WHITE PAPER

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SQL Server License Reduction with PernixData FVP Software

Beyond Database Acceleration

Poor storage performance continues to be the largest pain point with enterprise Database Administrators (DBAs) in today's virtual world. However, it is not the only challenge to the enterprise. The cost of the infrastructure pales in comparison to the licensing costs of the database platform. These challenges impact not only the DBA, but also the financial side of the business. The business is constantly seeking ways to reduce the financial strain of the IT infrastructure, looking for ways to cut operational costs any way possible.

Decoupling storage acceleration from the storage layer can improve performance, and also introduces some benefits not immediately obvious to the technologists in the organization.

What if the business could improve performance and reduce licensing costs at the same time?

This paper discusses SQL Server licensing reduction when leveraging PernixData FVP® software to improve storage performance.

SQL Server Resource Consumption Footprint

SQL Server's resource consumption is atypical in the application space. Most application servers do not consume large quantities of compute resources (CPU, memory, network, and storage), and tend to perform well in a highly consolidated virtual environment.

SQL Server is different.

SQL Server will consume as much memory as you allow. Bad code or inefficient queries can cause the CPU consumption to become elevated or even spike to 100%. Data will reside in RAM for only seconds at a time before being forcefully swept away to make room for other data. Disk consumption can push traditional storage devices to elevated response times or even failure.

All of these issues are guaranteed to cause performance delays for the end users.

Historically, this high resource consumption is why SQL Servers have generally been placed on dedicated infrastructure in an attempt to isolate each workload. Each dedicated infrastructure could be tuned for its specific workload. One 'hungry' workload would not have the ability to negatively impact the other.

Some of these resource consumption trends are by design. SQL Server consumes all of the allocated memory in an attempt to keep the most accessed data in its buffer pool memory as a read cache. It makes an assumption that memory is faster than traditional storage. If SQL Server is granted 56 GB of RAM on a 64 GB server for its buffer pool, the engine will store as much data as possible to fill this 56 GB.

If the working set of day-to-day data is greater than this 56 GB, SQL Server will repeatedly flush data to keep only the hottest data in RAM and will constantly jump from RAM to disk to fetch the data that is currently not in RAM. This process elevates the storage consumption of the server.

In the end, these intensive workloads cause problems for all of the IT silos. DBAs are tasked with maintaining the performance of the data layer, but are generally impacted by poor storage performance. Storage administrators provide the space required for increasing data volumes but cannot provide the storage-layer performance to keep the databases running smoothly. The business cannot afford the exponential increase in storage costs required to keep the storage layer running efficiently.

As a result of poor storage performance, DBAs have historically turned to adding memory to SQL Server in an attempt to better insulate their workloads from the insufficient storage performance. The more data they can hold in RAM, the less dependency on storage performance exists, and theoretically the SQL Server performance should improve.

SQL Server Virtualization Consolidation Challenges

Introducing SQL Server to highly consolidated environments, such as virtual infrastructures, only magnifies these challenges. In shared-everything environments such as virtualized infrastructures, this high level of resource consumption can (and usually does) cause significant problems, both for the level of consolidation that can occur in the environment without performance problems, as well as the "noisy neighbor" syndrome where high resource consumption by one VM can cause performance issues for the surrounding VMs.

In normal virtualized environments, a blanket assumption by VM administrators is that the VMs are not necessarily using all of their allocated memory. Therefore, host-level memory overcommitment is a quite feasible proposition, and the consolidation bottleneck is shifted from host RAM capacity onto CPU capacity.

However, since SQL Server VM memory footprints are much larger than the average VM, ordinarily the limiting factor to SQL Server consolidation on virtual infrastructures is the host memory capacity and not the amount of CPUs on the host. The host could be at 90% RAM consumed with just two or three SQL Server VMs, and the host CPUs are at little more than idle.

Increasing the host memory allocations can be cost prohibitive too. Upgrading to double capacity memory DIMMs is not a linear operation. Double capacity memory usually hits a point of inflection where the next step up is four times (or more) as expensive.

