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Achieve more with less:

Helping to reduce total cost of ownership with IBM DB2 and VMware software

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Information Management software

Audience

This paper is intended for the following audience:

C-Level IT Managers who are interested in information about how they can reduce their overall total cost of ownership (TCO).

IT Managers and System Administrators who need to understand what combination of products can be used for database server consolidation tasks.

1. Executive Summary

Faced with the challenge of reduced IT budgets and an increased need for new information systems to help improve operational efficiency and competitiveness, IT administrators adopt virtualization technologies to optimize their IT infrastructure. IBM® DB2® for Linux®, UNIX®, and Windows® database software ("DB2 database software") together with VMware® virtualization technologies may help companies reduce the total cost of ownership (TCO) and increase business responsiveness through server consolidation and software licensing options that allow customers to pay for only what they use. This paper details the potential cost-saving advantages of running DB2 software on a VMware virtualized environment on x86 platforms.

2. Introduction

Because of the constantly changing economic climate, companies across all industry sectors have to be innovative in reducing costs and increasing their profitability to remain competitive. To achieve this goal, many companies have decreased their IT budgets in order to lower operating costs.

Even as budget cutbacks are introduced, the amount of data that must be managed continues to grow exponentially. Data collected from various sources including Enterprise Resource Management (ERP) and Customer Relationship Management (CRM) systems is essential for the day-to-day operations of a business. Therefore, administrators are not only required to maintain the same level of IT service delivery with fewer resources, but are also challenged by the ever-growing amount of data.

In order to deliver more with less, IT administrators have turned to a technology that has been around for many years. Virtualization technologies were first developed by IBM for its mainframe systems, and similar technologies have been developed across many different computer architectures over the years. It is the global economics and the innovation of software and hardware virtualization technologies on the x86 platforms that have helped bring this topic to the forefront in the past few years.

In this paper, we will examine how the use of VMware virtualization technologies, available on x86 platforms, along with IBM DB2 data server can help companies bring about lower hardware costs and utilize their current infrastructure more efficiently. This mixture of pioneer technologies offers one of the most significant opportunities to lower IT costs.

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3.   Increasing Machine Utilization in Data Centers

As with many other business operations, the DB2 development laboratory relies on its data center to conduct day-to-day business activities including the development of DB2 database software. In order to provide reliable software to customers, the development team invests in a large amount of capital and other resources to maintain development and testing environments. The team did not need to use many of these environments all the time, but had to maintain them in order to avoid duplicating the time and effort required to set them up during times when they were needed. Thus many of these systems in the data center were under-utilized with low CPU usage or even sat completely idle for days at a time.

The IT administrators for the DB2 development laboratory turned to VMware virtualization technologies to consolidate many of these x86 development and testing machines. When the server consolidation effort was completed, a consolidation ratio between 4:1 and 9:1 was observed, depending on the workloads running on the physical machines. This means the workloads that used to be run on four to nine physical machines now run on virtual machines inside only one physical server. This in turn reduced the power and cooling requirements in the data center, and also alleviated the need to purchase new equipment in great quantities.

To learn more about the work accomplished in this project, please read the "*IBM Software uses VMware Virtualization for DB2 Development*" success story published at
http://www.vmware.com/files/pdf/customers/08Q3_isv_vmw_ibm_DB2_english_r1_proof.pdf.

Depending on the workloads considered in the physical to virtual (P2V) server consolidation, the server consolidation ratio accomplished by using VMware software on x86 platforms will vary. A consolidation of 4x to 20x is observed in most scenarios, and survey respondents reported an average hardware cost savings of more than 50 percent[1].

