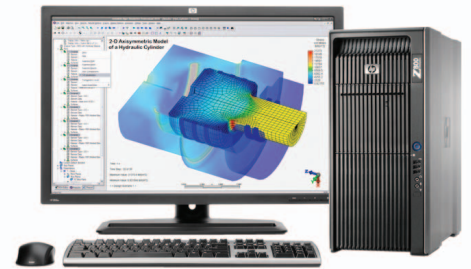




High Performance Workstation Compute Cluster enabled with Parallels® Workstation Extreme

Parallels Workstation Extreme can provide many flexible solutions to users of HP Workstations, creating a potent resource for analysis or rendering while continuing to deliver workstation-class interactive performance.

HP recommends Windows® 7.



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Getting every ounce of power from your HP Workstations

Desktop workstations serve the needs of professional engineers, architects, animators and others who require powerful computational and graphics performance on the desktop. Workstations are also occasionally incorporated into compute clusters, where they serve as nodes in distributed computations. However, such compute jobs can consume most or all of the resources on a workstation, making it unresponsive or too resource-constrained to fulfill its primary purpose, and leaving the user with an unusably slow workstation.

Therefore, such solutions need to dispatch compute jobs to workstations only when the users are not using them, either while in the office or remotely via technologies such as HP Remote Graphics Software. This is a challenging scheduling problem, at best.

Parallels® Workstation Extreme, a virtualization solution from Parallels Inc., can address this challenge. It can turn a group of workstations into a powerful distributed compute cluster while protecting each workstation’s resources so that the user can continue to design, create and visualize without even being aware that there are compute jobs running on the same system. This allows the organization to fully utilize all of the workstations’ high-performance multi-core Intel® processors for their desktop users, as well as for large analysis, simulation, and rendering tasks.

This usage model suggests that the workstations deployed should be richly-configured with many processor cores installed, as well as an expanded amount of memory. While this type of configuration may appear to be “overkill” for the user sitting at the workstation, it may provide a very cost-effective way to dynamically provision additional computation power for the organization.



Sharing workstations using Parallels Workstation Extreme



Parallels Workstation Extreme (PWE) implements virtual machines (VMs), known as “guests”, on top of a “host” operating system. For example, with PWE you can have a Microsoft® Windows Server 2008 guest VM running on a Microsoft Windows® 7 host. VMs are not new, and are commonplace in server-based commercial computing. However, a unique feature of PWE is that it can take full advantage of Intel’s Virtualization Technology for Directed I/O (VT-d). This allows PWE to assign—and to constrain—hardware resources to individual VMs. This is the primary way in which PWE enables the concurrent user/cluster usage model presented in this paper.

Here is how the guest and host relationship works. Imagine for example an HP Z800 Workstation running Windows 7 (our host), equipped with two 6-core Intel® Xeon® processors and 24 GB of memory. Imagine, too, that the applications used by the engineer sitting at the workstation benefit from four of those 12 cores and 8 GB of that memory, but no more than that. This may be typical for certain workflows, though the exact resource requirements will depend on applications, model sizes, etc. We can now create a Windows 7 virtual machine (our guest) which is constrained by PWE to use our workstation’s available resources—no more than eight cores and 16 GB of memory. This means that even when the guest is running a compute job at maximum capacity, four cores and 8 GB are still completely available to the user, and his or her experience is guaranteed to be maintained at the level of a four core, 8 GB configuration. Think of PWE as placing a fence around each guest VM, so that the workstation’s primary function—engineering, animation, etc.—is not impacted by the additional computation that is being gained from using the available cores on the system.

Furthermore, since the compute job is not using the workstation’s graphics card, the user will continue to experience full 3D acceleration. One exception to this is when the compute job is running GPU-accelerated code, such as via NVIDIA’s CUDA. In this case, a good approach is to add a second graphics card or NVIDIA Tesla card into each workstation and assign it (using PWE’s VT-d capabilities) to the guest VM. This provides a cluster of GPU-accelerated compute nodes for extreme numerical performance.

Note that PWE is able to launch the VM as a Windows service at boot time, which means that the guest VM is protected from changes by a standard workstation user; only those users with administrative privileges are authorized to make changes to the virtual compute infrastructure.

Compute cluster software

Because Parallels Workstation Extreme is flexible with regards to the host and guest operating systems, it’s possible to deploy the compute cluster on Windows or Linux. Various frameworks exist for cluster administration and job scheduling, and the approach described in this paper is applicable to many of them, as the guest VMs on the workstations can run whichever operating system is required by the organization’s HPC implementation. For example, Moab Cluster Suite from Adaptive Computing Enterprises, Inc.® is a framework for Linux-based applications and would therefore require Linux VMs to run under PWE.

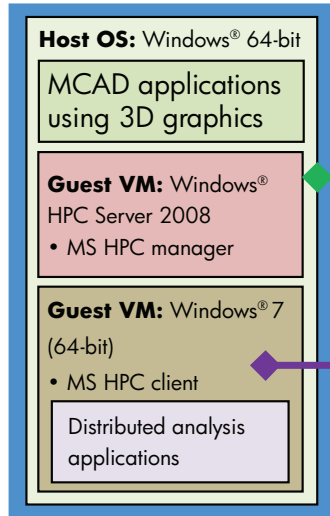
Another example of a cluster management and job scheduling system is Microsoft’s High Performance Computing (HPC) Server, which is a component of Windows Server 2008 HPC Edition. This OS can run either on a server in the organization’s environment, or alternatively in a guest VM on one of the workstations. This would be designated the “head node” of the cluster. Applications which are configured to run under Microsoft HPC would then be distributed across the workstations, running in the guest VMs which could be running Windows 7.



