

# UPGRADE YOUR BUSINESS

by upgrading to new Dell™ OptiPlex™ desktops powered by Intel®



DELL OPTIPLEX  
9030 ALL-IN-ONE



DELL OPTIPLEX  
9020 MICRO PC

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## FASTER OUT-OF-BAND MANAGEMENT

97% lower IT costs with Dell  
Command | Intel vPro™ Out of Band

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## LESS WAITING WHILE WORKING

Up to 145% better system performance

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## LOWER POWER COSTS

Up to 60% lower power consumption

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IN OUR HANDS-ON TESTS vs  
A 5-YEAR-OLD LEGACY DESKTOP

Aging desktops present obstacles as they lack the latest hardware and software technology. Your business faces a difficult decision: You can replace those older desktops now, or you can push the capital expense to the next fiscal year. How do you know when it's the right time to invest in new technology for your business?

We examined the advantages of upgrading to the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro from a representative five-year-old desktop tower system. We found that the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro offered compelling reasons to upgrade, including support for remote systems management, much faster performance for increased productivity, and significantly lower power consumption.

Upgrading to Dell OptiPlex desktops brings many benefits to your business. Your IT can leverage Dell technology to save time and reduce costs when supporting out-of-band systems. Your employees have the opportunity to be more productive with faster and more power-efficient desktops that also enable your business to lower power costs.



# FASTER OUT-OF-BAND MANAGEMENT WITH DELL COMMAND | INTEL VPRO OUT OF BAND

## Manage desktops remotely and regardless of state with out-of-band management

Remote management has traditionally relied on in-band management, which requires each managed device to fully load its operating system (OS) and receive commands through a software-based management agent. With out-of-band (OOB) management, IT staff can now use a special hardware-based channel to connect with the device remotely when the OS is unreachable. Specifically, OOB management can happen when a system is in any of the following conditions:<sup>1, 2</sup>

- the system is plugged in but not actively running (i.e., powered off or “asleep”)
- the operating system has not loaded
- the system is booted into its operating system and the software-based management agent is not available
- the system is hung or non-operational

OOB management functionality is valuable in situations that necessitate accessing, updating, or restoring multiple remote systems that IT staff cannot otherwise reach. For example, if vicious malware infects and corrupts the operating systems of many desktops and begins to propagate, IT staff need to shut down the systems to stop further infection. Using OOB management with hardware-based Keyboard-Video-Mouse (KVM) Remote Control, IT staff can access the infected desktops while they are offline, and then correct the problem by configuring the systems to boot to a separate drive or by redirecting them to run an executable.

Intel Core™ vPro processors offer a hardware-based option for OOB management with the Intel Management Engine, an isolated and protected coprocessor that can communicate with the network and draw power independently of the system’s main components.<sup>3</sup>

## Save time and lower IT costs with common management tasks

With legacy desktop towers that are out-of-band, IT staff have to make physical deskside visits to perform common management tasks, one system at a time. This means more time and associated costs to complete the tasks. With new Dell OptiPlex desktops, however, your IT staff can apply changes to multiple systems simultaneously and remotely, regardless of their current power state.

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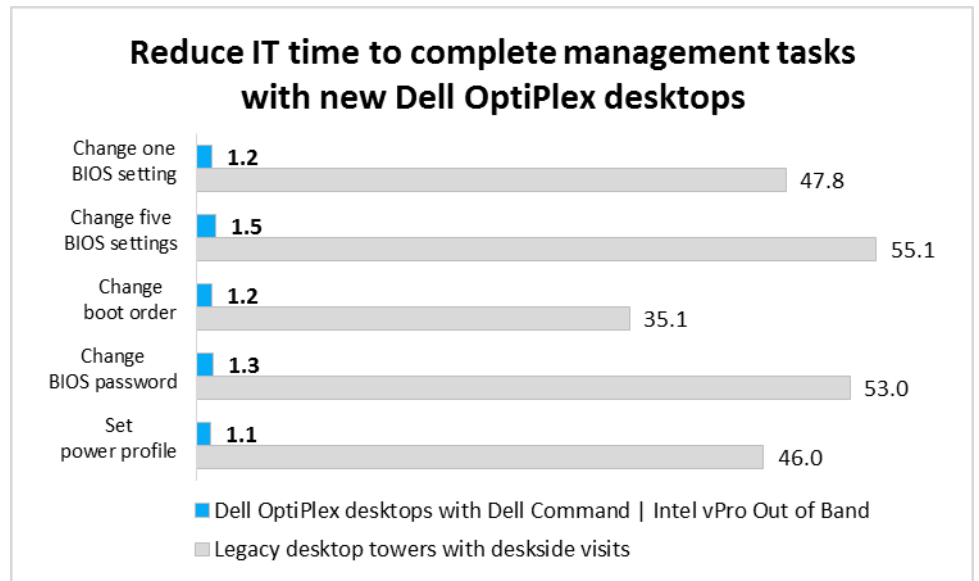
<sup>1</sup> [en.community.dell.com/techcenter/extras/m/white\\_papers/20179305/download.aspx](http://en.community.dell.com/techcenter/extras/m/white_papers/20179305/download.aspx)

<sup>2</sup> [www.intel.com/content/www/us/en/architecture-and-technology/vpro/vpro-technology-general.html](http://www.intel.com/content/www/us/en/architecture-and-technology/vpro/vpro-technology-general.html)

<sup>3</sup> [www.kernel.org/doc/Documentation/misc-devices/mei/mei.txt](http://www.kernel.org/doc/Documentation/misc-devices/mei/mei.txt)

We looked at the amount of time your IT staff could save when managing a group of Dell OptiPlex 9030 All-in-One or Dell OptiPlex 9020 Micro desktops instead of a group of legacy desktop towers. We timed how long it took to complete five OOB management tasks on the Dell OptiPlex desktops using an SCCM management environment and Dell Command | Intel vPro Out of Band, and then timed how long it took to complete the same tasks manually on the legacy desktop tower. Figure 1 shows the amount of time your IT staff can save for common OOB management tasks with 50 systems when you upgrade to new Dell OptiPlex desktops; more efficient management can reduce IT labor time by up to 97 percent.

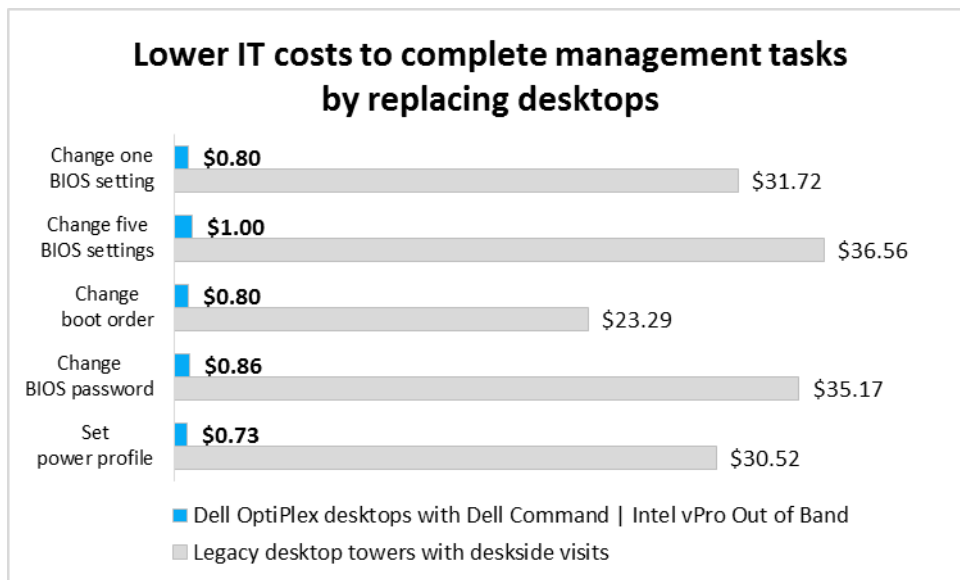
**Figure 1: Amount of IT time to complete five separate management tasks on 50 systems, in minutes. Lower numbers are better.**



Saving time with new Dell OptiPlex desktops when completing common OOB management tasks ultimately means savings in labor costs. For example, we found that new Dell OptiPlex desktops could save your business over \$35 in IT labor costs for the simple task of changing a BIOS password for 50 systems. Figure 2 shows the lower costs that your business can realize with OOB management tasks when upgrading to new Dell OptiPlex desktops.<sup>4</sup>

<sup>4</sup> We estimated an IT cost of \$.6635 per minute, based on an average annual total compensation estimate from Salary.com of \$82,809 for a Help Desk Support senior-level position.

**Figure 2: Cost of IT to complete five separate management tasks on 50 systems, in dollars. Lower numbers are better.**



## Reduce repair costs and employee downtime when supporting a non-operational system at a remote site

IT can resolve some problems for a non-operational Dell OptiPlex desktop remotely with OOB management that previously would have required an expensive deskside visit to a remote site with a legacy desktop tower. The travel time for a deskside visit ultimately increases the cost and overhead for IT to make a repair, and increases employee downtime and lost productivity.<sup>5,6</sup> With hardware-based KVM Remote Control and OOB management, IT staff can remotely access the target desktop and implement the necessary changes as soon as possible.

We considered an example 10-minute repair of a single non-operational system to illustrate the potential IT savings with new Dell OptiPlex desktops for a single repair at a remote site. When repairing a legacy desktop tower, the one hour of total travel time to and from the remote site in this scenario represents a significant amount of overhead for IT. With the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro, IT could simply launch a KVM Remote Control session—a process that we found took only 15 seconds.

<sup>5</sup> The Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro in our study included the latest Intel vPro technology and the latest version of Intel Active Management Technology (Intel AMT). For more information on Intel AMT, visit [www.intel.com/content/www/us/en/architecture-and-technology/intel-active-management-technology.html?wapkw=amt](http://www.intel.com/content/www/us/en/architecture-and-technology/intel-active-management-technology.html?wapkw=amt).

<sup>6</sup> The legacy desktop tower in our study shipped with an older release of Intel AMT (5.2), which meant that it did not support hardware-based KVM Remote Control. [software.intel.com/sites/manageability/AMT\\_Implementation\\_and\\_Reference\\_Guide/default.htm?url=WordDocuments%2Fkvman\\_dintelamt.htm](http://software.intel.com/sites/manageability/AMT_Implementation_and_Reference_Guide/default.htm?url=WordDocuments%2Fkvman_dintelamt.htm)

We also looked at the amount of employee downtime for this example 10-minute repair of a single non-operational system. With the legacy desktop tower, the employee would have to wait until the following business day for a deskside visit, representing eight business hours of downtime after the initial call. With the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro, the employee would have to wait only 15 seconds for IT to initiate the KVM Remote Control session.<sup>7</sup>

Figure 3 shows the total amount of employee downtime and IT labor for a single repair of a non-operational system at a remote site. Replacing desktops would enable IT to reduce employee downtime significantly and reduce overhead for IT staff when supporting a non-operational system. Instead of waiting eight business hours for the repair, the employee could get back to work much sooner. In addition, quicker repairs give IT staff more time to complete other tasks.

