![Adaptive Computing logo] Adaptive COMPUTING

Intelligent Workload Management Software for HPC and Cloud Environments

Accelerate Insights
Converging Cloud and HPC

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HPC Product Manager   September 2014
Adaptive Computing

Adaptive Computing Highlights

- **Innovating world-class HPC, Big Data, and Cloud solutions**

- **Over a decade of experience**

- **Pioneering in Scheduling and Optimization**

- **70+ patents issued or pending**

- **Backed by top-tier investors**

- **Numerous customers in the Top 500 and Fortune 500**

  - Top systems including: Blue Waters, Titan, Cielo, Hopper

  - Major multi-nationals including: DOW, ExxonMobil, & Boeing

  - Largest provider of HPC workload management software to HPC sites*

  - Global partnerships include Intel, Cray, HP, IBM, SGI, & Microsoft

Accelerating Insights with Big Workflow

- **Unify data center resources**
  - As a single, adaptive ecosystem
  - Technical computing (HPC & big data)
  - Public and private cloud
  - Bare metal and virtual machines

- **Optimize the analysis process**
  - Increase throughput and productivity
  - Ensure SLAs, maximize uptime
  - Reduce cost, complexity and errors

- **Guarantee service to the business**
  - Policies that model your organization
  - Prove services were delivered
  - Job completion in spite of failures
  - Verify resources were allocated fairly

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Intelligent Workload Management Software for HPC and Cloud Environments

HPC Bursting

Virtual Cluster and Job Isolation Use Case

- **Medical research**
  - Health information privacy regulations
- **Hospital Isolation**
  - One physical data center shared among multiple hospitals
  - Hospitals have minimum compute node requirement
  - Dynamically partition data center into independent "virtual clusters"
- **Patient Isolation**
  - One patient – one job
  - Isolate patient job from all other patient jobs
  - Run 1 patient job in 1 VM on 1 compute node for complete isolation

Virtual Cluster and Job Isolation Use Case

- **One physical HPC cluster**
  - Multiple "virtual clusters"
  - Virtual clusters completely isolated using own scheduler
  - One partition of "unused" compute nodes for on–demand allocation to "virtual clusters"
- **Virtual clusters expand and shrink resources**
  - Request compute nodes from "unused" partition
  - Provision, use, and destroy one VM per compute node
  - Return compute nodes to "unused" partition
  - Triggered by job backlog "pressure"
- **HPC Bursting**

Canadian Hospital Consortium

Pilot project with two hospitals and one consortium cluster with three partitions

