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Introduction

This document provides direction to those interested in running BlackBerry® Enterprise Server on VMware® Infrastructure 3 or VMware vSphere™ 4. It provides basic guidance on the architecture of BlackBerry Enterprise Server as well as the value of utilizing the VMware platform to provide virtual infrastructure. The document then provides results of recent testing done jointly by VMware and Research in Motion (RIM®), which characterizes the performance and functionality of Blackberry Enterprise Server on VMware infrastructure version 3.5 update 3 and vSphere 4. Finally, the document outlines some best practices for utilizing Blackberry Enterprise Server and VMware virtual infrastructure together in your datacenter.

VMware and Blackberry Enterprise Server Overview

VMware and RIM have worked together over the past two-plus years to provide official support of Blackberry Enterprise Server (BES) solutions on VMware virtual infrastructure. Both RIM and VMware have had active virtualized BlackBerry Enterprise Server deployments running on VMware virtual infrastructure for three-plus years. There are also many other customers that have successfully deployed BlackBerry Enterprise Server in VMware virtualized environments.

BlackBerry Enterprise Server

The BlackBerry Enterprise Server is a middleware software package from Research In Motion that connects to messaging and collaboration software, such as Microsoft Exchange, Lotus Domino, and Novell GroupWise, on enterprise networks to redirect emails and synchronize PIM information between desktop and mobile software. The BlackBerry Enterprise Server provides push-based access to email; calendar, contacts, tasks and notes; instant messaging; web-based applications and services and enterprise applications.

BlackBerry Enterprise Server v5.0 features built-in over the air software loading which simplifies wireless deployment of BlackBerry smartphone software. Engineered to meet the demands of mission critical enterprise environments, BlackBerry Enterprise Server v5.0 offers peace of mind with a proven, secure and stable IT platform that supports current and evolving mobility requirements.

Table 1. Benefits of BlackBerry Enterprise Server

<table>
<thead>
<tr>
<th>IMPROVE IT PRODUCTIVITY AND EFFICIENCY</th>
<th>SIMPLIFY DEPLOYMENTS AND UPGRADES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Manage your BlackBerry environment with the new BlackBerry Administration Service, which provides web-based access to centralized management tools.</td>
<td>• Deploy hundreds of applications to thousands of users with enhanced job management, throttling and scheduling.</td>
</tr>
<tr>
<td>• Customize roles and permissions to create different levels of access to server functions.</td>
<td>• Schedule device, application and IT policy updates to minimize impact on end-users and business operations.</td>
</tr>
<tr>
<td>• Expand group management capabilities where users can now belong to multiple groups and groups can belong to groups.</td>
<td>• New BlackBerry Enterprise Transporter allows for seamless migration of BlackBerry Enterprise Server v5.0 users without requiring end-user intervention.</td>
</tr>
<tr>
<td>• Schedule device, application and IT policy updates to minimize impact on end-users and business operations.</td>
<td></td>
</tr>
</tbody>
</table>
End-User Productivity

BlackBerry Enterprise Server v5.0 offers more control of desktop features on BlackBerry smartphones, helping to bridge the gap between employees and the business tools they rely on while away from the office. BlackBerry Enterprise Server deployments allow customers and users to perform the following tasks:

- Organize email messages that require follow-up with the use of flags, as they do in Microsoft® Outlook®.
- Easily access network drives using the remote file explorer directly from their BlackBerry smartphones.
- Open and forward calendar appointments, including attachments.
- Browse folders on the BlackBerry smartphone to view and attach files to email messages.
- Use Calendar Meeting Delegation for IBM® Lotus® Domino®, which allows attendees to delegate invitations to another person.
- Simplify mailbox folder management by adding, renaming, deleting, and moving folders as necessary.
- Listen to WMA files while on the go with extended support for audio file types.

The BlackBerry Enterprise Server consists of a number of different services that carry out the basic operations of the system.

BlackBerry Enterprise Server Components and Features

The following list provides hyperlinks to more information on components and features that are part of a typical BlackBerry Enterprise Server deployment:

- BlackBerry messaging and collaboration services
- BlackBerry MDS
- Managing BlackBerry Java Applications and BlackBerry Device Software
- BlackBerry MDS Application Console
- BlackBerry device management
- BlackBerry Enterprise Solution security
- BlackBerry Monitoring Service
- BlackBerry Router
- BlackBerry Policy Service
- BlackBerry Configuration Panel
- BlackBerry Administration Service
- BlackBerry Web Desktop Manager

Blackberry Enterprise Server is typically deployed and managed within a business or enterprise by messaging administrators. That resource may sometimes be a dedicated BlackBerry Administrator, or may be someone already responsible for managing other messaging and collaboration services such as Microsoft Exchange, Lotus Domino, or Novell GroupWise).
VMware Infrastructure 3 and VMware vSphere 4

VMware’s leading virtualization solutions provide multiple benefits to IT administrators and users. VMware virtualization creates a layer of abstraction between the resources required by an application and operating system, and the underlying hardware that provides those resources. A summary of the value of this abstraction layer as it pertains to Blackberry server deployments includes the following:

- **Consolidation**: VMware technology allows multiple application servers to be consolidated onto one physical server, with little or no decrease in overall performance. Customers can increase the utilization of physical hardware running BlackBerry Enterprise Server and database virtual machines and consolidate dedicated and isolated environments for all users on to a few physical systems. Customers can also run multiple operating systems and BlackBerry Enterprise Server versions on the same system, eliminating the need for dedicated hardware for each one.

