6-ON THE MANAGEMENT OF VIRTUAL MACHINES FOR CLOUD INFRASTRUCTURES

Cloud Computing

Principles and Paradigms

Presented by
Majid Hajibaba

IaaS Anatomy

- IaaS provider characteristic
  1. on-demand provisioning of computational resources
  2. Virtualization technologies to lease resources
  3. Provide public and simple remote interfaces to manage resources
  4. use a pay-as-you-go cost model
  5. “infinite capacity” or “unlimited elasticity”
- Private and Public difference
- Role of Virtualization
  - Key of these characteristic
  - Allocating resources efficiently
  - Taking into account an organization’s goals
  - Reacting to changes in the physical infrastructure

IaaS Anatomy

- Problems In VM Solutions
  - Distributed management of virtual machines
  - Reservation-based provisioning of virtualized resource
  - Provisioning to meet SLA commitments
- RESERVOIR project
  - Resources and Services Virtualization without Barriers
  - Addressed above problems

DISTRIBUTED MANAGEMENT OF VIRTUAL INFRASTRUCTURE

Distributed Management

- Manage the virtual infrastructures themselves
- Efficiently selecting or scheduling computational resources
- VM-based resource scheduling
  - Static approach
  - Efficiency approach

- Solution
  - Virtual Infrastructure Manager
    - Managing VMs in a pool of distributed physical resources
- Case Study
  - OpenNebula

VM Model and Life Cycle (OpenNebula)

- VM model attributes
  - A capacity in terms of memory and CPU
  - A set of NICs attached to one or more virtual networks
  - A set of disk images
  - A state file (optional) or recovery file

- Life Cycle
  - Resource Selection
  - Resource Preparation
    - Contextualization
  - VM Creation
  - VM Migration
  - VM Termination

VM Management
(OpenNebula)

- Management Areas
  - Virtualization
    - physical resource
  - Image management
  - Networking

Virtualization

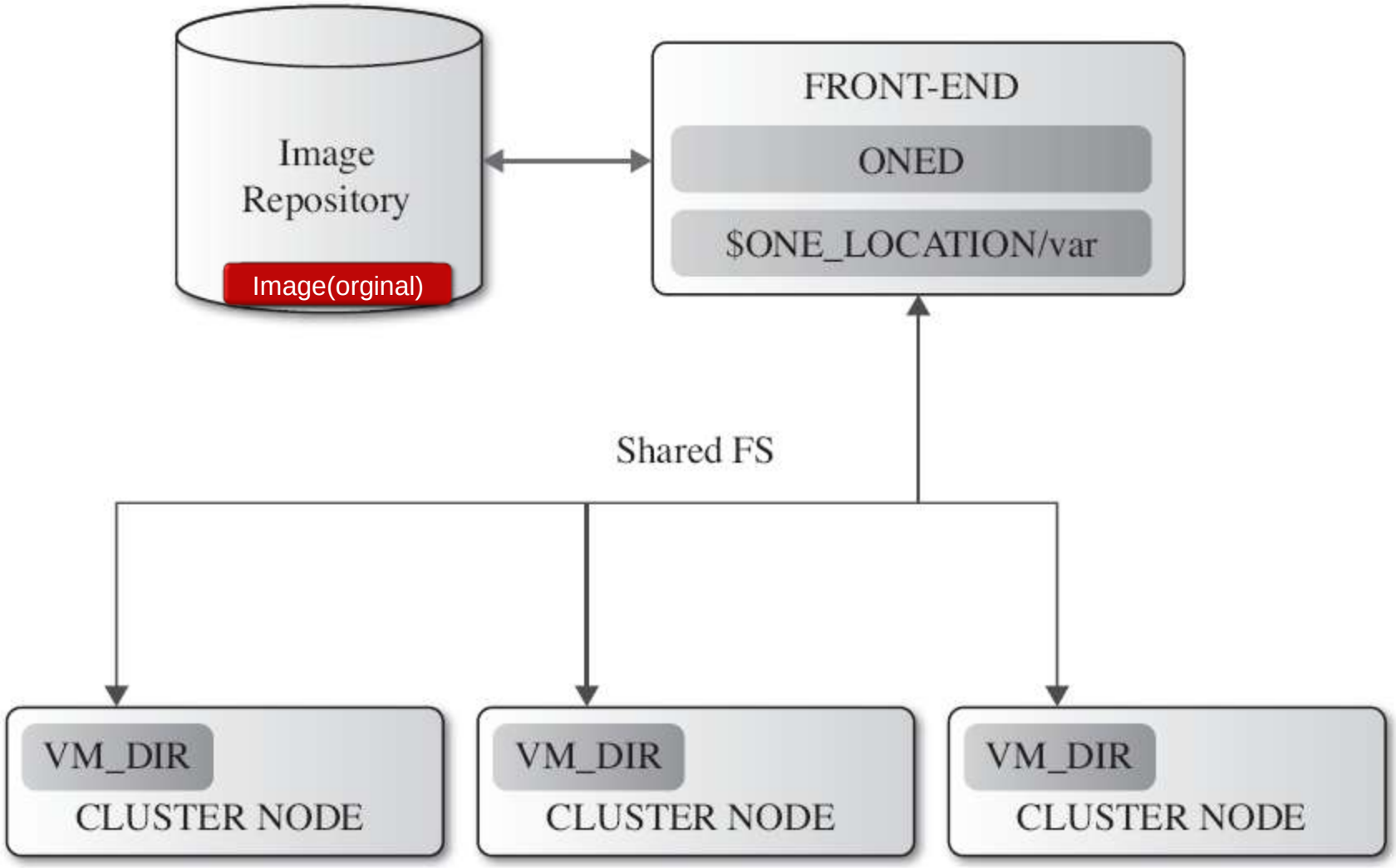
- How?
  - Interfacing with the physical resource virtualization technology (hypervisors like Xen, KVM)
- More detail
  - Pluggable drivers
    - Decouple the managing process from the underlying technology
  - High-level command
    - start VM, stop VM
  - Driver-based architecture
    - Adding support VIMs by writing drivers