How can we shift this bottleneck from host RAM capacity back onto the CPU capacity? Simple. Reduce the amount of RAM on each SQL Server VM. How can we do this without hurting performance?

PernixData FVP Software – What Is It?

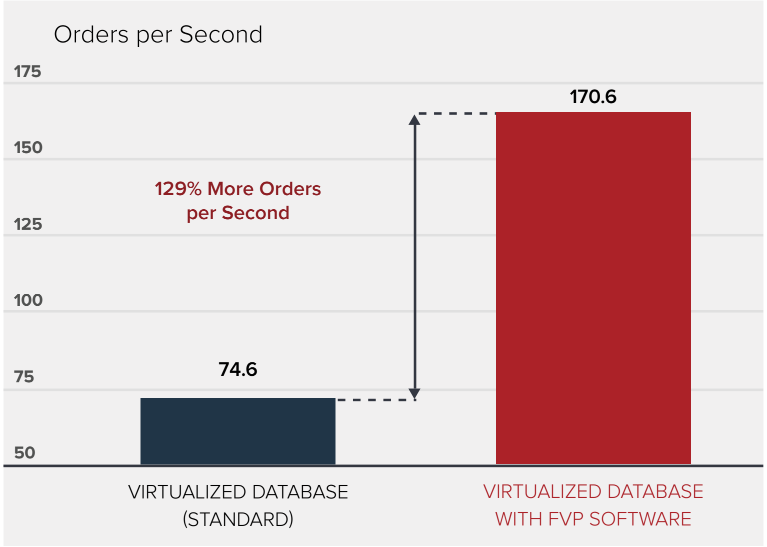
PernixData FVP software helps shift the in-memory discussion to the layer below the databases – into the hypervisor and physical servers themselves. FVP software clusters server flash and/or RAM into logical pools of resources used to accelerate storage reads and writes. It can optimize both read- and write-intensive workloads, making it ideal for virtualized database applications. FVP installs inside the hypervisor in minutes, and requires no changes to the database, other applications, or the storage array.

Once in place, FVP delivers faster database response times, which results in more transactions in any given time period. In internal testing, for example, the DVDStore application was used to generate load against a Microsoft SQL Server instance deployed in a VM. DVDStore measures the orders processed per second as well as the time to complete an order.

The most recent version of DVDStore is available for download at https://github.com/dvdstore/ds3.

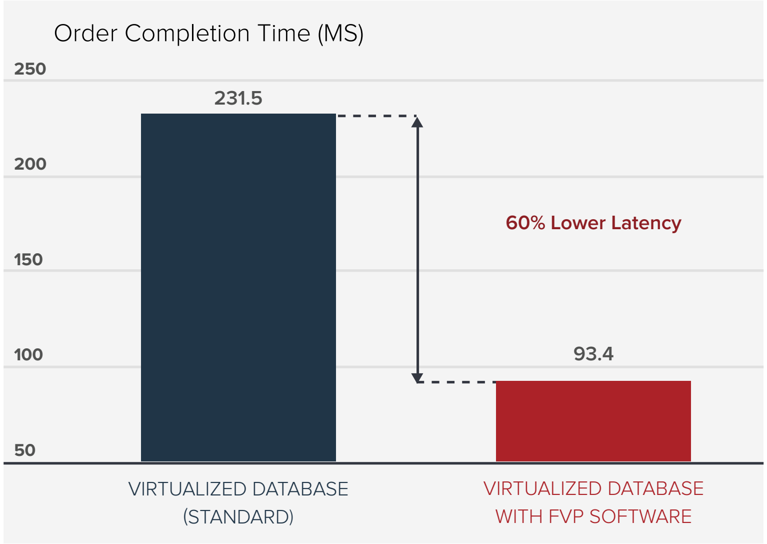
Note that a single "order" is composed of multiple transactions, such as customer logins, browsing for different titles, and placing orders. In addition, each transaction is composed of multiple read/write SQL statements.

The key metric in this test is "Orders per Second". With the standard database, 75 orders are processed per second while the FVP accelerated database can process 171 orders per second, which is a 129% improvement.



PernixData FVP grows revenue by increasing orders processed per second.