- **Ease of Provisioning**: VMware virtualization encapsulates an application into an image that can be duplicated or moved, greatly reducing the cost of application provisioning and deployment and speeding new rollouts of Blackberry servers. Customers can streamline activation, deployment, and validation of BlackBerry Enterprise Server hosts, avoid manual configuration errors, quickly respond to peaks in activity, and quickly restore service after OS/virtual machine failure. In addition, customers can maintain a template library of multiple BlackBerry Enterprise Server versions and pass cloned production images directly to testers for accurate and thorough results.

- **Manageability**: BlackBerry Enterprise Server virtualization enables customers to take advantage of increased management and administrative flexibility. Using Templates, customers can keep an inventory of all server images and deploy a new virtual machine OS in minutes, saving countless hours when deploying new systems. This frees up valuable IT resources, and can be especially important in test/development labs, when a new server image needs to be deployed quickly and consistently. Furthermore, customers can migrate virtual machines online across ESX servers with VMware vMotion™ and automatically control and balance the resources used by the BlackBerry Enterprise Server virtual machines in real-time with VMware Distributed Resource Scheduler (DRS), thus providing unprecedented levels of flexibility for all virtual servers.

- **Availability**: VMware virtual infrastructure can significantly improve the availability of the BlackBerry Enterprise Server deployments. Customers leverage VMware vMotion to migrate BlackBerry Enterprise Server virtual machines to another ESX host to address planned server downtimes. For unplanned server downtimes, VMware HA enhanced hardware level protection without the costs and complexities of MSCS clustering.
Using vSphere to Optimize Blackberry Enterprise Server Deployment

The figure below is a graphical representation of one possible solution architecture for running Blackberry Enterprise Server on VMware virtual infrastructure in a single site, based on joint RIM/VMware performance testing. The diagram shows a complete Exchange 2007 and Blackberry Enterprise Server infrastructure deployed on seven virtual machines on four ESX hosts. The use cases presented in the following sections are based loosely on this configuration and are intended to demonstrate architectural principles and techniques rather than strict performance guidelines. RIM and VMware are continuing to test performance and develop best practices for Blackberry Enterprise Server on VMware virtual infrastructure.

Figure 1. Solution Architecture – Blackberry Enterprise Server on VMware Virtual Infrastructure
Achieve Better Resource Utilization through Server Consolidation

Blackberry Enterprise Server deployments can benefit significantly from separation of application, database, administration, and attachment services. Unfortunately, this can often result in server sprawl and over-provisioning of physical resources in production, testing, and disaster recovery environments.

Using vSphere to run your Blackberry Enterprise Servers will help contain server sprawl and increase physical server utilization, resulting in a higher return on investment. With vSphere, Blackberry Enterprise Servers can be run in virtual machines on fewer, highly scalable and reliable enterprise-class servers without giving up the advantages of service separation.

VMware vSphere benefits for consolidation and resource utilization:

1. Consolidate Blackberry Enterprise Servers on fewer physical systems without sacrificing service separation. Reduce machine counts in production, test, and disaster recovery environments.
2. Fewer physical systems results in reduced total cost of ownership (TCO) and increased return on investment (ROI).
3. Run multiple operating systems and Blackberry Enterprise Server versions on the same physical systems, eliminating the need for dedicated hardware for each one.

Rapid Provisioning

As every administrator knows, deploying physical servers can be time consuming, requiring coordination from multiple teams, schedules, projects. Typically, new server deployment requires hardware procurement followed by installation of the hardware (i.e. racking, cabling, etc.), the operating systems, and the applications, a process that consumes significant time and IT resources.

Using vSphere to deploy Blackberry Enterprise Servers will significantly reduce time to provision new Blackberry Enterprise Servers; simply use virtual machine templates to provision new, pre-configured Blackberry Enterprise Servers in minutes! Rapid deployment capabilities allow your organization to respond quickly to changing workloads and shifting business requirements.
VMware vSphere benefits of rapid provisioning:

1. Streamline activation, deployment, and validation of BlackBerry Enterprise Servers by deploying from virtual machine templates. Entire libraries can be maintained with multiple configurations that can be provisioned instantly to meet production and lab/testing requirements.

2. Quickly respond to changing workloads by rapidly provisioning additional BlackBerry Enterprise Server instances during peak activity or business changes.

3. Quickly respond to OS/virtual machine failure by deploying replacement virtual machines to restore service.

4. Reduce deployment configuration problems due to manual error.

**Achieve Faster and More Accurate Change Management**

Blackberry Enterprise Server administrators face two key challenges in change management: testing patches and upgrades for compatibility with corporate standards and efficiently deploying them throughout the enterprise.

With physical servers, creating test environments that closely match production configurations can be challenging: acquire hardware similar to a production environment and either try to estimate user workloads or engineer some method of synchronization with a production environment.

