem and Status
- ▶ Scheduling Virtual Workspaces
- ▶ Roadmap

Index

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- ▶ Scheduling Virtual Workspaces
- ▶ Roadmap



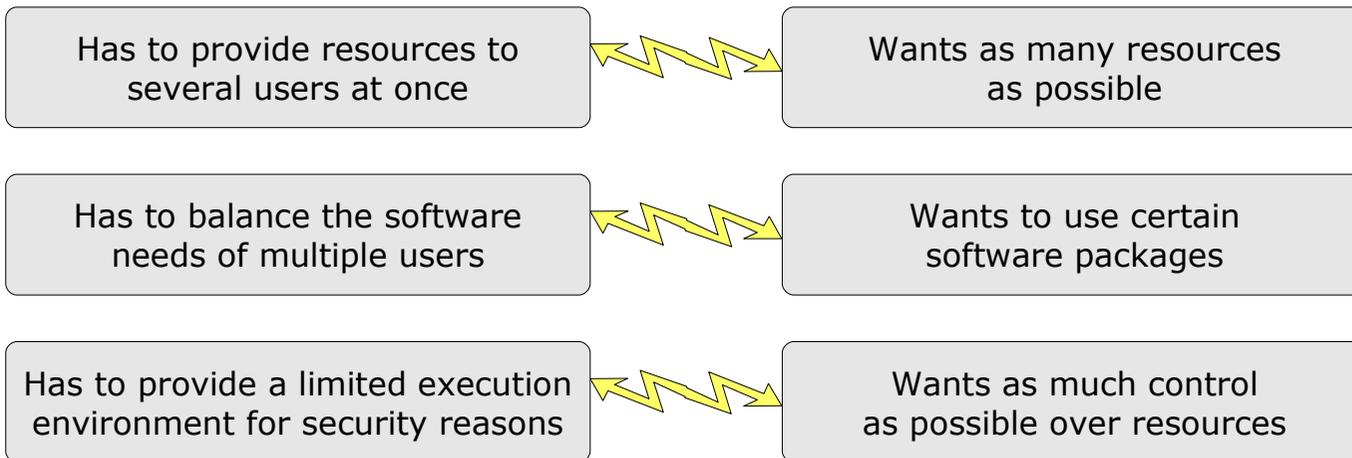
Resource provider

Provides computational, storage, and network resources



Resource consumers

Want to run experiments on the resources, but they each have different software and hardware requirements



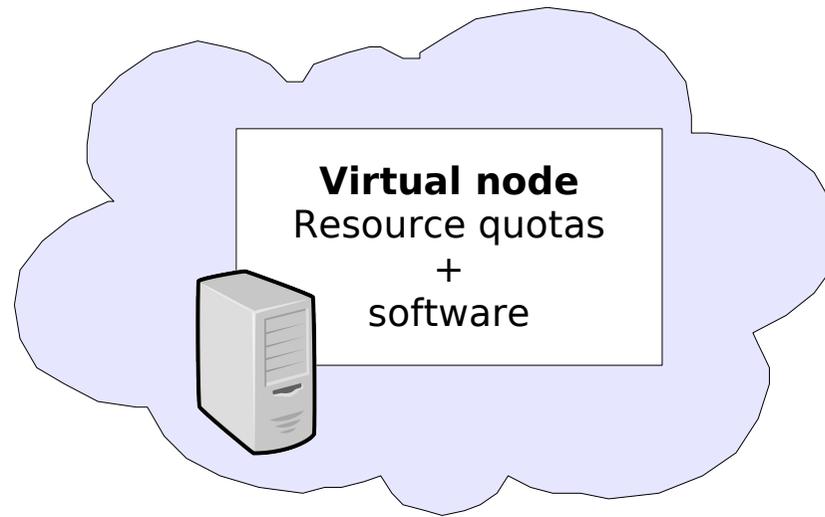
Problem (I)

- ▶ Current solution: Impose restrictions on resource consumers.
 - ▶ Widespread abstraction: *job*
- ▶ Ideally, we want to eliminate these conflicts.
- ▶ Possible solution: *virtual workspaces*

Workspace Refresher (I)

- ▶ Let's take a look at how virtual workspaces work.

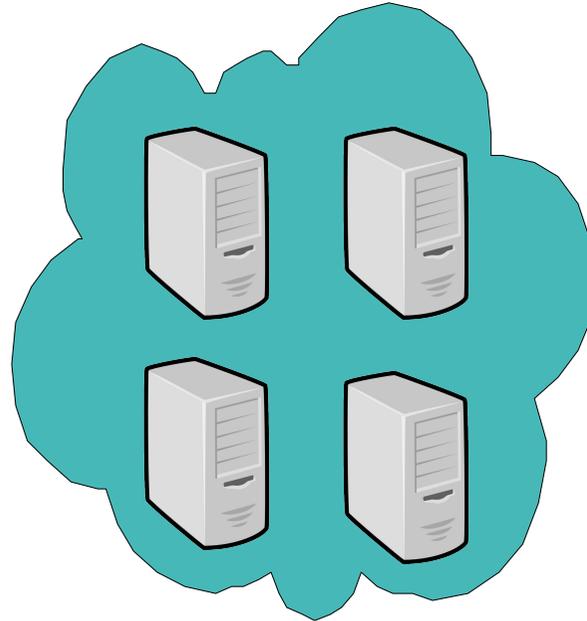
Workspace Refresher (II)



