Shirako: Virtual Machine Hosting for Networked Clusters

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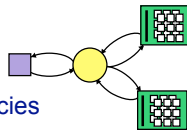
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Goal: Develop a virtual computing infrastructure for autonomic resource management across federated clusters that is adaptive, on demand, and reliable
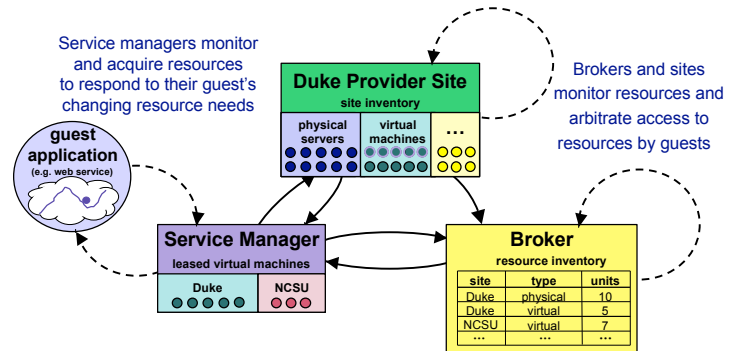
Motivation

- Efficient and adaptive coordinated resource management between federated clusters
- Encourage contribution of resources for sustainability
- Easy access to distributed resources (e.g., for virtual computing with controlled sharing)
- Virtualization technology (e.g., Xen, VMware) offers useful "knobs"
  - Migration and suspend/checkpoint
  - Performance isolation - sliver resizing
- Rich policy space for fine-grained adaptation to changing demands and conditions

Federating Clusters

- Challenge: Balance the need for sites to retain control of their resources with the need for application environments (services) to span multiple sites
- Approach: Separate resource placement (*where*) from provisioning (*what* and *when*)
  - Provider sites delegate provisioning power to brokers
  - Brokers aggregate resources from multiple sites and arbitrate between requests
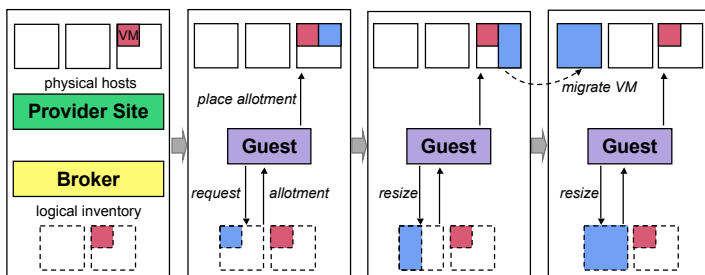 - Pluggable resource management policies
- No central global authority

Virtual Machine Migration

- Need for virtual machine migration at sites
  - Reconcile provisioning and placement policies
  - Resolve failures and allow for system maintenance
  - Thermal or energy resource management [USENIX05, ICAC06, SYSML06, ISCA06]
- Challenge: Need policies for migration planning
- Approach: Live migration with configurable resource suspend-resume to break potential deadlock

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Service managers monitor and acquire resources to respond to their guest's changing resource needs

Brokers and sites monitor resources and arbitrate access to resources by guests

- Toolkit for generic brokered utility service architectures
- Contracts in the form of leases for resource control
  - Resources (e.g., VM slivers) granted for fixed time period
  - Renewable leases and adaptive resource allocation
- Generic leasing core for system extensibility [USENIX06]
- SHARP [SOSP03] framework defines roles for self-interested, accountable actors:
  - Service Manager - requests and maintains leases
  - Provider Site - controls resource placement and enforces guest isolation
  - Broker - map requests to resources
- Fine-grained allocation with partitionable resources
  - Memory, CPU, network bandwidth
- Enables autonomic resource management, and continuous adaptation

Example Systems

- Grid Hosting [Supercomputing06]
  - Host grids within "containers" - all software and resources required for a virtual organization
  - Each grid runs a coordinator (GROC) to procure resources from provider sites in response to changing load

- Virtual batch computing
  - Assign each job to a custom, virtalized container
  - Broker acts as "job scheduler"
  - Learn job runtime predictions based on given resources over time (NIMO [VLDB06])
- Plush [Jeannie Albrecht et. al]
  - Deploys, manages, and maintains distributed applications on allocated resources
  - Allows combined use of resources from PlanetLab and Shirako