With vSphere, you can provision up-to-date testing environments either by cloning production systems directly or by creating a library of virtual machine templates that mirror production. Once the test environment is prepared, you can test the latest patches and upgrades against the cloned BlackBerry Enterprise Server virtual machines. Once testing is complete and patches have been approved for production, you can deploy the patches onto production servers with minimal interruption to end users and minimal risk of outage. In case of problems, VMware snapshots allow you to instantly roll back BlackBerry Enterprise Servers to a known good state.
VMware vSphere benefits for change management:

1. Achieve faster and more accurate change management with fewer system resource requirements for hosting test environments. Move tested and approved Blackberry Enterprise Servers into production in minutes.

2. Utilize a library of standard production configurations to perform change management testing and deployment.

3. Test patches on multiple configurations (OS, Blackberry Enterprise Server versions, etc.) concurrently, all hosted on the same physical systems.

4. Recreate distributed production Blackberry Enterprise Server instances, along with supporting Windows and Exchange roles, in your test environment for holistic integration testing using a fraction of the hardware.

5. Reset test images (after test completion) using snapshots and templates where appropriate to reduce test reset times.

6. Dramatically simplify the patch management process while helping you protect your data center against bugs and security vulnerabilities with VMware vCenter Update Manager.
VMware vCenter Update Manager

With VMware vCenter Update Manager, you can automate patch management and eliminate manual tracking and patching of VMware ESX hosts and virtual machines. VMware vCenter Update Manager scans the state of the physical VMware ESX hosts, as well as select guest operating systems, compares them with baselines set by the administrator and then applies updates and patches to enforce compliance to mandated patch standards. This capability dramatically simplifies the patch management process while helping you protect your data center against bugs and security vulnerabilities.

Figure 5. Patch Management with VMware vCenter Update Manager

Achieve Higher Availability with VMware HA, vMotion, and VMware DRS

Continual access to email is crucial to the productivity of an increasingly distributed and mobile workforce. An outage to a single Blackberry Enterprise Server can impede the information capabilities of hundreds of users, forcing workarounds that result in lost efficiency.

VMware vSphere can improve the overall availability of Blackberry Enterprise Server application and database servers. Using features like vMotion and VMware HA, administrators can limit unplanned downtime with rapid service restoration or eliminate planned downtime during regularly scheduled maintenance.

VMware vSphere benefits of high availability:

1. Automatically restart failed Blackberry Enterprise Server virtual machines with VMware HA.
2. With vMotion, migrate Blackberry Enterprise Server virtual machines to other systems while performing maintenance or changes on the current physical system.
3. Increase service availability using VMware DRS and VMware HA to achieve application service level objectives.
4. Optimize Blackberry Enterprise Server deployments across a virtualized enterprise data center by providing reserved resource pools with pre-defined minimum and maximum resource requirements.

5. Dynamically migrate Blackberry Enterprise Servers requiring additional capacity to an ESX Host with the spare resource capacity with VMware DRS.

**Unplanned Physical Server Downtime (HA)**

VMware HA provides easy to use, cost effective high availability for Blackberry Enterprise Servers running in virtual machines. In the event of an ESX server failure, the affected Blackberry Enterprise Server virtual machines are automatically restarted on other ESX servers that have spare capacity. VMware HA minimizes downtime and IT service disruption while eliminating the need for dedicated stand-by hardware and installation of additional software. VMware HA provides uniform high availability across the entire virtualized IT environment without the cost and complexity of failover solutions tied to either operating systems or specific applications.

![ VMware HA Restart of Virtual Machines on ESX Host Failure ]

**Planned Physical Server Downtime (vMotion)**

As with any application running directly on a physical server, planned outages to Blackberry Enterprise Servers are sometimes necessary to perform maintenance, upgrade hardware, apply software patches, etc. Maintenance activities adversely affect end-user productivity and are often performed after business hours, which results in increased staff requirements and less time for more forward-looking activities.

VMware vMotion enables the live migration of running Blackberry Enterprise Server virtual machines from one physical server to another with zero downtime, continual service availability, and complete transaction integrity. Live migration of virtual machines enables you to perform evacuation for hardware maintenance without scheduling downtime and disrupting business operations.
Data Center Optimization (DRS)

A vSphere environment provides additional management capabilities that help optimize the infrastructure resources used by both Blackberry Enterprise Servers and other application types in an enterprise data center. VMware vSphere addresses resource management across the entire data center infrastructure and across multiple Blackberry Enterprise Servers.

VMware Dynamic Resource Scheduler (DRS), part of vSphere, dynamically allocates and balances computing capacity across a collection of hardware resources aggregated into logical resource pools. VMware DRS continuously monitors utilization across resource pools and intelligently allocates available resources among the virtual machines based on pre-defined rules that reflect business needs and changing priorities.
**VMware DRS Modes**

You can set VMware DRS to operate in advisory or “recommendation” mode, where it consults with a human operator before taking any action such as, for example, moving a virtual machine to a new host for load balancing reasons. VMware DRS can also operate in “partially automated” mode, which automatically chooses the optimal VMware ESX host on which to deploy Blackberry Enterprise Server instances in order to make use of their full capacity. It will not move the virtual machines during normal operations, but only make recommendations in the vCenter Console.

**Capacity Management**

When a Blackberry Enterprise Server virtual machine experiences an increased load, VMware DRS will re-balance the load across the cluster by moving some virtual machines to other hosts that may be less utilized. In the event of all VMware ESX hosts being fully utilized, and where predefined service level agreements cannot be met, an additional ESX host can be added to your VMware virtual infrastructure environment to provide a larger resource pool to handle the extra load. VMware DRS will automatically allocate additional resources from the newly added ESX host instance by placing virtual machines across the physical servers.