VMware Capacity Planner™ is a tool used to gather inventory and utilization information that drives the server consolidation recommendations used to plan the virtual infrastructure (see Figure 1). It collects data through sniffing network traffic for CPU, disk, I/O, and RAM information. Data is then analyzed and compared to reference data, collected across the industry. This unique capability helps in guiding decisions around server consolidation and capacity optimization. Among other data points, Capacity Planner tends to show utilization rates of less than 6 percent CPU on average across the surveyed implementations[2]. Most of the capital

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[1] Source June 2009: Comprehensive survey of VMware customers
[2] Source June 2009: Comprehensive survey of VMware customers

budget spent on purchasing these systems is not seeing a return on investment as expensive physical machines might be sitting underutilized. In addition to idle hardware, lack of sub-capacity software licensing[3] can further limit how companies meet the goal of "doing more with less." This issue will be discussed in more detail in the next few sections.
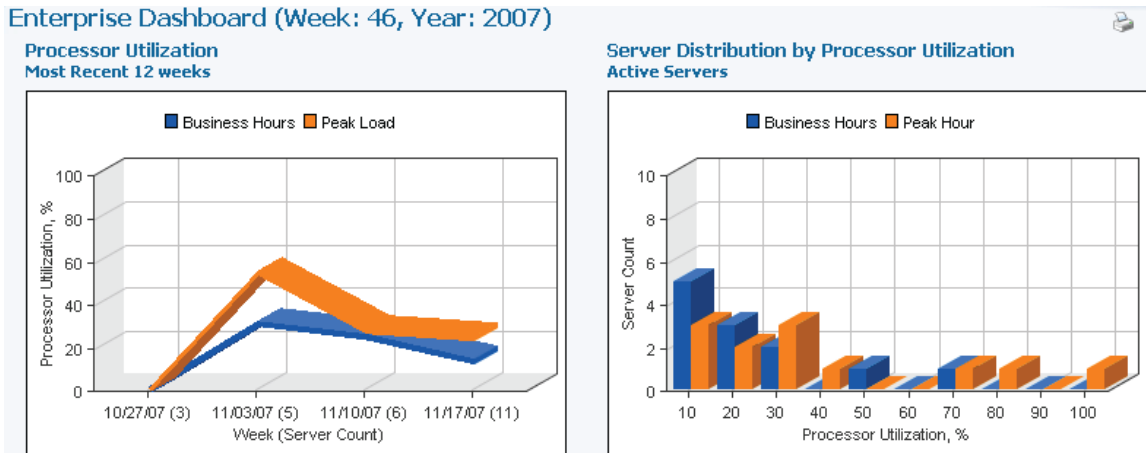

Figure 1. *VMware Capacity Planner dashboard*

4. Helping to Reduce Hardware and Operation Cost with VMware vSphere™ on the x86 Platform

The success story from the DB2 development laboratory, mentioned previously, is not an isolated example. A major benefit derived from virtualization is the potentially large cost savings achieved through server consolidation. These potential cost savings may be realized from the areas discussed below:

1) Capital costs

Traditionally, each x86 server is deployed to serve a single purpose. For example, it will run one operating system (OS) and operate as either an application or a database server. Many of these machines are not fully utilized at all times, and thus their computing power is not efficiently used. By employing VMware virtualization technologies, such as VMware vSphere, we can convert each of these servers into a virtual machine. The OS and function of these servers are encapsulated in individual virtualized environments but the functionality inside remains unchanged.

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[3] Sub-capacity licensing lets you license a PVU-based software program for less than the full processor core capacity of the server, when the software program is deployed in an eligible virtualization environment. With full capacity licensing, customers are required to obtain PVU license entitlements for all activated processor cores in the server, regardless of how the software was deployed.

This strategy allows a single physical server to run multiple virtual machines at once and create a complete operational infrastructure, avoiding idle resources and reducing the existing physical infrastructure footprint. Consolidation can increase the utilization of each physical x86 server, allowing the use of fewer machines to satisfy the operational needs of the company. By using existing hardware and optimizing its usage, we can help relieve the pressure to purchase new hardware for deploying new applications, and thus help reduce the overall capital expenditure of the IT department.

VMware vSphere eliminates "server sprawl" by running applications inside virtual machines on fewer servers and with more efficient use of storage and network resources. Organizations using VMware vSphere can achieve high consolidation ratios per x86 server through its unique dynamic optimization and memory management capabilities. VMware vSphere reduces the complexity of hardware management through comprehensive virtualization of server, storage, and networking hardware. VMware vSphere customers have said they slashed capital expenses per application on average by at least 50 percent, and operating (labor) costs by over 60 percent[4].