Image Management

- How?
  - Transferring the VM images from an image repository to the selected resource and by creating on-the-fly temporary images
- More detail
  - What is image?
    - Virtual disk contains the OS and other additional software
  - Image management model

Image Management Model

(openNebula)

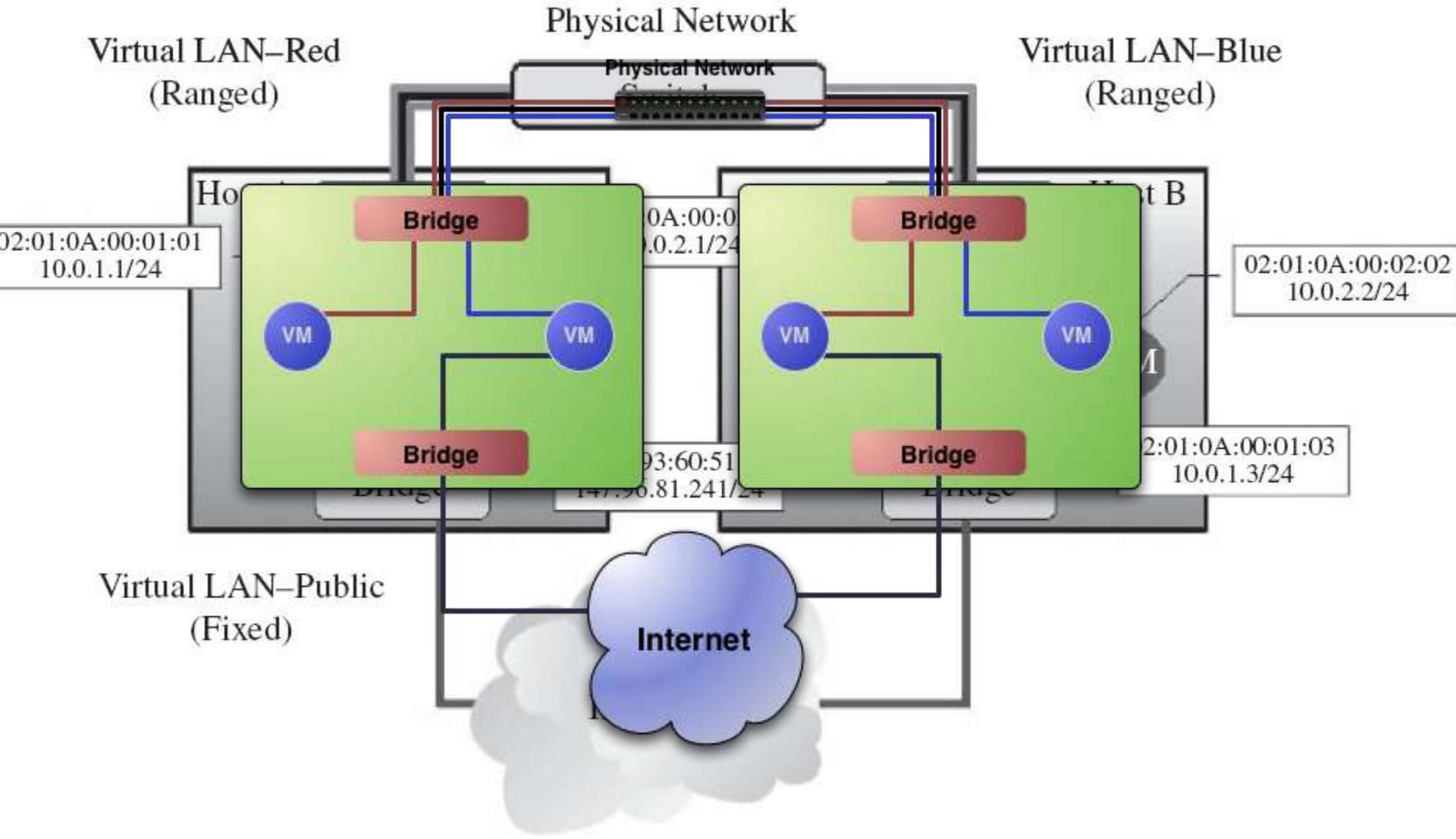


Networking

- How?
  - creating local area networks (LAN) to interconnect the VMs and tracking the MAC addresses leased in each network.

- More detail
  - virtual application network (VAN)
    - the primary link between VMs
  - OpenNebula dynamically creates VANs
  - physical cluster
    - set of hosts with one or more network interfaces
    - each of them connected to a different physical network
  - Networking Model

Networking Model (OpenNebula)



SCHEDULING TECHNIQUES FOR ADVANCE RESERVATION OF CAPACITY

Advance Reservation

- Demand for resources is known beforehand
- Example
  - an experiment depending on some complex piece of equipment is going to run from 2 pm to 4 pm
- Commercial Providers
  - Infinite capacity
- Private clouds
  - Finite capacity
  - Reservation lead resource to be underutilized
- Haizea
  - Lease manager
  - Scheduling backend by openNebula to support provisioning models

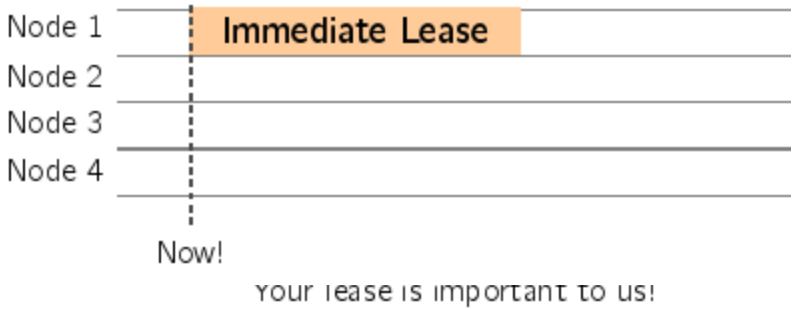
Existing Approach

- Preemption
  - Checkpointing
  - Checkpointable applications
  - OS-level checkpointing
- VARQ
  - Virtual advance reservation for queues
  - Queuing based approach
  - Wait time prediction
- Planning based approach
  - Immediately planned by making a reservation

Reservation with VMs

- Challenges
  - Preparation overhead
  - Runtime overhead

- Haizea
  - Leases
    - Advance reservation
    - Best-effort
    - Immediate