Moab H P C

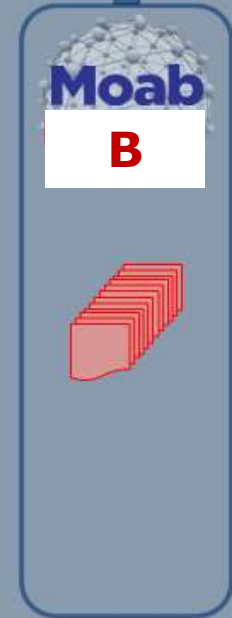**Two partitions for two hospitals (A & B) and one "free" partition (HPC)**
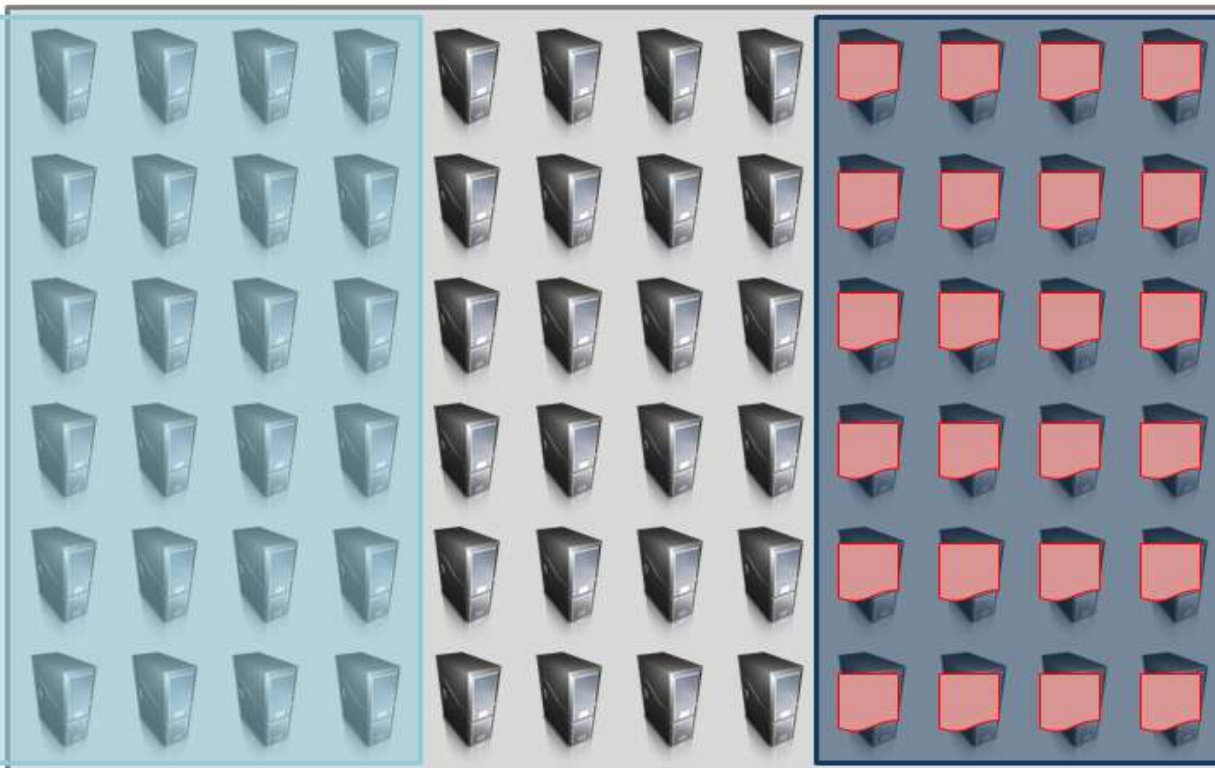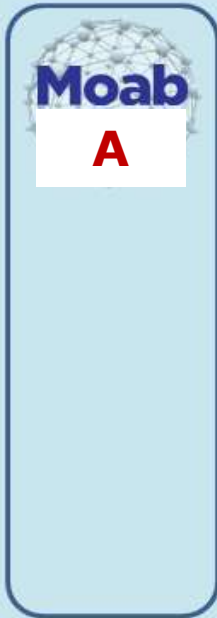