2)   IT operating costs

Because of server consolidation, a lower number of physical servers may translate to other cost reductions as well. Each server within a data center requires resources to operate; electrical power, physical space, and energy for cooling are ongoing costs incurred for the lifetime of these servers. By reducing the number of machines necessary to handle business workloads, all of these resource requirements can be decreased substantially, with probable savings on IT operational costs. VMware Distributed Power Management (DPM), included with VMware Distributed Resource Scheduler (DRS), can automate energy efficiency in VMware DRS clusters by continuously optimizing server power consumption within each cluster.

Through virtualizing with VMware software, companies have typically reduced their IT operational costs by more than 25%[5]. Additionally, customers can also benefit from being able to delay data center expansion as a result of virtualization, and can thus increase their total savings and cut their data center energy costs by 80%[6].

3)   Time and resources

Furthermore, VMware provides the technology and products to help increase the manageability of the data center after virtualization has been implemented. This technology allows customers to manage Service Level Agreements (SLAs) instead of managing single components, and to automate various mundane tasks. Using VMware technologies, customers can realize the benefits of "tune once and deploy anywhere." Robust and predictable test and production environments can be

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[4] Source June 2009: Comprehensive survey of VMware customers
[5] Source June 2009: Comprehensive survey of VMware customers
[6] Source June 2009: Comprehensive survey of VMware customers

cloned and deployed within hours instead of weeks, improving the overall agility of the IT organization.

Virtualization can significantly increase the productivity of IT administrators, freeing up time and human resources for other high-priority activities. VMware customers report an average of 33% reduction[7] in time spent on routine administration tasks. The time saved can be invested in new and existing innovative projects that can bring business optimization and transformation to help a company build competitive advantage over its competitors.

Figure 2 below sums up the energy savings that are achievable through server consolidation across the different fields within a company.
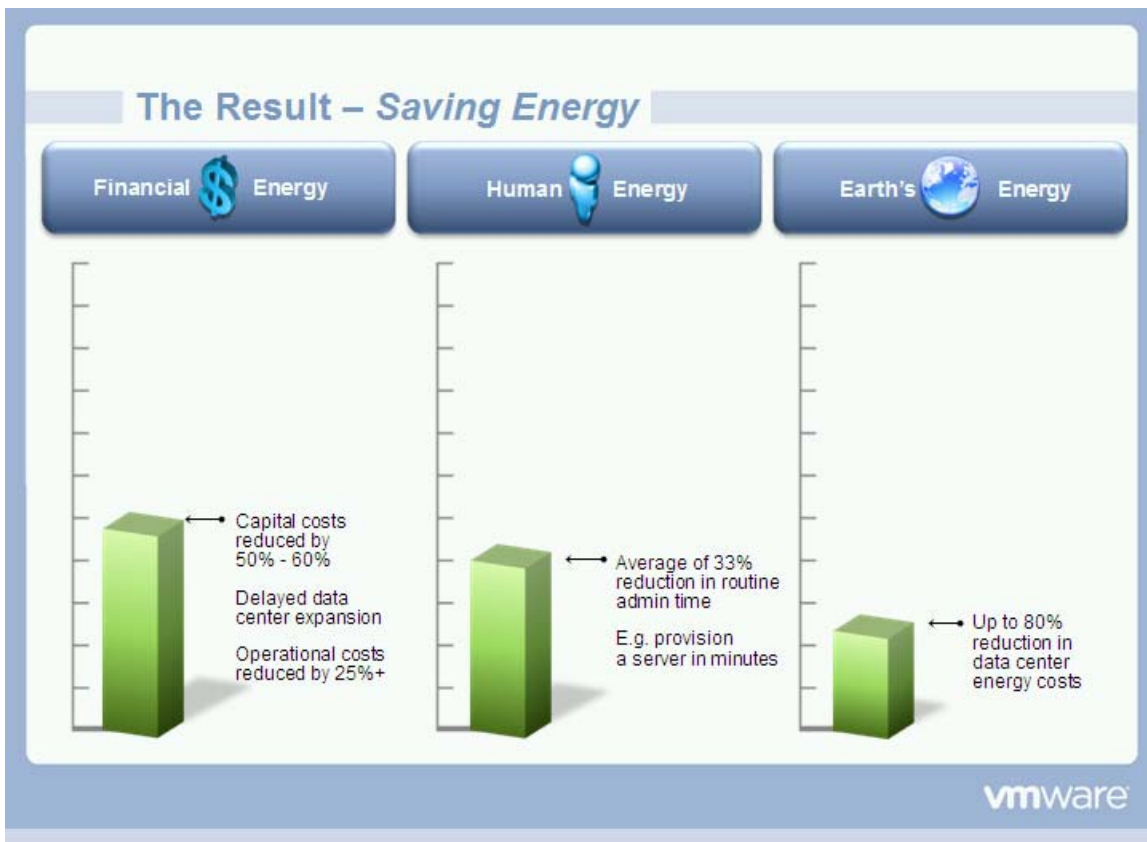
Figure 2. *Saving Energy - Finance, Personnel, Earth*

