High Definition Experience & Performance Ratings Test

HDXPRT 2012 v1.0 SCALING WHITE PAPER

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1 HDXPRT 2012 SCALING OVERVIEW

HDXPRT, the High Definition Experience & Performance Ratings Test, is a benchmarking software tool for assessing the capabilities of a PC for handling real-world media scenarios using common consumer applications. The benchmark presents results in a way that is meaningful to and easily understandable by consumers. The HDXPRT Development Community, administered by Principled Technologies, Inc. has collaboratively developed the benchmark. The latest version, HDXPRT 2012, released in July 2012, is a major update of HDXPRT 2011. Compared to HDXPRT 2011, HDXPRT 2012 has a new set of applications and expanded set of usage scenarios. Its results are not comparable with that earlier version.

The purpose of this white paper is to show how different hardware subsystems influence HDXPRT 2012 scores in tests using second- and third-generation Intel® Core™ processors. HDXPRT 2012 uses real commercial applications and realistic workloads to evaluate PC performance. We believe this is the best way to relate a PC's performance to the experience people will have using it.

This paper considers some of the choices a typical consumer has when buying a PC. We took a single system and ran dozens of tests, changing one variable at a time. This let us isolate the effect each component had on performance. We show the effect of changing the processor, amount of memory, memory speed and banking. We also compare the impact of traditional hard disk drives and solid state drives.

Not all workloads reacted to these changes to the same degree. For example, the Video Producer score frequently showed a much bigger impact than Music Maker. We will present the effect on the component scores as well as the effect on the Create HD score.

2 BENCHMARK COMPONENTS

HDXPRT 2012 is a benchmark focused on digital media creation. The benchmark has five major digital media creation components, which measure the performance of a target system using best-of-breed applications executing workloads in each of five categories:

- **Media Organizer.** The users this scenario models carry out basic consumer media tasks, such as organizing, auto-enhancing, and converting captured content of various media types (photos, videos, and music). This scenario uses the following applications: Adobe® Photoshop® Elements to import photos and videos, enhance photos, and organize a media library; and Apple® iTunes® to import music, organize a music library, and convert a video for viewing on Apple iPhone®.
- **Media Creator.** These consumers organize and customize their photos and video using more advanced features of their media creation software. This scenario uses the following applications: Adobe® Photoshop® Elements to convert raw photos to JPEG, stitch photos together, and

organize the photos in a photo book; Adobe Premiere® Elements to import, edit, and enhance videos, and export the result and organize the library; CyberLink Media*Espresso* to convert the video to be more efficient on Web and mobile devices, a process known as transcoding; GIMP, the GNU Image Manipulation Program , to apply filters on photos; HDRsoft Photomatix, to create HDR Photos; and HandBrake, an open-source, GPL-licensed, multiplatform, multithreaded video transcoder, to convert a video to the x264 video format.

- **Photo Blogger.** These consumers are photo enthusiasts who take many pictures, process them, and share them via messaging or social networks. This scenario uses the following applications: Adobe Photoshop Elements to convert raw photos to JPEG, GIMP to edit, Adobe Photoshop Elements to stitch photos to create panoramas, and HDRsoft Photomatix to create HDR photos.
- **Video Producer.** These consumers are advanced and savvy media enthusiasts who shoot, edit, tag, and publish videos to share with others. This scenario uses the following applications: CyberLink PowerDirector to combine video clips, add transitions and preset effects, and create an AVCHD video, and CyberLink Media*Espresso* to transcode a video.
- **Music Maker.** These consumers create, edit, and post music and podcasts for sharing. This scenario uses the following applications: Audacity® to create and edit a music podcast and mix music with voiceover, and Apple iTunes to convert WAV files to MP3 for posting.

The HDXPRT 2012 v1.0 White Paper, available on the HDXPRT Web site, describes the test workloads for the five scenarios.

2.1 HDXPRT 2012 scores

This report compares HDXPRT for various test hardware configurations.

At the start of a benchmark run, the user specifies a number of benchmark iterations for the run. The benchmark executes the workload that number of times and averages the results from the iterations. An average of multiple iterations provides a better prediction of actual performance than any single iteration result would. We recommend at least three iterations and selected that number for the runs we made on the many hardware configurations we tested for this paper. At the end of a run, the benchmark reports a result for each scenario and an overall Create HD Score.

Scenario results. Metrics for the scenarios in HDXPRT 2012 are the amount of time the test system needed to complete the scenario workload. For runs with multiple iterations, this is the average time for those iterations. The HDXPRT Results Viewer (shown in Figure 1) displays these results in minutes. Lower times represent better system performance.

Create HD Score. The HDXPRT 2012 Create HD Score represents the system's overall HD media creation performance. The benchmark calculates this score by taking a geometric mean of ratios between test system scenario results and results of a calibration system. A higher overall score represents better performance. For further information on scenario results and the overall score and

on the calibration machine, please see the HDXPRT 2012 v1.0 White Paper, available on the HDXPRT Web site.

Figure 1. HDXPRT Results Viewer.

3 SYSTEM CONFIGURATION

Figure 2 provides the detailed configuration of the systems we tested for this white paper. We used two white box desktop systems for testing and swapped in different configurations of CPUs, motherboards, memory, and disk drives for the various tests. We tested with Windows 7 Ultimate Service Pack 1 (64-bit). We used the Intel HD Graphics integrated on the test processors. For the Intel Core i5 and Intel Core i7 processors that support Intel Turbo Boost 2.0 Technology, we tested with that feature enabled.

We compared scores for the following second- and third-generation Intel Core processors. We list the processor, Intel HD Graphics version and driver, and whether it included Intel Turbo Boost Technology 2.0.

Processor	Graphics manufacturer model/ driver	Intel Turbo Boost Technology 2.0
Intel Core i3-2105 processor (3M cache, 3.10 GHz)	Intel HD Graphics 3000 / Intel 8.15.10.2696 (03-19-2012)	Not available
Intel Core i3-2125 processor (3M cache, 3.30 GHz)	Intel HD Graphics 3000 / Intel 8.15.10.2696 (03-19-2012)	Not available
Intel Core i7-2600K processor (8M cache, 3.4 GHz up to 3.80 GHz)	Intel HD Graphics 3000 / Intel 8.15.10.2696 (03-19-2012)	Enabled

Processor	Graphics manufacturer model/ driver	Intel Turbo Boost Technology 2.0
Intel Core i5-3450S processor (6M cache, 2.8 GHz up to 3.50 GHz)	Intel HD Graphics 2500 / Intel 8.15.10.2618 (01-05-2012)	Enabled
Intel Core i5-3550 processor (6M cache, 3.3 GHz up to 3.70 GHz)	Intel HD Graphics 2500 / Intel 8.15.10.2618 (01-05-2012)	Enabled
Intel Core i7-3770 processor (8M cache, 3.4 GHz up to 3.90 GHz)	Intel HD Graphics 4000 / Intel 8.15.10.2618 (01-05-2012)	Enabled

Figure 2. Detailed configuration of the test systems.

For most tests, we used the following standard configuration:

Component	Specification
CPU	One of the processors from the above table
Operating system	Microsoft® Windows® 7 Ultimate Service Pack 1 (64-bit) with updates current as of 8/7/2012
Motherboard	
Manufacturer	Intel
Model	DZ77BH-55K
BIOS version	BHZ7710H.86A.0085
Memory	
Manufacturer	Corsair XMS3
Channels	Dual
Type	DDR3
Size	2 x 2GB
Speed	1,600 MHz
Latency	9-9-9-24
Hard drive	
Manufacturer model / size / RPM / cache	Seagate® HDD ST31000528AS / 1 TB / 7,200 RPM / 32 MB
Power supply	
Manufacturer	Antec®
Model	TruePower 650
Power	650 W
Other system settings	
Display resolution	1,280 x 1,024; 60 Hz
System restore	Off
Windows Update	Off
Screen saver	Off
Power Management	Off

Figure 3. HDXPRT 2012 basic test system configuration.

