BLACKBOARD LEARN™ AND VIRTUALIZATION

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Introduction

• Anand Gopinath
  – Software Performance Engineer
  – 5 years (including WebCT)
  – Recent projects: VMware benchmark, XenServer benchmark, 9.0 Release, database optimization, interface tuning, upcoming releases

• Nakisa Shafiee
  – Senior Software Performance Engineer
  – 3 years (including WebCT)
  – Recent projects: VMware benchmark, XenServer benchmark, 9.0 Release, JVM tuning, database optimization, upcoming releases
Blackboard Performance Engineering

- Team Mission: To provide the fastest performing, most scalable e-learning software application in the world
- Software Performance Engineering (SPE)
  - SPE is a systematic, quantitative approach to the cost-effective development of software systems to meet performance requirements
  - The team’s focus is on performance (response times) and scalability (adoption/usage) of our web-based products
- Software Performance Testing (SPT)
  - Release to release comparison of platform regression
  - Transaction comparisons by data workload variation (Apdex tests)
Blackboard Performance Engineering

• Benchmarking Efforts
  – Sizing and Capacity Planning
  – Advanced Configurations such as Virtualization
  – Environmental Optimization such as JVM Tuning, SQL Tuning and "Environmental Tuning"
Goals of the Presentation

• Reasons for virtualization
• Best practices for virtualization
• Share our experiences with virtualization
Learning Objectives for Presentation

• Understand what are collapse ratios and why they are important for sizing virtualization deployments
• Learn different techniques for optimizing performance within a virtualization platform
• Learn about different tools and techniques for monitoring virtual machines.
Blackboard's Virtualization Message

- Blackboard encourages the use of virtualization as an extension of the Blackboard Reference Architecture
- Blackboard supports clients using virtualization when VMs are running Blackboard supported or certified operating system configurations
- The creation, maintenance, and troubleshooting of the VM environment is the responsibility of the client
Virtualization Platforms that Blackboard is Most Familiar with

- VMware® ESX 3.5 (Linux® and Windows®)
- Citrix XenServer 5.5
- Solaris™ 10 Zones
- Red Hat® Enterprise Linux® 4 & 5 Xen™
Benefits of Virtualization

- Hardware consolidation
- Reduced Cost
- Reduced risk through proven reliability, scalability and performance
- Achieve Higher Levels of Availability/ Business Continuity
- Gain operational flexibility
- Save the environment
- Simplified management
Determining Collapse Ratios

- In a 32-bit world, deploying one application server on an average physical server does not utilize all the available resources. It makes sense to virtualize to make better use of available resources.
- In a 64-bit world, while we can utilize most of the available resources on a physical server, virtualizing will provide more availability.
- Use Collapse Ratios to determine how far you can push your physical server.
Determining Collapse Ratios

• Performance Archetype Ratio (PAR)
  – Process of predicting scalability based on resource consumption
• Through the process of calibration (which depends on transactional response time), we determine a VM can handle X amount of workload and consumes Y amount of resources.
• To handle double the workload, we need to double the resources
• Assume that resources consumption grows linearly as workload grows linearly until we reach our saturation point
• PAR calculation is important as it allows us to predict how many VMs a physical server can handle prior to saturating resources
• Measure 4 key resources: CPU, Memory, I/O and Network
• Saturated resource consumption prior to breaking response time SLAs
VM Configuration and Optimization

• Physical resources can be redistributed as needed
• Ability to move a virtual machine across multiple physical servers
• VM image is stored on external storage device
  – Can be stored on either NFS, iSCSI or fiber channel based external storage
• Shared resource model
• Recommend to install Virtualization tools (ie. VMWare tools, XenServer tools)
• Ability to allocate more/less resources per VM
Monitoring Virtual Machines
VMware

- VMware Infrastructure Client
VMware

- VMware Infrastructure Client
VMware

- Esxtop

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root@pdr36esx01:~

2:19:20pm up 317 days 4:27, 90 worlds; CPU load average: 0.00, 0.01, 0.01
PCPU(%): 0.58, 0.06, 0.04, 0.05, 0.04, 0.03, 0.06, 0.07; used total: 0.12
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VMware

- Veeam Monitor
VMware

- vFoglight
Monitoring VMs

- vFoglight
XenServer

- Citrix XenCenter
Red Hat Xen

- XenSource Management Console
Share Our Experience
VMware Benchmark

- Blackboard Academic Suite, Release 8 SP 4
- 64 bit SQL Server database on bare metal
- 32 bit Windows Application Server on VM
- 32 bit JVM on Java 1.5
- Goals of the benchmark:
  - To obtain advanced knowledge of optimizing VMWare ESX for the benefit of joint Blackboard and Dell customers.
- Optimizing Blackboard Academic Suite on Dell Servers and Storage- Taking Advantage of Virtualized Resources
- Virtualizing the Blackboard Reference Architecture for Release 9
Vmware Benchmark