Virtual workspace

- ▶ A virtual workspace includes...
 - ▶ Resource allocation (disk, CPU, memory, ...)
 - ▶ Software (encapsulated in a VM)

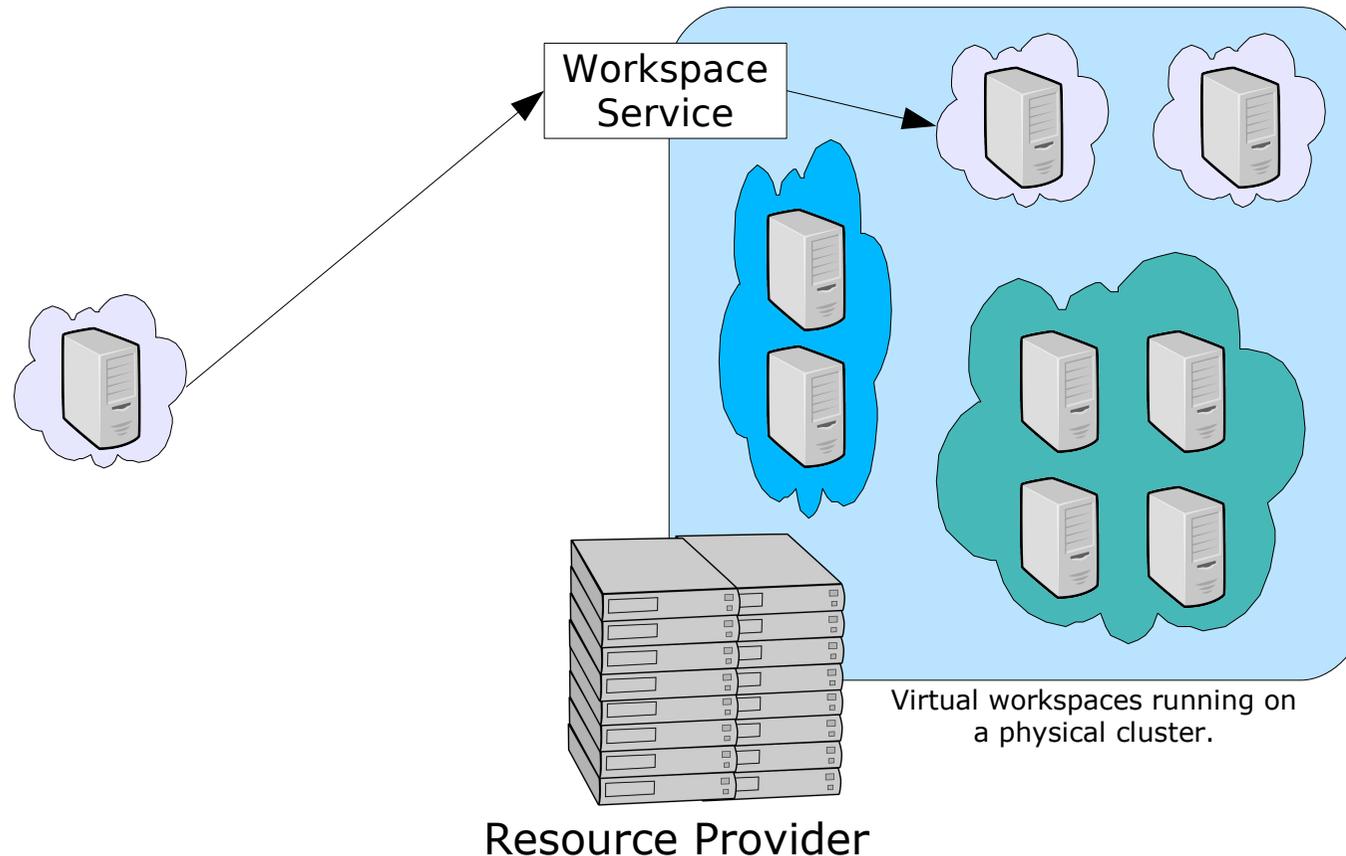
Workspace Refresher (III)