We deviated from the above configuration for memory tests and for disk tests. For memory tests, we tested 1,600 MHz and 1,333 MHz memory in 2GB, 4GB, or 8GB sizes with single- and dual-channel configurations. We matched motherboards to memory speed. Figures 4 and 5 show the memory and motherboard for the 1,333 and 1,600 MHz tests.

Motherboard and memory for tests with 1,333 MHz memory	
Motherboard	
Manufacturer	Intel
Model	DH67BL
BIOS version	BLH6710H.86A.0110.2011.0415.1506 (04/15/2011)
Memory	
Manufacturer	Micron® 9JSF25672AZ-1G4D1
Channels	Dual
Type	DDR3
Size	1 x 2 GB; 2 x 2 GB; 1 x 4 GB; 2 x 4 GB; 1 x 8 GB; or 2 x 8 GB
Speed	1,333 MHz
Latency	9-9-9-24

Figure 4. Motherboard and memory for tests with 1,333 MHz memory.

Motherboard and memory for tests with 1,600 MHz memory	
Motherboard	
Manufacturer	Intel
Model	DZ77BH-55K
BIOS version	BHZ7710H.86A.0085
Memory	
Manufacturer	Corsair XMS3
Channels	Dual
Type	DDR3
Size	1 x 2 GB; 2 x 2 GB; 1 x 4 GB; 2 x 4 GB; 1 x 8 GB; or 2 x 8 GB
Speed	1,600 MHz
Latency	9-9-9-24

Figure 5. Motherboard and memory for tests with 1,600 MHz memory.

For the SSD tests in our disk comparison, we removed the hard disk drive and substituted the following SSD:

SSD	
Manufacturer model / size / RPM / cache	Samsung® SSD MK0060EAVDR / 60 GB / N/A / N/A

4 RESULTS

We measured the effect of the following components on HDXPRT 2012 scores:

- Processor
- Memory amount
- Memory speed
- Memory banking
- Hard disk drive (HDD) vs. solid-state drive (SSD)

4.1 Processor

The overall score increased as processor speeds and cache sizes increased.

For the processor characterization tests, we tested the following six second- and third-generation Intel Core processors to see how processors with different speeds and cache sizes affected HDXPRT 2012 scores:

- Intel Core i3 second-generation processors
  - Intel Core i3-2105 processor (3M cache, 3.10 GHz)
  - Intel Core i3-2125 processor (3M cache, 3.30 GHz)
- Intel Core i7 second-generation processor
  - Intel Core i7-2600K processor (8M cache, 3.4 GHz up to 3.80 GHz)
- Intel Core i5 third-generation processors
  - Intel Core i5-3450S processor (6M cache, 2.8 GHz up to 3.50 GHz)
  - Intel Core i5-3550 processor (6M cache, 3.3 GHz up to 3.70 GHz)
- Intel Core i7 third-generation processor
  - Intel Core i7-3770 processor (8M cache, 3.4 GHz up to 3.90 GHz)

For each of these tests, we configured the test system with the processor under test, 4GB (2x2GB) 1,600MHz RAM, and an Intel DZ77BH-55K motherboard. Figure 6 gives the scores from these tests. Higher overall scores and lower result times are better.

	Second-generation Intel Core processors			Third-generation Intel Core processors		
Processor	**Intel Core i3-2105 processor (3M cache, 3.10 GHz)**	**Intel Core i3-2125 processor (3M cache, 3.30 GHz)**	**Intel Core i7-2600K processor (8M cache, 3.40 GHz up to 3.80 GHz)**	**Intel Core i5-3450S processor (6M cache, 2.80 GHz up to 3.50 GHz)**	**Intel Core i5-3550 processor (6M cache, 3.30 GHz up to 3.70 GHz)**	**Intel Core i7-3770 processor (8M cache, 3.40 GHz up to 3.90 GHz)**
HDXPRT overall score (higher is better)	**173**	**183**	**225**	**226**	**230**	**242**
Media Organizer (lower is better)	6.02	5.48	4.54	4.65	4.44	4.35
Media Creator (lower is better)	12.64	11.90	8.49	8.96	8.73	7.98
Photo Blogger (lower is better)	8.89	8.30	6.82	7.08	6.86	6.53
Video Producer (lower is better)	2.67	2.62	2.28	1.87	1.90	1.81
Music Maker (lower is better)	2.61	2.52	2.16	2.26	2.24	2.15

Figure 6. HDXPRT 2012 scores and scenario times in minutes for the system configured with varying processors and 4 GB of RAM. Higher overall scores and lower scenario result times are better.

Figures 7 and 8 normalize the scores and results from Figure 6 to the score for the second-generation Intel Core i3-2105 processor (3M cache, 3.10 GHz). Normalized results for that processor equal one. Results for the other processors show how much faster they were on these tests relative to that processor. Higher results are better. Figure 7 shows the results in a table and Figure 8 graphs those results.

	Second-generation Intel Core processors			Third-generation Intel Core processors		
Processor	**Intel Core i3-2105 processor (3M cache, 3.10 GHz)**	**Intel Core i3-2125 processor (3M cache, 3.30 GHz)**	**Intel Core i7-2600K processor (8M cache, 3.40 GHz up to 3.80 GHz)**	**Intel Core i5-3450S processor (6M cache, 2.80 GHz up to 3.50 GHz)**	**Intel Core i5-3550 processor (6M cache, 3.30 GHz up to 3.70 GHz)**	**Intel Core i7-3770 processor (8M cache, 3.40 up to 3.90 GHz)**
HDXPRT overall score	1.00	1.06	1.30	1.31	1.33	1.40
Media Organizer	1.00	1.10	1.33	1.29	1.36	1.38
Media Creator	1.00	1.06	1.49	1.41	1.45	1.58
Photo Blogger	1.00	1.07	1.30	1.26	1.30	1.36
Video Producer	1.00	1.02	1.17	1.43	1.41	1.48
Music Maker	1.00	1.04	1.21	1.15	1.17	1.21

Figure 7. HDXPRT 2012 scores and scenario times normalized to the Intel Core i3-2105 processor. Higher normalized values are better.