Haizea Lease Scheduling

- Backfilling
- How to address preparation and runtime Overhead?
  - Disk image transfer before start
  - Caching
- How does best-effort lease?
  - Scheduling using queue
  - Backfilling algorithm
  - Depend on required disk image
- VM suspension/resumption
- How does advance reservation lease?
  - EDF algorithm for preparation overhead
  - Without preemption for Runtime overhead
- Pluggable policy
- Combine best-effort and advance reservation
  - Overcome utilization problems

CAPACITY MANAGEMENT TO MEET SLA COMMITMENTS

SLA Commitment

- Cloud consumer vs. End users
- SLA between Service owner and end user
  - High-Level SLA
- SLA between Cloud provider and Service owner
- Cloud provider task
  - Elasticity on demand
- Problem
  - Application specific metric for resource allocation
- Solution
  - Elasticity of the application should be contracted and formalized as part of capacity availability SLA between the cloud provider and service owner (RESERVOIR)
- Research issues

Infrastructure SLAs

- Main approaches:
  - No SLAs
    - Premises
      - Spare capacity
      - QoS-insensitive
    - Suitable for best-effort workloads
  - Probabilistic SLAs
    - Availability percentile
    - Less stringent commitment
    - Lower availability = cheaper cost
    - Suitable Small and medium business
  - Deterministic SLAs
    - 100% availability percentile
    - Most stringent guarantee
    - Suitable for Critical services

Elasticity rules

- Definition
  - Scaling and de-scaling policies
- Motivation
  - Pay-as-you-go billing
- Types
  - Time driven
    - Timer event
    - Predictable workload
  - OS Level Metric driven
    - OS parameter, auto scaling
    - Not precise
  - Application Metric driven
    - Application specific policies