**Simplified Business Continuity/Disaster Recovery**

Many customers depend on Blackberry Enterprise Servers for the continuation of their business and these servers are often included in Tier 1 recovery efforts. Rapid recovery of Blackberry Enterprise Servers can be crucial to field operations and communications in the event of a disaster.

Using vSphere, you can implement a unified disaster recovery (DR) platform that allows production Blackberry Enterprise Server virtual machines to be recovered in the event of hardware failure, without investing in costly one-to-one mapping of production and DR hardware.

VMware vSphere benefits for continuity and disaster recovery:

1. Reduce hardware costs for the DR solution.
   a. Re-purpose old hardware for use at a DR site.
   b. Remove HW requirements and costs as a barrier to DR adoption.
2. Simplify and lower the cost of disaster recovery test and recovery processes.
3. Reduce operational time, test more frequently.
4. Ensure business continuity in a disaster scenario by speeding up the recovery process through automation.
5. Ensure that a recovery takes place in a reliable way.
6. Simplify backup administration and reduce the load for VMware ESX host machines.
Cost-Effective Disaster Recovery with VMware

Disaster recovery plans are expensive in part because they can require a 1:1 relationship between the production site hardware and the recovery hardware at the fail-over site. One effective strategy for reducing the high costs of redundant hardware is to replicate some or all of the production site machines using virtual machines at the recovery site. This practice means that the recovery hardware can be significantly less expensive than the production version as you can consolidate your DR environment on fewer hardware resources. Using this strategy, you might bring up an entirely virtualized data center to maintain business continuity in the event of a failure at a non-virtualized one. Having recovery virtual machines available to replace out of service production virtual machines is also a natural path. These strategies do not absolve the business from the need for some redundancy in hardware at the recovery site, but they certainly can reduce the costs of that hardware.

Automated Disaster Recovery Testing and Failover

The second issue in business continuity is the time to recover business functionality. The answer to this requirement lies in the rapid provisioning of the Blackberry Enterprise Server production environment at a recovery site and the timely instantiation of the Blackberry Enterprise Servers and their required database servers. Performing all of this under the control of a scripted automation tool is one key to success. VMware Site Recovery Manager (SRM) enables you to do exactly that by using virtual machines at the recovery site that are provisioned by a vCenter server at the recovery site.
Accelerate the Recovery Process

The speed and accuracy with which critical Blackberry Enterprise Servers can be brought back into service at a recovery site determines the application’s “recovery time”. Many business put together disaster recovery “runbooks” that are largely based on manual procedures for re-configuring everything that is needed at a new site (computers, networks, databases, and infrastructure servers) to support the business applications. While these manual recovery plans can work, it is usually difficult and expensive to test them on a regular schedule. Even worse, the speed of recovery using these methods is often measured in hours if not in days.

VMware Site Recovery Manager helps to ensure that you are able to meet your recovery time objectives (RTOs) for Blackberry Enterprise Servers and databases by automating the recovery process. Site Recovery Manager eliminates the slow manual steps of recovery, turning the complex paper runbooks into an integrated part of your virtual infrastructure management.

Ensure that a Reliable Recovery takes place

Site Recovery Manager eliminates common causes of failure during recovery and makes it possible to test your recovery plans thoroughly and easily. By automating recovery, Site Recovery Manager eliminates error-prone manual steps in the recovery process and ensures that recovery procedures will be consistently executed as intended. Site Recovery Manager also makes it easy to execute non-disruptive tests of recovery plans within an isolated testing environment so that you can ensure that they are up to date and will execute successfully. This Disaster Recovery testing facility in itself is a significant benefit if you are concerned about business continuity.

Simplify the Disaster Recovery process

Simplify and centralize the process of creating, updating and managing recovery plans. Site Recovery Manager guides you through the process of building, managing and executing disaster recovery plans. It integrates seamlessly with VMware vSphere and VMware vCenter Server to make recovery plans significantly easier to manage and update. It also integrates easily with storage replication software from leading storage vendors to simplify the use of advanced replication software with your VMware virtual infrastructure.
Backup

VMware Consolidated Backup provides an easy to use, centralized facility for LAN-free and non-disruptive backup of virtual machines. VMware Consolidated Backup simplifies backup administration and reduces the load for VMware ESX host machines.

![Figure 11. VMware Consolidated Backup](image)

Testing Process and Results

In this section, we describe setup of an environment to test BlackBerry Enterprise Server performance under load conditions and summarize the results that were obtained from running these tests. The goal of the testing was to create a realistic deployment environment, running Blackberry Enterprise Server 4.1.6 virtualized on both VMware ESX 3.5 and ESX 4.0, while using Microsoft Exchange as the primary mail system to provide system load. We used the Exchange LoadGen tool to drive load against the mail server, and the Perk load driver to drive load against Blackberry Enterprise Server.

Overall, testing showed that a 2-vCPU virtual machine with 4GB of memory running Blackberry Enterprise Server can easily support up to 2000 users with the workloads described in the test results. A standard size virtual machine can then be replicated to scale to a higher user count, for example, using two such virtual machines for 4000 users, three virtual machines for 6000 users, and so on.