**Figure 3: Lost productivity due to employee downtime and IT labor for a single repair of a non-operational system at a remote site, in hours:minutes:seconds. Lower numbers are better.**

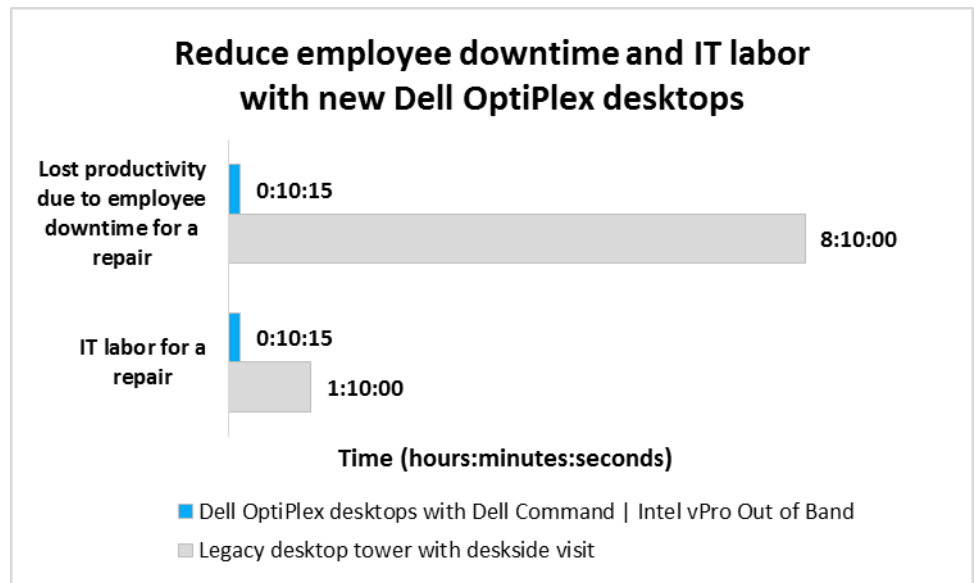


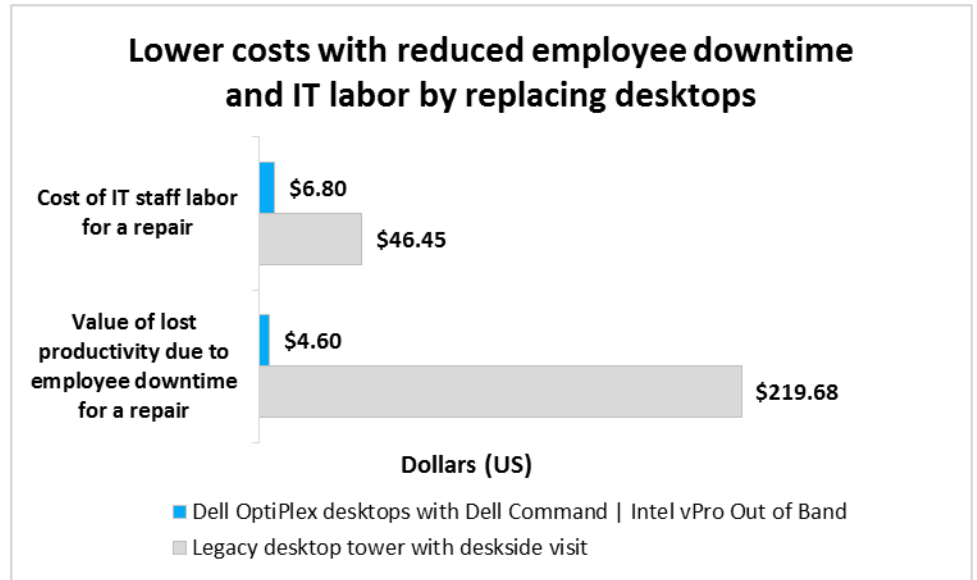
Figure 4 shows the value of the reduced employee downtime and the value of the time IT could save with the Dell OptiPlex 9030 All-in-One or Dell OptiPlex 9020 Micro for a single repair of a non-operational system at a remote site. The Dell OptiPlex 9030 All-in-One or Dell OptiPlex 9020 Micro would reduce the cost of employee downtime by \$215.08 for a single 10-minute software repair—a savings of nearly 98 percent.<sup>8</sup> The 10-minute software repair would cost \$39.65 less with the Dell OptiPlex 9030 All-in-One or

<sup>7</sup> We assumed an equal amount of time for IT to generate the support ticket with KVM Remote Control and the deskside visit, and did not include that time in our analysis.

<sup>8</sup> We estimated an average end-user cost of \$.4483 per minute, based on an average annual total compensation of \$55,954.00, which includes an average 2013 US salary of \$43,041.39 ([www.ssa.gov/OACT/COLA/AWI.html](http://www.ssa.gov/OACT/COLA/AWI.html)) plus 30 percent in benefits.

Dell OptiPlex 9020 Micro due to the elimination of IT travel time—a cost savings of 85 percent.<sup>9</sup>

Figure 4: Cost of lost productivity due to employee downtime and cost of IT labor for a single repair of a non-operational system at a remote site, in US dollars. Lower numbers are better.



## LESS WAITING WHILE WORKING WITH DELL OPTIPLEX DESKTOPS

### Promote productivity with up to 145% better system performance

Waiting on a slow PC can be painful. A faster, more responsive desktop means your employees can finish the same tasks in less time, ultimately providing your employees an opportunity to be more productive. We used five industry-standard benchmarks to show the performance boost your employees can get with a new Intel processor-based Dell OptiPlex 9030 All-in-One or Dell OptiPlex 9020 Micro. The new Intel processor-powered desktops outperformed the legacy desktop tower on all of the performance benchmarks.

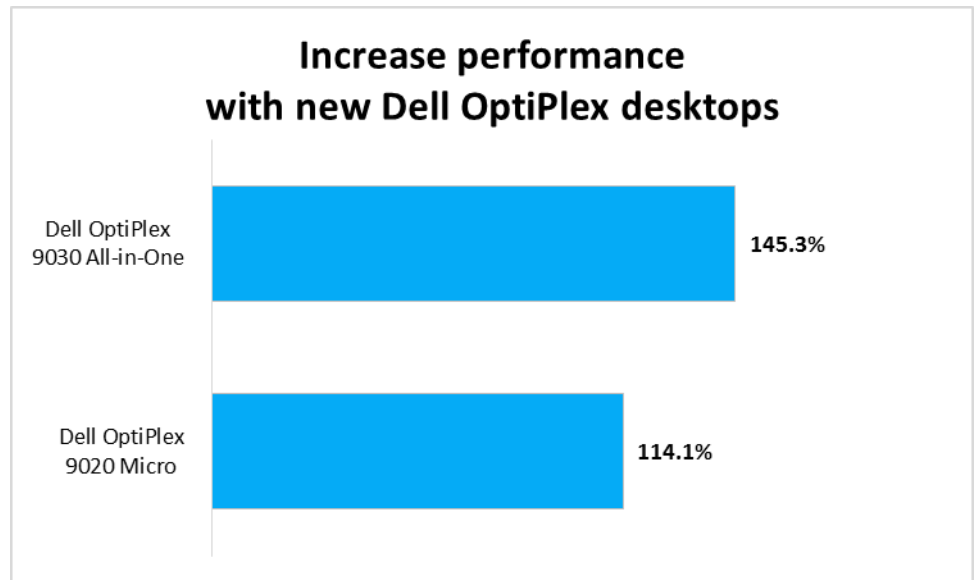
For detailed specifications of the test systems, see [Appendix A](#). For step-by-step details on how we performed our benchmark testing, see [Appendix D](#). For more on the benchmarks, see [Appendix E](#).

As Figure 5 shows, we found the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro provided significantly better system performance than the legacy desktop tower—145 percent and 114 percent, respectively. Note: We calculated the percentage wins for the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro on each benchmark, and then calculated system performance by taking the geometric mean of

<sup>9</sup> We estimated an IT cost of \$.6635 per minute, based on an average annual total compensation estimate from Salary.com of \$82,809 for a Help Desk Support senior-level position.

those percentage wins versus the legacy desktop tower. For more details on how we calculated the system performance, see [Appendix B](#).

**Figure 5: System performance for the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro vs. the legacy desktop tower. Higher numbers are better.**



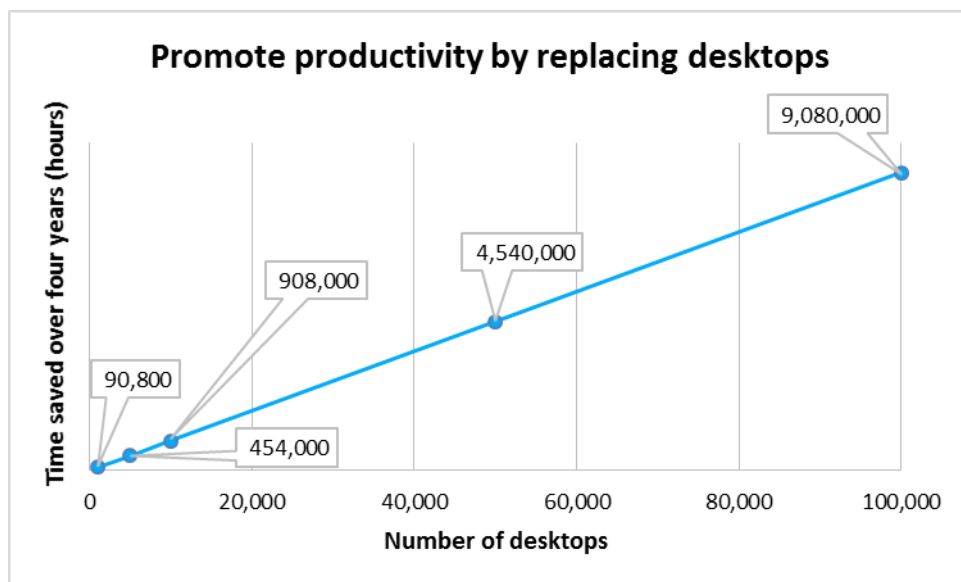
Faster desktops for your employees mean less waiting while working and an opportunity for increased productivity.