For more information about various studies conducted, visit http://www.vmware.com/solutions/cost-savings/ and http://download3.vmware.com/vi3/VMware-Virtualization-The-Right-Investment.ppt

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[7] Source June 2009: Comprehensive survey of VMware customers

5. Sub-Capacity Software Licensing in DB2 Software May Help Provide Additional Savings

Over 140,000 customers[8] have turned to VMware for their x86 virtualization needs. However, database software customers who want to employ VMware virtualization technologies to reduce cost are sometimes faced with database software licensing limitations that take away some of the cost-saving advantages that virtualization provides. The limitations are mainly introduced when sub-capacity pricing is not offered to customers implementing database software on VMware platforms. For example, Oracle® database software does not offer a sub-capacity licensing model when deployed in a VMware environment[9].

Sub-capacity pricing allows customers to pay only for the capacity that is being used on a server. In a virtualized environment, capacity is usually defined by the sum of all the CPU cores being allocated to virtual machines running on a physical server, up to the total server capacity. To illustrate the concept, consider the following example.

Figure 3 shows an environment where a physical server has four operational cores. Two virtual machines with DB2 database software are installed on the server, and each virtual machine has a single core allocated to it. In this case, the capacity used by the virtual machines is lower than the full (physical) capacity of the server. The customer only needs to license two cores because DB2 software will only use two.
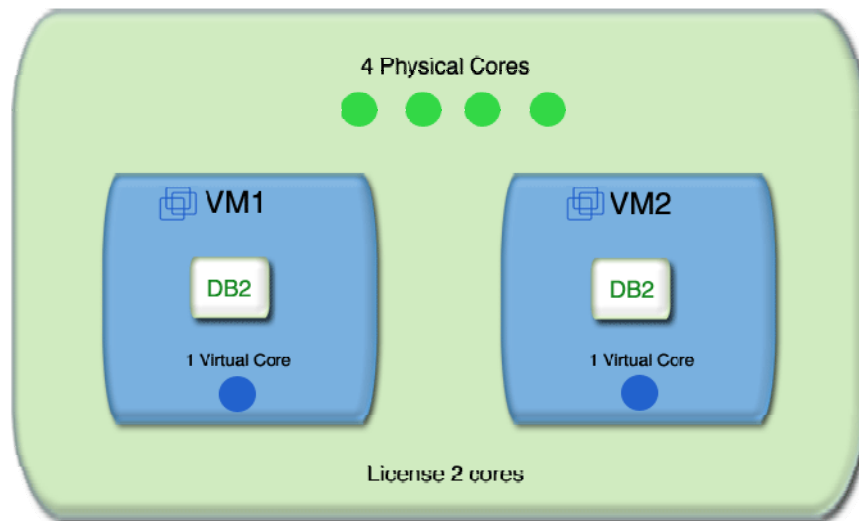
Figure 3. *DB2 software sub-capacity licensing in a virtualized environment: Capacity used by virtual machines is lower than physical capacity*

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[8] Including 100% of the Fortune 100 companies; 100% of Fortune Global 100 companies; 96% of Fortune 1000 companies, and 95% of Fortune Global 500 companies.

