Principled Technologies®

TEST REPORT
AUGUST 2006

System performance in common business multitasking collaboration and productivity-related scenarios

Executive summary

Intel® Corporation (Intel) commissioned Principled Technologies (PT) to compare the performance in common business multitasking scenarios of Intel® vPro™ technology platforms with that of two other earlier platforms. We ran a range of typical enterprise multitasking scenarios that involve real-time communication and collaboration with Microsoft Office Communicator 2005 and other common office applications, on four different Intel processor/platform combinations:

- **Intel Pentium® 4 630 Processor-based PC** (3.0 GHz) supporting Hyper-Threading Technology (HT) on the Intel D945GTP desktop board (with the Intel i945G Express chipset)
- **Intel Pentium D 930 Processor-based PC** (3.0GHz Dual-Core processor) on the Intel D945GTP desktop board (with the Intel i945G Express chipset)
- **Intel vPro Technology-based PC with Intel Core™ 2 Duo Processor E6300** (1.86GHz Dual-Core) on Intel DQ965WC desktop board (with the Intel Q965 Express chipset)
- **Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700** (2.66GHz Dual-Core) on Intel DQ965WC desktop board (with the Intel Q965 Express chipset)

KEY FINDINGS

- Intel vPro Technology-based desktop platforms yielded significant performance advantages for users simultaneously running productivity, collaboration, and other tasks, and these platforms were the fastest in all tests.
- The Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 finished our tasks on average 2.12 times faster than the Intel Pentium 4 630 Processor-based PC and 1.68 times faster than the Intel Pentium D 930 Processor-based PC.
- The Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 finished our tasks on average 1.70 times faster than the Intel Pentium 4 630 Processor-based PC and 1.34 times faster than the Intel Pentium D 930 Processor-based PC.
- These performance improvements translate into multi-second time savings that would be noticeable to users.

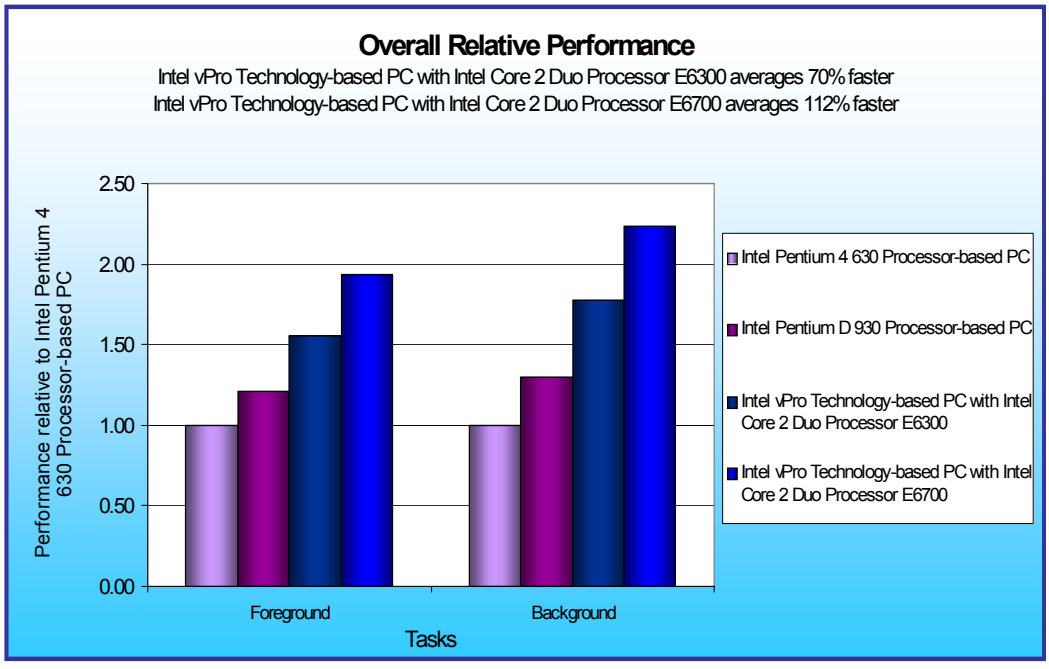

Figure 1: Overall average performance, relative to the Intel Pentium 4 630 Processor-based system, on all foreground and background tasks on all four systems. Average performance is the geometric mean of the normalized time for each task. Higher numbers are better.

We selected four scenarios and created scripts that allowed us to automate our testing. Though each scenario involved collaboration or productivity functions that use typical enterprise office applications, we varied the number, type, and computational intensity of the tasks to reflect a range of user experiences.

As Figure 1 shows, both Intel vPro Technology-based PCs significantly

outperformed the Intel Pentium 4 630 Processor-based PC and the Intel Pentium D 930 Processor-based PC on all our tasks. Compared to the Intel Pentium 4 630 Processor-based PC, the Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700 was from 1.41 times to 3.37 times faster on different applications and tasks and averaged 2.12 times faster across all the tasks. (In all comparisons in which we cite the average of task times, we use the geometric mean of the normalized times for each task.) Compared to that same Pentium 4 630 Processor-based PC, the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 was from 1.13 to 2.69 times faster on our tests and averaged 1.70 times faster

Compared to the Intel Pentium D 930 Processor-based PC, the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 was from 1.22 to 2.82 times faster on different applications and tasks and averaged 1.68 times faster. Compared to that same system, the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 was up to 2.17 times faster and averaged 1.34 times faster.

These performance improvements translated into multi-second time savings noticeable to users. The longest task took 294.9 seconds on the Intel Pentium 4 630 Processor-based PC but only 120.7 seconds--almost two and a half minutes faster--on the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700. The shortest task took 4.5 seconds on the Intel Pentium 4 630 Processor-based PC but only 3.2 seconds on the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700.

So that we could make the four test systems as similar as reasonably possible while varying the processors and motherboards, we built the systems rather than purchasing them from vendors. Intel specified the general system types and supplied the processors and motherboards. We purchased common such components as RAM, hard disks, and optical drives. Each test system had the following basic components (see Appendix A for detailed configuration information):

- 1GB of the fastest RAM its motherboard supported
- 300GB hard disk with an 8MB buffer (SATA)
- DVD-RW optical drive
- Microsoft Windows XP Professional (Service Pack 2)

We used the following common enterprise collaboration and productivity applications, which we list in alphabetical order:

- Adobe Acrobat 7.0 Standard Version 7.0.8
- Microsoft Office Communicator 2005 (Trial edition)
- Microsoft Office Excel 2003 (Service Pack 2)
- Microsoft Office Outlook 2003 (Service Pack 2)
- Microsoft Office PowerPoint 2003 (Service Pack 2)
- Microsoft Office Word 2003 (Service Pack 2)

We also used the following common enterprise security applications, which we list in alphabetical order:

- McAfee VirusScan Enterprise 8.0i
- Webroot Spy Sweeper version 4.5.9 (build 709) using Spyware Definitions v 745 (14-day trial)

The application scenarios we tested included such common functions as:

- Opening files
- Recalculating Excel spreadsheets
- Converting documents to .PDF format
- Sending files
- Sending email
- Starting a whiteboard-sharing session

- Making a VoIP one-to-one call
- Scanning for viruses
- Scanning for spyware

To make it easier to test our scenarios repeatedly and accurately, we automated the hand-timed application functions using scripts we wrote in IBM's Rational Visual Test 6.5. In our analyses we used the times from our tests of those scripts.

In the following sections we look more closely at our test application scenarios (Application scenarios), examine the results of our tests (Test results and analysis), and give detailed information about how we actually performed the tests (Test methodology). In the appendices, we present the configurations of the test systems, explain how to manually execute the application functions in our scenarios, and discuss some potential issues in the development of the test scripts.