“Order Completion Time” is another important metric in measuring performance. The standard database completes the task in 232 ms while the FVP accelerated database finishes orders in 93 ms, reducing the cycle time by 60%.



PernixData acceleraties revenue by decreasing latency in virtualized databases.

PernixData FVP accelerates virtualized server to deliver significantly better results in both key metrics compared to a standard virtualized database.

License Consolidation Through Memory Optimization

SQL Server Enterprise core-based licensing for virtualized SQL Servers is here to stay. With the introduction of the SQL Server 2012 core-based licensing changes, the world has been struggling to adapt to this new licensing model. Virtualization changes this model even more, as Enterprise-level core-based licensing is the default licensing model for larger enterprises that are not bound by a hosting SPLA.

Enterprises can leverage FVP to reduce the per-VM memory footprint for virtual SQL Server deployments, which improves the consolidation ratio and improves performance while reducing licensing expenses.

The process to implement these benefits in an enterprise organization are as simple as the following:

- Install and configure FVP to accelerate the storage layer underneath the mission-critical databases.
- Reduce the memory footprint of each SQL Server VM while maintaining performance because of FVP.
- Consolidate the VMs onto a smaller number of physical VM hosts in the SQL Server VM cluster.
- Reduce the licensing footprint of SQL Server Enterprise edition on this reduced VM cluster with less host core licenses to purchase.
- Celebrate.

No application code needs to go through functional regression testing. No code needed to be scrapped and written from the ground up because of the introduction of a new in-memory database platform. The platform does not need to be re-certified by the third-party application vendors.

Your CFO and CIO benefit from the reduced IT expenses. End users receive a better application experience. Infrastructure admins benefit from reduced shared resource consumption. DBAs see improved query performance and reduced storage latencies.

Everyone wins.

Real-World Licensing Examples

The following examples show scenarios where deploying FVP reduces the SQL Server licensing footprint.

Pricing Assumptions

First, let's establish some basic pricing assumptions.

SQL Server 2014 list licensing, including Software Assurance, is $1,793 per core for Standard Edition and $6,874 per core for Enterprise Edition. A minimum of four core licenses must be purchased per server, physical or virtual, if core-base licensing is selected.

VMware's vSphere licensing is priced at $4,369 per CPU socket, including production support. This price does not include the cost of the vCenter server, as this is assumed to be in the VMware-based virtualized infrastructure already.

PernixData FVP Enterprise licensing is $7,500 list per VMware host.

The average price for a mid-range virtualization host, assuming two CPU sockets and a moderate amount of memory, is approximately $20,000, and the colocation cost for datacenter hosting is $600 per year.

SQL Server 2014 Licensing (including SA)		
Standard	$1,793	per core
Enterprise	$6,874	per core
VMware Licensing		
vSphere Enterprise Plus (including support)	$4,369	per socket
PernixData Licensing		
FVP Enterprise	$7,500	per host
Hardware		
Host Server Cost	$20,000	
Host CoLo Cost (per year)	$600	

Infrastructure Architecture Assumptions

Our host hardware configuration default assumptions include a two CPU socket host, with 12 physical cores per socket, with 512 GB of physical RAM in the server, and a host-based SSD device for I/O caching.

The VMware host cluster is configured to maintain enough free resources to tolerate up to two hosts failing while being able to keep all of the VMs running at an acceptable level.

Because the dedicated hot-standby hosts are only to be used if a physical host suffers an unplanned outage, the assumption is that these hosts are not licensed for SQL Server VM placement.

During these outages, the goal is to keep each host at no more than 85% memory allocated from VM memory. This percentage reserves a small amount of memory for hypervisor and VM memory management operations while not approaching a high threshold that could trigger hypervisor-level memory reclamation processes.

Across all SQL Server VMs, the average configuration of the VMs is six vCPUs and 64 GB of vRAM.