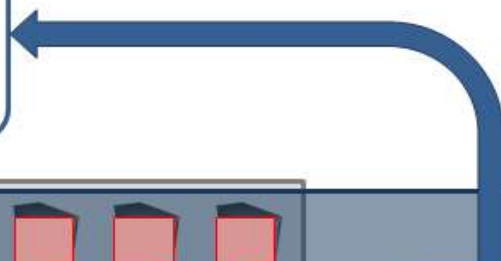
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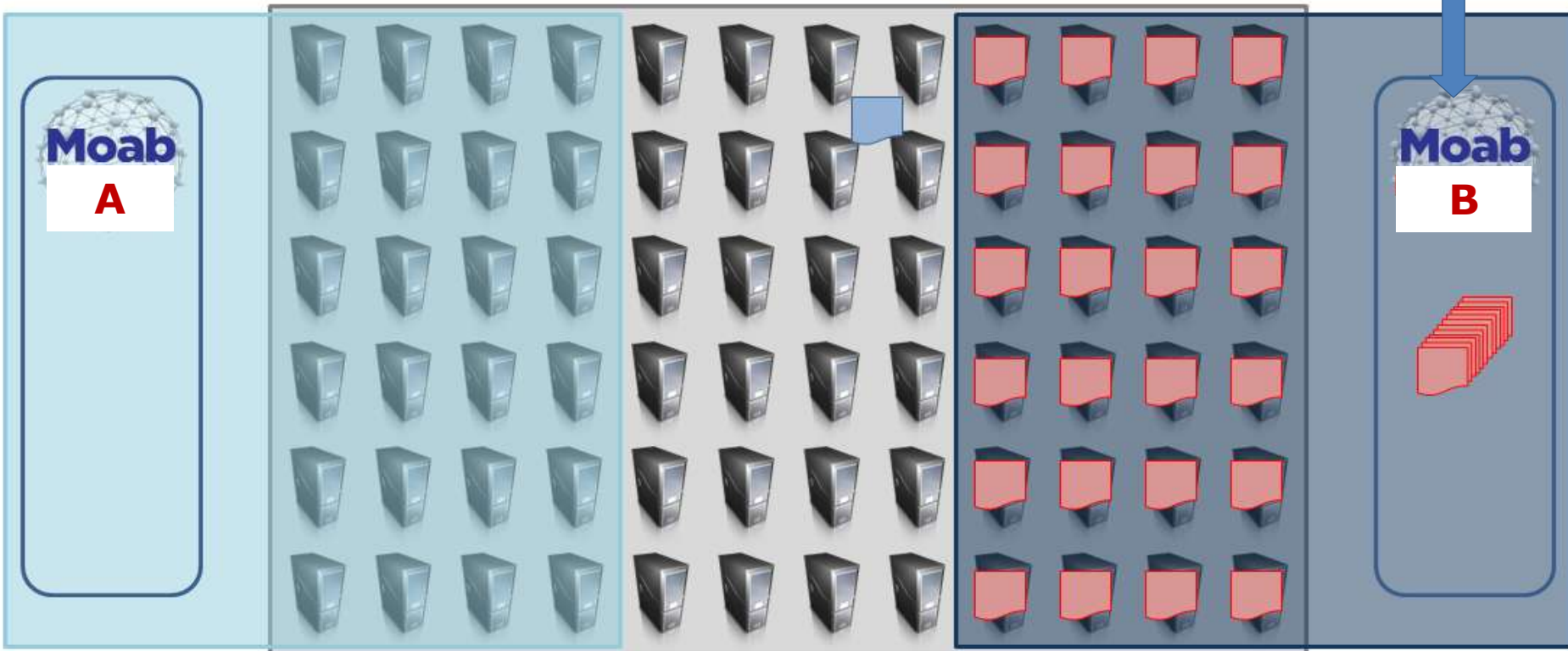
Users submit jobs to B Moab until job backlog present