So what does better system performance mean for your business? If your average employee spends 10 minutes a day waiting to do the types of tasks included in the benchmarks (e.g., writing documents, browsing Web sites, and creating spreadsheets), 145 percent better system performance means your average employee could save almost 23 hours per year when moving from the legacy desktop tower to the Dell OptiPlex 9030 All-in-One. As Figure 6 shows, replacing desktops represents a significant opportunity for increased productivity as the size of the desktop fleet increases. For example, a business replacing 10,000 legacy desktop towers with 10,000 new Dell OptiPlex 9030 All-in-One desktops could see significant savings over four years—5.923 minutes saved daily per employee would add up to over 900,000 total hours saved that employees could use for other tasks.<sup>10, 11</sup>

<sup>10</sup> Based on a conservative estimate that a hypothetical mix of productivity tasks would take an average of 10 minutes per employee per day with the legacy desktop tower. With 145.3 percent better system performance, the same mix of tasks would take an average of 4.077 minutes per employee per day with the Dell OptiPlex 9030 All-in-One, saving 5.923 minutes per employee per day.

<sup>11</sup> Based on a 46-week work year per employee, which includes holidays, vacation, and sick leave ([www.bls.gov/opub/btn/volume-2/paid-leave-in-private-industry-over-the-past-20-years.htm](http://www.bls.gov/opub/btn/volume-2/paid-leave-in-private-industry-over-the-past-20-years.htm)).

Figure 6: Time saved in hours over four years when replacing a fleet of legacy desktop towers with Dell OptiPlex 9030 All-in-One desktops.



## PAY LESS FOR POWER WITH DELL OPTIPLEX DESKTOPS

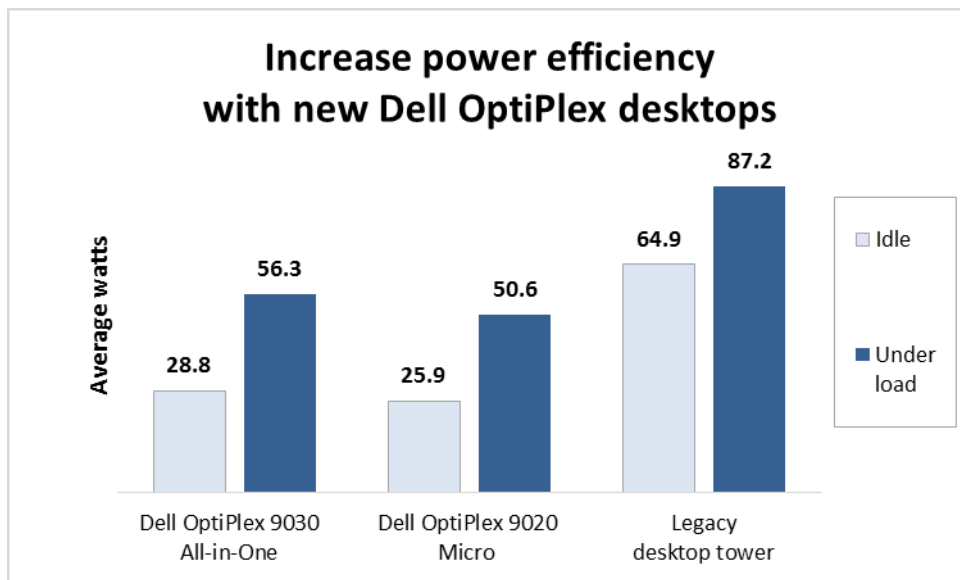
Save at the outlet with up to 60% fewer watts at idle and up to 42% fewer watts under load

The Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro consumed less power **under load** than the legacy desktop tower consumed at **idle**.

Why waste energy and dollars with inefficient older desktops? We found that both the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro consumed significantly less power than the legacy desktop tower—and, notably, consumed less power under load than the legacy desktop tower consumed at idle. The Dell OptiPlex 9030 All-in-One consumed 55 percent fewer average watts while idle and 35 percent fewer average watts under load than did the legacy desktop tower. The Dell OptiPlex 9020 Micro consumed 60 percent fewer average watts while idle and 42 percent fewer average watts under load than did the legacy desktop tower. Figure 7 shows the power usage of all three systems while idle and under load.

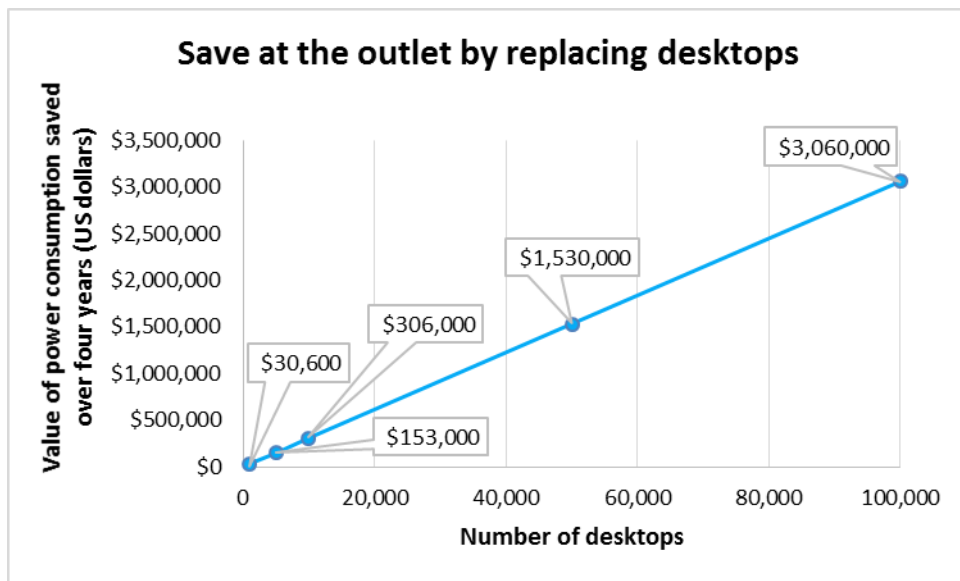


Figure 7: The average number of watts each system consumed while idle and under load. Lower numbers are better.



As Figure 8 shows, replacing older inefficient desktops can significantly affect the bottom line. For example, a business replacing 10,000 legacy desktop towers with 10,000 new Dell OptiPlex 9020 Micro desktops could realize significant savings over four years; \$7.65 saved annually per employee would add up to \$306,000 total savings in power costs.<sup>12</sup>

Figure 8: Power consumption savings in dollars over four years when replacing a fleet of legacy desktop towers with Dell OptiPlex 9020 Micro desktops.



<sup>12</sup> Based on a conservative estimate of one hour under load and seven hours idle for average power consumption per employee per day, 46-week work year per employee, and average US commercial power costs of \$0.1075 per kilowatt-hour from the U.S. Energy Information Administration ([www.eia.gov/electricity/monthly/pdf/epm.pdf](http://www.eia.gov/electricity/monthly/pdf/epm.pdf)).

# LEVERAGE THE NEWEST TECHNOLOGY WITH DELL OPTIPLEX DESKTOPS

## Gain the benefits of touch

If a touchscreen delivers a productivity benefit of one minute per day with the Dell OptiPlex 9030 All-in-One, it could pay back its added cost in **under 20 months**.

Touch-interactive technology is becoming as popular in the office as it is at home. An Intel study shows respondents overwhelmingly preferred laptops with touch,<sup>13</sup> and shipments of touchscreen monitors are seeing growth.<sup>14</sup>

Microsoft® Windows® 8.1 does not require touch technology, but a touch-enabled version of the operating system can allow users to access information, collaborate, and make presentations through quick touch gestures. For the Dell OptiPlex 9030 All-in-One with the included touchscreen display, users can engage content such as Web pages, images, videos, pdfs, and email with touch-enabled apps such as Microsoft Office 365™, and then switch to the keyboard and mouse for typing and editing content, choosing the more comfortable interface for each task.

For the Dell OptiPlex 9030 All-in-One that we tested, the touch-enabled display added \$186 to the starting price over a similarly configured model without touch.<sup>15</sup> If the touchscreen on the Dell OptiPlex 9030 All-in-One can deliver a productivity benefit of just one minute per day, the optional touch capability could pay back its added cost in under 20 months.<sup>16, 17</sup>

## Connect via USB 3.0, DisplayPort, HDMI, and Wireless AC

Replacing desktops can enable your business to take advantage of the latest USB technology. The Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro included USB 3.0 ports—eight and six, respectively. The legacy desktop tower offered USB 2.0 ports. USB 3.0 ports, such as those on the two Intel processor-powered desktops, can provide up to 4.8 Gbps transfer rates to USB 3.0 devices—up to 10 times faster than the transfer rate for USB 2.0 connections to USB 2.0 devices that you could get with the legacy desktop tower.

Replacing desktops can also bring the latest display technology to your business. In addition to the touchscreen display on the Dell OptiPlex 9030 All-in-One, both the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro included DisplayPort, which

<sup>13</sup> [www.neowin.net/news/intel-80-percent-of-pc-users-prefer-touch-screens](http://www.neowin.net/news/intel-80-percent-of-pc-users-prefer-touch-screens) and [www.intelfreepress.com/news/do-people-want-touch-on-laptop-screens/197/](http://www.intelfreepress.com/news/do-people-want-touch-on-laptop-screens/197/)

<sup>14</sup> [www.businesswire.com/news/home/20141215006340/en/Worldwide-PC-Monitor-Market-Aided-Touch-Screen#.VJPVgCsgBg](http://www.businesswire.com/news/home/20141215006340/en/Worldwide-PC-Monitor-Market-Aided-Touch-Screen#.VJPVgCsgBg)

<sup>15</sup> The starting price (\$1,598) + three-year ProSupport Service brought the price to \$1,677.57 for non-touch-enabled display with Intel Core i5 processor and 8 GB memory for the Dell OptiPlex 9030 All-in-One. The starting price (including three-year ProSupport Service) for the Dell OptiPlex 9030 All-in-One with the same processor and memory and touch-enabled display was \$1,863.29 via [www.dell.com/us/business/p/optiplex-9030-aio/fs?pf=v](http://www.dell.com/us/business/p/optiplex-9030-aio/fs?pf=v) on 12/19/2014.

<sup>16</sup> A minute a day, valued at \$9.72 (\$350/36), per month could provide payback for a \$186 cost in 19.1 months.