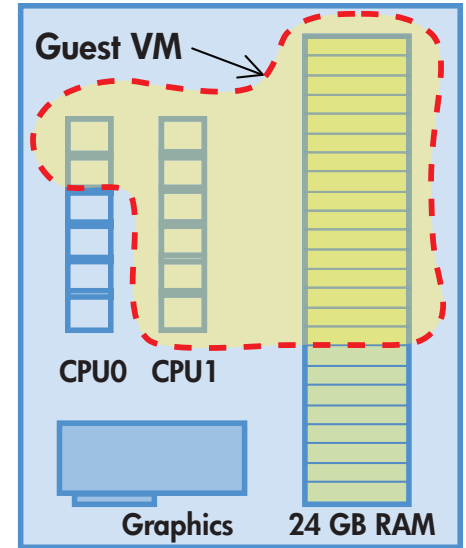
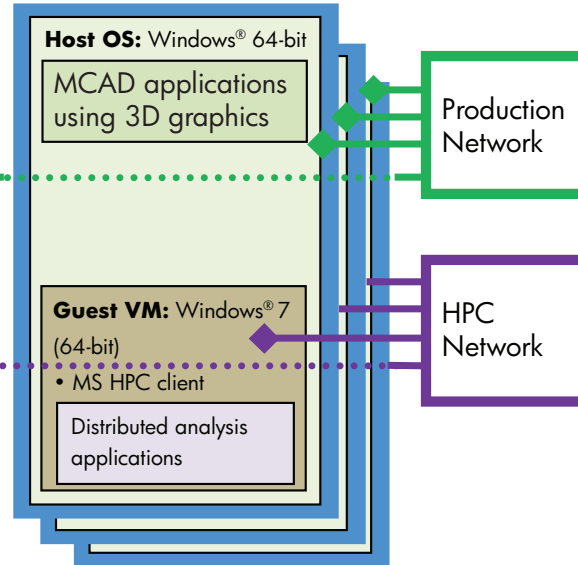
FIGURE 1

Parallels Workstations Extreme on HP Z Workstations:

HP Z800 Workstation 1: The “head-node”



HP Z800 Workstations 2, 3 & 4: The client nodes



An example configuration

Here we describe a configuration using four HP Z800 Workstations, each equipped with two 6-core Intel® Xeon® processors, 24 GB of memory and a 3D graphics card. Each workstation runs Windows® 7 (64-bit version), and has applications installed which are used by engineers for mechanical design (MCAD). The objective is to provision compute resources for analysis jobs.

Let us suppose that there is no server available to run Microsoft® HPC Manager, so we assign that role to one of the workstations (the “head node”). This system will host two guest VMs: one will run Windows Server 2008 HPC Edition and will serve as the HPC cluster manager; the other VM will run Windows 7 and will serve as a compute node. The other three workstations can run Windows 7 VMs for computation that are identical to the one on the head node. Since it is possible to copy VMs from one installation of PWE to another, it is easy to add additional compute nodes as needed.

For all workstations, we will imagine that Parallels Workstation Extreme has been configured to allow each compute node VM to access 8 of the 12 available cores and 16 GB of the 24 GB of available memory, resulting in the following allocation of resources:

- Each MCAD user has full use of at least 4 processor cores, at least 8 GB of memory and the 3D graphics card, leading to uncompromised productivity.
- Each compute node has full use of up to 8 processor cores and up to 16 GB of memory.

Since Microsoft HPC Manager does not require many system resources, its effect on the head-node’s performance can be mostly disregarded. Therefore we truly have a deployment of four engineering workstations for design and four powerful compute nodes (with 32 cores total) for analysis.

Note that by taking advantage of the HP Z800 Workstation’s second built-in network port, it’s possible to set up a dedicated subnet for the compute cluster, rather than sending jobs and results over the corporate LAN. And, by adding 10-Gigabit Ethernet or other high-bandwidth, low-latency interfaces, it’s possible to further improve the performance of the compute cluster, especially if it relies on high capacity MPI (node to node) communication, or accesses shared storage.



Paying for itself

By deploying richly-configured workstations for desktop users, the provision of a powerful compute cluster may prove very cost-effective, as it can reduce pressure on existing resources in the organization's data center, and it can expand the ability of users to run more analyses and get those answers much quicker.

This approach is attractive in several scenarios:

- Adding compute nodes to a new or existing cluster by incorporating existing workstations (taking advantage of "all those cycles out there").
- Adding additional compute nodes to an existing cluster by deploying additional or replacement workstations that deliver excellent productivity for desktop users.
- Enabling a cluster across existing or new workstations which provides a computation resource that was otherwise not affordable or practical.

Any of these scenarios can benefit the organization in a number of ways:

- More compute nodes provide quicker simulation-to-production times and allow for faster time-to-results.
- Workstation workgroups can now sustain their own internal compute needs, helping to reduce overall demand on existing data center infrastructure. This type of provisioning of compute resources can reduce a department's reliance on centralized servers, which are often over-subscribed.
- Standardization on powerful HP Workstations using Parallels virtualization technology can provide better ROI for a workgroup by increasing overall compute resource utilization.
- In cases where workstation compute nodes are added to the resources available to an HPC data center, this can improve throughput for the entire organization.

Best of both worlds

The unique capabilities of Parallels Workstation Extreme can provide many flexible solutions to users of HP Workstations. In this paper, we explored how it can be used to turn a set of workstations into a potent resource for analysis or rendering while giving up none of the desktop power for which the workstations were deployed in the first place. The approach described here may be directly applicable or creatively leveraged to solve additional difficult challenges faced by the reader's organization.

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