After checking performance of the basic virtualized environment, we tested BlackBerry Enterprise Server in conjunction with additional VMware virtualized infrastructure features that can reduce the cost of IT management – specifically VMware vMotion, VMware Distributed Resource Scheduling (DRS), VMware HA and VMware Fault Tolerance (FT). Results for those tests are also included in following sections.
Baseline Virtualized Environment Performance

Baseline results for the reference VMware ESX 3.5 virtual environment configuration of BlackBerry Enterprise Server are summarized in the table below. The table lists resource utilization (measured by ESXtop) from two Exchange virtual machines, the BlackBerry Enterprise Server virtual machine, a SQL Server virtual machine, and the load driver virtual machines – both Load Gen (LG) and Perk.

Table 2. ESX 3.5 – 2000 Users

<table>
<thead>
<tr>
<th>Virtual Machine</th>
<th>CPU (%)</th>
<th>MEM (MB)</th>
<th>Pkts (RX/sec)</th>
<th>Pkts (TX/sec)</th>
<th>CMD/sec</th>
<th>DAVG/ms</th>
<th>GAVG/Ms</th>
<th>Total LG Tasks</th>
<th>LG Tasks/sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exch1</td>
<td>18</td>
<td>1724</td>
<td>814</td>
<td>674</td>
<td>399</td>
<td>15</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exch2</td>
<td>38</td>
<td>3665</td>
<td>766</td>
<td>665</td>
<td>1066</td>
<td>13</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perk</td>
<td>3</td>
<td>79</td>
<td>23</td>
<td>18</td>
<td>2</td>
<td>15</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BES1</td>
<td>27</td>
<td>808</td>
<td>1268</td>
<td>1090</td>
<td>13</td>
<td>6</td>
<td>6</td>
<td></td>
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</tr>
<tr>
<td>SQL</td>
<td>3</td>
<td>213</td>
<td>116</td>
<td>107</td>
<td>45</td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LG</td>
<td>6</td>
<td>432</td>
<td>358</td>
<td>342</td>
<td>1</td>
<td>10</td>
<td>10</td>
<td>134010</td>
<td>9.3</td>
</tr>
</tbody>
</table>

CMD/sec: The number of commands issued per second.
DAVG/cmd: The average device latency (milliseconds) per command.
GAVG/cmd: The average Guest OS latency (milliseconds) per command.

As shown in the CPU and MEM columns of the table, the BlackBerry Enterprise Server virtual machine utilizes 27% of the CPU resources, with two vCPUs in the virtual machine, and uses an average of 808 MB RAM. Other columns in the table provide data on network traffic, I/O rates (CMD/sec is the number of I/O operations done each second), the latency to disk observed from the device and guest levels (DAVG and GAVG), as well as metrics from the LoadGen driver tool.

The data presented in all test results represents average values. With any workload, the load level varies during the normal course of a business day. So system administrators should allow for spikes in resource utilization when determining how many virtual machines to run on an ESX Server host.
VMware ESX 3.5 versus VMware vSphere ESX 4.0

Adoption of VMware vSphere is happening quickly, so we wanted to understand the performance changes customers might expect when migrating from VMware ESX 3.5 to ESX 4.0. An illustration of performance differences is shown in the figure below, where we compare the CPU utilization of the BlackBerry Enterprise Server virtual machine while running each of the two ESX versions.

![BES Server CPU Utilization](image)

As shown in the figure, we observed about a 17% decrease in CPU utilization (from 27% to 23%) on the BlackBerry Enterprise Server host when moving from ESX 3.5 to 4.0. More detail on resource utilization for ESX 4.0 is provided in the following table.

<table>
<thead>
<tr>
<th>Virtual Machine</th>
<th>CPU (%)</th>
<th>MEM (MB)</th>
<th>Pkts (RX/sec)</th>
<th>Pkts (TX/sec)</th>
<th>CMD /sec</th>
<th>DAVG/ms</th>
<th>GAVG/Ms</th>
<th>Total LG Tasks</th>
<th>LG Tasks/sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exch1</td>
<td>18</td>
<td>1920</td>
<td>942</td>
<td>759</td>
<td>489</td>
<td>6</td>
<td>8</td>
<td>134010</td>
<td>9.3</td>
</tr>
<tr>
<td>Exch2</td>
<td>17</td>
<td>1778</td>
<td>766</td>
<td>662</td>
<td>459</td>
<td>6</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perk</td>
<td>2</td>
<td>84</td>
<td>18</td>
<td>16</td>
<td>2</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BES²</td>
<td>23</td>
<td>814</td>
<td>1392</td>
<td>1116</td>
<td>12</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SQL</td>
<td>2</td>
<td>15</td>
<td>49</td>
<td>46</td>
<td>16</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LG</td>
<td>5</td>
<td>393</td>
<td>300</td>
<td>296</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

² CMD/sec: The number of commands issued per second.
DAVG/cmd: The average device latency (milliseconds) per command.
GAVG/cmd: The average Guest OS latency (milliseconds) per command.
Hardware Choice and Performance Observations

VMware ESX can be run on a variety of hardware platforms; system and CPU functionality and performance is increasing substantially with every new processor release. To provide guidance on some of the CPU alternatives available today, we tested BlackBerry Enterprise Server using three different CPU configurations – Intel 54xx CPUs, Intel 55xx (Nehalem) CPUs, and Intel 55xx CPUs with Extended Page Tables (EPT) enabled. EPT is hardware assist technology, designed to help specifically with virtualized systems by reducing the overhead of memory management operations. VMware has worked closely with Intel to ensure this technology works optimally when used in conjunction with VMware ESX.

