Providing Automated Detection of Problems in Virtualized Servers using Monitor framework

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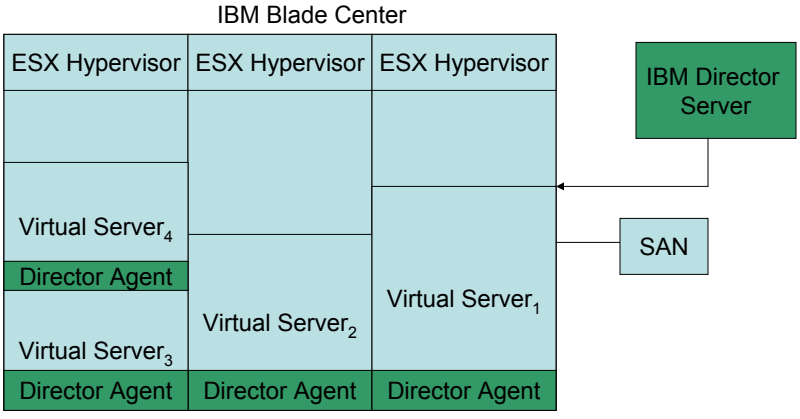
Background

- Detection and diagnosis of problems in IT systems is a challenging task
  - Performance, configuration etc.
- Server virtualization is a widely adopted practice
- Virtualization is a way of providing indirection
  - Server Virtualization aims at converting physical machine(s) into virtual server(s) and deploying on top of a hypervisor
- Provides isolation, homogeneity, and increased resource utilization
  - Prevents server sprawl

Motivation

- Virtualization Technology (hypervisor) and Management systems have been developed independently
  - Both exercise control over the OS
- Dynamic resource allocation via hypervisor further heightens the problem
- Current management systems only concentrate on system resources
  - Centralized and inflexible
  - Most require management agents to be co-located

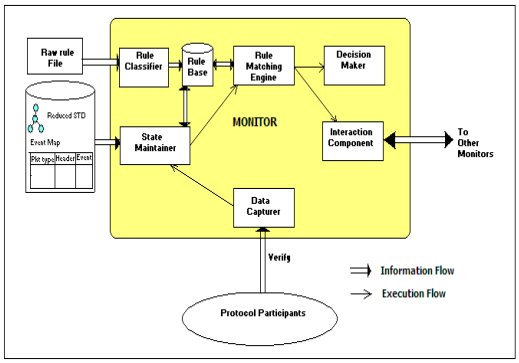
Example Virtual Scenario



Challenges in Addressing Problems in Virtualized Environments

- How to quickly detect the problem arising due to resource contention between co-located virtual machines ?
- How to interpret the system metrics from one virtual machine with the metrics from physical machine ?
  - System Metrics : CPU, Memory, I/O etc.
- How to correlate the application state information with the system metrics ?
- Address error propagation and scalability ?

Monitor(s) for Virtualized Environments



Characteristics

- Observes external interactions between system components
- Uses fast matching against a database of rules to detect problems
- Hierarchical topology allowing for correlation and filtering of information
- Can work with black-box components

Rule Framework

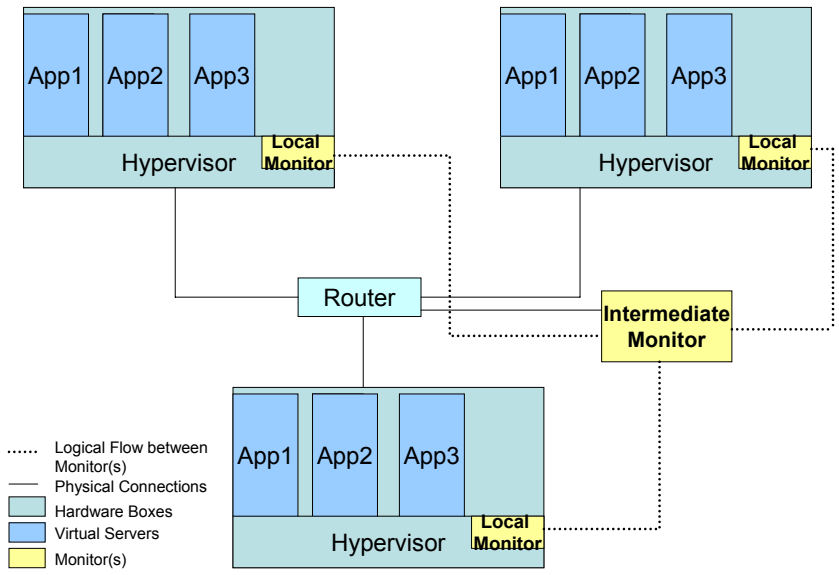
- Combinatorial Rules
  - $S_1 \wedge S_2$
- Temporal Rules
  - 5 different types of temporal rules
  - Expressive enough to form rules for wide range of applications and scenarios
  - Type I:

$$S_p = \text{true for } T \in (t_N, t_N + k) \Rightarrow S_q = \text{true for } T \in (t_I, t_I + b)$$