<sup>17</sup> Note: We tested the Dell OptiPlex 9030 All-in-One installed with Windows 7 so that system configuration matched closely to the legacy desktop tower. The Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro are available with either Windows 7 or Windows 8.1.

can support higher performance and lower power monitor displays than the legacy desktop tower we tested. The Dell OptiPlex 9030 All-in-One also offered HDMI—either DisplayPort or HDMI on the Dell OptiPlex 9030 All-in-One can be used to add a second display.

Replacing desktops can also boost your business with the latest in wireless technology. The Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro both included Intel Dual Band Wireless-AC 7260 cards, while the legacy desktop tower we tested did not include a wireless card. Replacing a fleet of legacy desktop towers without wireless cards provides more flexibility by removing the requirement of an Ethernet port and cable for each desktop.

### Save workspace with All-in-One and Mini form factors

Upgrading to new Dell OptiPlex desktops can also offer workspace savings for your business. As Figure 9 shows, the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro required significantly less workspace than the legacy desktop tower in our study—59 and 60 percent less square inches, respectively. In addition, Dell offers mounts for the OptiPlex 9020 Micro that can further reduce its required workspace, creating more space savings when compared to the legacy desktop tower. Note: For more details on how we calculated workspace for the three systems, see [Appendix C](#).

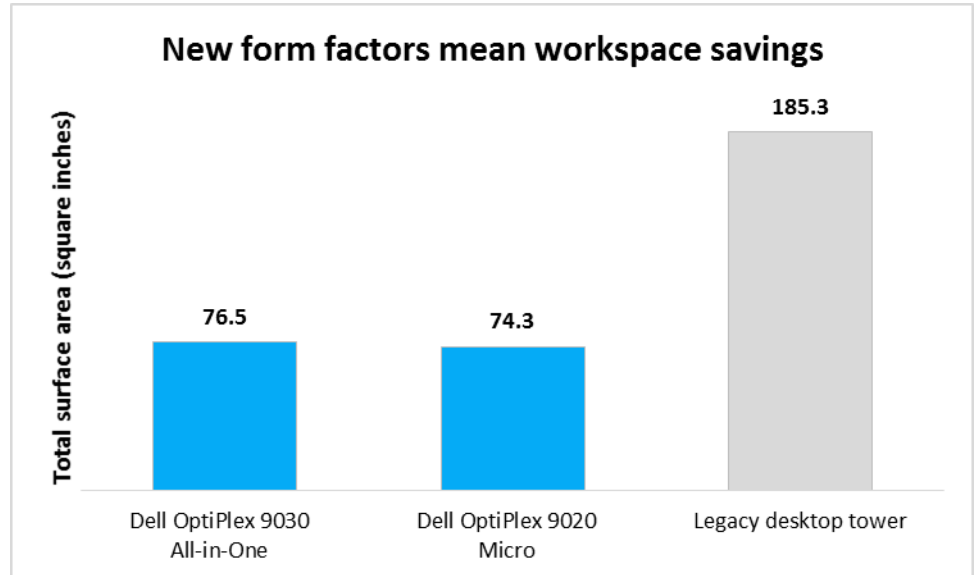
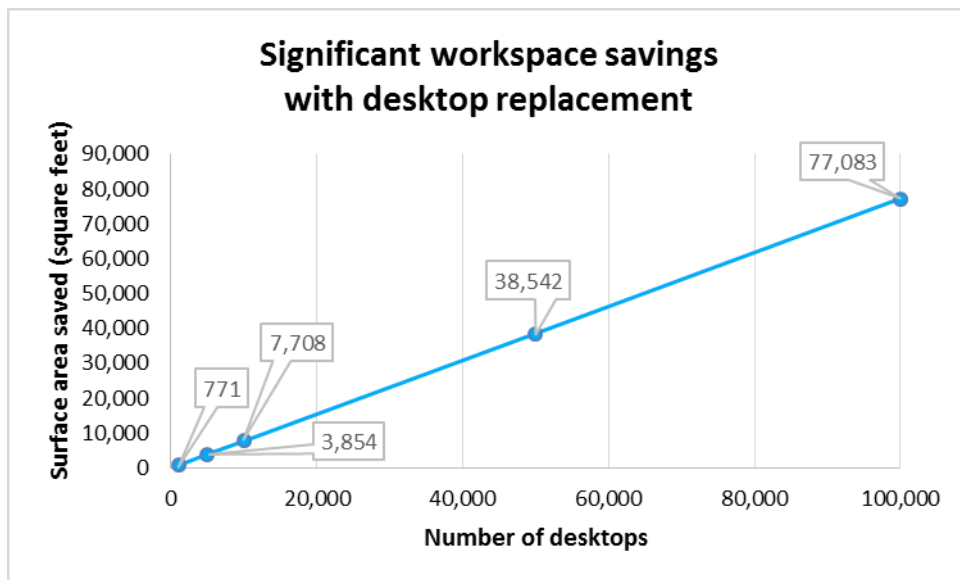


Figure 9: Total workspace based on footprint for each system. Lower numbers are better.

As Figure 10 shows, the workspace savings that replacing desktops can bring your business can have an enormous impact at scale. For example, a business replacing 10,000 legacy desktop towers with 10,000 new Dell OptiPlex 9020 Micro desktops could save 7,708 sq. ft. of valuable workspace.

Figure 10: Workspace saved in square feet when replacing a fleet of legacy desktop towers with Dell OptiPlex 9020 Micro desktops.



## CONCLUSION

Compared to aging desktops, new Dell OptiPlex desktops can allow employees to be more productive with faster and more reliable hardware while providing significantly lower power costs. Improved management technology with the new desktops can support the efforts of your IT staff and can reduce costly desktside visits. Upgrading your aging desktops with the Dell OptiPlex 9030 All-in-One or the Dell OptiPlex 9020 Micro desktops brings important improvements to your business through both hardware and software.

## APPENDIX A – SYSTEM CONFIGURATION INFORMATION

Figure 11 details the systems we used in our tests.

System	Dell OptiPlex 9030 All-in-One	Dell OptiPlex 9020 Micro	Legacy desktop tower
<b>General</b>			
Number of processor packages	1	1	1
Number of cores per processor	4	4	2
Number of hardware threads per core	1	1	1
Total number of processor threads in system	4	4	2
System power management policy	Balanced	Balanced	Balanced
Processor power-saving option	EIST	EIST	EIST
Dimensions (h × l × w in inches)	20.50 × 22.25 × 8.50	1.50 × 7.38 × 7.19	17.63 × 17.38 × 7.00
Weight (lbs.)	24.1	2.5	23.8
<b>CPU</b>			
Vendor	Intel	Intel	Intel
Name	Core i5	Core i5	Core 2 Duo
Model number	4590S	4590T	E8400
Stepping	C0	C0	E0
Socket type	Socket 1150 LGA	Socket 1150 LGA	Socket 775 LGA
Core frequency (GHz)	3.0 / 3.7 Turbo	2.0 / 3.0 Turbo	3.0
Bus frequency	DMI2 5 GT/s	DMI2 5 GT/s	1,333 MHz
L1 cache	4 × 32 KB + 4 × 32 KB	4 × 32 KB + 4 × 32 KB	2 × 32 KB + 2 × 32 KB
L2 cache	4 × 256 KB	4 × 256 KB	6 MB
L3 cache	6 MB	6 MB	N/A
<b>Platform</b>			
Vendor and system name	Dell OptiPlex 9030 All-in-One	Dell OptiPlex 9020 Micro	HP Compaq 8000 Elite Convertible Minitower
Motherboard model number	0VNGWR	0Y5DDC	3647h
Motherboard chipset	Intel Q87	Intel Q87	Intel Q45/Q43
BIOS name and version	Dell A03 (09/15/2014)	Dell A02 (08/11/2014)	Hewlett-Packard 786G7 v01.13 (07/20/2011)
AMT Version	5.2.50	9.1.0	9.1.0

System	Dell OptiPlex 9030 All-in-One	Dell OptiPlex 9020 Micro	Legacy desktop tower
<b>Memory module(s)</b>			
Vendor and model number	Samsung® M471B5173DB0-YK0	Hyundai Electronics HMT41GS6BFR8A-PB	Samsung M378B5673EH1-CH9
Type	PC3-12800	PC3-12800	PC3-10600
Speed (MHz)	1,600	1,600	1,333
Speed running in the system (MHz)	1,600	1,600	1,066
Timing/Latency (tCL-tRCD-tRP-tRASmin)	11-11-11-28	11-11-11-28	7-7-7-20
Size (MB)	4,096	8,192	2,048
Number of memory module(s)	2	1	2
Total amount of system RAM (GB)	8	8	4
Channel (single/dual)	Dual	Single	Dual
<b>Hard disk</b>			
Vendor and model number	Seagate® ST500LT012	Samsung PM851 SSD	Seagate ST3320418AS
Number of disks in system	1	1	1
Size (GB)	500	128	320
Buffer size (MB)	16	N/A	16
RPM	5,400	N/A	7,200
Type	SATA 6.0 Gb/s	SATA 6.0 Gb/s	SATA 3.0 Gb/s
Controller	Intel 8 Series/C220 Chipset Family SATA AHCI	Intel 8 Series/C220 Chipset Family SATA AHCI	Intel Express Chipset SATA RAID Controller
Driver	Intel 12.8.7.1000 (10/18/2013)	Intel 13.0.0.1098 (02/05/2014)	Intel 10.1.0.1008 (11/06/2010)
<b>Operating system</b>			
Name	Windows 7 Professional x64	Windows 7 Professional x64	Windows 7 Professional x64
Build number	7600	7600	7600
Service Pack	1	1	1
File system	NTFS	NTFS	NTFS
Kernel	ACPI x64-based PC	ACPI x64-based PC	ACPI x64-based PC
Language	English	English	English
Microsoft DirectX® version	11	11	11