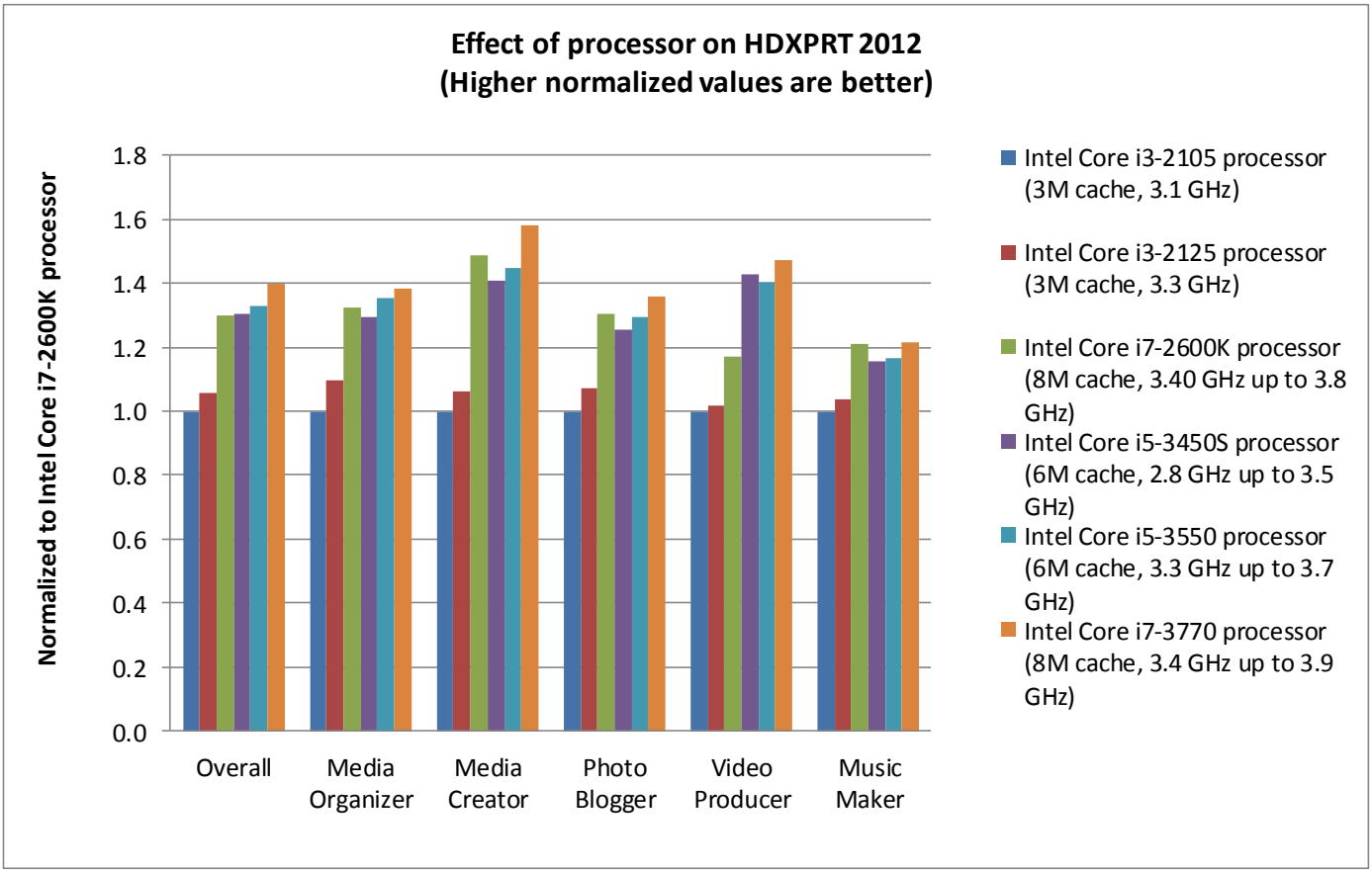

Figure 8. Normalized HDXPRT 2012 scores and times for the system configured with varying processors and 4 GB of RAM.

As one would expect, the Intel Core i7-3770 processor, with its 8M cache and up to 3.90 GHz processor speed, delivered the best performance of all, with an overall score exceeding those of the Intel Core i5-3450S and Intel Core i5-3550 processors by 7 percent and 5 percent respectively. Its improvement over the Intel Core i3-2105 and Intel Core i3-2125 processors was even more dramatic, 40 percent and 32 percent respectively. These improvements were reflected across all five scores.

Our mix of six processors represented two Intel Core processor generations and three processor families. In the remainder of this section, we look more closely at differences the benchmark shows between pairs of processors both across and within those Intel Core i3, i5, and i7 families and second and third generations.

Two second-generation Intel Core i3 processors: Intel Core i3-2125 processor compared to Intel Core i3-2105 processor

Figure 9 compares the two second-generation Core i3 processors.

Processor	Intel Core i3-2105 processor (3M cache, 3.10 GHz)	Intel Core i3-2125 processor (3M cache, 3.30 GHz)
HDXPRT overall score	**1.00**	**1.06**
Media Organizer	1.00	1.1
Media Creator	1.00	1.06
Photo Blogger	1.00	1.07
Video Producer	1.00	1.02
Music Maker	1.00	1.04

Figure 9. Results normalized to the Intel Core i3-2105 processor. Higher results are better.

The benchmark highlights differences between two different speed processors within a processor family. Comparing the two second-generation Intel Core i3 processors, we see that the 3.30 GHz Intel Core i3-2125 delivered a 6 percent better overall score than the 3.10 GHz Intel Core i3-2105, in line with the difference in processor speed of the two processors. The faster processor improved the scenario times by between 2 and 10 percent, with the biggest increase in the Media Organizer scenario.

Two third-generation Intel Core i5 processors: Intel Core i5-3550 processor compared to Intel Core i5-3450S processor

Figure 10 compares the two third-generation Core i5 processors.

Processor	Intel Core i5-3450S processor (6M cache, 2.80 GHz up to 3.50 GHz)	Intel Core i5-3550 processor (6M cache, 3.30 GHz up to 3.70 GHz)
HDXPRT overall score	**1.00**	**1.02**
Media Organizer	1.00	1.05
Media Creator	1.00	1.03
Photo Blogger	1.00	1.03
Video Producer	1.00	0.98
Music Maker	1.00	1.01

Figure 10. Results normalized to the Intel Core i5-3450S processor. Higher results are better.

The Intel Core i5-3550 processor, at 3.70 GHz, outperformed the 3.50GHz Intel Core i5-3450S by 2 percent on the overall score. The faster processor improved the Media Organizer time by 5 percent, the Media Creator time by 3 percent, the Photo Blogger time by 3 percent, and the Music Maker time by 1 percent. The Video Producer score was 2 percent lower. These differences are less than the 6 percent difference in maximum clock speeds of the two processors.

Second-and third-generation Intel Core processors: Intel Core i5-3450S processor compared to Intel Core i3-2125 processor

Figure 11 compares the faster of the two second-generation Intel Core i3 processors and the slower of the two third-generation Intel Core i5 processors.

Processor	Intel Core i3-2125 processor (3M cache, 3.30 GHz)	Intel Core i5-3450S processor (6M cache, 2.80 GHz up to 3.50 GHz)
HDXPRT overall score	**1.00**	1.23
Media Organizer	1.00	1.18
Media Creator	1.00	1.33
Photo Blogger	1.00	1.17
Video Producer	1.00	1.40
Music Maker	1.00	1.12

Figure 11. Results normalized to the Intel Core i3-2125 processor. Higher results are better.

These two processors are separated by a 0.2 GHz maximum clock speed. The Intel Core i5-3450S with a clock speed of 2.8 GHz can deliver a maximum clock speed of 3.50 GHz using Intel Turbo Boost Technology 2.0. It produced an overall score that was 23 percent better and scenario scores between 1.12 and 1.40 percent better than the 3.30 GHz Intel Core i3-2125. These performance improvements, which are far greater than the difference in maximum clock speed, highlight the architectural improvements and bigger cache in the third-generation processor.

Second- and third-generation Intel Core i7 processors: Intel Core i7-3770 processor compared to Intel Core i7-2600K processor

Figure 12 compares the second-and third-generation Core i7 processors.

Processor	Intel Core i7-2600K processor (8M cache, 3.40 GHz up to 3.80 GHz)	Intel Core i7-3770 processor (8M cache, 3.40 GHz up to 3.90 GHz)
HDXPRT overall score	**1.00**	**1.08**
Media Organizer	1.00	1.04
Media Creator	1.00	1.06
Photo Blogger	1.00	1.04
Video Producer	1.00	1.26
Music Maker	1.00	1.00

Figure 12. Results normalized to the Intel Core i7-2600K processor. Higher results are better.

The Intel Core i7-3770 processor improved the overall score by 8 percent. The improvement was uneven across the usage care categories. The Video Producer category had the greatest increase, 26 percent. The Music Maker category had the smallest increase, under a half percent.

4.2 Memory amount

Increasing the amount of RAM improved performance up to 8 GB. Increasing to 16 GB did not improve performance further.

We tested from 2 GB to 16 GB of 1,600 MHz RAM on two third-generation Intel Core processors: the Intel Core i5-3550 and the Intel Core i7-3770. We tested with the following chip counts and memory sizes: 2GB (1 x 2 GB); 4GB (2 x 2 GB); 8 GB (2 x4 GB) and 16 GB (2 x 8 GB).

Figure 13 shows the overall scores and scenario times for each memory amount on the Intel Core i5-3550 processor.

Amount of system memory	2 GB	4 GB	8 GB	16 GB
HDXPRT overall score (higher is better)	**198**	**230**	**235**	**234**
Media Organizer (lower is better)	4.82	4.44	4.45	4.49
Media Creator (lower is better)	10.34	8.73	8.57	8.66
Photo Blogger (lower is better)	7.91	6.86	6.78	6.78
Video Producer (lower is better)	2.68	1.90	1.81	1.81
Music Maker (lower is better)	2.28	2.24	2.20	2.19

Figure 13. HDXPRT 2012 scores and scenario times in minutes for the system configured with the Intel Core i5-3550 processor, Intel HD Graphics 2500, and varying amounts of RAM. Higher overall scores and lower times are better.