[9] http://www.oracle.com/corporate/pricing/partitioning.pdf

Figure 4, on the other hand, depicts an environment where the physical server is the same but runs five virtual machines, each with a single core and DB2 database software installed. In this situation, the customer needs to license only four cores since this is the full capacity of the physical server.
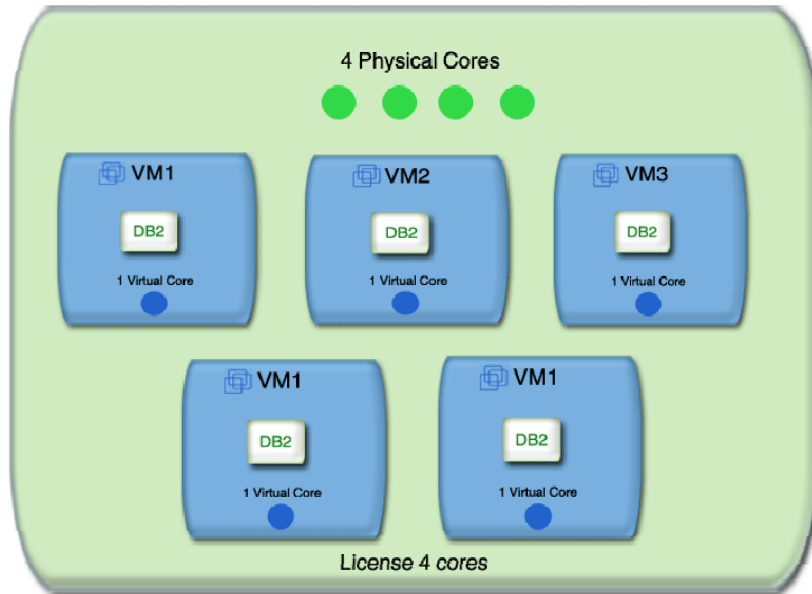

Figure 4. *DB2 software sub-capacity licensing in a virtualized environment: Capacity used by virtual machines higher than physical capacity*

When sub-capacity pricing is not offered, as is the case for Oracle database software, customers must license software based on the maximum number of cores in the server regardless of whether all of the cores are being used for the database. This represents a significant increase in the software license cost of running a database with no sub-capacity licensing option on a server over running DB2 database on the same size server.
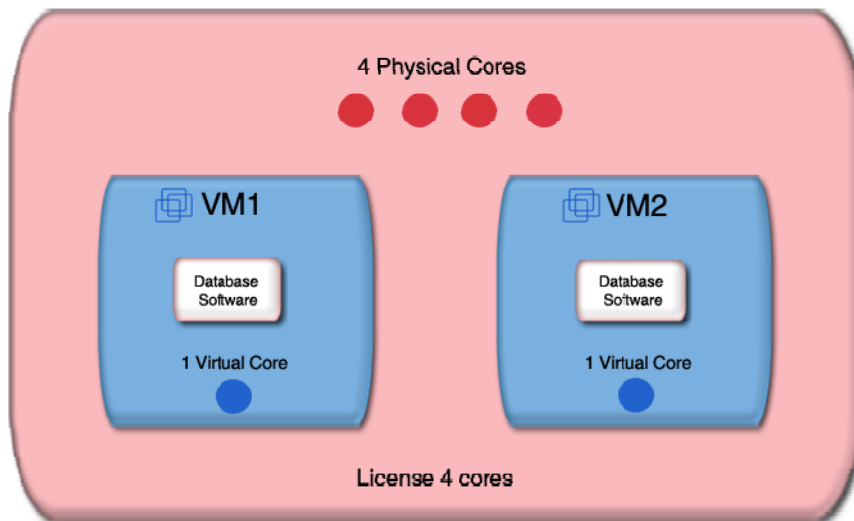
Figure 5. *Database software: no sub-capacity licensing available*

Figure 5 illustrates this situation by building on the previous examples. In this scenario, there are still four physical cores in the server. Only two cores are being used to run a non-DB2 database in two virtual machines, each with one core. However, the customer must still license all four physical cores. Because of the lack of sub-capacity pricing for the database software running on a VMware platform, customers are not able to realize one of the biggest advantages of virtualization, and, as a result, must pay 100 percent for software licenses that are not even being utilized.