System	Dell OptiPlex 9030 All-in-One	Dell OptiPlex 9020 Micro	Legacy desktop tower
<b>Graphics</b>			
Vendor and model number	Intel HD Graphics 4600	Intel HD Graphics 4600	Intel GMA 4500
Type	Integrated	Integrated	Integrated
Chipset	Intel HD Graphics Family	Intel HD Graphics Family	Intel 4 Series Express Chipset Family
BIOS version	2179.5	2179.1	2066.0
Total available graphics memory (MB)	1,696	1,696	1,695
Dedicated video memory (MB)	64	64	64
System video memory (MB)	0	0	0
Shared system memory (MB)	1,632	1,632	1,631
Resolution	1,920 × 1,080	1,920 × 1,080	1,920 × 1,080
Driver	Intel 10.18.10.3412 (01/29/2014)	Intel 10.18.10.3412 (01/29/2014)	Intel 8.15.10.2413 (06/03/2011)
<b>Sound card/subsystem</b>			
Vendor and model number	Realtek® High Definition Audio	Realtek High Definition Audio	Realtek High Definition Audio
Driver	Realtek 6.0.1.6053 (10/16/2014)	Realtek 6.0.1.6032 (04/25/2014)	Realtek 6.0.1.6383 (05/31/2011)
<b>Ethernet</b>			
Vendor and model number	Intel Ethernet Connection I217-LM	Intel Ethernet Connection I217-LM	Intel 82567LM-3 Gigabit Controller
Driver	Intel 12.12.50.4 (06/12/2014)	Intel 12.12.50.7205 (07/31/2014)	Intel 12.10.13.0 (12/16/2013)
<b>Wireless</b>			
Vendor and model number	Intel Dual Band Wireless-AC 7260	Intel Dual Band Wireless-AC 7260	N/A
Driver	Intel 17.0.5.8 (06/18/2014)	Intel 17.0.5.8 (06/18/2014)	N/A
<b>Optical drive(s)</b>			
Vendor and model number	TSSTcorp SU-208FB	N/A	HP TS-H653R
Type	DVD-RW	N/A	DVD-RW
<b>USB ports</b>			
Number	8	6	10
Type	3.0	3.0	2.0
Other	Media card reader, DisplayPort, 1 × HDMI In, 1 × HDMI Out	DisplayPort	N/A

System	Dell OptiPlex 9030 All-in-One	Dell OptiPlex 9020 Micro	Legacy desktop tower
<b>Monitor</b>			
Model	Dell All-in-One Touch Display	Dell P2314H	ViewSonic® VG730m
LCD type	Backlit LED	Backlit LED	SXGA LCD
Screen size	23"	23"	17"
Refresh rate (Hz)	60	60	60
Maximum resolution	1,920 × 1,080	1,920 × 1,080	1,280 × 1,024

Figure 11: Detailed information for our test systems.

Figure 12 describes the configuration of the server that we used to access the desktops for management tasks.

System	Dell PowerEdge™ R620
<b>Power supplies</b>	
Total number	2
Vendor and model number	Dell D750E-S1
Wattage of each (W)	750
<b>Cooling fans</b>	
Total number	7
Vendor and model number	Delta® GFC0412DS
Dimensions (h × w) of each	1-1/2" × 1-3/4"
Volts	12
Amps	1.82
<b>General</b>	
Number of processor packages	2
Number of cores per processor	8
Number of hardware threads per core	2
System power management policy	Default
<b>CPU</b>	
Vendor	Intel
Name	Xeon®
Model number	E5-2660
Socket type	LGA 2011
Core frequency (GHz)	2.20
Bus frequency	8
L1 cache	32 KB + 32 KB (per core)
L2 cache	256 KB (per core)
L3 cache	20 MB
<b>Platform</b>	
Vendor and model number	Dell PowerEdge R620
BIOS name and version	Dell 2.4.3 (10/10/2014)
BIOS settings	Default



System	Dell PowerEdge™ R620
<b>Memory module(s)</b>	
Total RAM in system (GB)	128
Vendor and model number	Micron® MT36KSF1G72PZ
Type	PC3-12800R
Speed (MHz)	1,600
Speed running in the system (MHz)	1,600
Timing/Latency (tCL-tRCD-tRP-tRASmin)	9-9-9-24
Size (GB)	8
Number of RAM module(s)	20
Chip organization	Double-sided
Rank	Dual
<b>Operating system</b>	
Name	Microsoft Windows Server® 2012 R2 Datacenter
Build number	9600
File system	NTFS
Kernel	6.2.9600.16452
Language	English
<b>RAID controller</b>	
Vendor and model number	Dell PERC H710P Mini
Firmware version	21.3.1-0009 06/23/2014
Driver version	6.802.21.00 08/27/2014
Cache size (MB)	1,024
<b>Local storage</b>	
Vendor and model number	Seagate ST9900806SS
Number of drives	4
Size (GB)	900
RPM	10K
Type	SAS
<b>Ethernet adapters</b>	
Vendor and model number	Intel Gigabit I350 4-port
Type	Integrated
Driver	12.11.97.1 (08/13/2014)
USB 2.0 ports	4

Figure 12: Detailed information for our test server.

## APPENDIX B – HOW WE CALCULATED OVERALL SYSTEM PERFORMANCE

We included the following benchmarks in our performance/productivity calculation:

- HDXPRT 2012
- PCMark® 8 Work workload
- SYSmark® 2014
- 3DMark® Ice Storm
- 3DMark Ice Storm Extreme

We ran the five benchmarks on the Dell OptiPlex 9030 All-in-One, Dell OptiPlex 9020 Micro, and legacy desktop tower, repeating each test three times. For our calculations, we selected the median of the three results for each benchmark and system. We calculated the percentage wins for the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro versus the legacy desktop tower on each benchmark. The Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro outperformed the legacy desktop tower on all five benchmarks.

We calculated system performance by taking the geometric mean of the percentage wins; that gave us a 145.3 percent system performance improvement for the Dell OptiPlex 9030 All-in-One versus the legacy desktop and a 114.1 percent system performance improvement for the Dell OptiPlex 9020 Micro (see Figure 13).

	Dell OptiPlex 9030 All-in-One		Dell OptiPlex 9020 Micro		Legacy desktop tower
	Score	% improvement over legacy desktop tower	Score	% improvement over legacy desktop tower	Score
HDXPRT (Create HD score)	229	129%	193	93%	100
SYSmark (Overall Rating)	1,417	133%	1,334	120%	607
PCMark (Work Score)	3,015	29%	3,093	32%	2,341
3DMark Ice Storm (Median)	57,050	361%	40,258	225%	12,385
3DMark Ice Storm Extreme (Median)	34,812	360%	25,834	241%	7,566
<b>Geometric mean of percentage wins</b>		<b>145.3%</b>		<b>114.1%</b>	

Figure 13: System performance improvement based on our benchmark testing.

## APPENDIX C – HOW WE CALCULATED WORKSPACE

Figure 14 shows the dimensions for the three systems and the workspace savings for the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro. The base of the Dell OptiPlex 9030 All-in-One was roughly the same size as the 9" circular base of the monitor that we paired with the legacy desktop tower. The legacy desktop tower chassis (17.6" × 17.4" × 7.0") took up 121.7 square inches of desk space. The circular base of the monitor added 63.6 square inches, for a total footprint of 185.3 square inches. With a footprint of 76.5 square inches, the Dell OptiPlex 9030 All-in-One was 108.8 square inches smaller than the legacy desktop tower—a savings of 59 percent.

The Dell OptiPlex 9020 Micro chassis (1.5" × 7.4" × 7.2") took up 11.1 square inches of desk space. We used monitors with similar footprints for the Dell OptiPlex 9020 Micro (62.2 square inches) and the legacy desktop tower (63.6 squares inches). Including the monitors, the footprint of the Dell OptiPlex 9020 Micro was 111.0 square inches smaller than the footprint of the legacy desktop tower—a savings of 60 percent.

	Monitor		System		Total		
	Length × width (inches)	Area (sq. inches)	Length × width (inches)	Area (sq. inches)	Total Area (sq. inches)	Advantage vs. legacy (sq. inches)	Advantage (%)
Dell OptiPlex 9030 All-in-One	8.5 × 9.0	76.5			<b>76.5</b>	<b>108.8</b>	<b>59%</b>
Dell OptiPlex 9020 Micro (on its narrow side)	7.1 × 8.9	63.2	7.4 × 1.5	11.1	<b>74.3</b>	<b>111.0</b>	<b>60%</b>
Legacy desktop tower (circular base)	9.0	63.6	17.4 × 7	121.7	<b>185.3</b>		

**Figure 14: Dimensions of the three systems and the workspace savings for the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro.**

## APPENDIX D – HOW WE TESTED

### Configuring the SCCM management environment

Starting from our base Microsoft System Center 2012 Configuration Manager build, we configured our environment to test KVM Remote Control capability on our target clients. Figure 15 shows our isolated testing environment, which comprised of one Dell PowerEdge R620 server running Windows Server 2008 R2 Hyper-V® with four virtual machines. Before configuration, we installed all available Windows updates on our clients and joined each desktop to the test.local domain. We created Active Directory accounts for AMT provisioning and installed Intel Setup and Configuration Software (Intel SCS). Next, we provisioned the desktops using Configurator, provided by Intel, to apply our custom management profile from SCS to each client’s management engine. We provide detailed steps below for each of these procedures. Finally, Dell Command | Intel vPro Out of Band , which we used to connect to the Dell OptiPlex 9030 All-in-One and Dell OptiPlex 9020 Micro to complete our out-of-band management testing.

Description	Computer name	Operating system	Roles Installed	Assigned IP	vCPU	vRAM
Domain controller	dc.test.local	Windows Server 2008 R2 Standard	Active Directory, Domain Controller, DHCP	192.168.1.10	1	8 GB
Certificate authority	ca.test.local	Windows Server 2008 R2 Enterprise	Certification Authority	192.168.1.15	1	8 GB
Database server	db.test.local	Windows Server 2008 R2 Standard	SQL Server 2012 Enterprise	192.168.1.20	1	16 GB
Management server	cm.test.local	Windows Server 2008 R2 Standard	System Center 2012 Configuration Manager SP1	192.168.1.50	2	16 GB

Figure 15: The details of our isolated testing environment.

### Constructing the infrastructure

#### Creating Active Directory accounts for AMT provisioning

1. Log into the Domain Controller using the domain\administrator account.
2. Open Active Directory Administrative Center.
3. Under test(local), click New→Group.
4. On the Create Group window, for Group name, use Kerberos Admins; for Group type, use security.
5. Add Kerberos Admins as a member of the Domain Admins group.
6. Add the computer account of the SCCM server to the Kerberos Admins security group.
7. Create an Organizational Unit for AMT managed systems. We used `AMT`
8. Create a security group called `AMT`
9. Add the Kerberos Admins group to the AMT security group.

#### Creating certificate templates for OOB management

1. Log into the Windows 2008 R2 Enterprise server designated for Certificate Authority as domain\administrator.
2. Click Start→Administrative Tools→Certification Authority.
3. Right-click on test-CA-CA, and click Properties.