Virtual workspace

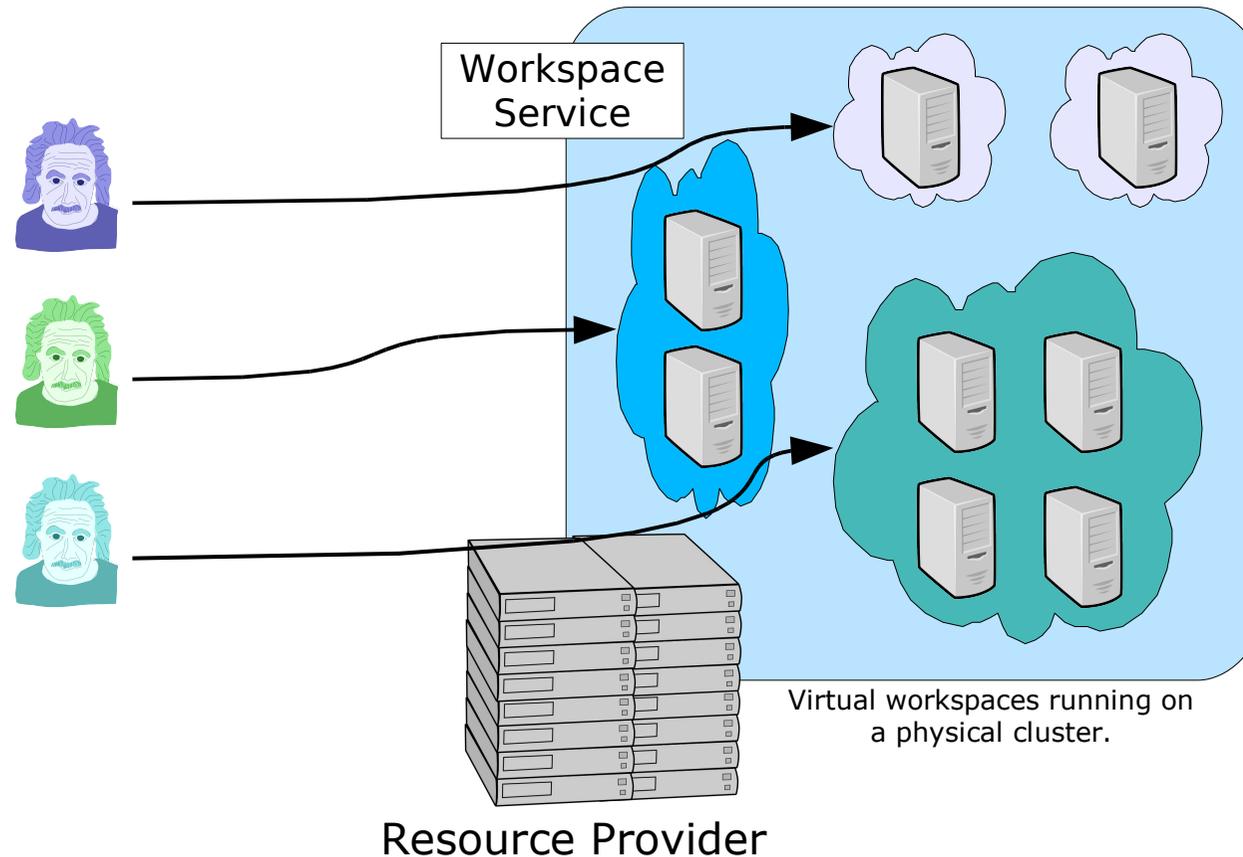
- ▶ A virtual workspace can have multiple nodes (*aggregate workspace* or *virtual cluster*)

Workspace Refresher (IV)



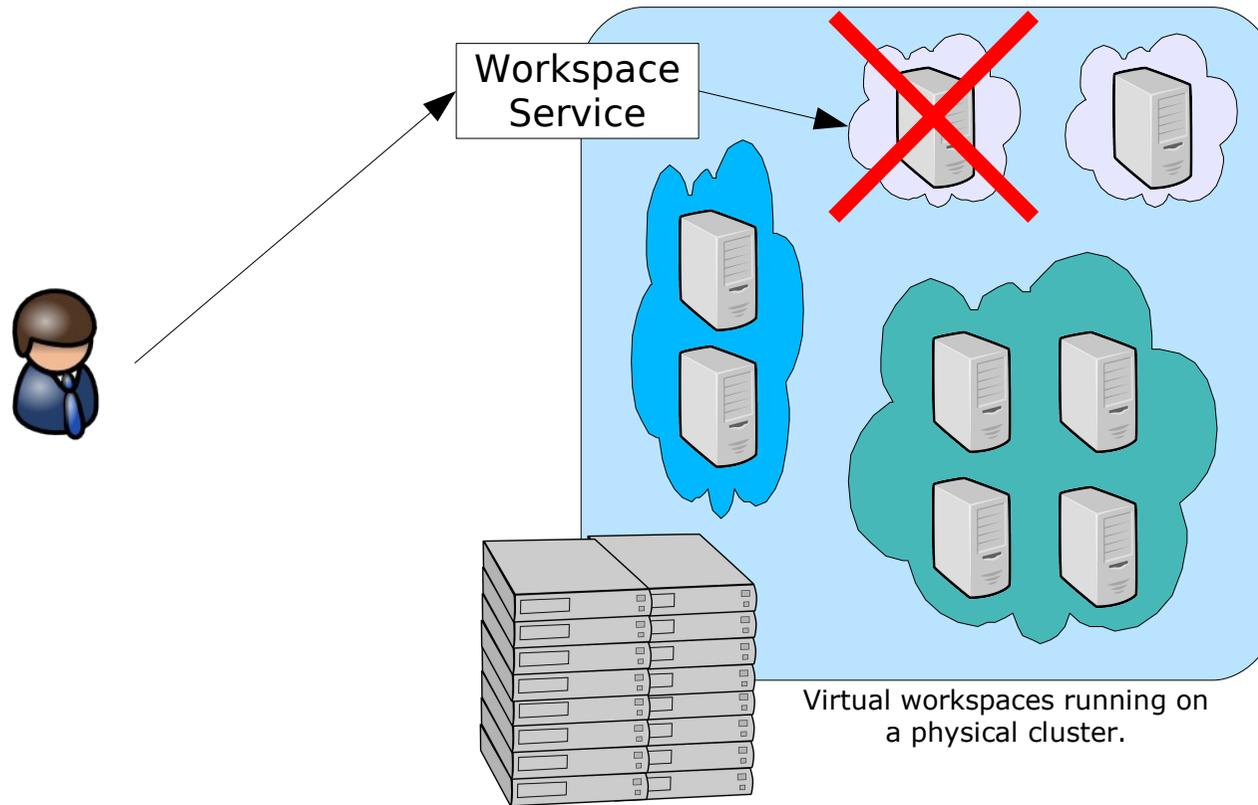
- ▶ A virtual workspace is deployed into a resource provider using the workspace service. The workspaces are VMs running on the resource provider's nodes (which must be VM-enabled)