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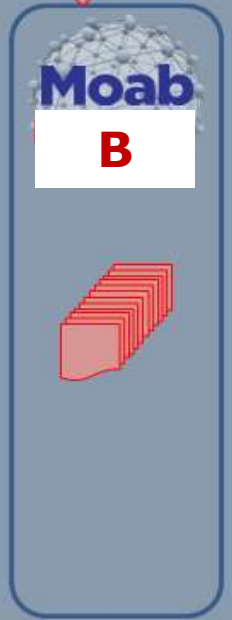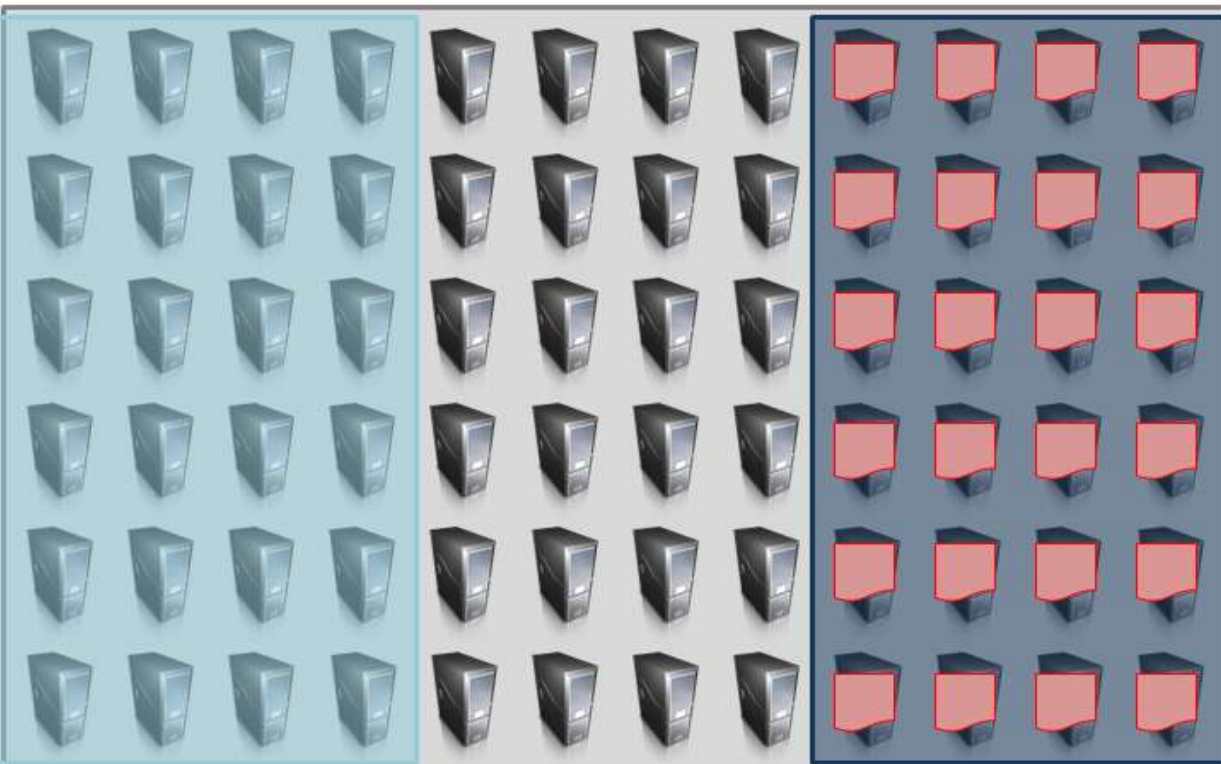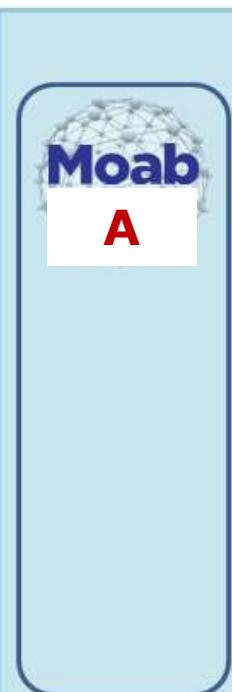
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Job backlog triggers B Moab to request additional resources of HPC Moab