  - Type IV:

$$If\ S_i = true, and\ \forall t \in (t_0, t_0 + a)\ L \le |V_t| \le U \Rightarrow L' \le |B_q| \le U' \forall t \in (t_n, t_n + b)$$

Using Monitor(s) in Virtualized Server Scenario(s)



Detecting Problems

- Avoid simultaneous Peak Resource Usage for co-located virtual machines
  - S_i is the state of peak resource usage for machine $_i$.
  - $\neg(S_1 \wedge S_2 \wedge S_3)$
- Fault propagation from one physical machine to another
  - WAS sends more messages to a DB2 replica
  - Suitable assertions should be placed
- Correlation of alarms
  - Derived alarms at higher level Monitor(s)

$$\exists t = T \; s.t. \;\; S_i = true \Rightarrow \; A_L \leq A_{LM} \leq A_U \;\; \forall \, t \, \varepsilon \, (T, T + \alpha)$$

Relating the system resources with Application semantics

- Simply looking at system metrics like CPU, memory etc. does not provide a complete view of the system
  - Composite Rules relating the application with system metrics are necessary
- DB2 (Data Base) table contention
  - Response Time $\exists t = T \; s.t. \;\; S_j = true \Rightarrow \; R_{\max} \leq R_{DB} \leq \infty \;\; \forall \, t \, \varepsilon \, (T, T + \delta)$
  - Open Connections

$$\exists t = T \; s.t. \;\; S_i = true \Rightarrow \; L_0 \leq O_c \leq U_0 \;\; \forall \, t \, \varepsilon \, (T, T + \delta)$$

- WAS (Application Server) resource contention
  - C_w and WAS_{CPU} are application and system metric respectively

$$If \;\; C_0 \leq C_W \leq C_1 \;\; \forall \; t \; \varepsilon \; (T, T + \delta)$$
$$\Rightarrow \; L_{CPU} \leq WAS_{CPU} \leq U_{CPU} \;\; \forall \; t \; \varepsilon \; (T, T + \ell)$$

Conclusions

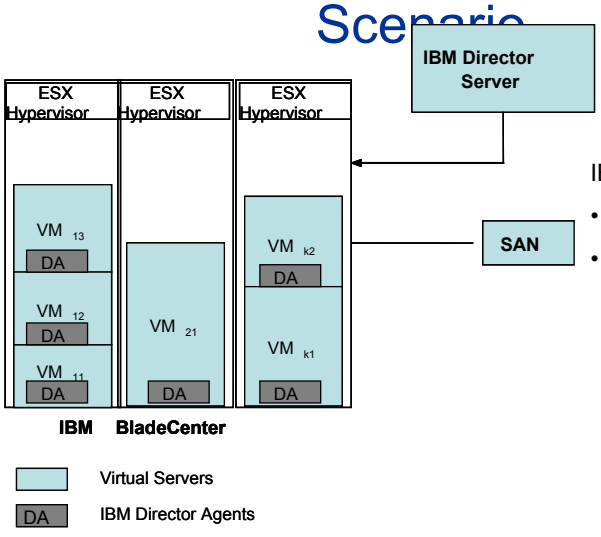
- We show the mismatch between the current management systems and virtualization layer(s)
- We propose a hierarchical management framework for addressing problems faced in a virtualized server system
- Address some of the challenges raised by virtualization
- As a future work we are working on diagnosis of problems in virtualized scenarios

Thank You !

Differences from existing Management framework(s)

Properties	Monitor Framework	Existing Management Framework(s)
Architecture	Hierarchical	Centralized
Adaptability	Re-configurable	Rigid
Internal Access	Non-Intrusive	Require Agents
Applicability	Generic in nature	Sensors for specific applications

Example Virtualized Server Scenario



IBM Director Server

- Management Framework
- Provides discovery of systems and remote management