Figures 14 and 15 show in table and graph formats the relative performance improvements for each memory amount on the Intel Core i5-3550 processor.

Amount of system memory	2 GB	4 GB	8 GB	16 GB
HDXPRT overall score	1.00	1.16	1.19	1.18
Media Organizer	1.00	1.09	1.08	1.07
Media Creator	1.00	1.18	1.21	1.19
Photo Blogger	1.00	1.15	1.17	1.17
Video Producer	1.00	1.41	1.48	1.48
Music Maker	1.00	1.02	1.04	1.04

Figure 14. Normalized HDXPRT 2012 scores and times for the different RAM amounts on an Intel Core i5-3550 processor. Scores and results are normalized to the 2GB values. Higher normalized values are better.

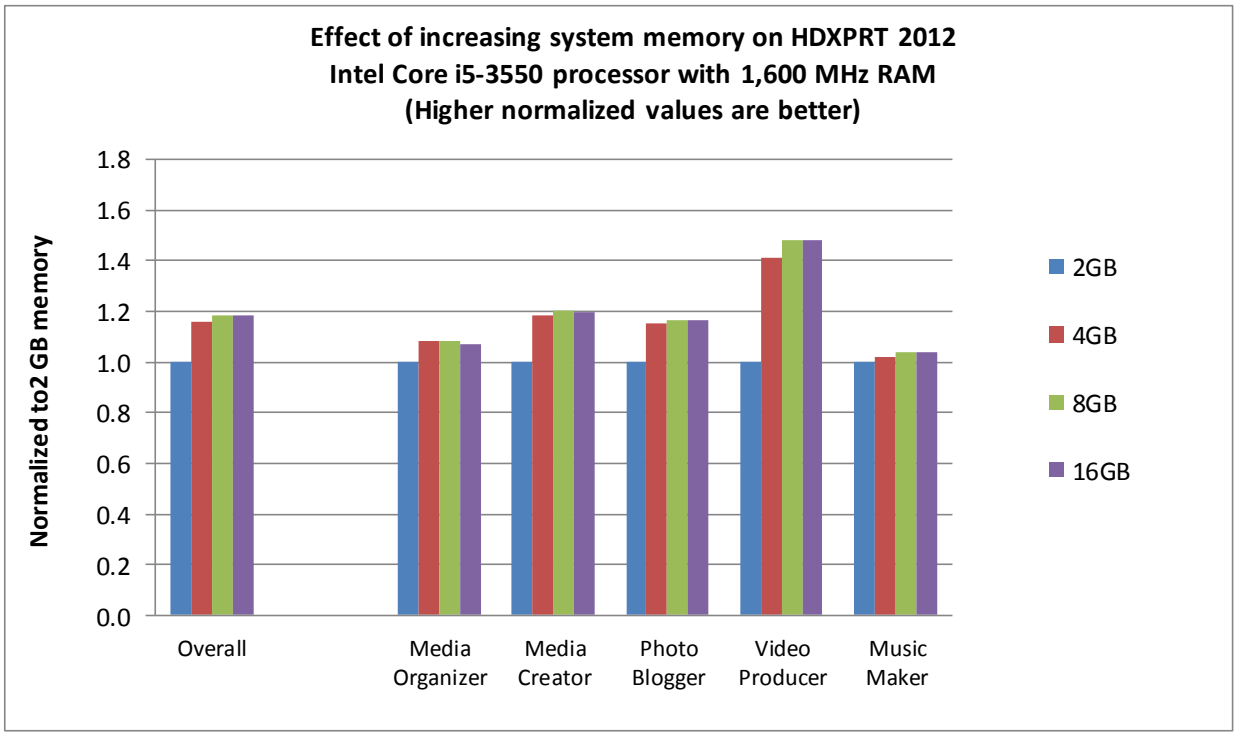

Figure 15. Normalized HDXPRT 2012 scores and times for the system configured with the Intel Core i5-3550 processor, Intel HD Graphics 2500, and varying amounts of RAM.

The overall score increased as the amount of memory in the system increased up to 8 GB. Increasing memory from 2 GB to 4 GB on the system configured with the Intel Core i5-3550 processor led to a 16 percent increase in overall score. However, since the 2 GB test used a single DIMM, some of the improvement may have been due to the 4 GB test using two DIMMs. We explore this is in the section on memory banking below. Increasing from 4 GB to 8 GB brought an additional increase of only 3 percent. Going to 16 GB did not improve scores, with the overall score dropping slightly by just over half a percent.

Increasing memory from 2 GB to 4 GB significantly improved times for four of the five scenarios. Video producer showed the biggest impact, 41 percent. The exception was the Music Maker category, showing only a 2 percent improvement. Increasing to 8 GB delivered much more modest

improvements. Again, Video Producer showed the most impact, increasing another 7 percent compared to the 2GB result. Increasing the memory to 16 GB slightly decreased performance of all scenarios except Music Maker, which improved by less than a half percent.

The reason for these diminishing returns is that as memory size increases, a point comes where the various use case workloads fit entirely in the memory. After that threshold is reached, the associated memory management costs for tight memory conditions disappear. We observed this behavior for both processors in our memory tests.

Figure 16 shows the scores for each memory amount on the Intel Core i7-3770 processor.

Amount of system memory	2 GB	4 GB	8 GB	16 GB
HDXPRT overall score (higher is better)	**207**	**242**	**248**	**245**
Media Organizer (lower is better)	4.58	4.35	4.28	4.35
Media Creator (lower is better)	9.77	7.98	7.80	7.88
Photo Blogger (lower is better)	7.70	6.53	6.41	6.44
Video Producer (lower is better)	2.63	1.81	1.73	1.83
Music Maker (lower is better)	2.15	2.15	2.10	2.08

Figure 16. HDXPRT 2012 scores and scenario times in minutes for the system configured with the Intel Core i7-3770 processor, Intel HD Graphics 4000, and varying amounts of RAM. Higher overall scores and lower times are better.

Figures 17 and 18 show the relative performance improvements for each memory amount on the Intel Core i7-3770 processor. As they show, the overall score increased as the amount of memory in the system increased up to 8GB. Going from 8 GB to 16 GB of RAM did not improve the score further.

Amount of system memory	2 GB	4 GB	8 GB	16 GB
HDXPRT overall score	**1.00**	**1.22**	**1.25**	**1.24**
Media Organizer	1.00	1.05	1.07	1.05
Media Creator	1.00	1.22	1.25	1.24
Photo Blogger	1.00	1.18	1.20	1.20
Video Producer	1.00	1.45	1.52	1.44
Music Maker	1.00	1.00	1.02	1.03

Figure 17. HDXPRT 2012 performance normalized to 2GB RAM for the system configured with the Intel Core i7-3770 processor, Intel HD Graphics 4000, and varying amounts of RAM. Higher normalized results are better.