A comparison of CPU performance is shown in Figure 13 below. We observed a 38% reduction in CPU utilization when moving to Nehalem-based servers from servers using Intel 54XX series CPUs. When we enabled EPT on the Nehalem servers, we saw a further 25% reduction from the Nehalem baseline CPU utilization. So, in total, CPU utilization went from 27% average down to 13% utilization as we moved to Nehalem with EPT, a total improvement of over 50%.

![Figure 13. Nehalem CPU and EPT Performance](image)

More detail on these results is provided in the tables below. Baseline results for non-Nehalem-based systems are provided in the previous sections.

<table>
<thead>
<tr>
<th>Virtual Machine</th>
<th>CPU (%)</th>
<th>MEM (MB)</th>
<th>Pkts (RX/sec)</th>
<th>Pkts (TX/sec)</th>
<th>CMD /sec</th>
<th>DAVG /ms</th>
<th>GAVG /ms</th>
<th>Total LG Tasks</th>
<th>LG Tasks/sec</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exch1</td>
<td>32.25</td>
<td>3679</td>
<td>632</td>
<td>534</td>
<td>991</td>
<td>12</td>
<td>12</td>
<td>134010</td>
<td>9.3</td>
</tr>
<tr>
<td>Exch2</td>
<td>29.25</td>
<td>4060</td>
<td>597</td>
<td>505</td>
<td>1177</td>
<td>15</td>
<td>15</td>
<td></td>
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<tr>
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<td>84</td>
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<td>1</td>
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<td></td>
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<tr>
<td>SQL</td>
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<td>193</td>
<td>55</td>
<td>51</td>
<td>16</td>
<td>1</td>
<td>1</td>
<td></td>
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<tr>
<td>LG</td>
<td>4</td>
<td>830</td>
<td>287</td>
<td>193</td>
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Table 5. ESX 4.0 Nehalem – 2000 Users – EPT

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<tr>
<th>Virtual Machine</th>
<th>CPU (%)</th>
<th>MEM (MB)</th>
<th>Pkts RX/sec</th>
<th>Pkts TX/sec</th>
<th>CMD sec</th>
<th>DAVG ms</th>
<th>GAVG ms</th>
<th>Total LG Tasks</th>
<th>LG Tasks/sec</th>
</tr>
</thead>
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<td>3726</td>
<td>690</td>
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<td>16</td>
<td>134010</td>
<td>9.3</td>
</tr>
<tr>
<td>Exch2</td>
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<td>4253</td>
<td>538</td>
<td>465</td>
<td>1148</td>
<td>19</td>
<td>19</td>
<td>134010</td>
<td>9.3</td>
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<td>Perk</td>
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<td>71</td>
<td>15</td>
<td>14</td>
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<td>3</td>
<td>3</td>
<td>2</td>
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<td>1</td>
<td>2</td>
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</tr>
</tbody>
</table>

VMware vMotion with BlackBerry Enterprise Server

VMware vMotion enables the live migration of running virtual machines from one physical server to another with zero downtime, continuous service availability, and complete transaction integrity. This capability makes hardware maintenance possible at any time of the day and does not require clustering or redundant servers. There is generally a small impact to performance during the vMotion migration process. In our vMotion testing, we attempted to quantify that performance impact while running the Exchange and Perk load tests described in previous sections.

Overall, we observed only a very small change in BlackBerry Enterprise Server performance during vMotion migration. We expected CPU utilization to increase on both the existing and new virtual machines, as the memory image of the initial virtual machine is copied on the new virtual machine. As the memory images of the virtual machines converge, control is passed to the virtual machine on the new host. The graph in Figure 14 shows the CPU utilization of the existing virtual machine, and then the CPU utilization of the new virtual machine after the vMotion migration has taken place.

Figure 14. Virtual Machine Migration with vMotion

From the graph, we can see that the time most impacted is roughly one minute after the vMotion migration starts and we observed transaction rate changes that were approximately 10%. So, in summary, customer may expect that vMotion migration of a high loaded system is likely to see about a 10% impact on throughput for roughly one minute; vMotion migration of a lighter-loaded system are likely to be substantially less.
Note that one of the primary “users” of vMotion is the VMware capacity management solution – VMware Distributed Resource Scheduler (DRS). VMware DRS uses vMotion to balance load across a cluster of ESX hosts and can automatically manage any load imbalance in a complex mix of workload components. Given the small impact of vMotion operation with BlackBerry Enterprise Server as validated by the test results, customers may also safely enable VMware DRS in production environments.

**VMware HA with Blackberry Enterprise Server**

VMware provides a high availability solution (VMware HA) that is nearly free to implement, and which provides reasonable recovery time for a virtual machine-based workload. VMware HA automates the monitoring of physical server availability, detects server failures and initiates virtual machine restarts without any human intervention. VMware HA also performs resource checks to ensure that capacity is always available to restart all virtual machines affected by server failure. VMware HA continuously monitors capacity utilization and “reserves” spare capacity to maintain the ability to restart virtual machines.