Application scenarios

To assess platform performance on typical user activities involving collaboration and productivity applications, we developed a set of multitasking scenarios that employ leading collaboration, productivity, and security applications. We focused primarily on processor-intensive operations that often force users to wait, because users are likely to appreciate performance improvements on such operations.

Each scenario contains two to three timed tasks. Tasks are a combination of background computing tasks and foreground applications. Background computing tasks are typically activities that run unattended while users are performing other functions. In our scenarios, security functions such as virus and spyware scans are backgrounds, as are other lengthy tasks on which users would be unlikely to wait. A foreground task is one whose completion users will typically await before moving to the next task. Some of our scenarios include multiple background tasks. In our results graphs and tables, we label each task as either FG (foreground) or BG (background).

Two of our scenarios include collaboration tasks using Microsoft Office Communicator version 1.0 as well as common business applications. The other two include productivity tasks using Microsoft Office and Adobe applications, as well as some security-related programs.

Sharing data for a sales report

In the first scenario, Hannah, a business manager, needs to share some data that her team is using to develop a sales report. Like everyone else in her organization, she has McAfee VirusScan installed on her system, where it scans files as she opens them. Hannah has already exported sales data from Microsoft Access into an XML report. She now needs to get this report to Lily, a colleague who works at another location, so that Lily can use data from it in her section of the sales report. Due to the size of the file (68.5MB) Hannah decides to send Lily the file via Office Communicator's Send File Command rather than email it; the process begins with a transfer request from Hannah to Lily. Hannah also needs to copy charts into the sales report from an Excel spreadsheet that she has set up for manual calculation. Before Hannah starts work with the Excel file, Lily accepts the file transfer request, and the transfer starts. That transfer runs in the background while Hannah proceeds with her work. Hannah presses F9 in Excel to start the Excel calculation task. While the 2.56MB Excel spreadsheet is calculating, Hannah starts an e-mail message in Office Communicator to Otto, a marketing manager, to ask him to recommend titles for the sales report and charts.

We timed:

- the Excel task (BG) from when Hannah presses F9 until the calculation finishes and the status bar in Excel states that the file is Ready
- the file transfer (BG) from the start of the transfer until the Office Communicator status window shows the transfer is complete
- the email task (FG) from the time Hannah presses OK on the Send E-Mail dialog in Office Communicator until the new email message displays

The McAfee VirusScan background is not a separate task but does stress the system by automatically checking files when appropriate.

Preparing slides for a customer presentation

In our second scenario, Bert, an analyst in a marketing department, is preparing a PowerPoint deck for a customer presentation. He can get the data he needs for a new slide by calculating subtotals in an Excel spreadsheet. He has the Excel file open and has highlighted all the data on a worksheet that has 11,511 rows of sales data in 11 columns. Bert selects Data>Subtotals from the Excel menu, and the Subtotals dialog displays and fills in information on the subtotal he needs. Because the spreadsheet already displays another subtotal that he finds useful, he unchecks the Replace current subtotals field. He then presses Enter to start the subtotals task. While that task is underway, Bert opens the 33.5MB, 36-slide PowerPoint file. The file doesn't open in the slide sorter view he prefers, so he selects View>Slide Sorter from the PowerPoint menu to change the view.

We timed:

- the Excel task (BG) from the time Bert presses Enter to start the task until Excel displays a Ready message when it finishes the task
- the PowerPoint task (part of the FG task) from the beginning of the open until all the slide thumbnails display in PowerPoint
- the change view task (the other part of the FG task) from when Bert selects View>Slide Sorter from the PowerPoint menu until PowerPoint finishes displaying the slides.

We combine the times for these two consecutive foreground activities in our results presentation, because to most users they would happen automatically enough that they would feel like a single interaction with PowerPoint.

Collaborating on product development

In the third scenario, Nan, a developer, is collaborating with a team member, Emme, on an Office Communicator 1:1 Voice over Internet Protocol (VoIP) call to discuss an upcoming product launch. Nan has a 2.88MB Excel spreadsheet of product data that Emme would like her to convert to PDF format and send. Before Nan can start the conversion, a Spy Sweeper scan that the IT department scheduled starts. While the scan runs, Nan chooses Select Adobe PDF>Convert to Adobe PDF from the Excel menu to start the PDF conversion. When the Save Adobe PDF File As dialog displays, Nan presses Save to create the PDF with the default file name. While both the Spy Sweeper scan and the Adobe PDF conversion run in the background, Nan continues talking with Emme and opens an 11MB, 42-page XML file in Word that she will use as she and Emme move to their next topic.

We timed:

- the Spy Sweeper scan (BG) from when the scan begins until Spy Sweeper finishes it and displays a results window
- the PDF conversion (BG) from the time Nan presses the Save button in Excel until the new PDF file opens on her screen
- the Word XML file open (FG) from the time Nan starts the open until Word displays the document and updates the page count on the Word status bar

We do not time the VoIP call because it is going on throughout the scenario and the user, not the platform, determines its duration.

Collaborating on a marketing campaign presentation

In the fourth scenario, Anna, a marketing manager, is putting the final touches on a presentation for a campaign she is developing. Before making the presentation, she needs to review her ideas with another member of her team, Bob. She plans to use the Office Communicator whiteboard during the call with Bob to sketch out her ideas, and she will need to consult a large, 8.18MB, 42-page Microsoft Word document containing the product specification. When it's time for her to make the call using Office Communicator, an automatic virus scan scheduled by the IT department begins. While the scan is running, Anna opens the document in Word and starts a whiteboard sharing session in Office Communicator.

We timed:

- the virus scan (BG) from the time the scan window opens until it closes at the end of the scan
- the Word file open (BG) from when Anna launches Microsoft Word until Word displays the document and updates the page count for the document in the Word status bar
- the whiteboard sharing initialization (FG) from when Anna presses OK to start the sharing until the sharing window opens

For more details on how we executed and measured these scenarios, our specific test functions, and the files the scenarios use, see Appendix B.

Test results and analysis

In this section we examine the results of each of our tests. Figure 2 shows the times, in seconds, that each test system needed to complete each scenario. The times we show for each platform for each scenario are from the median run of the five test runs of that scenario on that platform. (We defined the median run as the one with the median sum of the times of its timed tasks.)

Tests	Intel Pentium 4 630 Processor-based PC	Intel Pentium D 930 Processor-based PC	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6300	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700
Sharing data for a sales report				
Microsoft Office Communicator open email (FG)	14.0	11.3	5.2	4.2
Microsoft Office Communicator send file (BG)	15.9	13.1	9.1	8.9
Microsoft Excel recalc (BG)	17.2	14.4	7.9	5.1
Preparing slides for a customer presentation				
Microsoft PowerPoint file open and change view (FG)	22.1	15.6	13.8	11.0
Microsoft Excel subtotals (BG)	24.5	15.6	12.4	8.3
Collaborating on product development				
Microsoft Word Open XML file (FG)	12.5	11.4	10.3	8.4
Microsoft Excel spreadsheet to Adobe PDF conversion (BG)	69.5	40.5	31.8	24.7
Webroot Spy Sweeper scan (BG)	294.9	265.5	169.7	120.7
Collaborating on a marketing campaign presentation				
Microsoft Office Communicator start sharing (FG)	4.5	4.0	4.0	3.2
Microsoft Word file open (BG)	16.4	14.5	12.2	11.0
McAfee virus scan (BG)	39.4	31.7	26.8	25.9

Figure 2: Median test times, in seconds, for all four test systems on all four scenarios. Lower numbers are better.

In the following sub-sections we explore these results in more detail. To make comparisons easier, we always show results normalized to those of the slowest system in the group, the Intel Pentium 4 630 Processor-based PC. To compute those normalized results, we divided each system's time by the time it took the system with the Intel Pentium 4 630 Processor-based PC to perform the same task. The result for the Intel Pentium 4 630 Processor-based PC is thus always 1.00, because it's the comparison basis. Results higher than 1.00 indicate how much faster a system is than that system. Because of the normalization, higher result numbers are better. For example, a result of 1.80 would mean the system in question was 80 percent faster than the Intel Pentium 4 630 Processor-based PC.