VMware VMotion™ eliminates the need to schedule application downtime due to scheduled server maintenance through live migration of virtual machines across servers, with no disruption to users or loss of service. VMware Distributed Resource Scheduler (DRS), based on VMotion technology, aggregates computer resources across many clusters and dynamically allocates them to virtual machines based on business priorities, reducing management complexity through automation.

Some customers choose to use VMware VMotion and other VMware features such as DRS to allow for live migration of virtual machines from one physical host to another to meet availability and performance SLAs. Customers who are using database software that does not offer sub-capacity licensing, must license the database software for all cores in all physical machines that are part of the VMware virtualization cluster.

Figure 6 shows four physical servers used together in a virtualization cluster. Each physical server has four cores. A single virtual machine allocated a single core runs on this cluster, installed with a database software that does not offer sub-capacity licensing. Because of the lack of sub-capacity licensing, the customer must license all 16 physical cores that might at some time be used by the virtual machine running the non-DB2 database -- a 16x increase in software license costs.
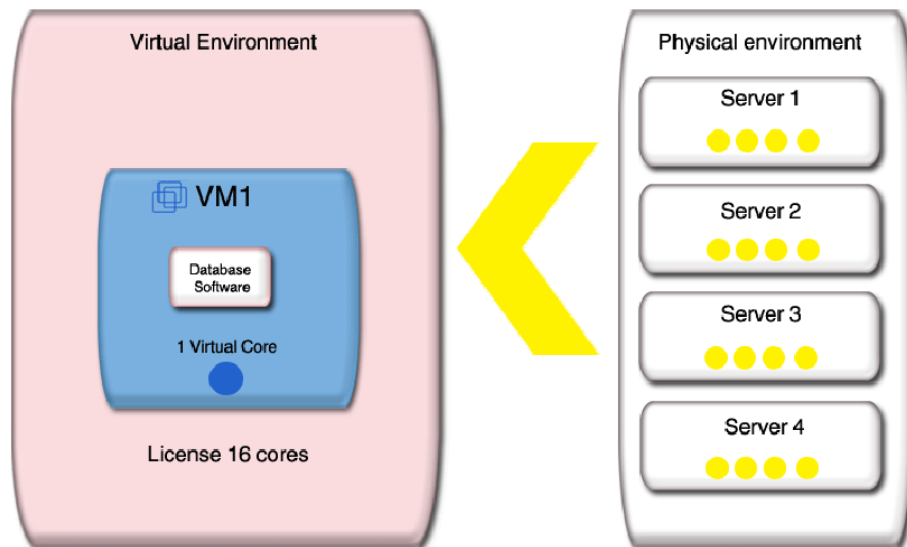

Figure 6. *Clustered environment: no sub-capacity licensing*

While some database software vendors do not offer sub-capacity pricing on VMware platforms, IBM DB2 for Linux, UNIX, and Windows database software has taken the opposite route. Sub-capacity licensing for virtualization is available for all

editions of DB2 database software on all virtualization platforms, allowing customers to fully realize the TCO advantage gained through virtualization.

Furthermore, when VMotion or other VMware virtualization features are used to perform migration of virtual machines from one physical host to another, it does not change the licensing for DB2 software. Sub-capacity software licensing for DB2 database software is simple: you only need licenses for what you are using.