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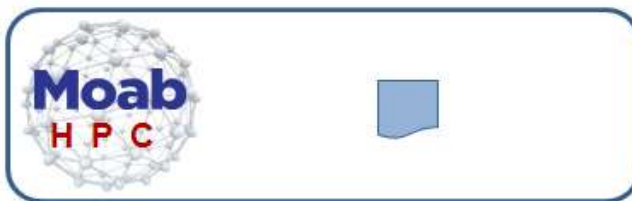
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HPC Moab allocates unused nodes and informs B's Moab of resources

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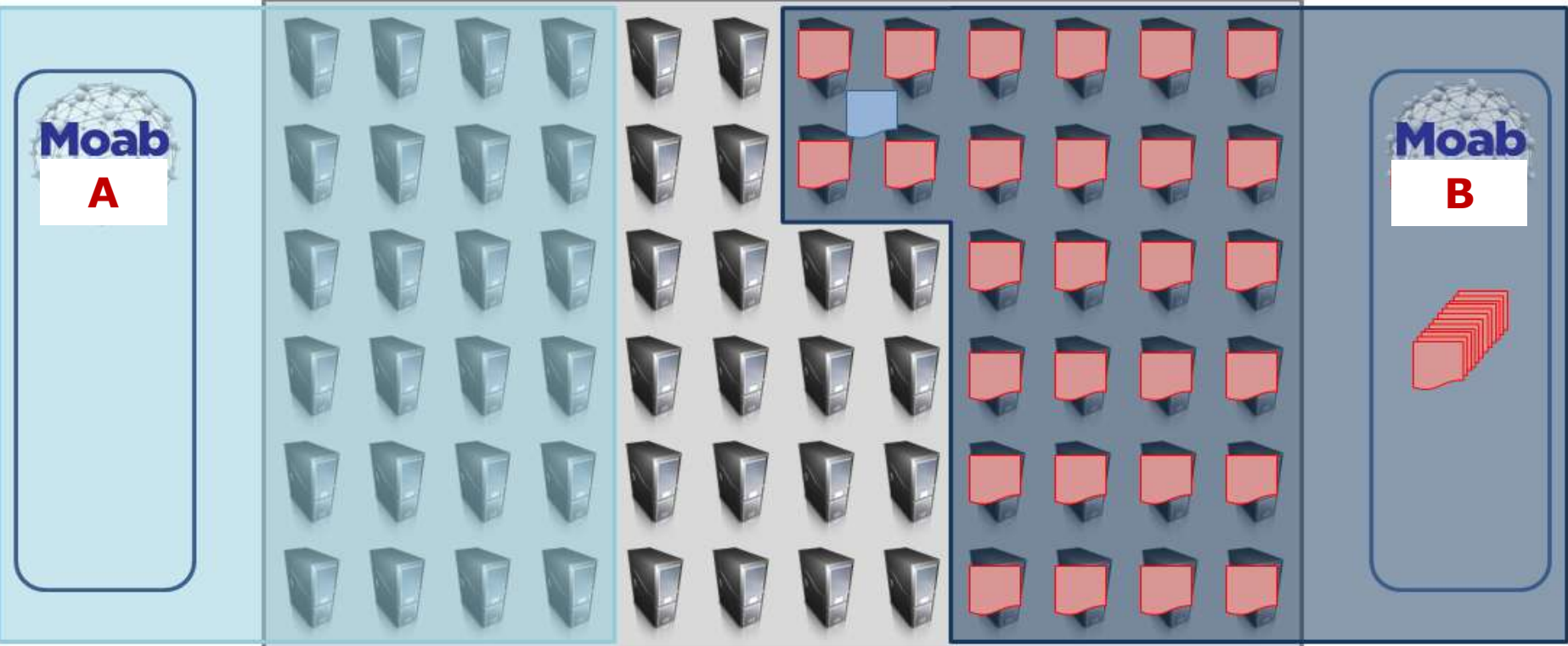IDC HPC User Forum 2014 – Seattle

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B Moab adds allocated nodes to its cluster