4. On the General tab, click View Certificate.
5. On the Details tab, scroll to and select Thumbprint. Copy the 40-character code displayed in the details. You will add this information to the AMT BIOS later.
6. To close the Certificate Authority properties, click OK.
7. Expand the Certification Authority, and select Certificate Templates.
8. Right-click Certificate Templates, and select Manage.
9. Locate Web Server in the list of available certificate templates. Right-click the template, and select Duplicate Template.
10. Select Windows 2003 Enterprise, and click OK.
11. Change the template name for the AMT Provisioning certificate. We used `AMT Provisioning`.
12. On the Subject Name tab, select Build from this Active Directory Information. Select Common Name, and choose the option UPN.
13. On the Security tab, add the security group created for the SCCM site server. We used the Kerberos Admin group. Add the Enroll permission for the security group. Ensure Domain Admins and Enterprise Admins have Enroll permissions.
14. On the Extensions tab, select Application Policies, and click Edit.
15. Click Add. Click New. Type `AMT Provisioning` for the name, and `2.16.840.1.113741.1.2.3` as the Object Identifier. Click OK.
16. Ensure AMT Provisioning and Server Authentication are listed, and click OK.
17. Click OK to close the template properties.
18. Right-click the AMT Web Server Certificate template, and select Duplicate Template.
19. Select Windows 2003 Enterprise, and click OK.
20. Change the template name for the AMT Web Server Certificate. We used `AMT Web Server Certificate Template`.
21. On the General tab, choose the option Publish Certificate in Active Directory.
22. On the Subject Name tab, select Supply in the request.
23. On the Security tab, ensure Domain Admins and Enterprise Admins have Enroll permissions.
24. To close the template properties, click OK.
25. In Certification Authority, navigate to Certificate Templates.
26. For both the AMT Provisioning Template, and the AMT Web Server Certificate Template, repeat the following steps:
27. Right-click the central panel, and select New → Certificate Template to Issue.
28. Select the AMT Provisioning Template.
29. Click OK.
30. Log into the management server as `domain\administrator`.
31. Click Start → Run. Type `mmc` and press Enter.
32. In the mmc console, click File → Add/Remove Snap-in...
33. Select Certificates, and click Add. Select Computer account. Click Next.
34. Select Local computer, and click Finish.
35. Click OK.
36. Expand Certificates (Local Computer) → Personal → Certificates.

37. In the right panel, click More Actions→All Tasks→Request a new certificate...
38. Click Next.
39. Accept the defaults, and click Next.
40. Select the new AMT Provisioning certificate. Click Enroll.
41. Click File→Add/Remove Snap-in...
42. Select Certificates, and click Add. Select Computer account. Click Next.
43. Select My user account, and click Finish.
44. Click OK.
45. Expand Certificates→Personal→Certificates.
46. In the right panel, click More Actions→All Tasks→Request a new certificate...
47. Click Next.
48. Accept the defaults, and click Next.
49. Select the new AMT Provisioning certificate. Click Enroll.
50. Click File→Add/Remove Snap-in...
51. Select Certificates, and click Add. Select My user account. Click Next.
52. Select Local computer, and click Finish.
53. Click OK.
54. Expand Certificates – Current User→Personal→Certificates.
55. From Certificates (Local)→Personal→Certificates, click and drag the certificate created using the AMT Provisioning template into Certificates – Current User→Personal→Certificates.
56. Click Close.

### ***Installing Intel Setup and Configuration Software (SCS) 9.1***

1. Download IntelSCS\_9.1.zip from [downloadcenter.intel.com/Detail\\_Desc.aspx?DwnldID=20921](http://downloadcenter.intel.com/Detail_Desc.aspx?DwnldID=20921).
2. Extract the contents to C:\IntelSCS\_9.1.
3. Browse to C:\IntelSCS\_9.1\IntelSCS\RCS.
4. Run IntelSCSInstaller.exe.
5. At the Welcome screen, click Next.
6. Select I accept the terms of the license agreement, and click Next.
7. Check the Boxes for Remote Configuration Service (RCS), Database Mode, and Console.
8. Enter the credentials of the Domain account that will run the service. We used `test.local\administrator`. Click Next.
9. Select db.test.local as the location for the SCS database. This information may populate automatically. Select Windows Authentication, and click Next.
10. On the Create Intel SCS Database pop-up, click Create Database.
11. On the confirmation screen, click Close.
12. On the confirmation screen, leave the default Installation Folder, and click Install.
13. Once the installation is complete, click Next.
14. Click Finish.

### **Setting up AMT provisioning with Intel SCS Remote Configuration Service**

#### ***Creating the configuration profile***

1. On the management server, launch the Intel Setup and Configuration Console.

2. Click Profiles.
3. To construct a profile for deployment, click New.
4. For Profile Name, enter a description of the target clients. We used `inteltest`. Click OK.
5. On the Getting Started Screen, choose Configuration / Reconfiguration.
6. On the Optional Settings screen, choose the options Active Directory Integration, Access Control List (ACL), and Transport Layer Security (TLS), and click Next.
7. On the AD Integration screen, browse for the OU created for the AMT managed devices. We used OU=AMT, DC=test, DC=local. Check the box for Always use host name, and click Next.
8. On the Access Control List screen, click Add.
9. Select Active Directory User/Group. Click Browse.
10. Add Kerberos Admin, Domain Admins, or other administrative users groups. Click OK.
11. For Access Type, select Remote.
12. Choose the option for PT Administration. Click OK.
13. Click Next.
14. On the TLS screen, from the drop-down menu, select the Enterprise Certificate Authority, `ca.test.local`.
15. Select the Server Certificate Template to be used to generate certificates for the AMT devices. We selected `AMTWebServerCertificate`. Click Next.
16. On the System Settings screen, choose the options Web UI, Serial Over LAN, IDE Redirection, and KVM Redirection.
17. Select Use the following password for all systems. Enter the password for use after provisioning is complete. We used `P@ssw0rd`
18. Click KVM Settings...
19. Enter the RFB Password for KVM sessions. We used `P@ssw0rd`
20. Enter the MEBX password. We used `P@ssw0rd`
21. Uncheck User Consent required before beginning KVM session, and click OK.
22. Choose the options Enable Intel AMT to respond to ping requests and Enable Fast Call for Help (within the enterprise network).
23. To Edit IP and FQDN settings, click Set.
24. In the Network Settings window, select Use the following as the FQDN, and choose Primary DNS FQDN from the drop-down menu.
25. Choose the option, the device and the OS will have the same FQDN (Shared FQDN).
26. Select Get the IP from the DHCP server.
27. Select Update the DNS directly or via DHCP option 81. Click OK.
28. Click Next.
29. Click Finish.

### Configuring the clients

Repeat these steps for each client.

### Reserving an IP address in DHCP

1. On the Domain Controller, run `dhcpgmt.msc`.
2. Expand FQDN → IPv4 → Scope, and click Reservations.
3. Click More Actions, and click New Reservation.

4. For Reservation Name, enter the host name of the target client.
5. Enter an IP address to reserve.
6. Enter the MAC address of the target client's Ethernet port.
7. Click Add.

#### ***Configuring policy on the target client***

1. Log onto the target client using domain\administrator.
2. Download and apply applicable driver packages from the manufacturer's Web site.
3. Open Windows Firewall with Advanced Security.
4. Click Firewall Properties.
5. On the Domain Profile, Private Profile, and Public Profile tabs, set the Firewall state to Off. Click OK.
6. Set the host name and IP of each virtual machine as described above.
7. Run lusrmgr.msc.
8. Select Groups.
9. Right-click Administrators, and click Properties.
10. Click Add.
11. Select Object Types, check the box for Computers, and click OK.
12. Disable the wireless adapter.

#### ***Configuring the Configuration Manager Client***

1. On the management server, navigate to Program Files→ Microsoft Configuration Manager folder.
2. Copy the Client folder to the target client.
3. On the target client, run ccmsetup.exe. This task will run in the background and will take a few minutes to complete.
4. In Control Panel, open Configuration Manager.
5. On the Site tab, click Configure Settings.
6. For Currently assigned to site code, enter PTL, and click Apply.
7. In the Actions panel, run the User Policy Retrieval & Evaluation Cycle and the Machine Policy Retrieval & Evaluation Cycle.
8. After a few minutes, the Actions panel will populate with more tasks. Run each one of the tasks.

#### ***Adding the enterprise certificate authority to the AMT trusted root certification authorities***

1. Power on the target client.
2. During POST, press CTRL-P to enter the Intel Management Engine BIOS settings.
3. When prompted for a password, type the default password `admin`
4. Provide and confirm a new password. We used `P@ssw0rd`
5. Select Intel AMT Configuration. Press Enter.
6. Select SOL/IDER/KVM.
7. All features should be Enabled. To exit the menu, press Esc.
8. Select User Consent.
9. Change User Opt-in to None.
10. Change Opt-in Configurable from Remote IT to Disabled. To exit the menu, press Esc.
11. Change Password Policy to During Setup and Configuration.
12. Select Network Setup.



13. Select Intel ME Network Name Settings.
14. For Host Name, use the same host name used for the operating system.
15. For Domain Name, enter the domain name. We used `test.local`
16. For Shared/Dedicated FQDN, select Shared.
17. For Dynamic DNS Update, select Enabled. Press Esc to exit the menu.
18. Select Remote Setup and Configuration. Press Enter.
19. On Provisioning Server IPv4/IPv6, enter the IP address of the system center server. We used `192.168.1.50`
20. For Provisioning Server FQDN, enter the FQDN of the management server. We entered `cm.test.local`. For port number we used `9971`
21. Select TLS PKI.
22. Select PKI DNS Suffix, and type the FQDN suffix. We used `test.local`. Press Enter.
23. Select Manage Hashes.
24. To add a new hash, press Insert.
25. Enter a descriptive name for the Enterprise Certificate Authority. We used `test.local CA`
26. Press Enter.
27. Following the syntax example provided in the prompt, enter the 40-character thumbprint previously copied from the Enterprise CA root certificate. Press Enter.
28. To set the hash certificate as active, press Y. `test.local CA` will appear in the list of trusted root authorities and should be active.
29. To return to the AMT Configuration Menu, press Esc.
30. Select Activate Network Access. To confirm, press Y.
31. To exit, press Esc until prompted. To confirm exit, press Y.

#### ***Executing the remote configuration script on the AMT managed client***

1. Log into the AMT managed target client as `domain\administrator`.
2. Copy the `\Configurator` folder from the `SCS_9.1` directory located on the management server to `C:\` on the local host.
3. Open a command prompt as administrator.
4. Type `cd C:\Configurator` and press Enter.
5. Execute the following command:  

```
ACUConfig.exe /lowsecurity /output console /verbose ConfigViaRCSONly  
cm.test.local inteltest
```
6. The Configurator utility will contact the Remote Configuration Service and apply the settings configured in the `inteltest` profile.

