A Classification of Middleware to Support Virtual Machines Adaptability in IaaS

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Introduction

- Virtual machines everywhere
  - Resource consolidation and efficiency, coarse grained resource management
- VMs adapt resource management at runtime
  - Monitor, Decision, Action
  - Guided by metrics inside the codebase or instructed by others
- How to analyze the quality of adaptation?
  - Responsiveness, Comprehensiveness and Intricateness
Agenda

- Virtualization fundamentals
- Adaptability techniques
- A classification framework
- Systems and their classification
- Conclusions
Virtualization at different layers

- Native app
- Native app
- Operating systems
- Hardware (CPUs, Memory, I/O, devices)
- C1 ... C2
- HLL VM
- Hardware
- Virtual Machine Monitor
- Hardware
- HLL VM
- Virtual Machine Monitor
- Hardware
System VMs

- Computations as a resource
  - Emulation of different Instruction Set Architectures (ISA)
  - CPU Scheduling
    - Enforces user level shares (or weights) and caps

- Memory as a resource
  - Generalizations of OS techniques using shadow pages
  - Pages can be shared across guests
  - Transparently transfer pages between guests using memory ballooning
Adaptability loop

- Collect data from sensors
- Event based, threshold checking
- What needs to be changed
- Decisions made inside or outside the VM determine the complexity of the process
- Act according to decision using the available effectors
- Change Parameters, algorithms
System VM techniques

- System VMs
  - Memory management
    - Monitoring
      - Page utilization
      - Page contents
      - Application performance
      - Share based
      - Linear optimization
    - Analysis and decision
      - Page share
      - Page/Memory transfer
      - CPU consumed by VCPU
    - Action
      - Virtual clock
      - Linear optimization
      - Application performance
      - Feedback control
      - Statistical analysis
  - CPU management
    - Analysis and Decision
      - Number of CPUs
      - Number of VCPUs
    - Action
      - CPUs share
      - Number of processes/threads
Introduction to the framework

- The RCI framework goal – understand and compare different adaptation processes
  - Responsiveness: how fast can the system adapt?
  - Comprehensiveness: which is the breadth and scope of the adaptation process?
  - Intricateness: which is the depth/complexity of the adaption process?

- The RCI conjecture
  - A given adaptation technique aiming at achieving improvements on two of these aspects, can only do so at the cost of the remaining one.
  - Similar to other tradeoffs in system research
    - Consistency, Availability, and tolerance to Partitions.
    - P2P: High Availability, Scalability, and support for Dynamic Populations
System VM deployments

- Friendly Virtual Machine [49]
  - Virtual time clock; Feedback control; Number of processes/threads
- HPC computing [36]
  - CPU consumed by each VCPU; Share based; Number of VCPUs assigned to CPU
- Ginko [28]
  - Application's performance; Linear optimization; Page/memory transfer
- AutoControl [34]
  - Application's performance; CPU consumed by each VCPU; Feedback control; Change shares or caps
- PRESS [20]
  - CPU consumed by each VCPU; Statistical analysis; Change shares or caps
- VM³ [30]
Different systems have a different RCI coverage
Intricateness seems to dominate but responsiveness is also strong
Systems with larger R and I are less comprehensive
Characteristics of the Adaptability loop
Conclusions

- Cloud infrastructures depend on VMs to provide support for multiple tenants
- Resource management is crucial and there is no one-fits-all strategy
  - VMs must adapt to their guest changing or being instructed to change their parameters or strategies

This work
- Surveys different adaptation techniques regarding resource management in VMs
- Proposes a classification framework to better understand the benefits and limitations of each one
- Surveys different systems and frames then into the classification framework

In the future
- New systems and new techniques can be added to enrich the analysis
- Values regarding the RCI of techniques should also depend on measurable aspects (e.g. ratio of functional and monitoring code)
References