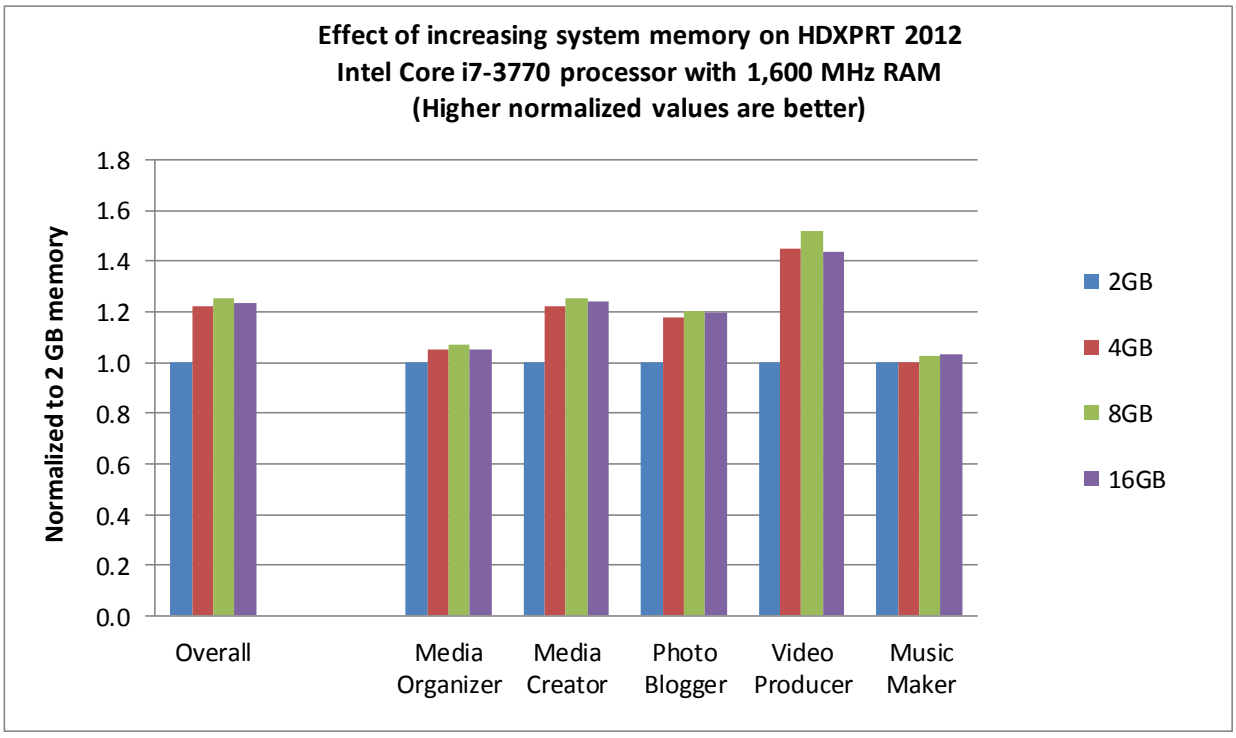

Figure 18. Normalized HDXPRT 2012 scores and times for the system configured with the Intel Core i7-3770 processor, and Intel HD Graphics 4000. Higher values are better.

The performance effect of increasing memory on the system configured with the Intel Core i7-2600K processor followed a pattern similar to the Intel Core i5-3550 processor. Increasing memory from 2 GB to 4 GB led to a 17 percent increase in overall score, while increasing from 4 GB to 8 GB brought an additional 3 percent increase. The drop in performance going from 8 GB to 16GB was slightly larger than for the i5-3550, almost 1.5 percent.

Increasing memory from 2 GB to 4 GB improved three of the five use case categories significantly. Again, Video producer showed the biggest impact, 45 percent. The exceptions were the Music Maker category, which showed no improvement, and the Media Organizer category, which showed only a 5 percent improvement. Increasing to 8 GB produced smaller benefits. Again, Video Producer showed the most impact, an additional 7 percent improvement. Like the Intel Core i5-3550 processor, increasing the memory to 16GB actually reduced performance on most scenarios cases, by as much as 8 percent on the Video Producer score.

4.3 Memory speed

Compared to 1,333 MHz RAM, the 1,600 MHz RAM produced a performance improvement consistent with the increase in RAM speed.

Figures in this section show how different memory speed affected HDXPRT 2012 scores. We tested 2GB, 4GB, 8GB, and 16GB memory sizes at 1,600MHz and 1,333MHz memory speeds on two third-generation Intel Core processors -- the Intel Core i5-3550 and the Intel Core i7-3770 processors.

For these tests, we configured the test system with the processor and memory under test. We installed an Intel DZ77BH-55K motherboard for tests with 1,600MHz RAM and an Intel DH67BL motherboard for tests with 1,333 MHz RAM. We tested with the following DIMM counts and memory sizes: 1 x 2 GB; 2 x 2 GB; 2 x4 GB or 2 x 8GB. Figure 19 shows the scores for 1,333 MHz memory at each memory size on the Intel Core i5-3550 processor. Results for the 1,600 MHz RAM are in the earlier Memory amount section.

Amount and speed of system memory	2 GB 1,333 MHz	4 GB 1,333 MHz	8 GB 1,333 MHz	16 GB 1,333 MHz
HDXPRT overall score (higher is better)	**198**	**225**	**229**	**230**
Media Organizer (lower is better)	4.91	4.82	4.73	4.74
Media Creator (lower is better)	10.37	8.93	8.77	8.76
Photo Blogger (lower is better)	8.01	7.18	6.95	6.91
Video Producer (lower is better)	2.64	1.88	1.84	1.80
Music Maker (lower is better)	2.27	2.19	2.21	2.19

Figure 19. HDXPRT 2012 scores and scenario times in minutes for the system configured with the Intel Core i5-3550 processor, Intel HD Graphics 2500, and varying amounts of 1,333MHz RAM. Higher overall scores and lower times are better.

Figures 20 and 21 show the relative performance improvement for each memory amount on the Intel Core i5-3550 processor when going from 1,333 MHz RAM to 1,600 MHz RAM.

Amount of system memory	2 GB	4 GB	8 GB	16 GB
HDXPRT overall score	**1.00**	**1.02**	**1.03**	**1.02**
Media Organizer	1.02	1.09	1.06	1.06
Media Creator	1.00	1.02	1.02	1.01
Photo Blogger	1.01	1.05	1.03	1.02
Video Producer	0.99	0.99	1.02	0.99
Music Maker	1.00	0.98	1.00	1.00

Figure 20. HDXPRT 2012 results for varying amounts of 1,600 MHz RAM normalized to the results for 1,333 MHz RAM for the system configured with the Intel Core i5-3550 processor, Intel HD Graphics 2500. Normalized results for the 1,333 MHz equal one and are omitted from this chart. Higher values are better.

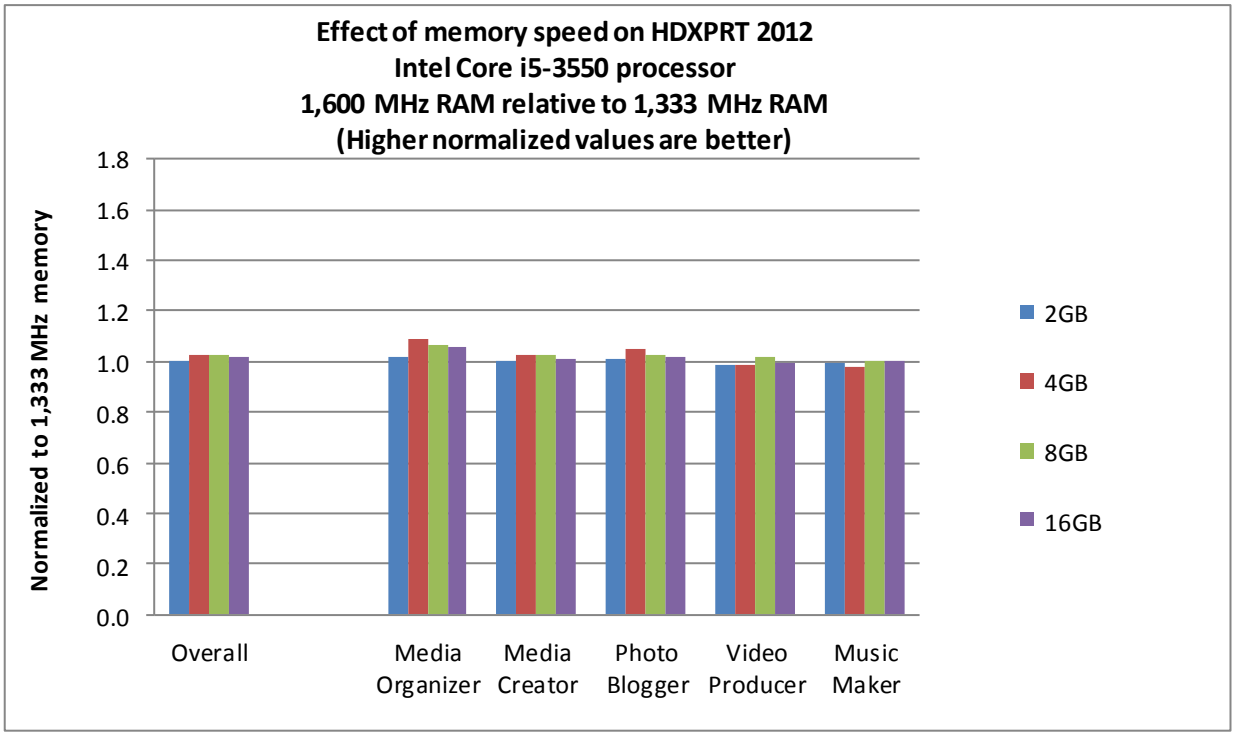

Figure 21. Normalized HDXPRT 2012 scores and times for the system configured with the Intel Core i5-3550 processor, Intel HD Graphics 4000, and varying amounts of RAM. Higher numbers are better.