As part of our discussion of each scenario, we also show processor utilization curves that we captured with Windows XP's Perfmon utility. In all the processor utilization charts, we use a blue line for foreground tasks and a red line for background tasks. We use these charts to illustrate how demanding each task would be if we ran it alone. In multitasking scenarios, the system faces each of these same demands, but all at the same time, because the tasks run simultaneously. When each of the simultaneous tasks has minimal processor requirements, keeping them all executing smoothly in parallel may not be difficult. When one or more of the tasks has significant processor demands, meeting those demands at the same time can be extremely difficult for a processor without the added execution ability of the Intel Core 2 Duo Processor. We captured each task's processor-demand curve on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled. We chose to capture this data on this system with HT Technology disabled to make it easy to see the processor demands; had we captured the processor utilization with HT Technology enabled or on one of the Dual-Core based systems, Perfmon would have capped each logical core at 50 percent utilization. (When we ran the scenarios on Intel Pentium 4 630 Processor-based PC, we of course took full advantage of the power of that system and had HT Technology enabled.)

Sharing data for a sales report

This scenario sends a 68.5MB XML file to another user via Office Communicator (the first background task) and then sends an email message via Office Communicator (the foreground task), while recalculating a function-rich, 2.56MB Excel spreadsheet (the second background task). As figures 3 and 4 show, the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 is 3.33 times faster on the foreground task, 1.79 times faster on the first background task, and 3.37 times faster than the Intel Pentium 4 630 Processor-based PC on the second background task,

The Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 also shows large performance improvements, coming in at 2.69 times faster on the foreground task than the Intel Pentium 4 630 Processor-based PC and 1.75 and 2.18 times faster on the two background tasks.

Figure 3 also demonstrates that both Intel vPro Technology-based PCs delivered better performance than the Intel Pentium D 930 Processor-based PC: the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 averaged 2.24 times faster on the three tasks, and the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 averaged 1.79 times faster.

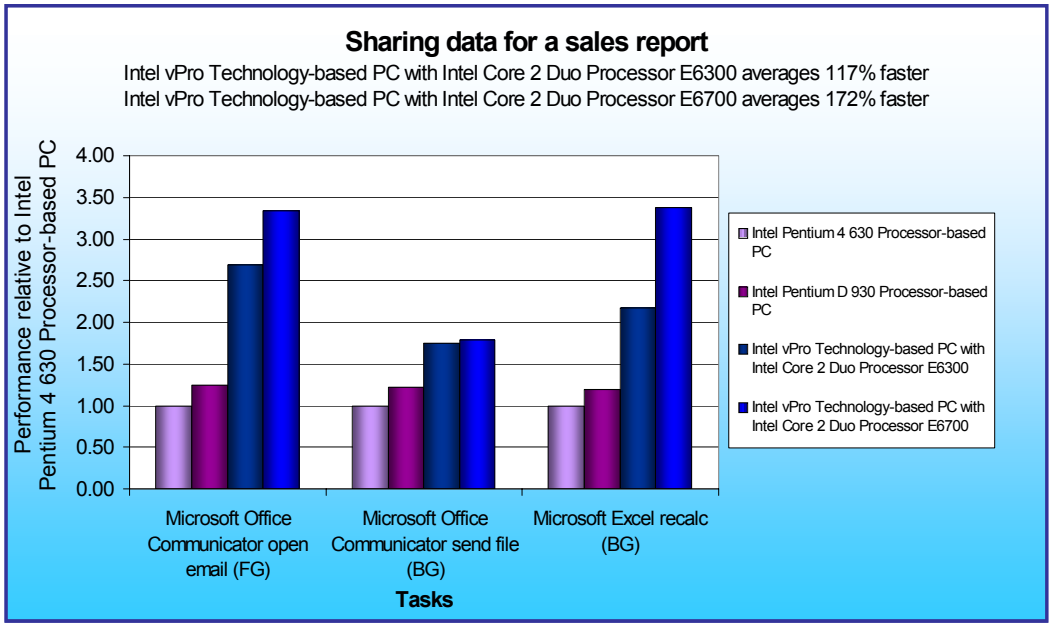

Figure 3: Performance, relative to the Intel Pentium 4 630 Processor-based PC, of each of the four systems sharing data for a sales report. Larger numbers represent better performance.

As Figure 4 shows, these differences represent significant improvements in the time it takes to perform each task. Compared to the Intel Pentium 4 630 Processor-based PC, the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 decreased the elapsed time from 14.0 to 4.2 on the foreground task, from 15.9 to 8.9 seconds on the first background task, and from 17.2 to 5.1 seconds on the

second background task. The Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 also showed significant gains over the Intel Pentium 4 630 Processor-based PC, completing the foreground task 8.8 seconds faster, the first background task 6.8 seconds faster, and the second background task 9.3 seconds faster.

PERFORMANCE RESULTS (seconds)				TASKS	COMPARATIVE RATING			
Intel Pentium 4 630 Processor-based PC	Intel Pentium D 930 Processor-based PC	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6300	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700		Intel Pentium 4 630 Processor-based PC	Intel Pentium D 930 Processor-based PC	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6300	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700
14.0	11.3	5.2	4.2	Microsoft Office Communicator open email (FG)	1.00	1.24	2.69	3.33
15.9	13.1	9.1	8.9	Microsoft Office Communicator send file (BG)	1.00	1.21	1.75	1.79
17.2	14.4	7.9	5.1	Microsoft Excel recalc (BG)	1.00	1.19	2.18	3.37

Figure 4: Results for each of the four systems sharing data for a sales report. Lower performance results are better. Higher comparative ratings are better.

The processor utilization curves in figures 5, 6, and 7 help identify a key reason for these time savings. As they show, each of the scenario's tasks has very high processor demands and so benefits heavily from the Intel vPro architecture and the Intel Core 2 Duo processors. The Excel background task demands the full processor most of the time, while the send file background task wants 60 percent or more of the processor for most of its duration. The foreground task demands 40 percent or more of the processor for most of its run.

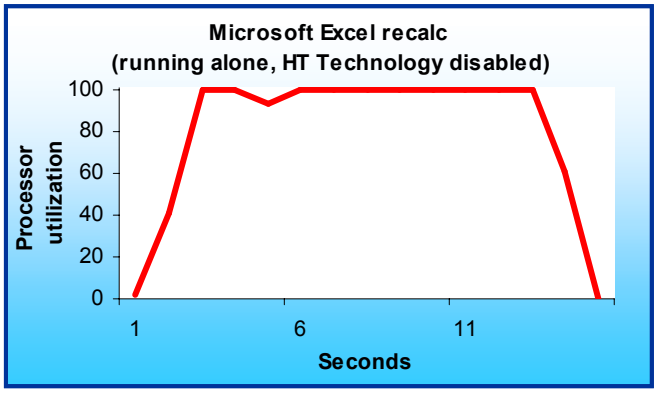

Figure 5: System processor utilization of the Microsoft Excel recalc background task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

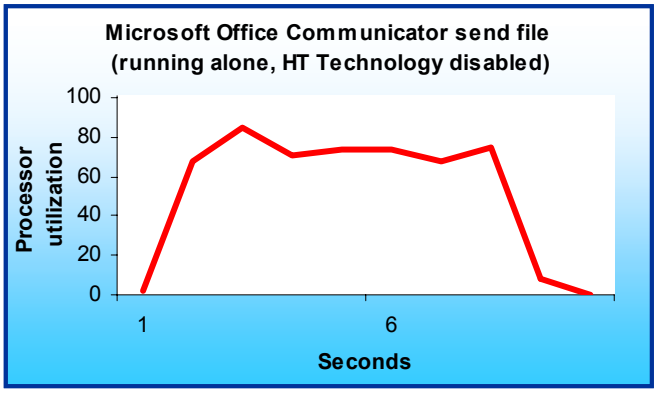

Figure 6: System processor utilization of the Microsoft Office Communicator send file background task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

