Condor in Networked Clouds
A brief presentation for Condor Week 2012
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Networked Clouds
IaaS: Clouds and Network Virtualization

Virtual Compute and Storage Infrastructure

Cloud APIs (Amazon EC2 ..)

Cloud Providers

Virtual Network Infrastructure

Network Provisioning APIs (NLR Sherpa, DOE OSCARS, Internet2 DRAGON, OGF NSI ...)

Network Transit Providers
Networked Clouds

- Virtual Infrastructure
- Bandwidth Provisioned Networks
- Cloud Providers
Networked Clouds

Virtual Infrastructure

Bandwidth Provisioned Networks

Cloud Providers

Network Transit Providers
Networked Clouds
GENI is an IaaS

- Each slice is infrastructure purpose-built to serve an application
- May require
  - Specific topology (e.g. “I need a mesh with specific average node degree”)
  - Specific connectivity (e.g. “I need to connect resources A, B and C”)
- A number of heterogeneous resources need to be co-scheduled
- Principal focus on
  - Repeatability of experiments
  - Measurements (performance, packet capture, physical layer)
- Also well-suited to science applications (computation- and data- intensive)
  - Performance guarantees
  - Simpler deployment of heterogeneous pieces
    - Batch scheduling
    - Map-reduce
    - Highly-parallel
    - Specialized (GPGPUs)
  - Native resource interfaces
ORCA: Open Resource Control Architecture
ORCA is a “wrapper” for off-the-shelf cloud and circuit networks etc., enabling federated orchestration:

+ Resource brokering
+ VM image distribution
+ Topology embedding
+ Stitching
+ Authorization

• GENI, DOE, NSF SDCI+TC
• http://networkedclouds.org
• http://geni-orca.renci.org
Overview

Provide publicly routable IP with port number(s) to reach VM

Download/register user images at multiple sites

Instantiate VM topologies

ORCA

EUCALYPTUS

VM
VM
VM
VM
VM

HEAD NODE

WORKER

WORKER

WORKER

WORKER

NEUCA

IMAGE PROXY

DNAT PROXY
1. Provision a dynamic slice of networked virtual infrastructure from multiple providers, built to order for a guest application.
2. Stitch slice into an end-to-end execution environment.
3. Deploy Workflow into the slice.
Actor (server) roles in Open Resource Control Architecture
User/application access

ORCA Actors

Broker (CH)

request

delegate

redeem

Slice Manager (SM)

Java
Web portal
XML – RPC

Operators

Web portal

Users and tools

Java
Web portal
XML – RPC

Authority/AM

Substrate owners
Operator portal interface to RENCI Clearinghouse (CH), listing AMs with substrate registered for brokering.
Solar fuels workflow
Solar Fuels: Creation of storable fuels using solar energy and catalysis

The Science
• Research in Solar Fuels and Photovoltaics will integrate light absorption and electron transfer driven catalysis
• Molecular assemblies to create efficient devices for solar energy conversion through artificial photosynthesis

A Theoretical Framework
• Co-design strategy for creation of new scalable codes
• Incorporation of workflow technologies to coordinate, launch, and enhance resilience of the design pipeline
• Apply the developed codes to solve complex problems in electronic structure, kinetics, and synthesis

Collaborations - Working directly with
• Experimentalists (UNC-CH)
• Model and methods developers (Duke, UNC-CH)
A multistep process for sustainable fuel creation

Dye Sensitized Photoelectrosynthesis Cell (DSPEC)
- Solar -> *Catalysts + abundant materials* -> Liquid Fuel
- Each step a significant research project
  - Focus on Oxidation catalyst

Image provided by UNC-CH EFRC: http://www.efrc.unc.edu/
Model Catalyst: Single site system based on Ru

Catalytic oxidation of water

- Multistep cyclic process
- Several steps difficult to analyze experimentally
- Desire to replace expensive Ru with earth abundant materials

\[
4\text{Ce}^{4+} + 2\text{H}_2\text{O} \rightarrow 4\text{Ce}^{3+} + 4\text{H}^+ + \text{O}_2
\]

Solar Fuels Workflow
Workflow

- argos.x
- mcdrt.x
- mcsf.x
- mofmt.x
- tran.x
- PSOCI.x

Serial (Condor/Orca)

MPI (Hopper)
Workflow: Ensemble
Inter-cloud slice

• ORCA negotiates a slice among a multitude of heterogeneous resource providers
• Multiple independent cloud providers
  – RENCI, UNC, Duke
• Multiple network providers
  – ESNet, NLR, BEN
• Inter-provider VLAN stitching
  – VLAN label agreement
• Multi-layered connections in BEN
  – Fiber, DWDM, VLAN/Ethernet layers provisioned in concert with each other
Resource/substrate providers

ORCA establishes a VLAN circuit via OSCARS

ORCA establishes a VLAN circuit via Sherpa

ESnet OSCARS

NLR FrameNet + Sherpa

ORCA does VLAN translation from ESnet/ANU to NLR FrameNet

NERSC

DTN

Eucalyptus

BEN@RENCI

BEN@Duke

Eucalyptus

NERC

BEN

Eucalyptus

ORCA establishes cloud resources at Duke (and perhaps RENCI)

ORCA establishes BEN connections

Dynamic VLAN

ORCA-controlled substrate

OSCARs L2 circuit terminates on Data-Transfer node accessible from Hopper
Challenges

• Temporary
• Diverse requirements
• Isolation/Security
• Authentication
• Dynamic Applications
• Data Access
Questions?