The difference in memory speed between 1,600 MHz and 1,333 MHz is approximately 2 percent. At 2 GB of RAM, the increased speed has no effect. This is consistent with the test being memory constrained. At all other RAM amounts, the improvement in overall score ranges from 2 percent to 3 percent, effectively scaling with the memory speed.

Figure 22 shows the scores for 1,333 MHz memory at each memory size on the Intel Core i7-7550 processor.

Amount and speed of system memory	2 GB 1,333 MHz	4 GB 1,333 MHz	8 GB 1,333 MHz	16 GB 1,333 MHz
HDXPRT overall score (higher is better)	**206**	**238**	**241**	**242**
Media Organizer (lower is better)	4.73	4.60	4.59	4.62
Media Creator (lower is better)	9.67	8.12	8.01	7.95
Photo Blogger (lower is better)	7.69	6.76	6.64	6.59
Video Producer (lower is better)	2.59	1.81	1.74	1.75
Music Maker (lower is better)	2.15	2.13	2.11	2.09

Figure 22. HDXPRT 2012 scores and scenario times in minutes for the system configured with the Intel Core i7-7550 processor, Intel HD Graphics 4000, and varying amounts 1,333MHz RAM. Higher overall scores and lower times are better.

Figures 23 and 24 show the relative performance improvement for each memory amount on the Intel Core i5-3550 processor when going from 1,333 MHz RAM to 1,600 MHz RAM. The relative

performance is based on the results given for the 1,600 MHz RAM in the Memory amount section.

Amount of system memory	2 GB	4 GB	8 GB	16 GB
HDXPRT overall score	**1.00**	**1.02**	**1.03**	**1.01**
Media Organizer	1.03	1.06	1.07	1.06
Media Creator	0.99	1.02	1.03	1.01
Photo Blogger	1.00	1.04	1.04	1.02
Video Producer	0.98	1.00	1.01	0.96
Music Maker	1.00	0.99	1.00	1.00

Figure 23. HDXPRT 2012 results for the 1,600 MHz RAM normalized to the results for the 1,333 MHz RAM for the system configured with the Intel Core i7-7550 processor, Intel HD Graphics 4000, and varying amounts of RAM at 1,333 MHz and 1,600 MHz. Normalized results for the 1,333 MHz equal one and are omitted from this chart. Higher values are better.

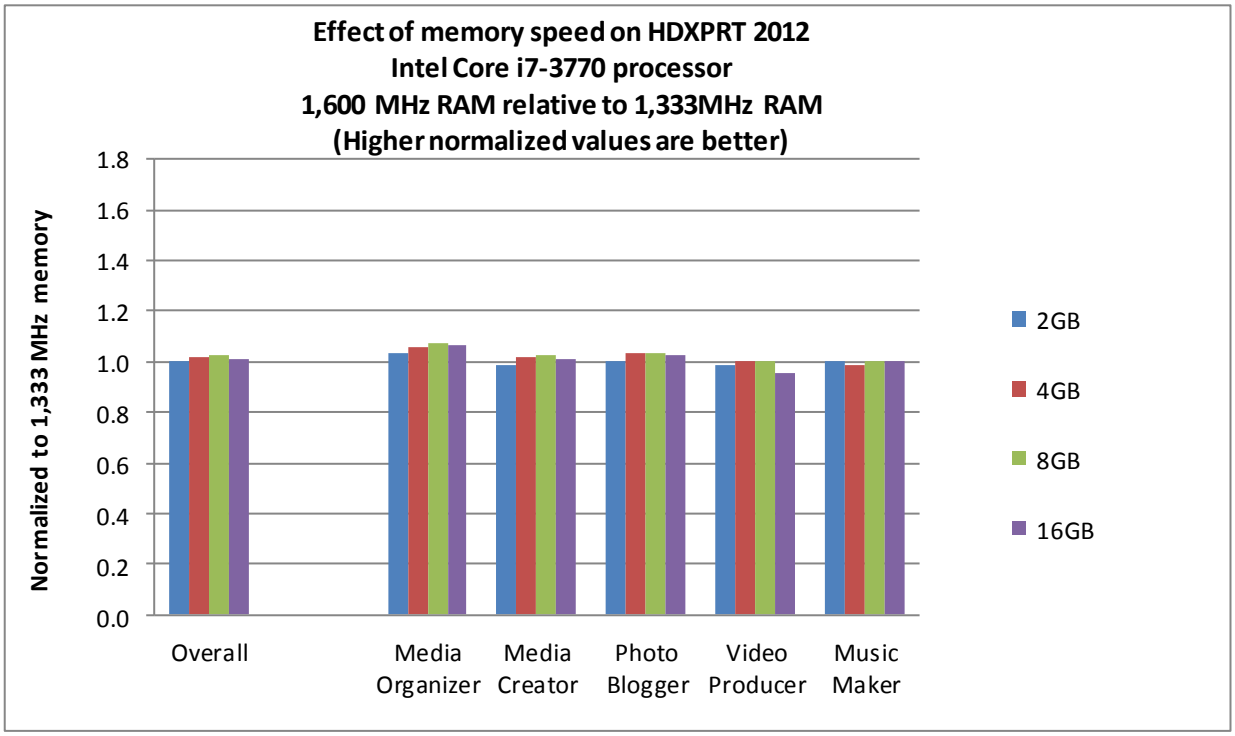

Figure 24. Normalized HDXPRT 2012 scores and times for the system configured with the Intel Core i7-3770 processor, Intel HD Graphics 4000, and varying amounts of RAM. Results are normalized to the 1,333 MHz RAM results, which are set equal to 1. Higher numbers are better.

The results for the Intel Core i7-3770 processor are very similar. At 2 GB, the difference in overall score was 0.49 percent. The improvement in overall score for the other RAM sizes ranged from 1 percent to 3 percent.

4.4 Single- vs. dual-channel memory

When holding the total amount of RAM constant, going from a single-channel DIMM to two DIMMs improved performance between 7 and 10 percent.

To characterize the impact of running the test using a single large DIMM instead of two smaller DIMMs, we ran single-channel tests at 4 GB and 8 GB of RAM. Figure 25 shows the results of the single-channel tests for the Intel Core i5-3550.

Amount and speed of system memory	4 GB 1,333 MHz	8 GB 1,333 MHz	4 GB 1,600 MHz	8 GB 1,600 MHz
HDXPRT overall score (higher is better)	210	211	214	216
Media Organizer (lower is better)	4.8	4.78	4.53	4.47
Media Creator (lower is better)	9.38	9.34	9.28	9.21
Photo Blogger (lower is better)	7.14	7.04	7.00	6.84
Video Producer (lower is better)	2.47	2.49	2.51	2.50
Music Maker (lower is better)	2.24	2.26	2.21	2.22

Figure 25. HDXPRT 2012 scores and scenario times in minutes for the system configured with the Intel Core i5-3550 processor, Intel HD Graphics 2500, and varying amounts and speeds of single-channel RAM. Higher overall scores and lower times are better.

Figures 26 and 27 show the relative performance improvement for four RAM sizes and speeds on the Intel Core i5-3550 processor when going from single-channel to dual-channel RAM. They compare the single-channel results in Figure 25 to the dual-channel results in the Memory amount section.