![VMware HA Restart of Virtual Machines after Server Failure](image)

In our testing, we wanted to determine the expected downtime for a system that encounters a catastrophic server failure with VMware HA enabled. Specifically, if an ESX server fails, the virtual machines on that server will be rebooted on another ESX host in the cluster.

Our VMware HA test was triggered by simulating the crash of one of the ESX hosts that is running a Blackberry Enterprise Server virtual machine. When the host went down, the Blackberry Enterprise Server virtual machine was migrated and restarted on the other host. All the Blackberry services were restarted automatically. For some time after migration, CPU utilization on the virtual machine was high, as there was a huge of queue of messages to be processed. Once the queue was cleared, CPU utilization went back to normal levels.
The graphic in Figure 16 shows that the BlackBerry Enterprise Server virtual machine was up and running again within a few minutes of the simulated server failure. Note that VMware HA does not provide zero downtime during such failures. However, given the small cost of implementing this HA technology, it provides a low cost alternative to other expensive technologies if some downtime is acceptable in handling such failures.

**VMware FT with BlackBerry Enterprise Server**

VMware Fault Tolerance (FT) is a new technology introduced in VMware vSphere that enables zero downtime in the case of catastrophic server failure. VMware FT utilizes an additional virtual machine, which runs in lock step with the protected virtual machine and, if there is a failure in the first virtual machine, control is automatically passed to the backup virtual machine. In the vSphere 4 release of VMware FT, protected virtual machines are limited to one vCPU.

To test VMware FT, we simulated a server crash with VMware ESX and a VMware FT-protected virtual machine running BlackBerry Enterprise Server. From this test, we observed a successful failover to the backup virtual machine with no downtime and no lost transactions. Given the relatively light load observed running 2000 users on this system, a VMware FT-protected virtual machine running on 1 vCPU would be a viable alternative to the 2-vCPU virtual machines used elsewhere in our testing.
Deployment Best Practices

RIM and VMware work closely together to determine how IT data centers can best meet enterprise service requirements when deploying BlackBerry Enterprise Server in VMware virtualized environments. Results from the performance testing we described earlier in this paper shows that running RIM BlackBerry Enterprise Server inside VMware virtual machines can provide an effective production-ready platform.

The performance metrics (throughput per virtual machine and average virtual machine CPU utilization) we presented in test results can help IT organizations size and design virtualized environments to meet their SLA targets. The number of actual users and transactions that can be supported in production environments will, of course, depend on the specific applications used and the level of user activity. Our performance testing shows that a consolidation approach running multiple BlackBerry Enterprise Server virtual machines can scale to meet IT organization’s capacity needs. With added benefits such management and administrative flexibility, strong isolation and higher availability, VMware virtual infrastructure can serve as an ideal platform for BlackBerry Enterprise Server consolidation. Specific recommendations include:

- Carefully design storage configurations, particularly of Exchange components; carefully evaluate external storage choices, RAID levels, and latency of I/O operations.
- High spindle count on LUNs to ensure I/O capacity available.
- Use VMware vMotion with VMware DRS to balance load.
- Use multiple storage groups for Exchange server.
- Consider Nehalem with EPT for maximum performance.
- Scale out versus scale up; determine what components of the architecture work well with more than one virtual machine, and how large each virtual machine should be.
- Provisioning: determine how templates and cloning of virtual machines can be used to reduce deployment time of the application.
- Adding capacity: determine how you could extend the configuration tested by adding more virtual machines or increasing the size of virtual machines to allow a higher user count or larger batch jobs to be run.
- Availability: plan use of VMware HA and VMware FT as well as other availability solutions (such as other clustering technologies). Consider use of other disaster recovery options such as VMware’s Site Recovery Manager (SRM).
Deployment Examples

This section provides an overview how one typically deploys Blackberry Enterprise Servers on vSphere in different scenarios, for example, small-and medium-sized businesses versus Enterprise environments.

Small Business (Less Than 250 Users) – MSDE DB

Small businesses that decide to implement Blackberry Enterprise Server on vSphere, or even large businesses with less than 250 Blackberry users, might choose to deploy the configuration shown in Figure 17 below. As the diagram shows, the Blackberry Enterprise Server application server runs on a virtual machine with one vCPU and 2 GB of RAM. For architectures with less than 250 users, an MSDE instance on the Blackberry Enterprise Server application server is sufficient for the Blackberry Enterprise Server configuration database (note that the database and transaction logs are on RDM disks). Figure 17 also shows how Blackberry Enterprise Server can be housed on a 2-node vSphere cluster along with other messaging and infrastructure services like Exchange and Active Directory.

Solution characteristics:

- 250 or fewer Blackberry/Exchange users
- Local Availability: vMotion, VMware DRS, VMware HA
- MSDE database
Small Business (1000 users) – Dedicated SQL DB

Businesses with 250 – 1,000 Blackberry users should deploy the configuration database as a separate SQL Server virtual machine to avoid resource contention with the Blackberry Enterprise Server application server. As Figure 18 below shows, both the Blackberry Enterprise Server application server and the Blackberry Enterprise Server configuration database run in virtual machines with two vCPU and 3GB of RAM. (Note that the database and transaction logs are on RDM disks.) The diagram in Figure 18 also shows how Blackberry Enterprise Server can be housed on a 4-node vSphere cluster along with other messaging and infrastructure services like Exchange and Active Directory. When planning the hardware to support your messaging environment, be sure to take into account any additional resource requirements like FT replicas or passive MSCS cluster nodes.