Workspace Refresher (V)



- ▶ Users interact with the workspace service as if it were just another physical resource.

Workspace Refresher (VI)



- ▶ The workspace's creator can manage it through the Workspace Service (pause, destroy, etc.)

Problem (II)

- ▶ Use cases
 - ▶ Educational
 - ▶ Virtual labs
 - ▶ Homework
 - ▶ Virtual servers
 - ▶ Scientific
 - ▶ Interactive experiments
 - ▶ Batch jobs
 - ▶ Event-driven jobs

Problem (III)

- ▶ General scenarios
 - ▶ Advance Reservation (AR)
 - ▶ Typically, but not necessarily, interactive workloads
 - ▶ Batch
 - ▶ Generally preemptible
 - ▶ Event-driven
 - ▶ High priority

Status (I)

- ▶ Unfortunately, there's still a lot of work to be done in virtual workspaces!
- ▶ Several groups are working on Virtual Workspaces, including Globus.
 - ▶ VIOLIN + VioCluster
 - ▶ Virtuoso
 - ▶ In-VIGO
 - ▶ Cluster-On-Demand
- ▶ Generally geared towards batch workloads, assuming 1 job/workspace.
- ▶ No advance reservation, and no scheduler that can deal with the three workloads simultaneously.

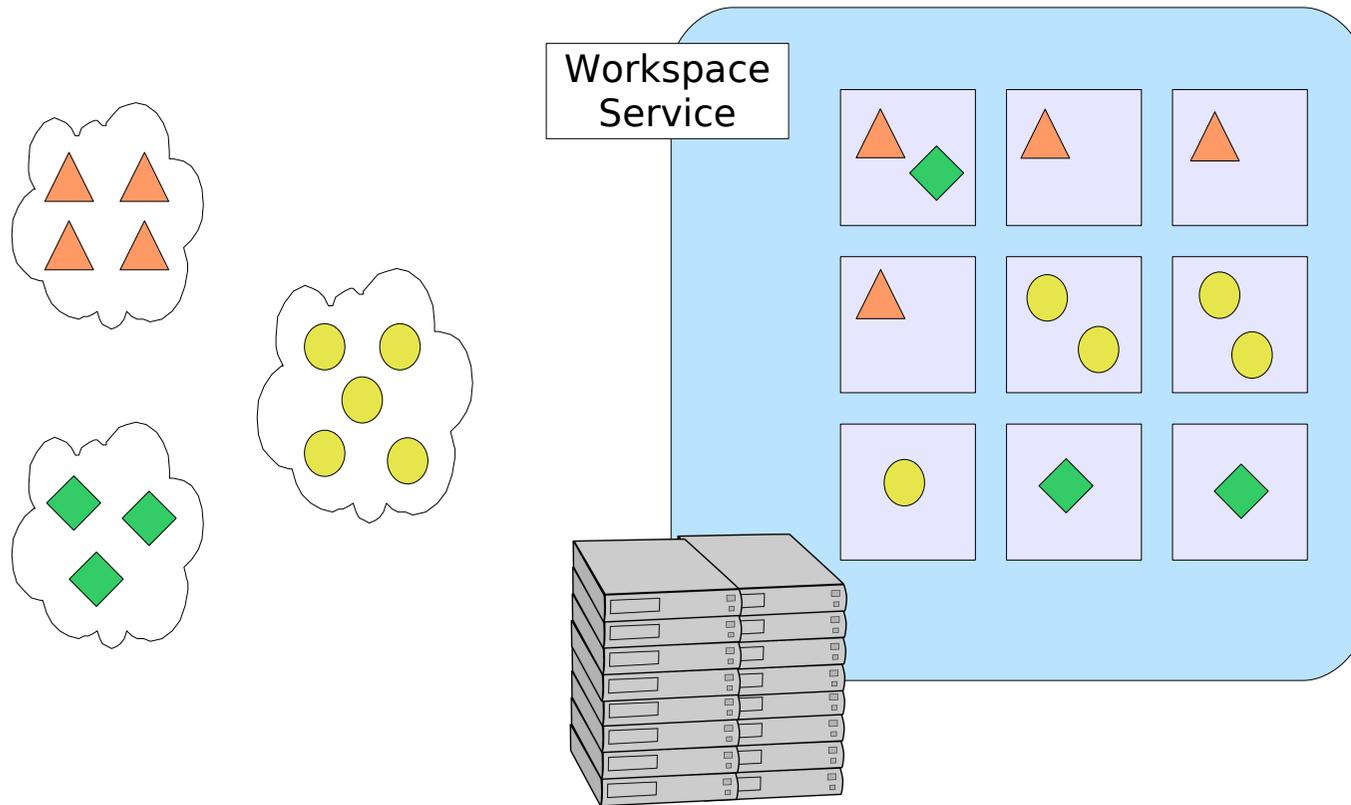
Status (II)