#### ***Setting up AMT discovery in SCCM***

1. On the management server, open the SCCM Management Console. Locate the target client in the Devices panel.
2. Right-click the headings bar in the Devices panel, and check the entries for AMT Status and AMT Version.
3. Right-click the server, and select Manage Out of Band → Discover AMT Status. Click OK.
4. In the Home menu at the top of the panel, click Refresh.

5. The Client, Site Code, and Client Activity fields will populate. The AMT Status will change to Externally provisioned.

### Installing Dell Command | vPro Out of Band

1. Download the Dell Command | vPro Out of Band 2.0 from [downloads.dell.com/FOLDER02502830M/2/DCIV\\_194\\_ZPE.exe](https://downloads.dell.com/FOLDER02502830M/2/DCIV_194_ZPE.exe)
2. Run DCIV\_194\_ZPE.exe. Continue as prompted to extract the installation files onto the management server.
3. Run DCIV\_Setup\_2\_0\_0.
4. On the Dell Command | Intel vPro Out of Band – v 2.0.0.194 window, click Next.
5. On the License Agreement screen, accept the License Agreement, and click Next.
6. On the Ready to Install the Program screen, click Install.
7. When complete, click Finish.
8. Open Dell Command | Intel vPro Out of Band.
9. At the welcome screen, click OK.
10. At the Settings screen, for Data Configuration enter the appropriate information. We used the following:
  - System Center SQL server : `db.test.local`
  - System Center database : `CM_PTL`
11. For Client Credentials, enter the appropriate information. We used the following:
  - Operating System Domain: `test.local`
  - Username : `administrator`
  - Password : `Password1`
  - Password confirmation : `Password1`
  - AMT Management Engine Domain : `test.local`
  - Username : `admin`
  - Password : `P@ssw0rd`
  - Password Confirmation : `P@ssw0rd`
12. On the Task Queue screen, turn off Refresh Automatically.
13. Set the History Limit to 7.
14. Click OK.

## Timing common management tasks on the Dell OptiPlex desktops

### Changing one BIOS setting

1. On the management server, place the mouse over the Windows start menu icon and start the timer. From the task bar, click on the icon to open Dell Command | Intel vPro Out of Band.
2. Select Client Configuration.
3. Select BIOS Settings.
4. Click Next.
5. On the BIOS Settings screen, for Active Processor Cores, for Value to Set select All and check the box to Apply the Setting.
6. Click Next.
7. On the Available clients screen, select the target client. Click the right pointing arrow to add the selected client to the list.
8. For a second client, repeat step 7.

9. Click Next.
10. Type a description in the Description field. We used test.
11. Click Next.
12. Click Finish.
13. Complete steps 1 through 12 two more times, and report the median of the three runs.

#### Changing five BIOS settings

1. On the management server, place the mouse over the Windows start menu icon and start the timer. From the task bar, click on the icon to open Dell Command | Intel vPro Out of Band.
2. Select Client Configuration.
3. Select BIOS Settings.
4. Click Next.
5. On the BIOS Settings screen, for Active Processor Cores, for Value to Set select All and check the box to Apply the Setting.
6. For Enable Intel SpeedStep for Value to Set select Enabled and check the box to Apply the Setting.
7. For Enable Intel Virtualization Technology for Value to Set select Enabled and check the box to Apply the Setting.
8. For Enable MEBx Hotkey for Value to Set select Enabled and check the box to Apply the Setting.
9. For Enable VT for Direct I/O for Value to Set select Enabled and check the box to Apply the Setting.
10. Click Next.
11. On the Available clients screen, select the target client. Click the right pointing arrow to add the selected client to the list.
12. Repeat step 11 for second client.
13. Click Next.
14. Type a description in the Description field. We used test.
15. Click Next.
16. Click Finish.
17. Complete steps 1 through 16 two more times, and report the median of the three runs.

#### Changing boot order

1. On the management server, place the mouse over the Windows start menu icon and start the timer. From the task bar, click on the icon to open Dell Command | Intel vPro Out of Band.
2. Select Client Configuration.
3. Select Boot Order.
4. Select Internal Optical Drive from the Device list and click the up Arrow button to move the drive up in the Boot order once.
5. Click Next.
6. Select the target client on the Available clients screen. Click the right pointing arrow to add the selected client to the list.
7. Repeat step 6 for the second system.
8. Click Next.
9. Type a description in the Description field. We used test.
10. Click Next.

11. Click Finish.
12. Complete steps 1 through 11 two more times, and report the median of the three runs.

### Changing the BIOS password

1. On the management server, place the mouse over the Windows start menu icon and start the timer. From the task bar, click on the icon to open Dell Command | Intel vPro Out of Band.
2. Select Client Configuration.
3. Select BIOS Passwords.
4. For Password task, select Set.
5. Select Administration.
6. For New Password, type `Password1`
7. For Confirm New Password, type `Password1`
8. Click Next.
9. On the Available clients screen, select the target client. Click the right pointing arrow to add the selected client to the list.
10. Repeat step 9 for the second system.
11. Click Next.
12. Type a description in the Description field. We used `test`.
13. Click Next.
14. Click Finish.
15. Complete steps 1 through 14 two more times, and report the median of the three runs.

### Changing the power profile

1. On the management server, place the mouse over the Windows start menu icon and start the timer. From the task bar, click on the icon to open Dell Command | Intel vPro Out of Band.
2. Select Client Configuration.
3. Select Power Profile.
4. For Desktop power policy, select ON in S0; ME Wake in S3, S4-S5.
5. For Mobile power policy, select No change.
6. Click Next.
7. On the Available clients screen, select the target client. Click the right pointing arrow to add the selected client to the list.
8. Repeat step 7 for the second system.
9. Click Next.
10. Type a description in the Description field. We used `test`
11. Click Finish.
12. Complete steps 1 through 11 two more times, and report the median of the three runs.

### Measuring the time to open a KVM session

1. On the management server, place the mouse over the Windows start menu icon and start the timer. From the task bar, click on the icon to open Dell Command | Intel vPro Out of Band.
2. Select Operations.
3. Select KVM Connect.
4. On the KVM Connect screen, select the target client, and click Connect.

5. The KVM window will appear and connect automatically. When the login screen is visible, stop the timer.
6. Complete steps 1 through 5 two more times, and report the median of the three runs.

## Timing common management tasks on the legacy desktop tower

### Changing one BIOS setting

1. With the client at the Windows login screen, start the timer. Restart the computer.
2. As the system reboots, press F10 to boot into the setup menu.
3. Select English.
4. Under the advanced tab, select device options.
5. Select Multi-processor.
6. Select Enable
7. Press F10 to accept.
8. Press escape, down, and Enter to Save Changes and Exit.
9. Press F10 and allow the system to reach the login screen. When the login screen is visible, stop the timer.
10. Complete steps 1 through 9 two more times, and report the median of the three runs.

### Changing five BIOS setting

1. With the client at the Windows login screen, start the timer. Restart the computer.
2. As the system reboots, press F10 to boot into the setup menu.
3. Select English.
4. Under the Security Tab, select System Security.
5. Select Virtualization Technology (VTx).
6. Select Enable.
7. Press F10 to accept
8. Select Virtualization Technology Direct I/O (VTd)
9. Select Enable.
10. Press F10 to accept.
11. Under the Power tab, select OS Power Management.
12. Select Runtime Power Management.
13. Select Enable.
14. Press F10 to accept.
15. Under the advanced tab, select device options.
16. Select Multi-processor.
17. Select Enable
18. Press F10 to accept.
19. Select Management operations.
20. Select MEBx Setup Prompt.
21. Select Displayed.
22. Press F10 to accept.
23. Press escape, down, and Enter to Save Changes and Exit.
24. Press F10 and allow the system to reach the login screen. When the login screen is visible, stop the timer.
25. Complete steps 1 through 24 two more times, and report the median of the three runs.

### Changing boot order

1. With the client at the Windows login screen, start the timer. Restart the computer.
2. As the system reboots, press F10 to boot into the setup menu.
3. Select English.
4. Under the Storage tab, select boot Order.
5. Select ATAPI CD-ROM Drive by pressing Enter.
6. Press up to move the CD-ROM Drive, and press enter.
7. Press F10 to accept.
8. Press escape, down, and Enter to Save Changes and Exit.
9. Press F10 and allow the system to reach the login screen. When the login screen is visible, stop the timer.
10. Complete steps 1 through 9 two more times, and report the median of the three runs.

### Changing BIOS password

1. With the client at the Windows login screen, start the timer. Restart the computer.
2. As the system reboots, press F10 to boot into the setup menu.
3. Select English.
4. Under the Security tab, select Setup Password.
5. For Enter New Setup Password, type Password1.
6. For Enter New Password Again, type Password1
7. Press F10 to accept.
8. Press escape, down, and Enter to Save Changes and Exit.
9. Press F10 and allow the system to reach the login screen. When the login screen is visible, stop the timer.
10. Complete steps 1 through 9 two more times, and report the median of the three runs. Before starting the next run, remove the added BIOS password.

### Changing the power profile

1. With the client at the Windows login screen, start the timer. Restart the computer.
2. As the system reboots, press Ctrl + P to boot into MEBX.
3. Enter the Password.
4. Select Intel ME Configuration.
5. Press Y to Confirm.
6. Select Intel ME Power Control.
7. Press Enter.
8. Select Desktop: ON in S0, S3, S4-5.
9. Press ESC three times
10. When asked if you want to exit, press Y and allow the system to reach the login screen. When the login screen is visible, stop the timer.
11. Complete steps 1 through 10 two more times, and report the median of the three runs.

## Measuring system performance

### HDXPRT 2012

#### Setting up the test

1. Insert the HDXPRT v1.1 DVD-ROM into your DVD drive.
2. At the HDXPRT Install screen, click Install HDXPRT.

3. Accept the HDXPRT end-user license agreement.
4. After the setup is complete, select Yes, I want to restart my computer now, and click Finish.

#### **Running the test**

1. On the desktop, click the HDXPRT 2012 shortcut.
2. Click Run HDXPRT.
3. Enter a test name, choose 3 iterations, and click Run.
4. The Results Screen automatically appears at the end of a successful run.

#### **BAPCo® SYSmark 2014 v1.0.1.21**

##### **Antivirus software conflicts**

SYSmark 2014 is not compatible with any virus-scanning software, so we uninstalled any such software that was present on the desktop PCs before we installed the benchmark.