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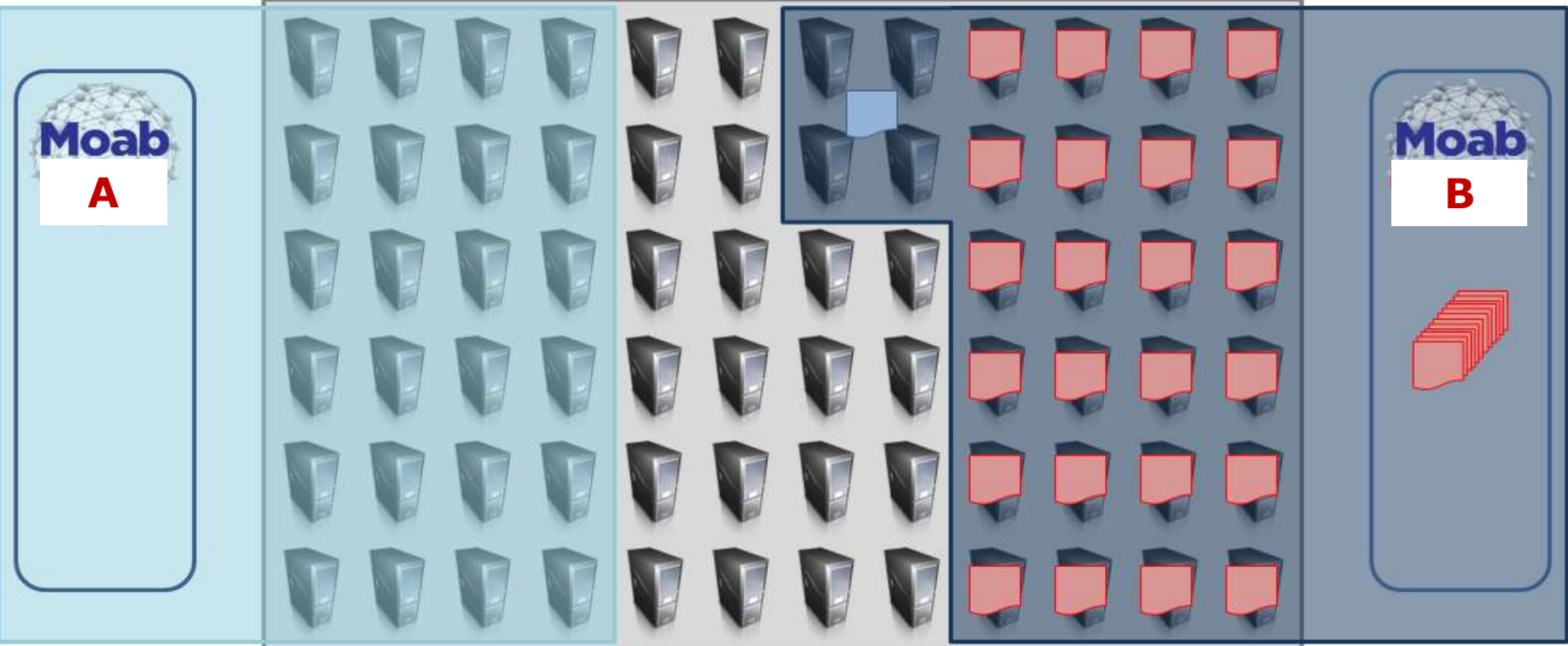
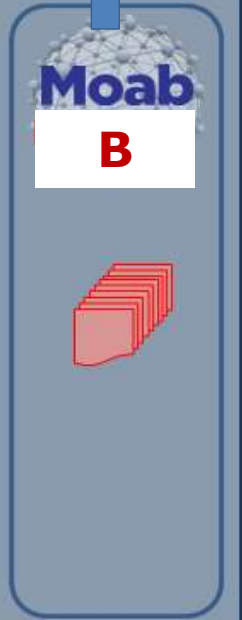