

# VM Migration

- Dynamic provisioning
- A workload increase can be handled by increasing the resources allocated to a virtual server.
- Two cases:
  - idle resources are available on the physical server
  - migrating the virtual server to a less loaded physical server.
- Migration is transparent to the applications
- all modern virtual machines support this capability

# Manual Migration

- Detecting workload hotspots and initiating a migration
- Manually-initiated migration
  - lacks the agility to respond to sudden workload changes;
  - it is also error-prone since each reshuffle might require migrations or swaps of multiple virtual servers to rebalance system load.
  - Migration is further complicated by the need to consider multiple resources—CPU, network, and memory—for each application and physical server.

# Automated Strategies

- Black box
- Gray box
- Automate the tasks:
  - monitoring system resource usage
  - hotspot detection
  - determining a new mapping and initiating the necessary migrations.

# Black box & Gray box

- black-box
  - Observing each virtual machine from the outside
  - Without any knowledge of the application resident within each VM.
- gray-box
  - access to a small amount of OS-level statistics in addition to external observations to better inform the migration algorithm.
- black-box approach is more general
- Blackbox approach alone is sufficient and effective for hotspot?
- limitations of the black-box?

migration is transparent  
to applications executing within virtual  
machines

# Sandpiper

- A system for automated migration of virtual servers.
- Knows the hardware configuration of each server—its CPU, network interface, disk and memory characteristics.
- Each physical server runs a virtual machine monitor (**Xen**) and one or more virtual machines.
- Each virtual server(VM) runs an application or an application component .
- Each virtual server is assumed to be allocated a certain slice of the physical server resources.

# Physical Resources Allocation (Sandpiper)

- **Case : CPU**
  - Achieved by assigning a weight to the vm.
  - Xen CPU scheduler allocates CPU bandwidth in proportion to the weight.
- **Case: network interface**
  - Xen implements a fair-share scheduler
  - FIFO scheduler is currently used
- **Case:memory**
  - A slice is assigned by allocating a certain amount of RAM.
  - All storage is assumed to be on a network file system or a storage area network, thereby eliminating the need to move disk state during VM migrations.



# Nucleus (Sandpiper)

- Sandpiper runs nucleus on each physical server;
  - Nucleus runs inside a special virtual server (domain 0 in Xen)
  - Responsible for gathering resource usage statistics on that server
  - Employs a monitoring engine that gathers processor, network interface and memory swap statistics for each virtual server.
  - For gray-box approaches, it implements a daemon within each virtual server to gather OS-level statistics and perhaps application logs.

# Control Plane (Sandpiper)

- Runs on a distinguished node
- Implements much of the intelligence in Sandpiper.
- Comprises three components:
  - A profiling engine
  - A hotspot detector
  - A migration manager
- Profiling engine
  - Uses the statistics from the nuclei to construct resource usage profiles for each virtual server
  - Aggregate profiles for each physical server.
- Hotspot detector
  - continuously monitors these usage profiles to detect hotspots
  - Based on predefined threshold or SLA violations
  - Determines when to signal the need for migrations

# Control Plane (Sandpiper)

- Migration manager
  - Hotspot mitigation via dynamic migrations
  - Implements algorithms that determine
    - What virtual servers to migrate from the overloaded servers
    - Where to move them
    - How much of a resource to allocate the virtual servers once the migration is complete.
  - Assumes that the virtual machine monitor implements a migration mechanism that is transparent to applications
- Currently uses Xen's migration mechanisms.

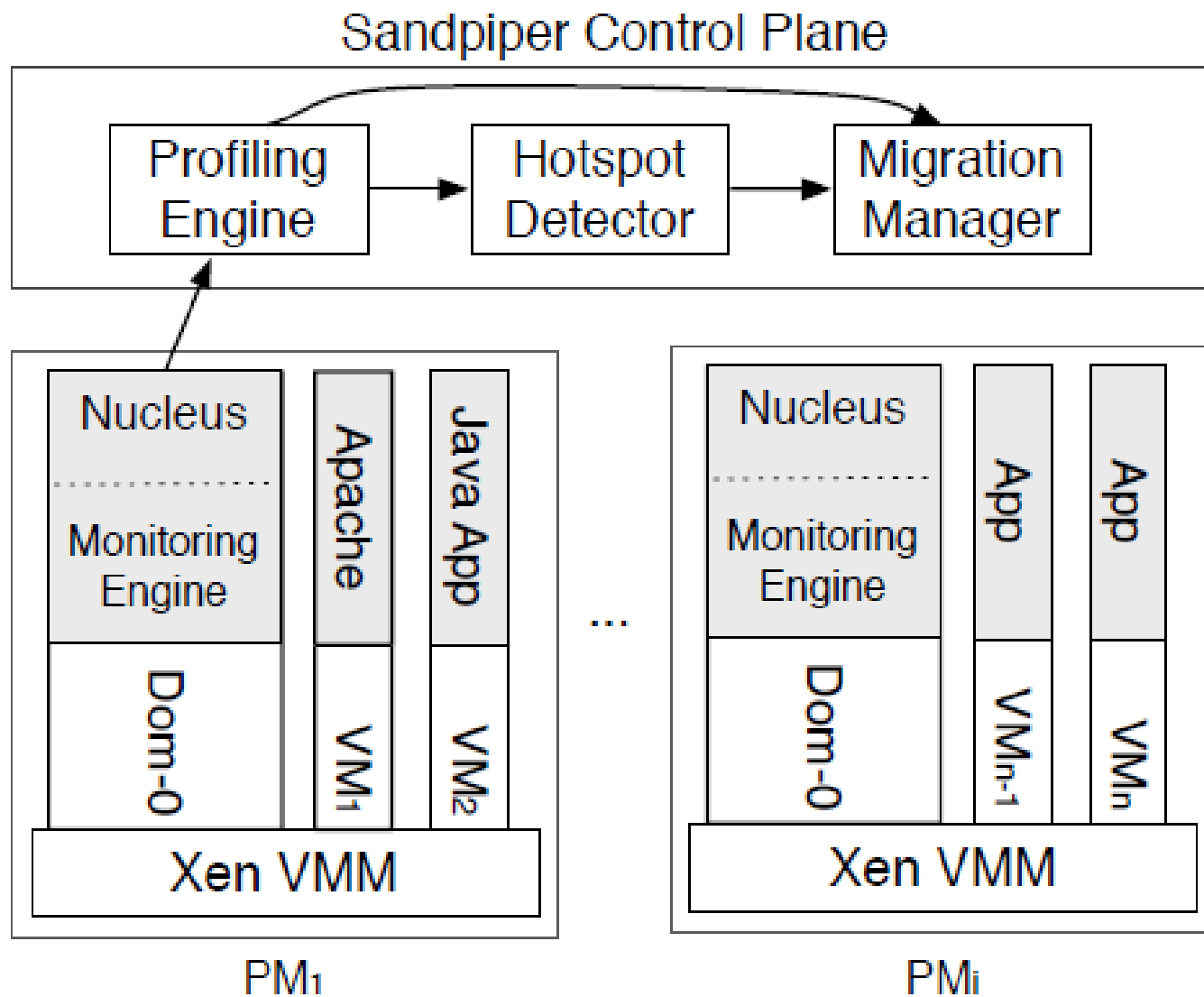


Figure 1: The Sandpiper architecture.

- Xen Migration Mechanism
  - Xen and the Art of Virtualization
- Xen Live Migration

Reference:

Black-box and Gray-box Strategies for Virtual  
Machine Migration