Amount and speed of system memory	4 GB 1,333 MHz	8 GB 1,333 MHz	4 GB 1,600 MHz	8 GB 1,600 MHz
HDXPRT overall score	1.07	1.09	1.07	1.09
Media Organizer	1.00	1.01	1.02	1.00
Media Creator	1.05	1.07	1.06	1.07
Photo Blogger	0.99	1.01	1.02	1.01
Video Producer	1.31	1.35	1.32	1.38
Music Maker	1.02	1.02	0.99	1.01

Figure 26. Performance improvement going from single- to dual-channel RAM. HDXPRT 2012 results normalized to single-channel RAM for the system configured with the Intel Core i5-3550 processor, Intel HD Graphics 2500, and varying amounts of and speeds of single-channel RAM. Normalized results for the single-channel RAM equal one and are omitted from this chart. Higher overall scores and lower times are better.

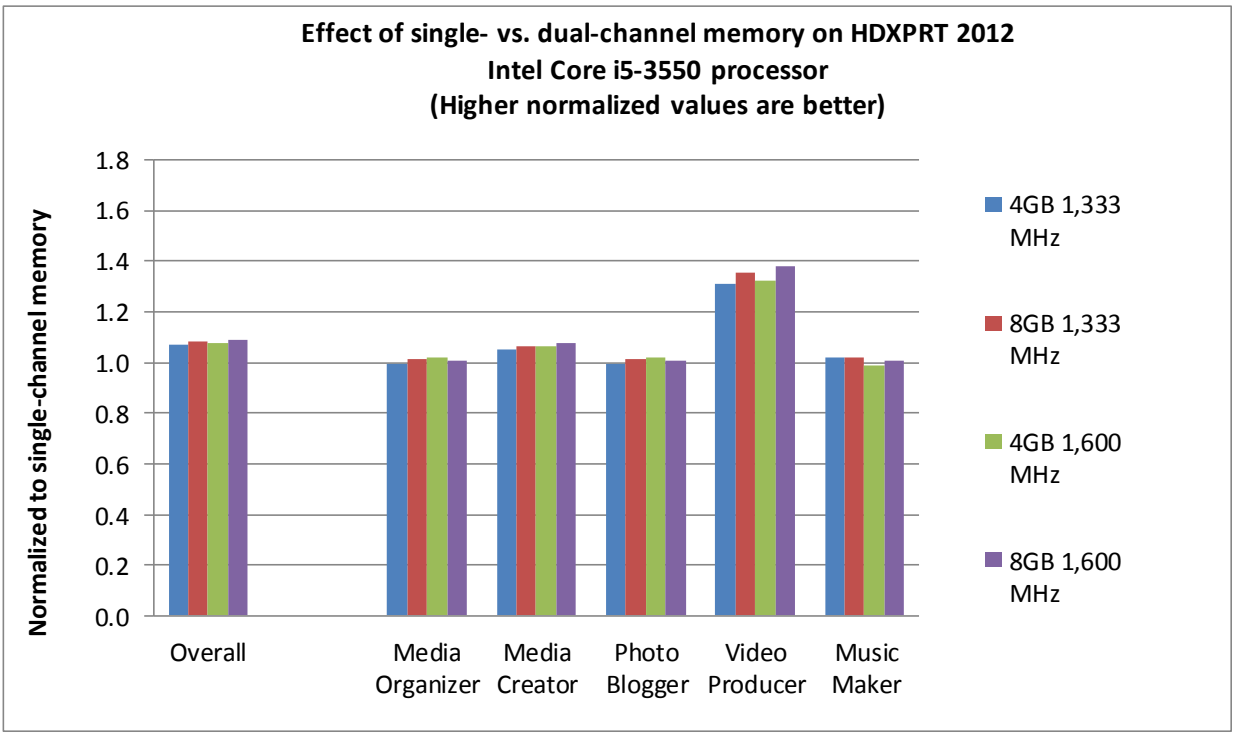

Figure 27. Normalized HDXPRT 2012 scores and times for the system configured with the Intel Core i5-3550 processor, Intel HD Graphics 2500, using single- and dual-channel RAM. Higher numbers are better.

The improvement in performance going from a single 4GB DIMM to two 2GB DIMMS was 7 percent for both the 1,333 MHz RAM and 1,600 MHz RAM. By far, the Video Producer category was the most improved, with increases in performance of over 30 percent for both speeds.

The improvement in performance going from a single 8GB DIMM to two 4GB DIMMS was 9 percent for both the 1,333 MHz RAM and 1,600 MHz RAM. Again, the Video Producer category was the most improved, with increases in performance of over 35 percent for both speeds.

Figure 28 shows the results of the single-channel tests for the Intel Core i7-3770.

Amount of system memory	4 GB 1,333 MHz	8 GB 1,333 MHz	4 GB 1,600 MHz	8GB 1,600 MHz
HDXPRT overall score (higher is better)	**222**	**221**	**226**	**227**
Media Organizer (lower is better)	4.60	4.61	4.34	4.30
Media Creator (lower is better)	8.63	8.55	8.50	8.44
Photo Blogger (lower is better)	6.75	6.70	6.62	6.52
Video Producer (lower is better)	2.44	2.46	2.44	2.46
Music Maker (lower is better)	2.10	2.14	2.09	2.10

Figure 28. HDXPRT 2012 scores and scenario times in minutes for the system configured with the Intel Core i7-3770 processor, Intel HD Graphics 4000, and varying amounts of single-channel RAM. Higher overall scores and lower times are better.

Figures 29 and 30 show the relative performance improvement for each memory amount on the Intel Core i7-3770 processor when going from single-channel to dual-channel RAM. The relative performance is based on the results given for the dual-channel results RAM in the Memory Size section.

Amount of system memory	4 GB 1,333 MHz	8 GB 1,333 MHz	4 GB 1,600 MHz	8GB 1,600 MHz
HDXPRT overall score	**1.09**	**1.12**	**1.07**	**1.09**
Media Organizer	1.06	1.08	1.00	1.00
Media Creator	1.08	1.10	1.07	1.08
Photo Blogger	1.03	1.05	1.01	1.02
Video Producer	1.35	1.42	1.35	1.42
Music Maker	0.98	1.02	0.97	1.00

Figure 29. HDXPRT 2012 results for the dual-channel RAM normalized to single-channel RAM results for the system configured with the Intel Core i7-3770 processor, Intel HD Graphics 4000, and varying amounts of RAM at 1,333 MHz and 1,600 MHz. Normalized results for the 1,333 MHz equal one and are omitted from this chart. Higher results are better.