Average VM Allocations	
vCPUs	6
vRAM (GB)	64
Num SQL Server VMs	50
Host Hardware Configuration	
pCores per Socket	12
pSockets	2
Size (Rack U)	2
pRAM (GB)	512
VMware Host Cluster	
Host RAM Usable Target	85%
Host Failure Tolerates	2
FVP Assumptions	
Per VM Memory Reduction	25%

SQL Server VM Memory Reduction

To improve the SQL Server consolidation ratio on a single VM host, the memory allocation for each SQL Server VM is to be reduced by a small amount. In these examples, the memory reduction amount is by 25%. Assuming a reserve of 8 GB of OS memory for operating system and SQL Server background processes, the amount of memory granted for the SQL Server Buffer Pool goes from 56 GB to 40 GB, a reduction of 28.6%.

SQL Server Assumptions	
RAM Reserved for OS (GB)	8
Avg. SQL Server RAM BP (GB)	56
Mem Reduction BP (GB)	40
BP Reduction	28.6%

Results

With the given parameters listed above, the operational expenses drop by over $325,000.

SQL Server Assumptions	Standard	With FVP	Savings
Number of VMs	50	50	
Total vCPUs	300	300	
Total vRAM (GB)	3,200	2,400	
vRAM (GB) Per VM	64	48	
Host Cluster SperCifications			
Max vRAM Available per Host (GB)	349	327	
VMs per Host	5	6	
vRAM Used per Host (GB)	320	288	
vCPU to pCPU Ratio	1.3	1.5	
Est. Number of Hosts	10	8	
Est. Number of Hosts to License	8	6	
Host Hardware Cost	$200,000	$160,000	$40,000
Host CoLo Cost	$6,000	$4,800	$1,200
VMware Licensing	$87,380	$69,904	$17,476
PernixData FVP Licensing	N/A	$60,000	($60,000)
SQL Server			
Cores to License	192	144	48
Enterprise Licensing	$1,319,808	$989,856	$329,952
Total	**$1,623,188**	**$1,284,560**	**$328,628**

The number of hosts requiring SQL Server and VMware licensing drops from eight to six. The VM density stays the same, as the required spare host memory for the host failure tolerates reserve grows. The vCPU to pCPU consolidation ratio stays the same at 1.3 vCPUs for every physical CPU core, which on most SQL Server deployments will result in negligible vCPU scheduling performance overhead.

Because of the FVP-layer I/O acceleration properties and how SQL Server leverages the improved storage performance, these VMs should perform better than their normal VM or physical server counterparts. This improved performance comes with a tremendous cost savings over traditional performance boosts.

At a larger scale, the cost savings are further magnified. The following example shows the improvement with 200 SQL Server VMs.

VM Counts	Standard	With FVP	Savings
Number of VMs	200	200	
Total vCPUs	1,200	1,200	
Total vRAM (GB)	12,800	9,600	
Host Cluster Sperciﬁcations			
Max vRAM Available per Host (GB)	408	401	
VMs per Host	6	8	
vRAM Used per Host (GB)	384	384	
vCPU to pCPU Ratio	1.5	2.0	
Est. Number of Hosts	32	25	
Est. Number of Hosts to License	30	23	
Host Hardware Cost	$640,000	$500,000	$140,000
Host CoLo Cost	$19,200	$15,000	$4,200
VMware Licensing	$279,616	$218,450	$61,166
PernixData FVP Licensing	N/A	$187,500	($187,500)
SQL Server			
Cores to License	720	552	168
Enterprise Licensing	$4,949,280	$3,794,448	$1,154,832
Total	**$5,888,096**	**$4,715,398**	**$1,172,698**

At this larger scale, the savings are over $1.1M. This amount of capital can be applied to IT budget cost savings, proactive infrastructure improvements, and/or improved training budgets.

Conclusion

PernixData FVP software is a strategic infrastructure component underneath any mission-critical database deployment. Leveraging PernixData FVP to reduce your SQL Server Enterprise core-based licensing footprint while improving the consolidation ratio and performance of these mission-critical databases can save your organization thousands, if not millions of dollars.

This license reduction technique can be applied not just to Microsoft SQL Server, but to any I/O-intensive application that is licensed by CPU core.

Let your infrastructure enhance your database servers instead of holding them back. Shift the in-memory computing layer to underneath the application to reduce complexity and improve performance and get the best possible database performance at the lowest cost.