##### **Pre-installed software conflicts**

SYSmark 2014 installs the following applications, which its test scripts employ:

- Adobe® Acrobat® XI Pro
- Adobe Photoshop® CS6 Extended
- Adobe Premiere® Pro CS6
- Google Chrome™
- Microsoft Excel® 2013
- Microsoft OneNote® 2013
- Microsoft Outlook® 2013
- Microsoft PowerPoint® 2013
- Microsoft Word 2013
- Trimble® SketchUp® Pro 2013
- WinZip® Pro 17.5

##### **Setting up the test**

1. Disable the User Account Control.
2. Click Start→Control Panel.
3. At the User Accounts and Family Safety settings screen, click Add or remove user account.
4. At the User Account Control screen, click Continue.
5. Click Go to the main User Accounts page.
6. At the Make changes to your user account screen, click Turn User Account Control on or off.
7. At the User Account Control screen, click Continue.
8. Uncheck Use User Account Control to help protect your computer, and click OK.
9. At the You must restart your computer to apply these changes screen, click Restart Now.
10. Purchase SYSmark 2014 v1.0.1.21 from [bapco.com/products/sysmark-2014](http://bapco.com/products/sysmark-2014) and install with default settings.
11. To launch SYSmark 2014, double-click the desktop icon, and select Configuration.
12. Select all options, and click Save.

##### **Running the test**

1. Double-click the desktop icon to launch SYSmark 2014.
2. Make sure Office Productivity, Media Creation, and Data/Financial Analysis are selected.

3. Enter a Project name.
4. Select 3 Iterations, check the box beside Conditioning Run and beside Process Idle Tasks, and click Run Benchmark.
5. When the benchmark completes and the main SYSmark 2014 menu appears, click Save FDR to create a report.

### **Futuremark® PCMark 8 v2.3.293**

#### **Setting up the test**

1. Download the PCMark 8 installer exe Windows package from [www.futuremark.com/benchmarks/pcmark8](http://www.futuremark.com/benchmarks/pcmark8).
2. Double-click the PCMark installer exe file to install PCMark 8 with the default options.
3. Click the PCMark 8 desktop icon to launch PCMark 8. Enter the registration code, click Register, and click OK.
4. Exit PCMark 8.

#### **Running the test**

1. Boot the system and type `CMD` to bring up a command prompt.
2. To open App options, right-click the Command Prompt app.
3. Click Run as administrator.
4. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
5. Do not interact with the system until the command completes.
6. After the command completes, wait 5 minutes before running the test.
7. Double-click the PCMark 8 desktop icon to launch the benchmark.
8. Select the Home test suite.
9. Click Run Conventional.
10. When the benchmark run completes, record the results.
11. Shut down the system.
12. Complete steps 1 through 11 two more times for the Home test suite, and report the median of the three runs.
13. After completing the three runs of the Home test suite, perform steps 1 through 12 for the Creative, Work, Storage, and Application suites.

### **3DMark**

#### **Installing 3Dmark v1.4.828**

14. Download the 3DMark installer from [www.futuremark.com/benchmarks/3dmark/all](http://www.futuremark.com/benchmarks/3dmark/all).
15. To install 3DMark with the default options, double-click the 3DMark installer exe file.
16. At the Welcome screen, click Next.
17. At the License Agreement screen, click I accept the terms of the license agreement, and click Next.
18. At the Setup Type screen, click Express, and click Next.
19. At the Ready to Install the Program screen, click Install.
20. At the Setup Complete screen, click Finish.
21. To launch 3DMark, double-click the 3DMark desktop icon. Enter the registration code, and click Register.
22. Exit 3DMark.

#### **Running 3DMark v1.4.828**

1. Boot the system and bring up a command prompt:
  - a. Type `CMD` into the Start menu search bar.



- b. Right-click the Command Prompt app.
  - c. Click the Run as administrator button.
2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait 5 minutes before running the test.
5. To launch the benchmark, double-click the 3DMark desktop icon.
6. At the 3DMark Benchmark screen, click Run Ice Storm Unlimited.
7. When the benchmark run completes, record the results.
8. Repeat steps 6 and 7, except run Ice Storm Extreme.
9. Perform steps 1 through 8 two more times, and report the median of the three runs.

## Measuring power consumption

### Test requirements

- ExTech 380801 True RMS Power Analyzer
- PassMark® BurnInTest Professional
- Thermometer

### Measuring system temperature while idle and under load

#### Setting up the test

1. Using a power strip, plug the system under test (and monitor if used) into the ExTech.
2. Plug the ExTech into its own circuit.
3. On the system used to monitor the ExTech, open the Power Analyzer.
4. From the drop-down Option menu, select Sample Rate.
5. For the sample rate, enter 1.0, and select OK.
6. On the systems under test, set the power plan to the manufacturer's default setting. Set the display brightness to 100 percent:
  - a. Click Start.
  - b. In the Start menu's quick search field, type `Power Options`
  - c. Move the Screen brightness slider all the way to the right.
7. Set the remaining power plan settings as follows:
  - Dim the display: Never
  - Turn off the display: Never
  - Put the computer to sleep: Never
8. Disable the screen saver.
9. Download PassMark BurnIn Test Professional V7 from [www.passmark.com/products/pt.htm](http://www.passmark.com/products/pt.htm).
10. To run setup, double-click `bitpro_x64.exe`.
11. At the Welcome screen, click Next.
12. Accept the license agreement, and click Next.
13. At the Choose Install Location screen, accept the default location of `C:\Program Files\BurnInTest`, and click Next.
14. At the Select Start Menu Folder screen, click Next.
15. At the Ready to Install screen, click Install.

16. At the Completing the BurnInTest Setup Wizard screen, deselect View Readme.txt, and click Finish to launch PerformanceTest.
17. At the Purchasing information screen, copy and paste the Username and key, and click Continue.
18. At the Key accepted screen, click OK.
19. From the Configuration menu item, select Test selection and duty cycles.
20. Change the Auto Stop After field to 180.
21. Select CPU, 2D Graphics, 3D Graphics, RAM, and Disk(s), and deselect all other subsystems.
22. Set load to 100, and click OK.
23. From the Configuration menu item, select Test Preferences and set or verify the following by clicking on each tab:
  - Disk: select C: drive
  - Logging: select Turn automatic logging on
  - 2D Graphics: select All available Video Memory
  - 3D Graphics: defaults
  - RAM: select Multi-Process Torture Test

### **Running the test**

1. Boot the system and bring up an administrative command prompt:
2. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`
3. Do not interact with the system until the command completes.
4. After the command completes, wait 5 minutes before running the test.
5. On the ExTech power monitor, enter a name for the test run.
6. Report the room temperature, and in the ExTech Power Analyzer window, click Start Recording
7. After 30 minutes, record the room temperature.
8. After 1 hour, record the room temperature and in the ExTech Power Analyzer window, click Stop Recording.
9. Record the average watts of the run as Idle Power consumption.
10. Record the average of the recorded room temperatures as the Idle Room Temperature.
11. On the ExTech power monitor, enter a name for the Under Load test run.
12. Double-click the PassMark BurnInTest desktop icon.
13. In the BurnInTest V7.0 Pro screen, click Start Selected Tests.
14. Report the room temperature, and in the ExTech Power Analyzer window, click Start Recording.
15. After 30 minutes, record the room temperature.
16. After 1 hour, record the room temperature, and in the ExTech Power Analyzer window, click Stop Recording.
17. Record the average watts of the run as Under Load Power Consumption.
18. Record the average of the recorded room temperature as the Under Load Room Temperature.
19. Record the average of the recorded room temperature as the Under Load Room Temperature.
20. Power the system down and let it rest for one hour.
21. Complete steps 1 through 19 two more times, and report the median of the three Idle and Under Load runs as well as the average temperature for each median run.

## APPENDIX E – BENCHMARK INFORMATION

### About HDXPRT 2012

The High Definition Experience & Performance Ratings Test (HDXPRT) 2012 is a benchmark that evaluates the capabilities of PCs in consumer digital media uses, divided into the following categories:

- Media Organizer
- Media Creator
- Photo Blogger
- Video Producer
- Music Maker

For more information on HDXPRT 2012, see

[principledtechnologies.com/benchmarkxpert/whitepapers/2012/HDXPRT\\_2012\\_White\\_Paper.pdf](http://principledtechnologies.com/benchmarkxpert/whitepapers/2012/HDXPRT_2012_White_Paper.pdf).

### About BAPCo SYSmark 2014

According to BAPCo, “SYSmark 2014 is an application-based benchmark that reflects usage patterns of business users in the areas of office productivity, media creation, and data/financial analysis.” The benchmark features notable applications from these fields. SYSmark 2014 generates a score from the times the tested system takes to complete each individual operation in each scenario. For more information on this benchmark, see [bapco.com/products/sysmark-2014](http://bapco.com/products/sysmark-2014).

### About Futuremark PCMark 8 v2.2.282

According to Futuremark, “PCMark 8 is the latest version in our series of industry standard PC-benchmarking tools.” PCMark 8 evaluates the performance of PCs from tablets to desktops by using real-world tasks and applications. Applications are divided into scenarios that reflect common usage in different capacities. For our testing, we used the Work portion of the benchmark, which offers workloads that test a system's ability to perform basic office work tasks, such as writing documents, browsing Web sites, creating spreadsheets, and using video chat.

### About Futuremark 3DMark (2013) v1.4.778

Futuremark 3DMark v1.4.778 is a collection of benchmarks designed to rate the graphics performance of smartphones, tablets, notebooks, laptops, desktops, or high-performance gaming PCs. 3DMark includes benchmarks designed for Windows, Apple®, and Android™ devices. The Ice Storm portion of 3DMark includes 720p graphics tests to measure GPU performance and a physics test to stress CPU performance. Ice Storm is available for Windows, iOS, and Android smart phones and tablets. It uses a DirectX® 11 feature level 9 for Windows and OpenGL® ES 2.0 for iOS and Android systems. Ice Storm Extreme increases the rendering resolution to 1080p and uses higher quality textures and post-processing effects in the Graphics tests.

For more information on 3DMark, see [www.futuremark.com/benchmarks/3dmark](http://www.futuremark.com/benchmarks/3dmark).

## ABOUT PRINCIPLED TECHNOLOGIES



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Our founders, Mark L. Van Name and Bill Catchings, have worked together in technology assessment for over 20 years. As journalists, they published over a thousand articles on a wide array of technology subjects. They created and led the Ziff-Davis Benchmark Operation, which developed such industry-standard benchmarks as Ziff Davis Media's Winstone and WebBench. They founded and led eTesting Labs, and after the acquisition of that company by Lionbridge Technologies were the head and CTO of VeriTest.

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