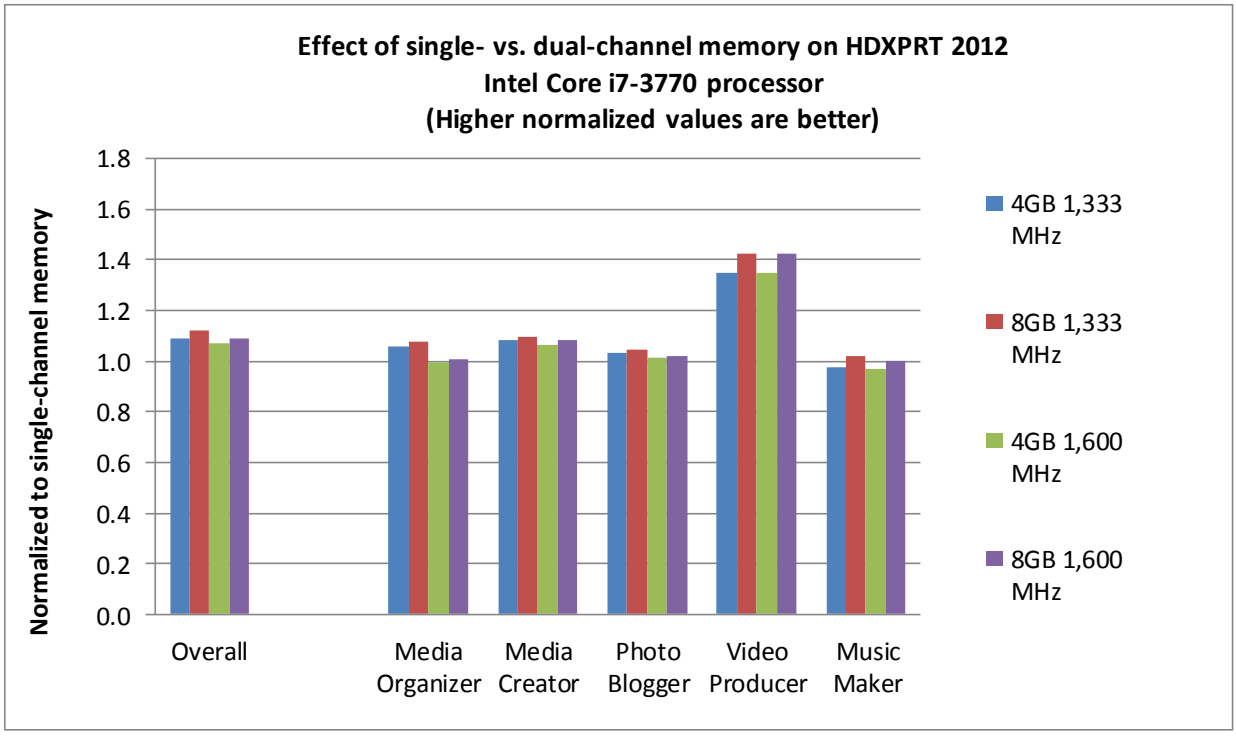

Figure 30. HDXPRT 2012 results normalized to single-channel RAM for the system configured with the Intel Core i7-3770 processor, Intel HD Graphics 4000, and varying amounts of RAM at 1,333 MHz and 1,600 MHz. Higher results are better.

The improvement in performance going from a single 4 GB DIMM to two 2 GB DIMMS was 9 percent for the 1,333 MHz RAM and 7 percent for the 1,600 MHz RAM. By far, the Video Producer category was the most improved, with increases in performance of 35 percent and 42 percent respectively.

The improvement in performance going from a single 8GB DIMM to two 4GB DIMMS was 12 percent for the 1,333 MHz RAM and 9 percent for the 1,600 MHz RAM. Again, the Video Producer category was the most improved, with increases in performance of 42 percent in both cases.

4.5 Hard disk drive vs. solid-state drive

Replacing a 7,200 RPM hard drive with a solid-state drive had little effect on the benchmark scores and scenario times.

We ran these tests using the Intel Core i5-3550 processor installed on an Intel DZ77BH-55K motherboard with 4GB 1,600 MHz RAM and with Turbo Boost Technology enabled. We compared the following two drive models:

- Seagate HDD ST31000528AS 1 TB 7,200 RPM HDD
- Samsung SSD MK0060EAVDR 60 GB SSD

Figure 31 shows the results for the two types of drives with the Intel Core i5-3550 processor.

Drive type	7,200 RPM HDD	SSD
HDXPRT overall score (higher is better)	**230**	**232**
Media Organizer (lower is better)	4.44	4.37
Media Creator (lower is better)	8.73	8.52
Photo Blogger (lower is better)	6.86	6.82
Video Producer (lower is better)	1.9	1.97
Music Maker (lower is better)	2.24	2.18

Figure 31. HDXPRT 2012 scores and use case times in minutes for the system configured with the Intel Core i5-3550 processor, Intel HD Graphics 2500, 4GB RAM, and two different drive types. Higher overall scores and lower times are better.

Figures 32 and 33 show how drive type affected scores and scenario times. As they demonstrate, the overall score increased negligibly—by less than a percent—when we replaced a 7,200 RPM hard disk drive with a solid-state drive.

Drive type	7,200 RPM HDD	SSD
HDXPRT overall score	1.00	1.01
Media Organizer	1.00	1.02
Media Creator	1.00	1.02
Photo Blogger	1.00	1.01
Video Producer	1.00	0.96
Music Maker	1.00	1.03

Figure 32. HDXPRT 2012 results for the HDD and SD normalized to 7,200 RPM HDD results for the system configured with the Intel Core i5-3550 processor, Intel HD Graphics 2500, 4GB RAM, and two different drive types. Higher results are better.

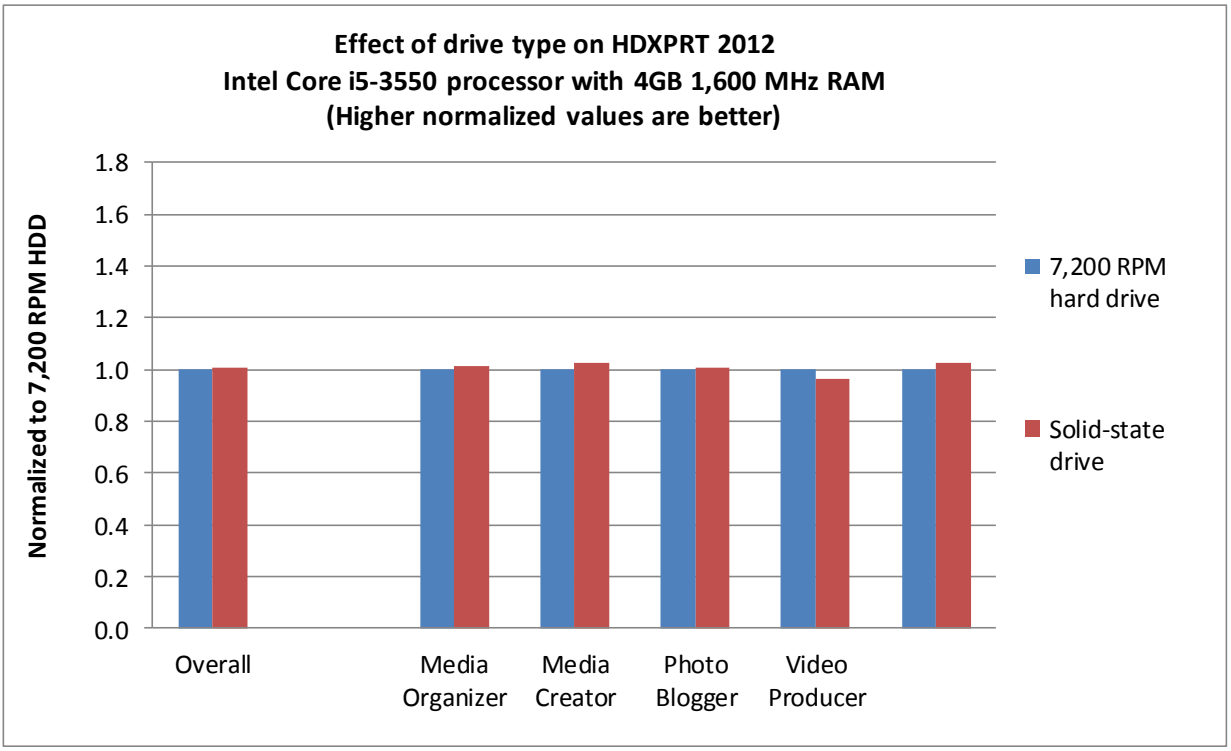

Figure 33. Normalized HDXPRT 2012 scores and times for the system configured with the Intel Core i5-3550 processor, Intel HD Graphics 2500, 4GB RAM, and two different drive types. Higher numbers are better.

The very small difference between the two types of drives suggests that disk performance is not a critical element in HDXPRT 2012, but rather that the benchmark is system memory and compute bound, as we would expect.

5 IN SUMMARY

Of the system components we tested, the processor, the amount of system memory, and memory banking made the greatest difference in HDXPRT 2012 scores. Overall HDXPRT results improved up to 40 percent between the slowest and fastest processors, the Intel Core i3-2105 processor and the Intel Core i7-3770 processor respectively. Increasing the RAM improved the overall Create HD Score by up to 20 percent when going from 2 GB to 8 GB on the Intel Core i7-3770 processor. However, increasing the total RAM to 16 GB did not improve performance. Going from a single-channel memory configuration to a dual-channel configuration improved performance from a minimum of 7 percent to over 9 percent when the processor and total amount of RAM remained constant. Going from single-channel to dual-channel RAM showed the biggest impact, 9.25 percent, at 8 GB of 1,600 MHz RAM on an Intel Core i7-3770 processor.

6 CONTACT INFORMATION

If you would like additional information or would like to provide us with feedback, please write to us at HDXPRTsupport@hdxprt.com. For up-to-date information on HDXPRT, patches, and workarounds, please visit www.hdxprt.com.