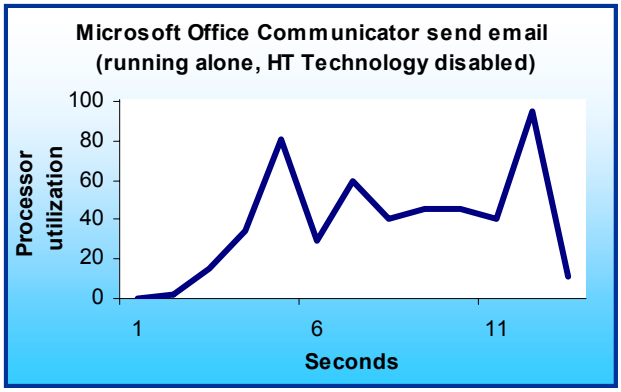

Figure 7: System processor utilization of the Microsoft Office Communicator send email foreground task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

Preparing slides for a customer presentation

In this scenario, two tasks run concurrently. The scenario opens a 33.5MB Microsoft PowerPoint presentation and changes the display to slide sorter view (the two actions together constitute the foreground task) while a 1.79MB Microsoft Excel spreadsheet calculates subtotals (the background task).

As Figure 8 illustrates, the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 was 2.01 times faster on the foreground task and 2.95 times faster on the background task than the Intel Pentium 4 630 Processor-based PC. The Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 also yielded large performance improvements, coming in at 1.60 times faster on the foreground task and 1.98 times faster on the background task than the Intel Pentium 4 630 Processor-based PC.

The Intel vPro-Technology-based PCs also out-performed the Intel Pentium D 930 Processor-based PC. The Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 averaged 1.63 times faster on the two tasks, and the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 averaged 1.19 times faster.

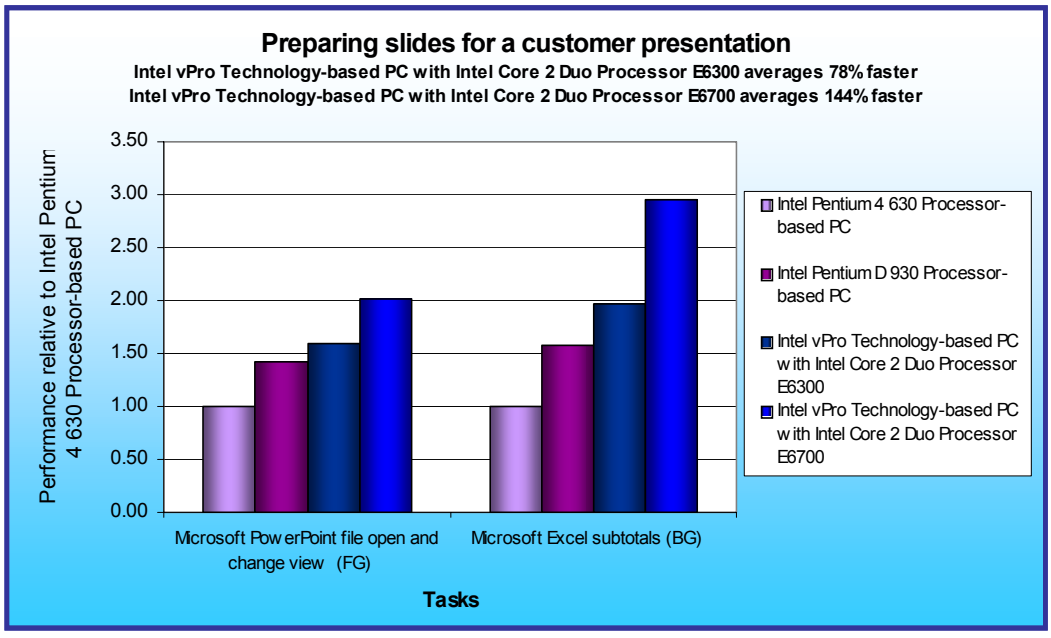

Figure 8: Performance, relative to the Intel Pentium 4 630 Processor-based PC, of each of the four systems preparing slides for a customer presentation. Larger numbers represent better performance.

Figure 9 demonstrates that these differences represent significant improvements in the time it took to perform each task. Compared to the Intel Pentium 4 630 Processor-based PC, the Intel vPro

Technology-based PC with the Intel Core 2 Duo Processor E6700 cut the elapsed time from 22.1 to 11.0 seconds on the foreground task and from 24.5 to 8.3 seconds on the background task. The Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 also significantly beat the Intel Pentium 4 630 Processor-based PC, running 8.3 seconds faster on the foreground task and 12.1 seconds faster on the background task.

PERFORMANCE RESULTS (seconds)				TASKS	COMPARATIVE RATING			
Intel Pentium 4 630 Processor-based PC	Intel Pentium D 930 Processor-based PC	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6300	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700		Intel Pentium 4 630 Processor-based PC	Intel Pentium D 930 Processor-based PC	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6300	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700
22.1	15.6	13.8	11.0	Microsoft PowerPoint file open and change view (FG)	1.00	1.42	1.60	2.01
24.5	15.6	12.4	8.3	Microsoft Excel subtotals (BG)	1.00	1.57	1.98	2.95

Figure 9: Results for each of the four systems preparing slides for a customer presentation. Lower performance results are better. Higher comparative ratings are better.

The Intel vPro Technology-based PCs with Intel Core 2 Duo Processors are able to handle this scenario's processor-intensive tasks with ease. The processor utilization curves in figures 10, 11, and 12 help illustrate the reason for these time savings. For this analysis, we separated the PowerPoint open and the PowerPoint change view functions into two figures to identify the processor requirements of each operation. As these figures show, all three tasks are demanding, reporting 100 percent processor utilization for significant lengths of time.

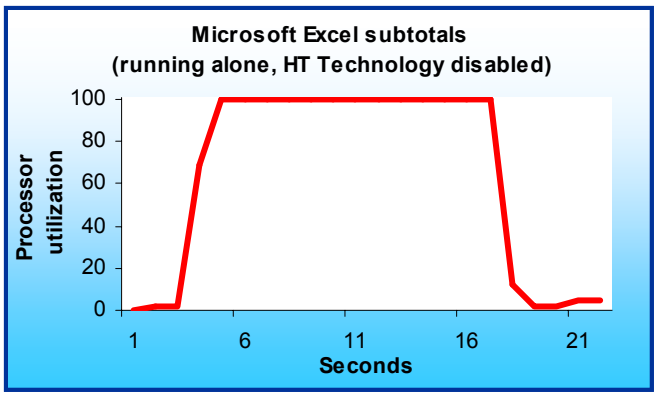

Figure 10: System processor utilization of the Microsoft Excel subtotals background task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

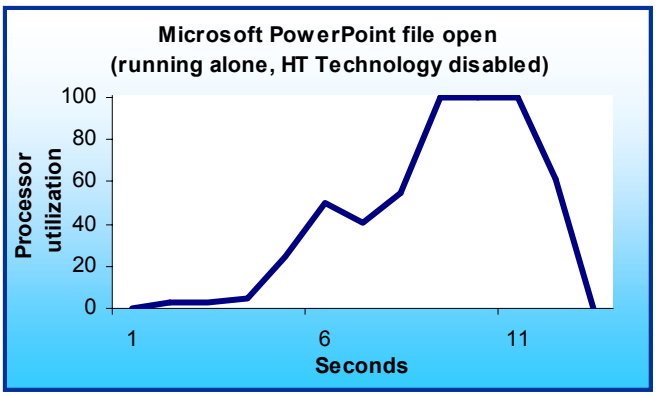

Figure 11: System processor utilization of the Microsoft PowerPoint file open foreground task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