- ▶ GT4 Virtual Workspaces
 - ▶ <http://workspace.globus.org/>
 - ▶ Technology Preview 1.1 includes support for atomic virtual workspaces.
 - ▶ We're working on supporting virtual clusters.
- ▶ The main challenge is developing a virtual cluster scheduler.

Index

- ▶ Problem and Status
- ▶ **Scheduling Virtual Workspaces**
- ▶ Future work

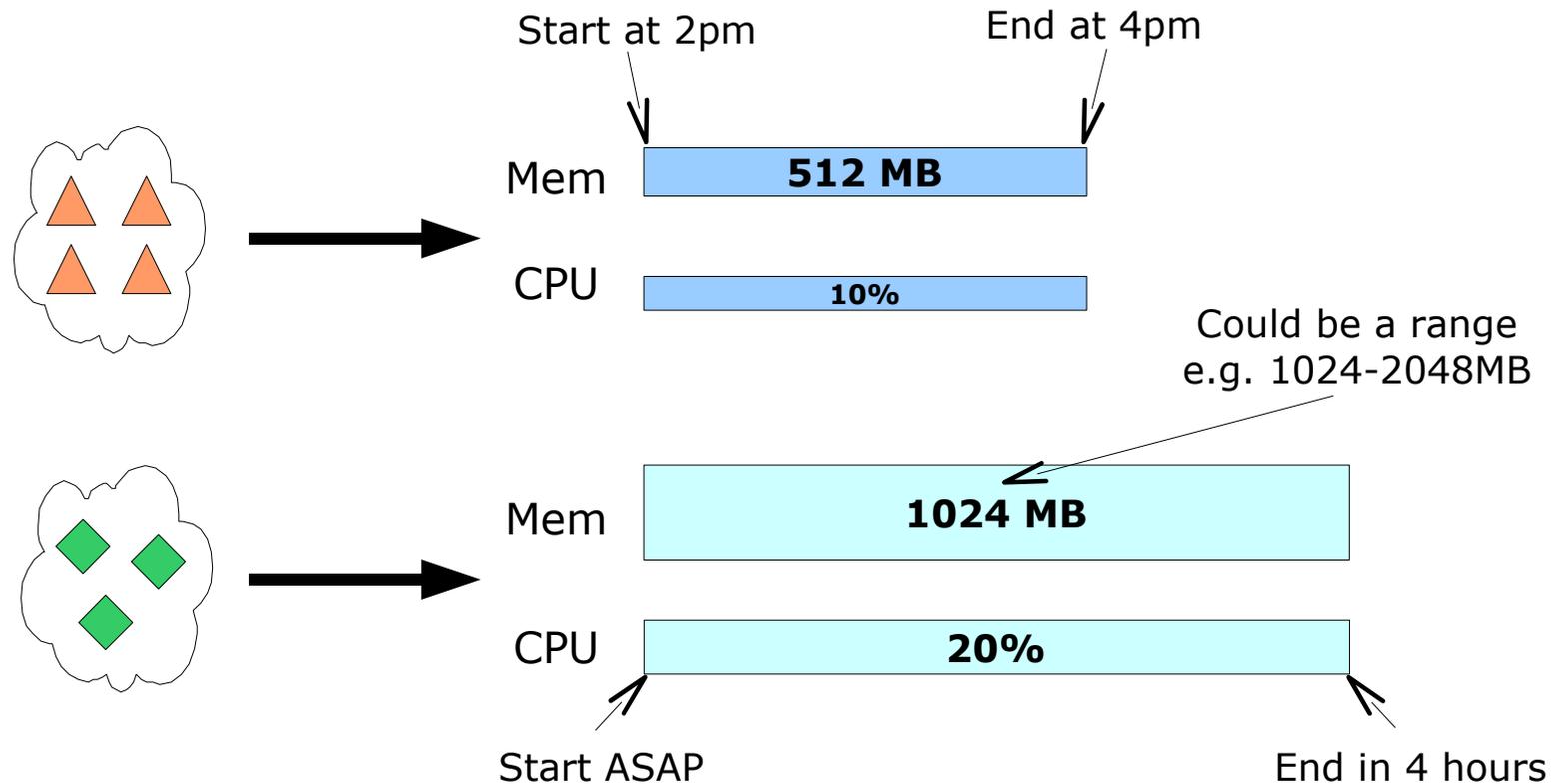
Easier said than done!