• Performance Objectives:
  – Calibrate an individual ESX VMWare instance running Windows 2003 Enterprise Edition and the Blackboard Academic Suite
  – Outperform past benchmarks’ Transactions Per Second Watermark in a Single Server
  – Saturate the R900 Database System

• Response time requirements (90-9-1)
  – At least 90% of all transactions have a response time requirement under 2 seconds
  – At most 9% of the transactions have a response time of between 2 and 10 seconds
  – At most 1% of all transactions have a response time of over 10 seconds
XenServer Benchmark

Response Time and Logins across VMs

- %>10
- %<=10
- %<=2
- Logins

Number of Virtual Machines:

- 1
- 8
- 16
- 24
- 27
- 30
- 33

Percentage:

- 0%
- 10%
- 20%
- 30%
- 40%
- 50%
- 60%
- 70%
- 80%
- 90%
- 100%
- 110%
Vmware Benchmark

- Database CPU PAR Calculation: Expected vs. Actual

Expected vs Observed DB CPU Utilisation as VMs Increase
Vmware Benchmark

- Number of Logins PAR Calculation: Expected vs. Actual

![Graph showing expected vs observed logins as VMs increase](image-url)
Vmware Benchmark

- Optimum performance could be achieved on:
  - a 16-core Dell PowerEdge R900 server
  - 8 VMs
  - 2 vCPU per VM
  - 4GB Memory per VM
XenServer Benchmark

- Blackboard Learn, Release 9 SP 1
- 64 bit Oracle database on bare metal
- 64 bit Red Hat Application Server on VM
- 64 bit JVM on Java 1.6
- Goals of the benchmark
  - To obtain advanced knowledge of optimizing and calibrating Citrix XenServer for the benefit of joint Blackboard and Dell customers.
  - Define new optimization standards for running the Blackboard Learn system on a 64-bit Java 6 JDK.
  - Identify best deployment and configuration practices for Oracle 11GR1 on a highly concurrent and transactional Blackboard Learn system.
XenServer Benchmark

- Performance Objectives
  - Able to support no less than 50k active sessions over the course of 60 minutes worth of simulation in which 10 million hits are achieved and response time percentiles are met
  - Evaluation of Citrix Netscaler Load-Balancer Advanced Performance Technologies and their effects on the Blackboard Learn application.
  - Calibrate the optimal configuration of Citrix XenServer 5.5 running Red Hat Linux Enterprise Edition 5.3 in 64-bit Mode
  - Determine the collapse ratio for the virtualized workload and configuration.
  - Quantify the appropriate storage needs to accommodate our concurrency and transactional metrics.
  - Evaluate Java 6 options
XenServer Benchmark

- Response time requirement (99-95-90)
  - 99% of all transactions have a response time of under 5 seconds
  - 95% of all transactions have a response time of under 3 seconds
  - 90% of all transactions have a response time of under 2 seconds
XenServer Benchmark

Response Time and Logins across VMs - 4vCPU Test with DB Optimization

- 99th Percentile
- 95th Percentile
- 90th Percentile
- Logins

Number of Virtual Machines

Transaction Response Time (seconds)
XenServer Benchmark

- Database CPU PAR Calculation: Expected vs. Actual
Xenserver Benchmark

- Number of Logins PAR Calculation: Expected vs. Actual
XenServer Benchmark

• Two tests were run on a single physical machine:
  – 4GB heap- this would be comparable to the 1VM test results
  – 16GB heap- this would be comparable to the 4VMs test results
• Performance of bare metal vs. virtualized environment was similar
• Virtualizing will provide you with a higher availability of Blackboard Learn instances
XenServer Benchmark

Baremetal Tests vs. Citrix XenServer

- Transactional Response Time (seconds)
- Configuration:
  - 1 VM
  - 4GB heap Baremetal
  - 4 VMs
  - 16GB heap Baremetal

Legend:
- 99th Percentile
- 95th Percentile
- 90th Percentile
- Logins
XenServer Benchmark

• Database CPU utilization did not scale linearly as expected
• At 8 VMs database CPU was saturated
• After some investigation and SQL statement tuning, we were able to reduce the database CPU consumption to the point where we were able to deploy more Blackboard instances to meet our benchmark goals
XenServer Benchmark

- optimum performance could be achieved on:
  - Three 8-core Dell PowerEdge R710 servers
  - 12 VMs (4 VMs per R710 Server)
  - 4 vCPU per VM
  - 8GB Memory per VM
Questions?

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Thank you!