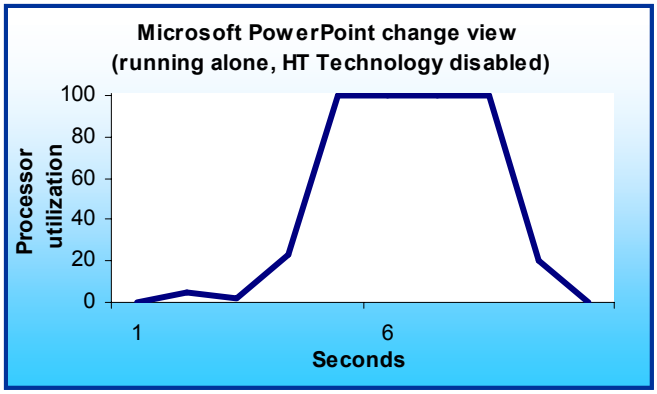

Figure 12: System processor utilization of the Microsoft PowerPoint change view foreground task running alone on Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

Collaborating on product development

This scenario opens an 11MB XML file in Word (the foreground task) while Webroot Spy Sweeper scans for spyware (the first background task) and Excel converts a 2.88MB spreadsheet to a PDF file (the second background task). As these tasks are executing, the user is on an Office Communicator 1:1 VoIP call. (We do not time this call, because the user, not the system controls its duration.) The tasks all run concurrently.

Figure 13 shows the improvement in performance of the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 on both the foreground and background tasks relative to the Intel Pentium 4 630 Processor-based PC. These results show that the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 was 1.49 times faster on the foreground task, as well as 2.81 and 2.44 times faster on the two background tasks. The Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 ran 1.21 times faster on the foreground task than the Intel Pentium 4 630 Processor-based PC, 2.19 times faster on the first background task, and 1.74 times faster on the second background task.

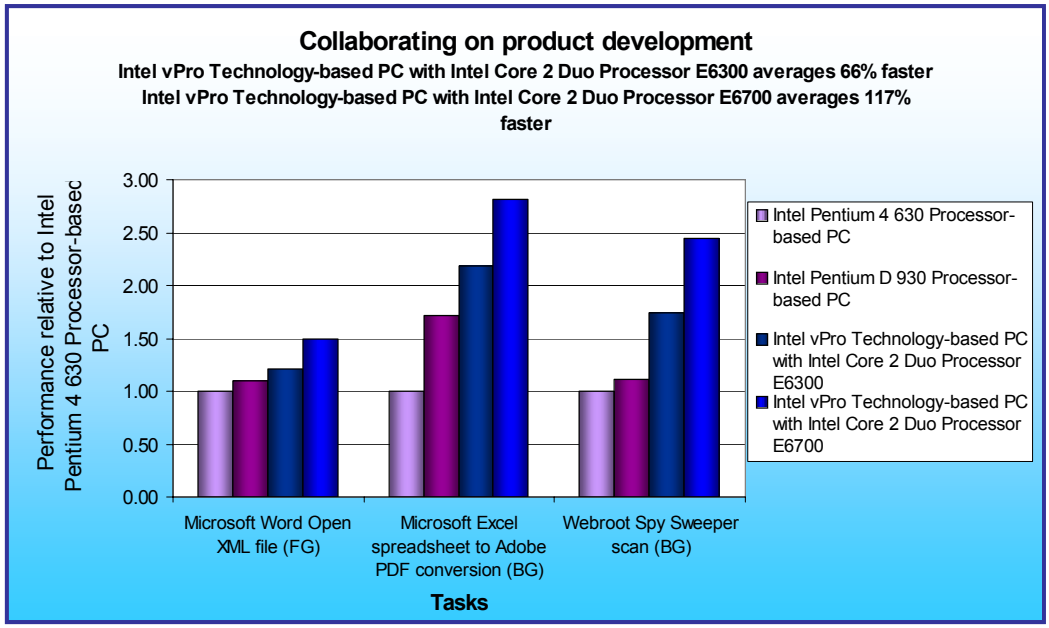

Figure 13: Performance, relative to the Intel Pentium 4 630 Processor-based PC, of each of the four systems collaborating on product development. Larger numbers represent better performance.

Both Intel vPro Technology-based PCs also outpaced the Intel Pentium D 930 Processor-based PC, with the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 averaging 1.70 times faster on the three tasks, and the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 averaging 1.30 times faster.

Figure 14 shows that these percentage differences mean valuable time savings

for users. Compared to the Intel Pentium 4 630 Processor-based PC, the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 decreased the elapsed time from 12.5 to 8.4 seconds on the foreground task, from 69.5 to 24.7 seconds on the first background task, and from 294.9 to 120.7 seconds on the second foreground task. The Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 also beat the Intel Pentium 4 630 Processor-based PC, with a 37.7-second edge on the first background task, a 125.2-second edge on the second background task, and a margin of 2.2 seconds on the foreground task.

PERFORMANCE RESULTS (seconds)				TASKS	COMPARATIVE RATING			
Intel Pentium 4 630 Processor-based PC	Intel Pentium D 930 Processor-based PC	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6300	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700		Intel Pentium 4 630 Processor-based PC	Intel Pentium D 930 Processor-based PC	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6300	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700
12.5	11.4	10.3	8.4	Microsoft Word Open XML file (FG)	1.00	1.10	1.21	1.49
69.5	40.5	31.8	24.7	Microsoft Excel spreadsheet to Adobe PDF conversion (BG)	1.00	1.72	2.19	2.81
294.9	265.5	169.7	120.7	Webroot Spy Sweeper scan (BG)	1.00	1.11	1.74	2.44

Figure 14: Results for each of the four systems collaborating on product development. Lower performance results are better. Higher comparative ratings are better.

The processor utilization curves in figures 15, 16, 17, and 18 give an overview of the demands the systems faced. In this scenario, the Office Communicator 1:1 VoIP call caused negligible load on the processor, but the background Webroot Spy Sweeper spyware scan wanted almost all of the processor, and the Excel PDF conversion put an appreciable additional load on the system. The processor requirements of the Word task varied but at times hit 100 percent. The Intel vPro Technology-based PCs with Intel Core 2 Duo Processors clearly handled this four-task load much better than the other two systems.

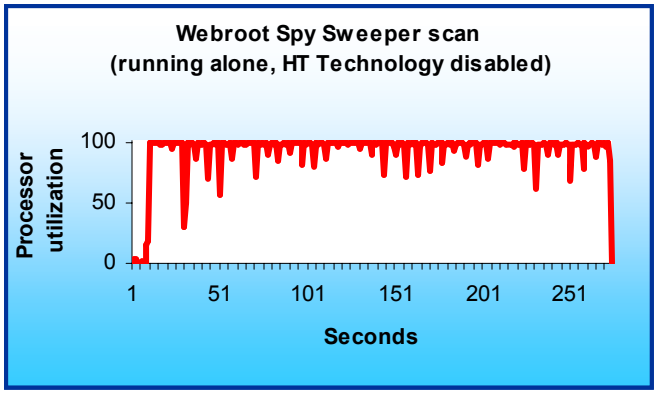

Figure 15: System processor utilization of the Webroot Spy Sweeper scan background task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