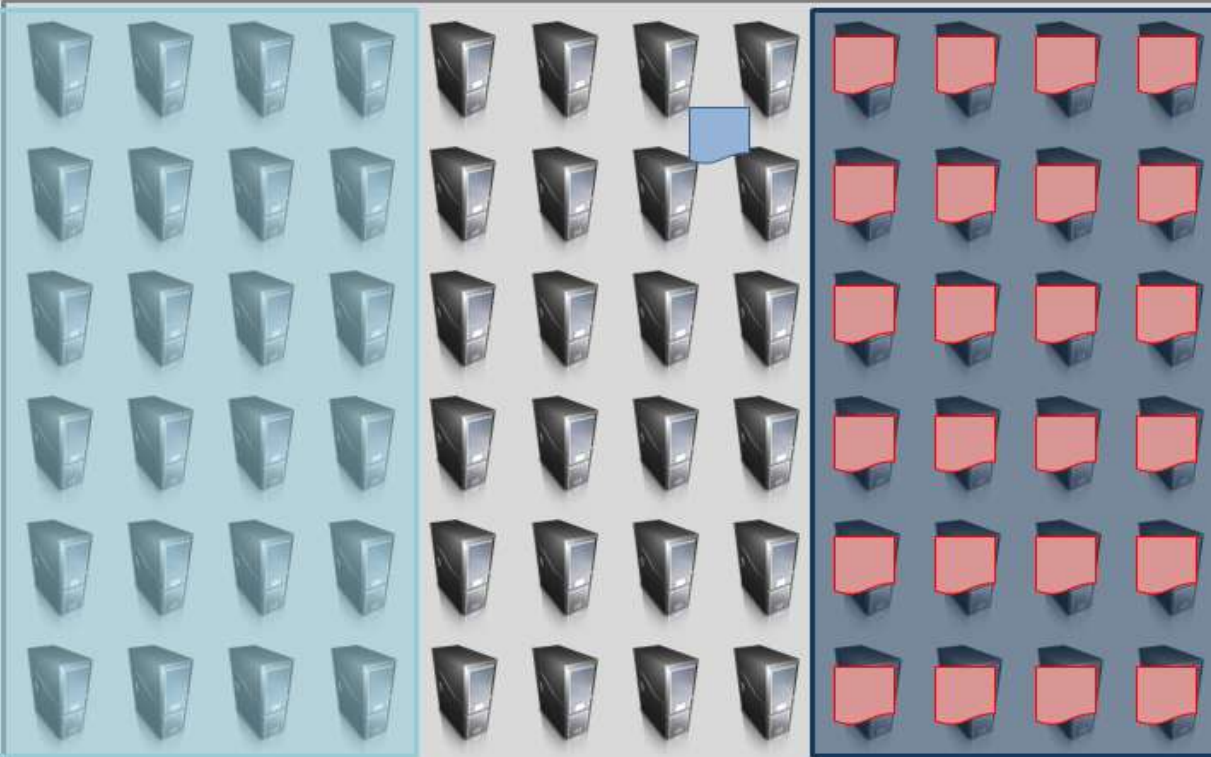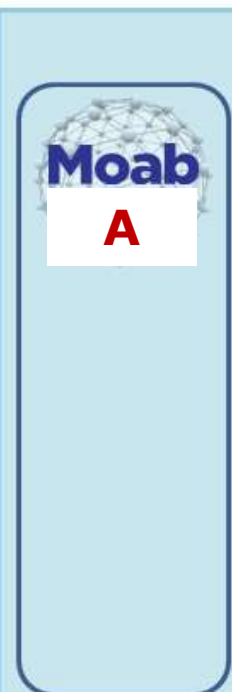# Hospital Consortium