![Figure 18. Small Business Deployment Solution – Dedicated SQL DB](image)

Solution characteristics:
- 1,000 users
- Dedicated SQL Database
- Local Availability: vMotion, VMware DRS, VMware HA, VMware FT
- 1-host failover capability

Enterprise (5,000 users) – Multi-site/Shared DB

Businesses with 1,000 – 5,000 Blackberry users will often need to provide Blackberry Enterprise Server services to multiple sites (for example, a home office with a large datacenter plus one or more branch offices with small server footprints). As shown in Figure 19 below, we assume that the majority of Blackberry users are served from a home office, with a few being served from a satellite office that also houses some Exchange and Active Directory services.

The Blackberry Enterprise Server application virtual machines for both the home office and the branch office are configured with two vCPU and 3-4 GB of RAM; there are simply more of them in the home office site. With 5,000 or fewer users, we can get away with one Blackberry Enterprise Server configuration database, which is housed in the home office datacenter on a SQL Server virtual machine with two vCPU and 4 GB of RAM.
In addition, in the home office datacenter, we will need to deploy a Blackberry Enterprise Server Attachment virtual machine with two vCPU and 4GB RAM and a Blackberry Enterprise Server Admin virtual machine with two vCPU and 4 GB RAM. In resource planning for both the home office and the branch office, consider availability requirements like CCR clustering or VMware FT. Remember, passive cluster nodes and shadow virtual machines require resources!

Figure 19. 5000-User Enterprise Deployment Solution

Solution characteristics:
- 5,000 users, multi-site
- BAS (Blackberry Administration Service) and desktop manager
- Local Availability: vMotion, VMware DRS, VMware HA, VMware FT, CCR
- Dedicated SQL Database shared across sites
- 1-host failover capability
Enterprise (16,000 users) – Multi-site/Distributed DB

Businesses with 5,000 to 16,000 Blackberry users may need to run multiple configuration databases to support multiple large sites. As shown in Figure 20, we assume that a little more than half of the Blackberry users are served from the home office, with a large minority being served from a satellite office that also houses some Exchange and Active Directory services. The Blackberry Enterprise Server application virtual machines for both the home office and the branch office are configured with two vCPU and 4 GB of RAM; again, there are simply more of them in the home office site.

With 16,000 users, we will deploy two Blackberry Enterprise Server configuration databases, one housed in the home office datacenter and the other in the branch office datacenter. Both Blackberry Enterprise Server database servers are deployed on a SQL Server virtual machine with two vCPU and 4 GB of RAM. In addition, in each datacenter, we will need to deploy a Blackberry Enterprise Server Attachment virtual machine with two vCPU and 4GB RAM. In the home office, we will need a Blackberry Enterprise Server Admin virtual machine with two vCPU and 4 GB RAM. In resource planning for both the home office and the branch office, consider availability requirements like CCR clustering or VMware FT. Remember, passive cluster nodes and shadow virtual machines require resources!

Figure 20. 16,000-User Enterprise Deployment Solution
Solution characteristics:

- 16,000 users; multi-site
- BAS (Blackberry Administration Service) and desktop manager
- Local Availability: vMotion, VMware DRS, VMware HA, VMware FT, CCR
- Distributed SQL Database
- 1-host failover capability

Conclusions

RIM and VMware work together to validate how IT data centers can meet the enterprise SLAs by deploying BlackBerry Enterprise Server in VI3 virtualized environment. The performance study we describe in this paper proves that running RIM BlackBerry Enterprise Server inside VMware virtual machines can provide an effective production-ready platform.

The performance metrics (throughput per virtual machine and average virtual machine CPU utilization) we present in this white paper can help IT organizations size and design virtualized environments to meet their SLA targets. The number of actual users and transactions that can be supported in production environments will, of course, depend on the specific applications used and the intensity of user activity. Our performance testing shows that a consolidation approach running multiple BlackBerry Enterprise Server virtual machines can scale to meet IT organization’s capacity needs. With added benefits such management and administrative flexibility, strong isolation and higher availability, VMware virtual infrastructure can serve as an ideal platform for BlackBerry Enterprise Server consolidation.

Resources

Customers can find more information about VMware and Blackberry Enterprise Server products via the links listed below:

- VMware official web site:
  http://www.vmware.com/
- RIM web site:
  http://www.RIM.com/
- VMware Infrastructure 3 and vSphere 4 product web site:
## Appendix A. BlackBerry Enterprise Server Version Support on VMware Virtual Infrastructure

The following versions of BlackBerry Enterprise Server are supported on the VMware platform.

<table>
<thead>
<tr>
<th>BlackBerry Enterprise Server Version</th>
<th>Supported VMware ESX Server Versions</th>
</tr>
</thead>
<tbody>
<tr>
<td>BES 4.1 SP6 (4.1.6)</td>
<td>2.5.2, 3.0.0, 3.0.1, 3.0.2, 3.5, and 4.0</td>
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<tr>
<td>BES 4.1 SP5 (4.1.5)</td>
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<tr>
<td>BES 4.1 SP2 (4.1.2)</td>
<td>2.5.2, 3.0.0, and 3.0.1</td>
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