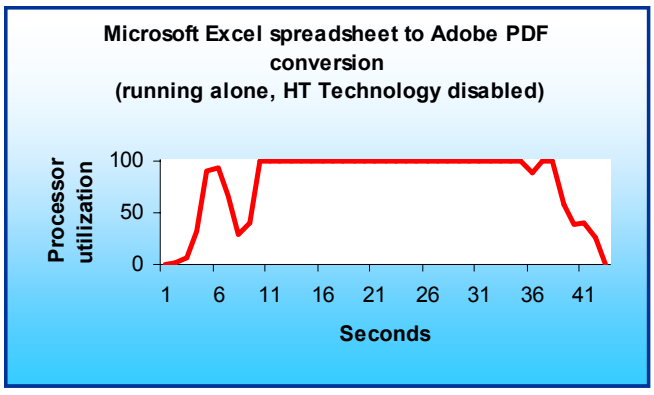

Figure 16: System processor utilization of the Microsoft Excel spreadsheet to Adobe PDF conversion background task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

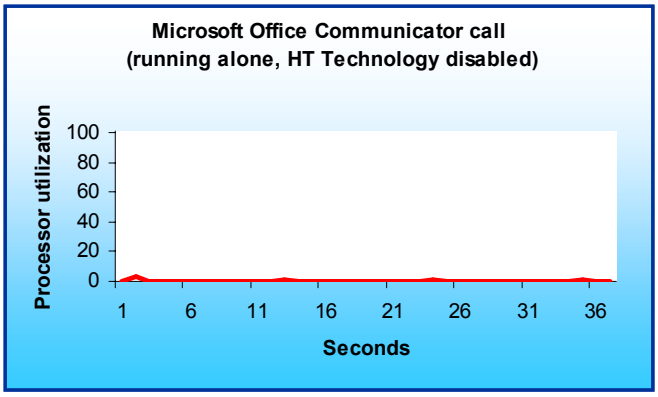

Figure 17: System processor utilization of the Microsoft Office Communicator call task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

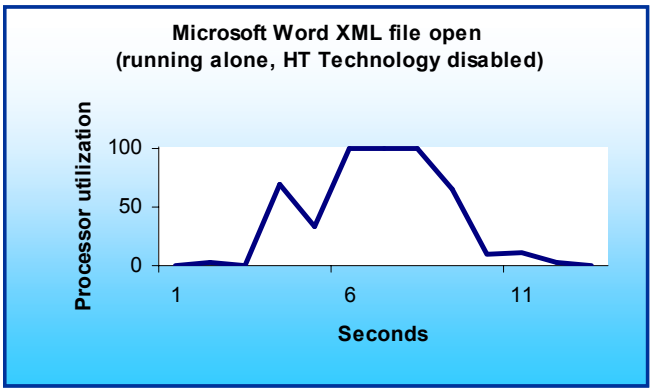

Figure 18: System processor utilization of the Microsoft Word open XML file foreground task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

Collaborating on a marketing campaign presentation

This scenario initiates a Microsoft Office Communicator 2005 whiteboard-sharing session (the foreground task) while Network Associates' McAfee VirusScan performs a scan on a medium-large (164MB) directory (the first background task) and Microsoft Word opens an 8.18MB document with uncompressed graphics (the second background task).

Figure 19 shows the improvement in performance of the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 on both tasks relative to the Intel Pentium 4 630 Processor-based PC. These results show the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 was 1.41 times faster on the foreground task, 1.49 times faster on the first background task, and 1.52 times faster on the second background task. The Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 also yielded serious performance improvements, coming in at 1.13 times faster on the foreground task than the Intel Pentium 4 630 Processor-based PC, 1.34 times faster on the first background task, and 1.47 times faster on the second background task.

Both Intel vPro Technology-based PCs also outpaced the Intel Pentium D 930 Processor-based PC, with the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6700 averaging 1.26 times faster on the three tasks, and the Intel vPro Technology-based PC with the Intel Core 2 Duo Processor E6300 averaging 1.12 times faster.

Figure 20 shows that these differences represent significant improvements in the time it took to perform each task. Compared to the Intel Pentium 4 630 Processor-based PC, the Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700 decreased the time from 16.4 to 11.0 seconds on the first background task, from 39.4 to 25.9 seconds on the second background task, and from 4.5 to 3.2 seconds on the foreground task. The Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6300 also showed gains over the Intel Pentium 4 630 Processor-based PC, running 4.2 seconds faster on the first background task, 12.6 seconds faster on the second background task, and half a second faster on the foreground task.

The processor utilization curves in figures 21, 22, and 23 help illustrate the reason for these time savings. As figure 21 shows, the McAfee virus scan task demands practically the full processor. The Microsoft Word file open

PERFORMANCE RESULTS (seconds)				TASKS	COMPARATIVE RATING			
Intel Pentium 4 630 Processor-based PC	Intel Pentium D 930 Processor-based PC	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6300	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700		Intel Pentium 4 630 Processor-based PC	Intel Pentium D 930 Processor-based PC	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6300	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700
4.5	4.0	4.0	3.2	Microsoft Office Communicator start sharing (FG)	1.00	1.13	1.13	1.41
16.4	14.5	12.2	11.0	Microsoft Word file open (BG)	1.00	1.13	1.34	1.49
39.4	31.7	26.8	25.9	McAfee virus scan (BG)	1.00	1.24	1.47	1.52

Figure 20: Results for each of the four systems collaborating on a marketing campaign presentation. Lower performance results are better. Higher comparative ratings are better.

task (Figure 22) was fairly demanding as well and needed more than half of the processor. On top of that, even the light demand of the Microsoft Office Communicator whiteboard sharing task was enough to further load the system.

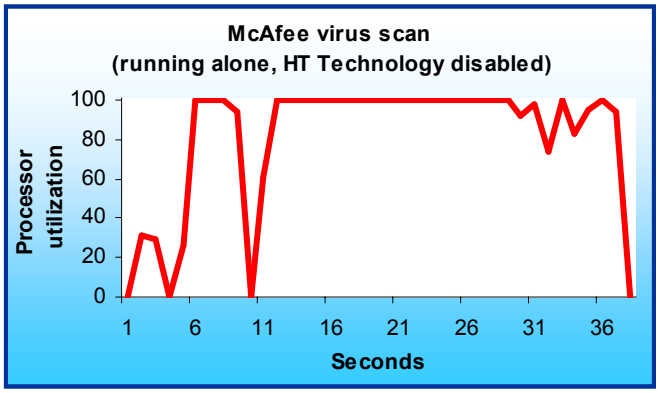

Figure 21: System processor utilization of the McAfee virus scan background task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

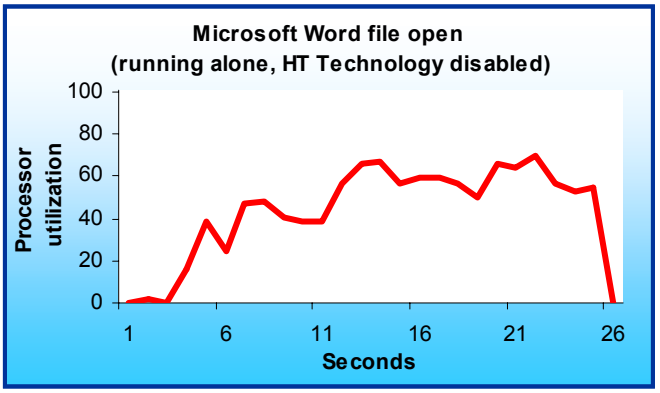

Figure 22: System processor utilization of the Microsoft Word file open background task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

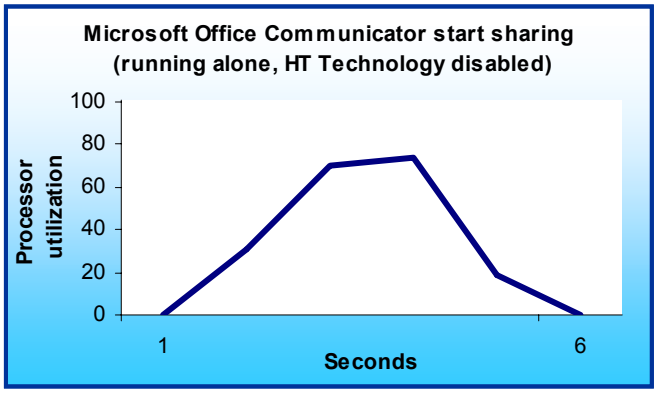

Figure 23: System processor utilization of the Microsoft Office Communicator start sharing foreground task running alone on the Intel Pentium 4 630 Processor-based PC with HT Technology disabled.

