Virtual Clusters Over Multiple Institutions

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About Me

- 3rd year at the University of California San Diego
- Computer Engineering major
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Project Proposal

- Create a Virtual Cluster using resources from multiple institutions
  - Use Rocks Cluster system to deploy virtual mahines
  - Create the virtual network using PIAX+OpenVPN
- Test Virtual Cluster using DOCK as a testing application

Background: Cluster Computing

- Cluster - a set of computers referred to as nodes
- Organized as one Head Node with the remaining nodes as Compute Nodes
- Has ability to run applications on multiple nodes at once

Background: Grid Computing

- Collection of the computing resources of many clusters
- Useful for running applications that are computationally heavy
- Heterogeneous in nature
  - Every cluster is not required to have the same set of software installed

Background: DOCK

- Receptor ligand virtual screening simulator
- Tests how well millions of ligands and one receptor fit together
- Assigns a score/rating based on fit

Motivation for making Virtual Clusters

- The heterogeneity of a grid computing environment can cause problems when running certain applications
- Virtual Clusters remove heterogeneity of a GRID computing environment
- Test Application:

  DOCK (dock.compbio.ucsf.edu)

Physical Cluster

- Physical computer nodes
- Connected with wired network
- Generally, nodes are close to each other

Difference between a Physical Cluster and a Virtual Cluster

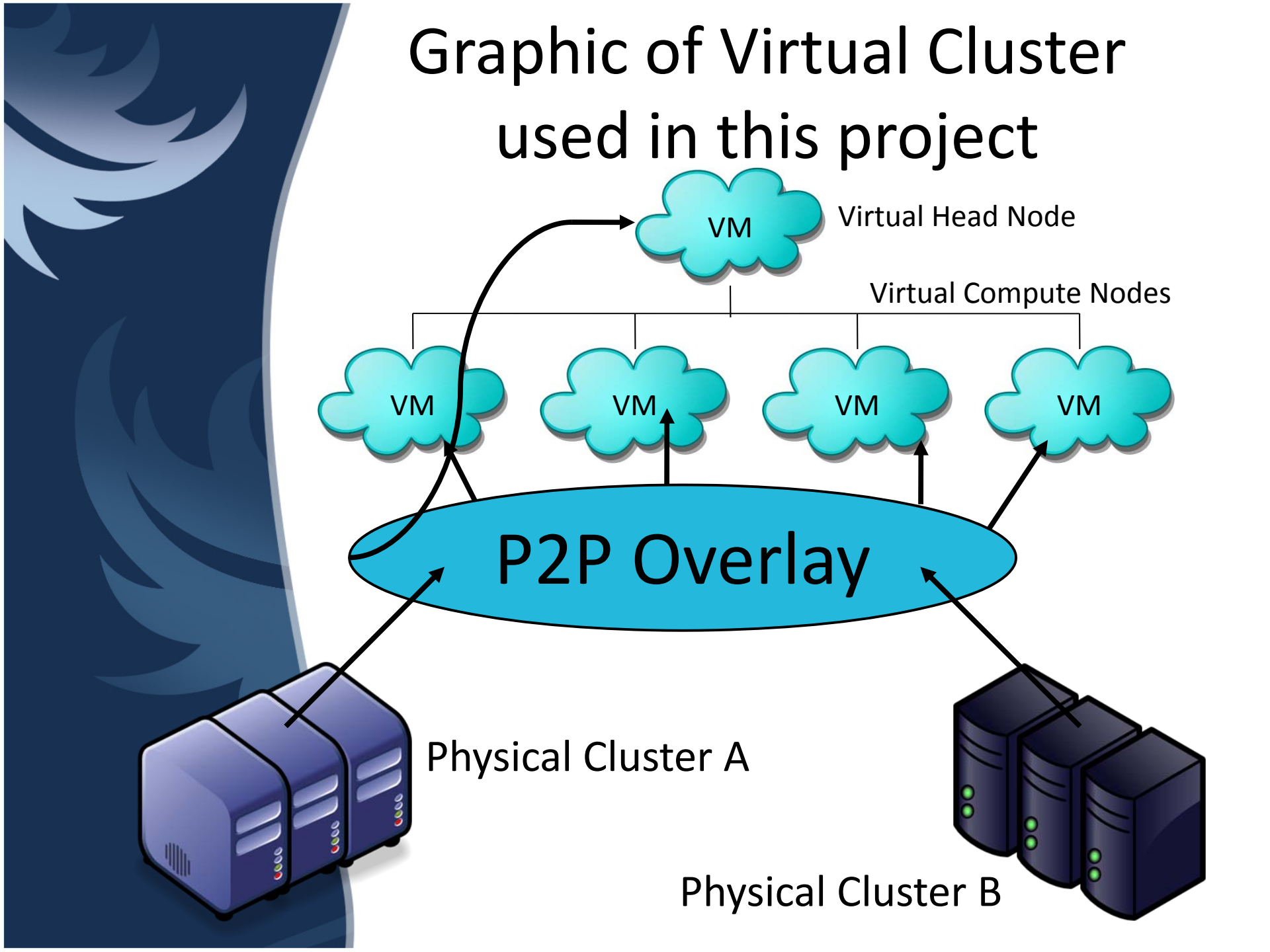
Physical Cluster

- Nodes are physical machines
- Networked together using a physical Ethernet switch

Virtual Cluster

- Nodes are virtual machines
- Networked together using virtual network technology

Graphic of Virtual Cluster used in this project



Virtual Cluster built over physical clusters at Osaka University and UCSD

- Used Osaka University's Network Solution
- Virtual machines deployed using Rocks Clusters (www.rocksclusters.org) system already installed on both clusters
- Virtual network created using:
  - PIAX (www.piax.org)
  - TCP Tunnel Agent written by Kusumoto Yasuyuki
  - OpenVPN (www.openvpn.net)

Rocks Cluster System

- Cluster management system
- Reason we used Rocks:
  - Easily deploy virtual machines
  - No need to prepare virtual machine hard disk files or configuration files

PIAX

- P2P overlay network
- Reason we used PIAX:
  - Open source
  - Potential for scalability
  - Fault-tolerant
- Agent Platform
  - More easily deploy

  TCP tunnel

OpenVPN

- Virtual Private Network technology
- Reason we used OpenVPN:
  - Foundation for structured connections between virtual nodes
  - Free
  - Scalability
  - Secure

Clusters used at Osaka University and UCSD

Qoo

- Osaka cluster
- 4 virtual nodes
  - 1 head node
  - 3 compute node

Cylab

- UCSD cluster
- 3 virtual nodes
  - 3 compute nodes

Results

- Virtual network was slow
- Initial tests using ping showed:
  - High latency
  - 15% average packet loss

Demo

Results continued

- High latency will multiply the time needed to run DOCK
- Dropped packets risks the loss of data and potential results for DOCK
- Conclusion: PIAX cannot be used as the virtual network of a Virtual Cluster over multiple institutions

Reasons for PIAX failure

- Not all nodes in a PIAX network know of every single node
- In that case, nodes must connect through at least one other node
- Example: compute-0-1-0 in UCSD connects to compute-0-0-0 in Osaka to connect to compute-0-5-0 in UCSD

Future Goals

- Look into alternative P2P overlay networks to use as the virtual network for a Virtual Cluster over multiple institutions
- Create a Virtual Cluster over multiple institutions that matches the performance of a physical cluster

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Questions?