Figure 7 illustrates the difference in licensing when DB2 database is used instead of other database software. Even though the physical clustered environment has 16 cores available, the virtual machine with DB2 database server installed uses only one of those 16 cores, so customers only need a DB2 license for a single core.
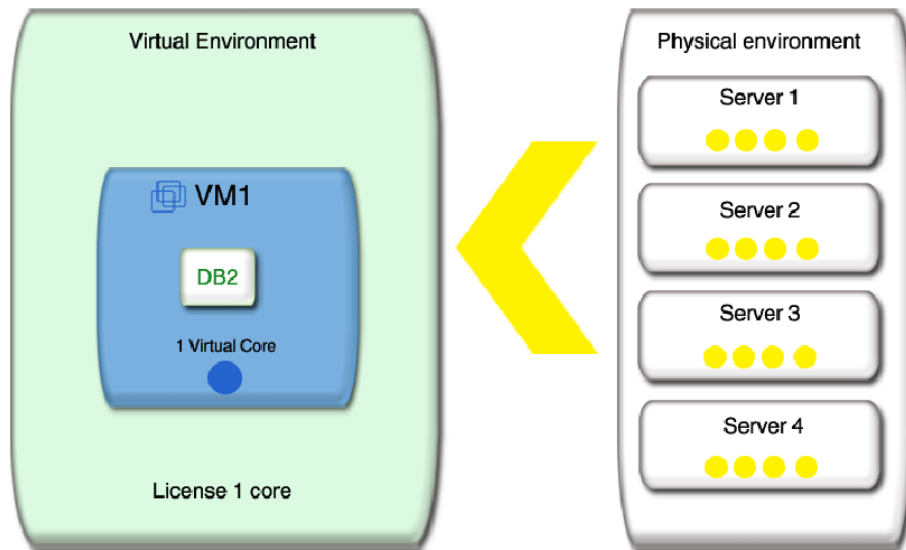
Figure 7. *Clustered environment: DB2 software sub-licensing*

6.   Introducing SQL Compatibility in DB2 9.7 for Linux, UNIX, and Windows Software

The use of the DB2 database software as a database platform can help customers maintain the TCO advantages gained through the use of virtualization. However, many customers may hesitate to migrate their database systems from other database vendors to DB2 database software. This hesitation can be due to a number of factors, but mostly to concerns that migration may require a large amount of resources and up-front investment. With the DB2 9.7 release, and its numerous enhancements in compatibility for applications originally written for Oracle database, IBM has dramatically reduced the cost and risk of moving from Oracle database to DB2 software.

6.1 Application and Administration Enhancements

The DB2 9.7 release introduces many application and administration enhancements to enable users with Oracle database knowledge to work with DB2 database software and complete migration tasks as seamlessly as possible. Some of these enhancements are described below.

1) CLPPlus

The CLPPlus processor is a new, easy-to-use, interactive command line processor for SQL statements and database commands. The processor provides support for dynamically creating, editing, and running SQL statements and scripts.

A set of commands is supported for connecting to databases, manipulating a statement or script defined in a buffer, modifying lines in the buffer, formatting result sets, and performing other related administrative tasks.

2) Compatibility of presentation between DB2 catalog information and Oracle data dictionary views

Views that present DB2 catalog information in a way that is compatible to Oracle data dictionary views are available in the DB2 9.7 release.

The compatible views are based on information found in the DB2 system catalog and snapshot monitor SQL administrative views. Applications that use information found in the Oracle data dictionary can now utilize these views to get the same information, reducing the need for application change.

3) Availability of DB2 system-defined modules compatible with a number of Oracle built-in packages

New system-defined modules provide an easy-to-use programmatic interface for performing a variety of application development tasks. A large number of new, pre-written, system-defined functions and modules are included in the DB2 9.7 release.

6.2 New SQL Constructs and Semantics

The DB2 9.7 release also introduces a number of new SQL constructs and semantics that work with applications written for Oracle databases. These include:

1) PL/SQL code compilation and execution in the DB2 9.7 release

DB2 9.7 software can compile and execute the most commonly-used PL/SQL code natively. Existing PL/SQL scripts, package definitions, or individual PL/SQL and SQL

statements that work with Oracle databases can now be run against DB2 9.7 software with little or no modification. In the DB2 9.7 release, you can run PL/SQL code from a DB2 command window or from the DB2 Command Line Processor.

PL/SQL anonymous blocks, as well as references to commonly used package routines and views, can also be compiled and executed.