- ▶ How do we map virtual resources to physical resources? A lot of variables to consider!
 - ▶ Advance reservation? Preemptible? Resource allocation? Overhead?

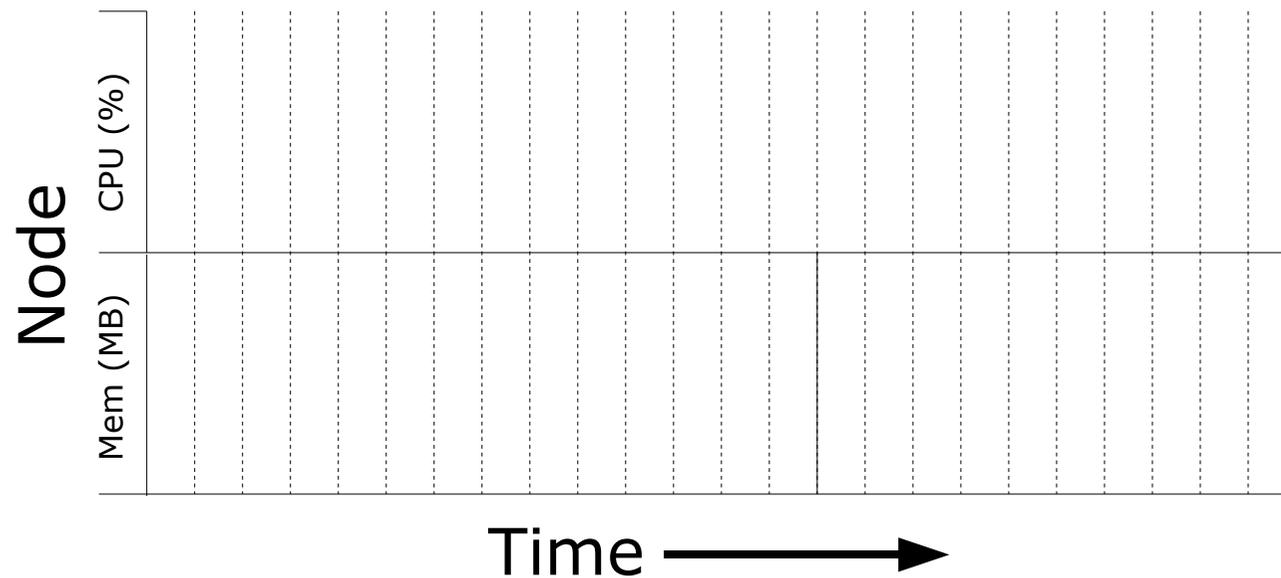
Model (I)