Test methodology

We evaluated the performance of each of the application scenarios (see "Application scenarios") both by hand and with automated test scripts, which we developed with IBM's Visual Test 6.5. Appendix B details the steps we followed when we hand-timed the scenarios. In this paper, we concentrate our discussions on the results of the automated scripts, because those results are generally more repeatable than hand timings.

We collected results for five runs of each script in each system configuration. (If any test or script failed, we discarded that test's results and ran the test again.) We refer in this paper only to the median results of those runs on each system configuration. The scripts produce times (in milliseconds), with lower times to complete a given function indicating better performance. We round those times to tenths of seconds in this report.

Appendix A provides detailed configuration information on the test systems. We set up each of those systems using the following process:

1. Install Microsoft Windows XP Professional.
2. Using the standard Microsoft Windows Update Web site, apply all current (as of August 18, 2006) Windows XP critical updates, including Windows XP SP2—but not including optional updates, such as Windows Media Player 10 or Windows Media Connect, that were totally unrelated to the goal of this paper.
3. Install Microsoft Office 2003 (with Access 2003).
4. Using the standard Microsoft Office Update Web site, apply all current (as of August 18, 2006) Office 2003 updates.
5. Turn off Windows Service Pack 2 Security Center Pop-up Alerts. Doing so prevents such alerts from occurring during testing and affecting results.
   a. Open the system Control Panel.
   b. Choose Security Center.
   c. Click Change the way Security Center Alerts me on the left.
   d. Uncheck Firewall, Automatic Updates, and Virus Protection.
6. Turn off Windows Automatic Updates. Doing so prevents such updates from occurring during testing and affecting results.
   a. Open the system Control Panel.
   b. Choose Automatic Updates.
   c. Select Turn off Automatic Updates.
7. Turn off System Restore. Doing so prevents such events from occurring during testing and affecting results.
   a. Open the system Control Panel.
   b. Choose System.
   c. Choose the System Restore tab.
   d. Select Turn off System Restore on all drives.
8. Turn off all Power Management settings. Doing so prevents such events from occurring during testing and affecting results.
   a. Open the system Control Panel.
   b. Choose Display.
   c. Choose the Screensaver tab.
   d. Select None as the Screensaver.
   e. Choose the Power button.
   f. Select the Power Schemes tab and choose Never to Turn off monitor, Turn off hard disks, and System standby.
   g. Select the Hibernate tab and uncheck the Enable Hibernation option.
9. To ensure as consistent a starting point as possible for the performance measurements, defragment the hard disk of each system.
10. Using Symantec's Ghost utility, make an image of each system's hard disk. (This image lets us return to a clean and consistent starting point whenever necessary.)
11. Install the additional software, using the versions current as of August 18, 2006, that each scenario requires:

- Sharing data for a sales report
  - Microsoft Office Communicator 2005 (Trial version)
  - Network Associates' McAfee VirusScan Enterprise version 8.0i
- Collaborating on product development
  - Adobe Acrobat 7.0 Standard Version 7.0.8
  - Microsoft Office Communicator 2005 (Trial version)
  - Webroot Spy Sweeper version 4.5.9 (build 709) using Spyware Definitions v 745 (14-day trial)
- Collaborating on a marketing campaign presentation
  - Microsoft Office Communicator 2005 (Trial version)
  - Network Associates' McAfee VirusScan Enterprise version 8.0i

In addition to the test systems, the two scenarios that use Office Communicator require the following additional systems:

- a Live Communications server
- a client system to serve as an Office Communicator contact for the system under test
- only in the scenario that includes a 1:1 VoIP call, a monitoring station to supply the audio for the call

Figure 24 shows the systems and connections that both of these Office Communicator scenarios require. The collaborating on product development scenario includes a VoIP call and requires an additional system to provide audio for that call; we discuss that system in the instructions for that scenario.

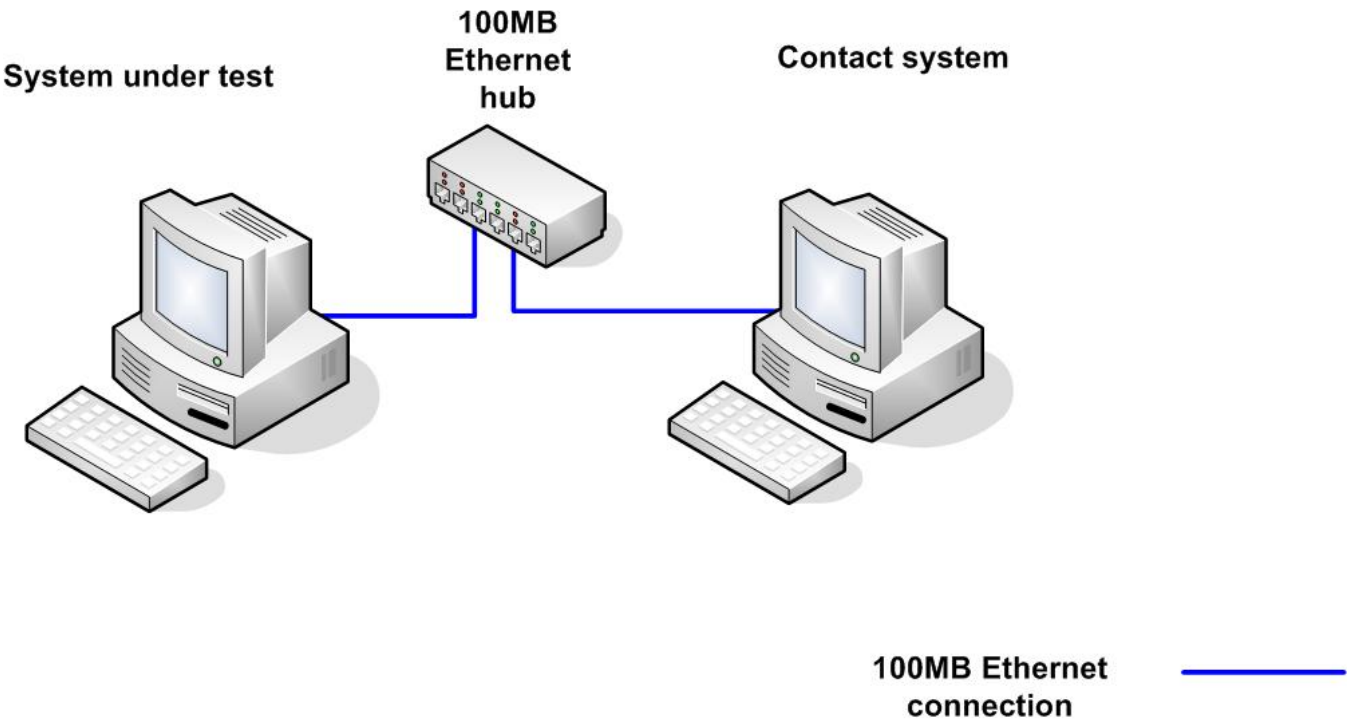

Figure 24: System configuration for the scenarios that involve Office Communicator.

The server running the Live Communications Server software must be part of a domain with Active Directory running. (During the installation of Active Directory, you must perform the Prep Schema, Prep Forest, and Prep Domain functions.) For some of the email functions to work properly, the scenarios also require an Exchange Server. To simplify setup, a single server can act as a Domain Controller with Active Directory, Application Server (IIS), DNS, and Exchange Server all running.