2) Support for NUMBER, VARCHAR2, and DATE with time component data types

The DB2 9.7 release supports NUMBER and VARCHAR2 data types. The DATE data type (normally composed of year, month, day) is also automatically interpreted as a TIMESTAMP(0) data type (composed of year, month, day, hour, minute, second). DATE data type can be stored inside DB2 software and used in applications. This support includes functions for casting data types and performing data type arithmetic on the DATE data type.

3) Allowance for implicit casting and weak typing within application code

DB2 9.7 software allows for implicit casting, also known as weak typing, which reduces the amount of SQL that needs to be modified when migrating applications that currently run on Oracle database to DB2 9.7 software.

4) Concurrency model with currently committed semantics that behaves similar to Oracle database

The *cursor stability (CS)* isolation level locks any row being accessed during a transaction while the cursor is positioned on that row. This lock remains in effect until the next row is fetched or the transaction terminates. However, if any data in the row was changed, the lock is held until the change is committed. Under this isolation level, no other application can update or delete a row while an updatable cursor is positioned on that row, and access by other applications to the uncommitted data is not possible. However, non-repeatable reads and phantom reads are possible.

Under the *currently committed (CC)* semantics introduced in the DB2 9.7 release, only committed data is returned, as was the case previously, but now readers do not need to wait for writers to release row locks. Instead, the software returns data that is based on the currently committed version, that is, data prior to the start of the write operation. This allows for increased currency and helps reduce the need to rewrite application logic in applications originally written for Oracle database.

All the new compatibility features available in the DB2 9.7 release can be controlled by using specific settings of the DB2_COMPATIBILITY_VECTOR registry variable, which only takes one simple command to enable.

6.3 Enablement Tools

In addition to the above examples of compatibility features, IBM has also provided the necessary tools to assess and complete an enablement activity from an Oracle database to a DB2 database:

IBM Data Movement Tool

Beginning with the DB2 9.7 for Linux, UNIX, and Windows release, the Migration Toolkit (MTK) is no longer required for migrating applications from Oracle database to DB2 software. The MTK is being replaced by the IBM Data Movement Tool, including functionality with a greatly simplified workflow.

For installation, configuration, and usage information about the IBM Data Movement Tool, see the IBM developerWorks® article found at http://www.ibm.com/developerworks/data/library/techarticle/dm-0906datamovement/.

IBM Business Partners and Customers who are interested in learning more about how to migrate their applications from an Oracle database to a DB2 database, can contact their IBM local representative or send an e-mail to askdata@ca.ibm.com.

New features and enhancements found in the DB2 9.7 release allow customers to quickly enable their application to work with both DB2 and Oracle databases. Also, application developers and database administrators can apply their existing Oracle database skills when using DB2 9.7 software. This will allow for relatively simple enablement projects to be completed at the same time as the physical x86 platform server consolidation effort, so you can take advantage of the TCO savings provided by VMware virtualization technologies with DB2 database system.

For more information about enabling your application to work with DB2 database software, see the *SQL Compatibility* section in the DB2 9.7 Information Center: http://publib.boulder.ibm.com/infocenter/db2luw/v9r7/topic/com.ibm.db2.luw.wn.doc/doc/c0054107.html), or send an e-mail to askdata@ca.ibm.com

7. Conclusion

VMware virtualization technologies can help provide a large TCO reduction for x86 platforms through server consolidation of various workloads. However, the lack of a sub-capacity pricing model for certain competing database vendors such as Oracle who license on VMware platforms prevents those vendors' customers from realizing the cost savings possible through virtualization. With the new SQL compatibility features found in the DB2 9.7 release, customers who undertake server consolidation to improve hardware utilization can also easily enable their database

systems to use DB2 software at the same time and help reduce software license cost by using the sub-capacity pricing model for IBM DB2 software customers.

The combination of DB2 for Linux, UNIX, and Windows database software running in a VMware virtual environment may bring substantial cost savings compared to other database implementations on physical systems. By investing in DB2 database software and VMware virtualization technologies, customers may enjoy an accelerated return on investment with potentially reduced total cost of ownership, while gaining a robust, flexible, and efficient IT infrastructure.

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