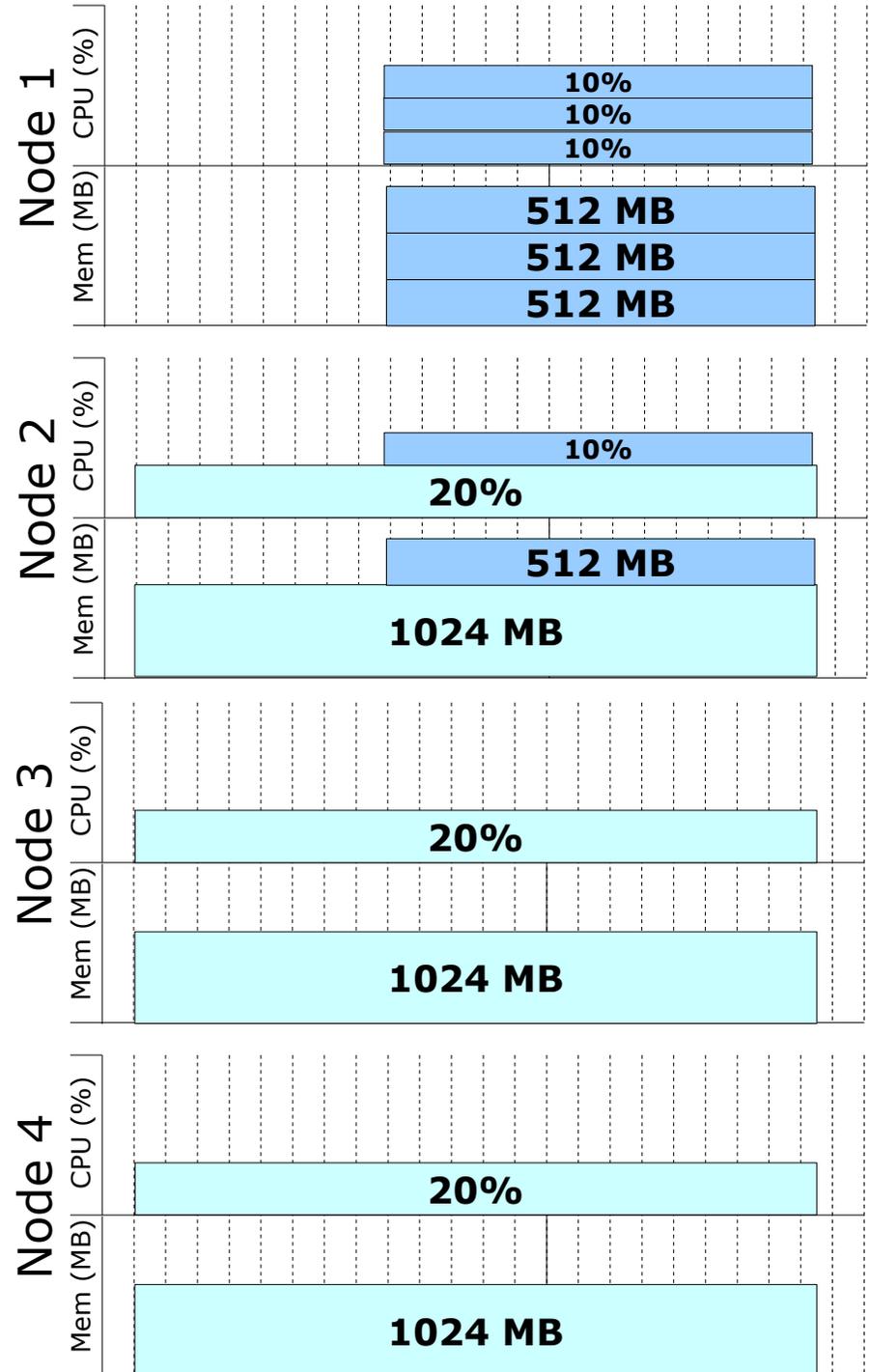
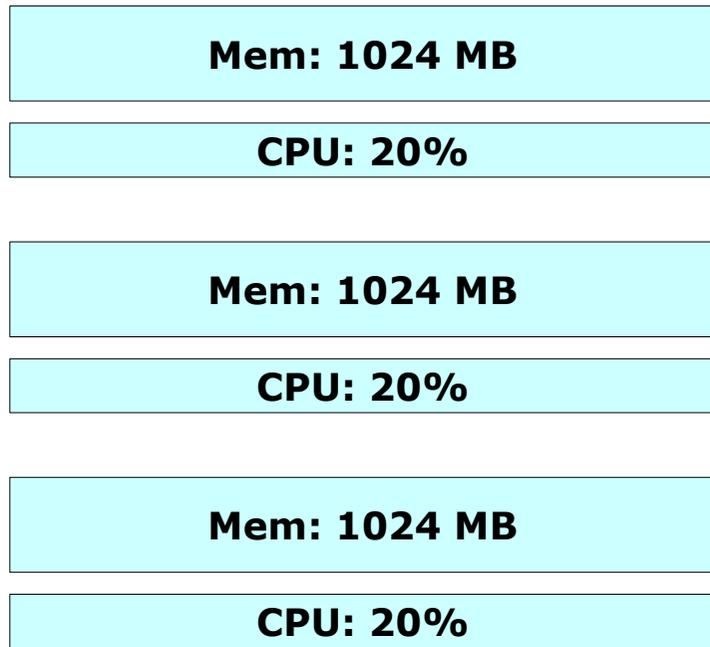
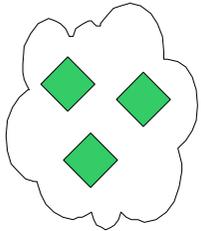
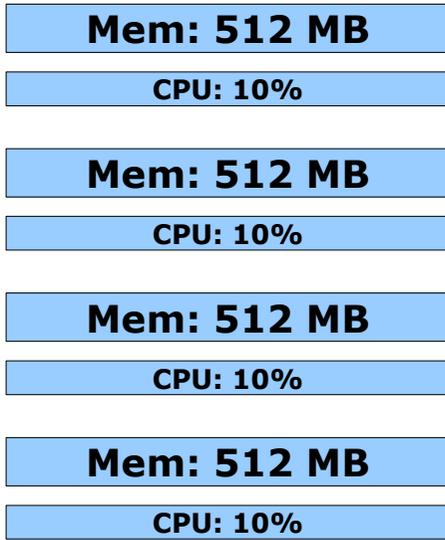
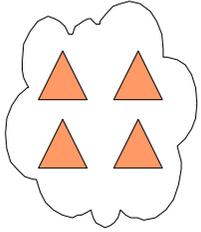
- ▶ We propose a model where the virtual resources are seen as *resource slots*.



Model (II)

- ▶ Physical nodes are empty resource slots where the virtual resources are mapped to.