B Moab runs jobs on new additional nodes

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When job backlog eases, B Moab returns nodes to HPC Moab

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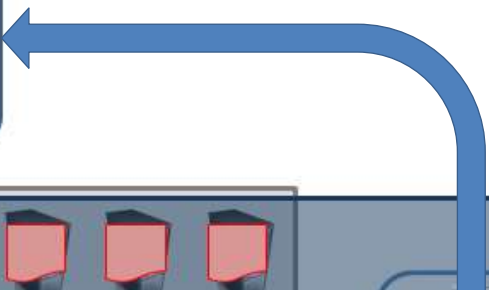
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Users submit more jobs to B Moab, repeating cycle

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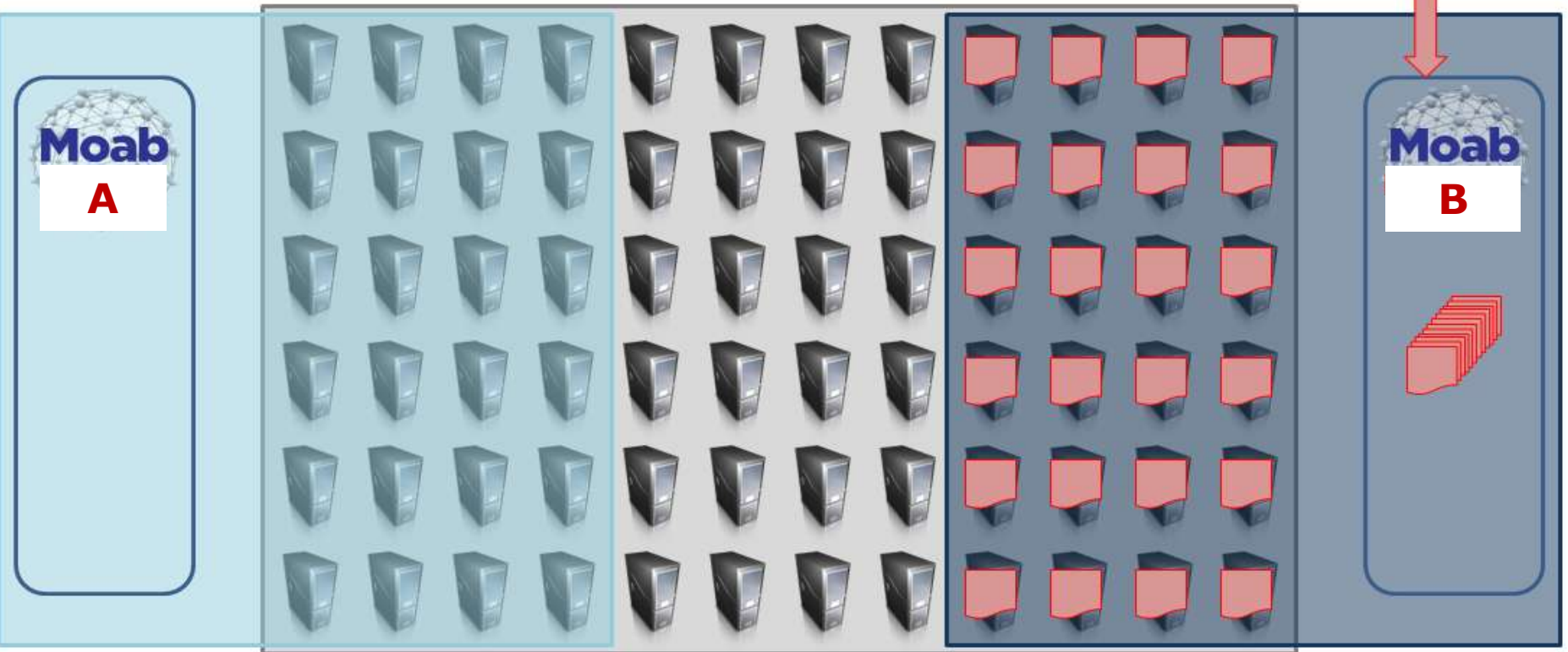
Virtual Cluster and Job Isolation Use Case

- **Use case can extend to cloud resources**
- **Future possible use of OpenStack for PM and VM provisioning**

High-Throughput Computing (HTC)

Nitro Task Manager

- **Distributed Scheduling Approach**
  - Combines small, homogeneous jobs into a "batch of tasks"
  - Creates policies for entire batch

- **Schedules batch as one job**
  - Incurs scheduling overhead <u>only once</u>

- **Launches Nitro job with task file**
  - Nitro "coordinator" launches tasks on "workers"
  - Tasks execute on Nitro job's allocated resources

- ***Independent Product***
  - Submit as job to any batch scheduler
  - Run standalone

Nitro Task Manager

- **100x faster throughput for small, short, serial jobs**

- **Early-access Version Benchmark**
  - 13,500 tasks/second submission rate
  - Sustained in 20-node EC2 cluster
  - 10 million tasks <12.5 minutes
  - Ramps higher for larger systems