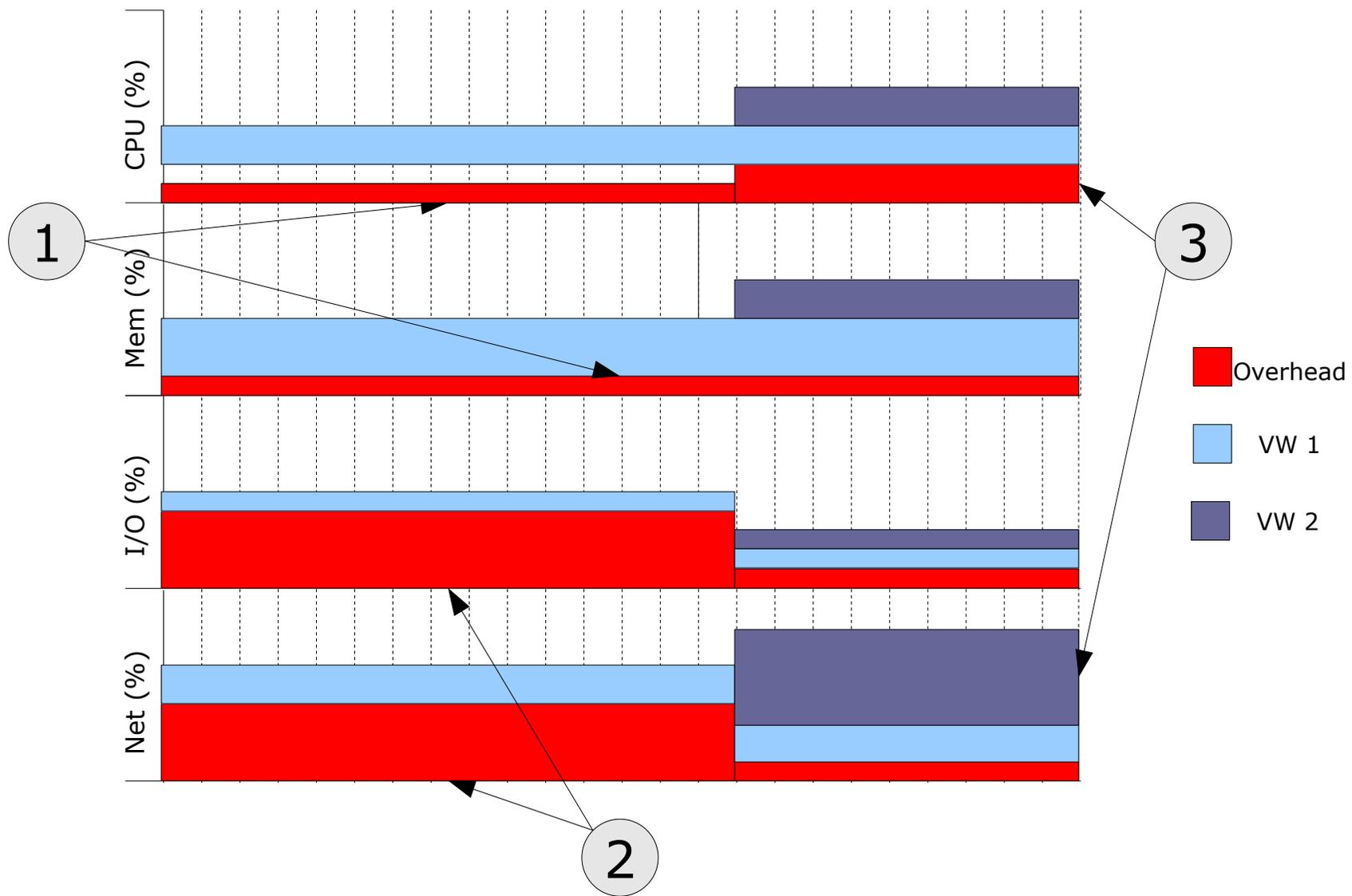




Model (III)

- ▶ However, this model doesn't account for overhead.
 - ▶ Other virtual workspace implementations downplay the importance of overhead.
 - ▶ We hold that an adequate overhead management can result in higher performance.
- ▶ Two types of overhead:
 - ▶ VM Hypervisor overhead
 - ▶ Scheduling activities

Model (IV)



Scheduling (I)

- ▶ The centerpiece of our system will be the scheduler.
- ▶ Scheduler must:
 - ▶ Perform admission control
 - ▶ Policies
 - ▶ Is request feasible?
 - ▶ Map virtual resources to physical resources
 - ▶ Manage execution
 - ▶ React to changes
 - ▶ Resource allocation renegotiations
 - ▶ Failures

Scheduling (II)

- ▶ The main challenges in designing and developing this scheduler are:
 - ▶ Managing overhead
 - ▶ Mapping virtual resources to physical resources
 - ▶ Handling changes in the system

Scheduling (III)

- ▶ Building the entire scheduler is a huge undertaking.
- ▶ We are currently focusing on specific problems, and making certain assumptions.
 - ▶ We will gradually deal with all scheduling scenarios, with as few assumptions as possible.

Index

- ▶ Problem and Status
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- ▶ Roadmap

Roadmap

- ▶ What we're working on right now
 - ▶ Overhead: Staging VW images to the nodes where they're needed.
 - ▶ Scheduler that only considers CPU and memory as apportionable resources.
 - ▶ Experiments
- ▶ What we'll work on next
 - ▶ More powerful scheduler (capable of allocating network and disk bandwidth)
 - ▶ Resource allocation renegotiation
 - ▶ Leveraging live migration of VMs to perform load balancing.

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