After you properly set up these applications or services, the final task is to set up Live Communications Server. The following steps, which assume those other server applications are already running, provide an overview of the process of installing and configuring Live Communications Server. For more details, consult the appropriate Microsoft documentation.

1. Install Live Communications Server with the default installation options.
2. Activate Live Communication Server.
3. Use TCP as the connection protocol.
4. The scenarios require one user for each system in the test. Add those users first within Active Directory.
5. After you create the users in Active Directory, right-click each user name, and select Properties.
    - In the Properties window, select the Live Communications tab.
    - Place a check in the Enable Live Communications for this user check box.
    - In the SIP URL, enter the user name.
    - Select this server pool (in a clean test setup, there should be only one) from the drop-down menu, and click Apply.
    - Repeat the above steps for each test user.
6. Close the Active Directory window.
7. Once you have enabled the users for Live Communication, you should be able to see them in the Live Communications Server window in the Users folder.
8. Each of the systems should be able to log into the server with its appropriate user account.

Each of the systems you use in the test must be running Microsoft Office Communicator 2005. The following steps, which assume you've already set up the server, provide an overview of the process of installing and configuring Office Communicator. For more details, consult the appropriate Microsoft documentation.

1. Before installing the software, edit the Hosts file in C:\Windows\system32\drivers\etc\ so that the file includes the server's name and IP address.
2. Install Office Communicator 2005 using all the default options.
3. After the installation is complete, open Office Communicator.
4. Choose Options from the Actions drop-down menu.
5. In the Accounts tab, enter the user name for this system.
6. Click the Advanced Options button.
7. In the Advanced Connection Settings window, choose Configure Settings.
8. Enter the server name in the appropriate line.
9. Use TCP as the connection setting.
10. Close both the Advanced and Option windows.

To sign in to the Office Communicator server before testing, do the following:

1. Select Sign In from the Connect drop-down menu.
2. When the Sign-In Name window appears, enter the user name.
3. Click OK.
4. In the next window, enter the password.
5. Select Save Password.

To obtain the results for each application scenario, we followed the same basic process:

1. Reboot the system.
2. Wait 10 seconds after the Windows hourglass disappears and Windows XP has completed its startup sequence. This delay ensures the system is in a consistent starting state.
3. Run the test script or hand-timed application functions, as appropriate.
4. Record the results.
5. Repeat the above three-step process five times.

If any test or script failed, we discarded that test's results and ran the test again.

Appendix A – Test system configuration information

This appendix provides detailed configuration information about each of the test systems, which we list in alphabetical order by processor name.

Processors in the systems	Intel Pentium 4 630 Processor-based PC	Intel Pentium D 930 Processor-based PC	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6300	Intel vPro Technology-based PC with Intel Core 2 Duo Processor E6700
General				
Processor and OS kernel: (physical, core, logical) / (UP, MP)	1P1C2L / MP	1P2C2L / MP	1P2C2L / MP	1P2C2L / MP
Number of physical processors	1	1	1	1
Single/Dual-Core processors	Single (with Hyper-Threading Technology enabled)	Dual/None	Dual/None	Dual/None
System Power Management Policy	Home/Office Desk	Home/Office Desk	Home/Office Desk	Home/Office Desk
CPU				
System type	Intel	Intel	Intel	Intel
Vendor	Pentium 4	Pentium D	Core2Duo	Core2Duo
Name	630	930	E6300 (pre-production)	E6700 (pre-production)
Stepping	3	2	5	5
Socket type	LGA775	LGA775	LGA775	LGA775
Core frequency (GHz)	3.0	3.0	1.86	2.66
Front-side bus frequency (MHz)	800 MHz	800 MHz	1066 MHz	1066 MHz
L1 Cache	16 KB + 12 Kμops	16 KB + 12 Kμops	32 KB + 32 KB	32 KB + 32 KB
L2 Cache	2 MB	2 MB	2 MB	4 MB
Platform				
Vendor	Intel	Intel	Intel	Intel
Motherboard model number	D945GTP	D945GTP	DQ965WC	DQ965WC
Motherboard chipset	Intel i945G Express	Intel i945G Express	Intel Q965 Express (pre-production)	Intel Q965 Express (pre-production)
Motherboard revision number	A2	A2	01	01
Motherboard serial number	AAC97837-301	AAC97837-301	AAD41834-300	AAD41834-300
BIOS name and version	Intel NT94510J.86A.3943.2006.0707.1405	Intel NT94510J.86A.3943.2006.0707.1405	Intel CO96510J.86A.4462.2006.0804.2059	Intel CO96510J.86A.4462.2006.0804.2059
BIOS settings	AHCI Enabled	AHCI Enabled	AHCI Enabled	AHCI Enabled

Memory module(s)				
Vendor and model number	Micron 8HTF6464AY-667D7	Micron 8HTF6464AY-667D7	Corsair CM2X512A-6400	Corsair CM2X512A-6400
Type	PC5300	PC5300	PC6400	PC6400
Speed (MHz)	667	667	800	800
Speed in the system currently running @ (MHz)	333	333	400	400
Timing/Latency (tCL-tRCD-tRP-tRASmin)	5-5-5-15	5-5-5-15	5-5-5-12	5-5-5-12
Size	1 GB	1 GB	1 GB	1 GB
Number of sticks	2 x 512 MB	2 x 512 MB	2 x 512 MB	2 x 512 MB
Chip organization	Double-sided	Double-sided	Double-sided	Double-sided
Channel	Dual	Dual	Dual	Dual
Hard disk				
Vendor and model number	Maxtor 6B300S0	Maxtor 6B300S0	Maxtor 6B300S0	Maxtor 6B300S0
Size	300 GB	300 GB	300 GB	300 GB
Buffer Size	16 MB	16 MB	16 MB	16 MB
RPM	7200	7200	7200	7200
Type	SATA 150 MB/s	SATA 150 MB/s	SATA 150 MB/s	SATA 150 MB/s
Controller	Intel 82801GB (ICH7)	Intel 82801GB (ICH7)	Intel 82801HB (ICH8)	Intel 82801HB (ICH8)
Driver	Intel 5.5.0.1035	Intel 5.5.0.1035	Intel 6.1.0.1002	Intel 6.1.0.1002
Operating system				
Name	Windows XP Professional	Windows XP Professional	Windows XP Professional	Windows XP Professional
Build number	2600	2600	2600	2600
Service pack	2	2	2	2
Microsoft Windows update date	NTFS	NTFS	NTFS	NTFS
File system	ACPI Multiprocessor PC	ACPI Multiprocessor PC	ACPI Multiprocessor PC	ACPI Multiprocessor PC
Kernel	English	English	English	English
Language	DirectX 9.0c	DirectX 9.0c	DirectX 9.0c	DirectX 9.0c
Microsoft DirectX version	Windows XP Professional	Windows XP Professional	Windows XP Professional	Windows XP Professional
Graphics				
Vendor and model number	Intel GMA 950	Intel GMA 950	Intel GMA 3000	Intel GMA 3000
Chipset	Integrated	Integrated	Integrated	Integrated
BIOS version	Intel 82945G Express Chipset	Intel 82945G Express Chipset	Intel Q965 Express Chipset	Intel Q965 Express Chipset
Type	1295	1295	1345	1345
Memory size	128 MB Shared	128 MB Shared	128 MB Shared	128 MB Shared
Resolution	1024 x 768	1024 x 768	1024 x 768	1024 x 768
Driver	Intel 6.14.10.4497	Intel 6.14.10.4497	Intel 6.14.10.4624	Intel 6.14.10.4624
Sound card/subsystem				
Vendor and model number	SigmaTel High Definition Audio	SigmaTel High Definition Audio	SigmaTel High Definition Audio	SigmaTel High Definition Audio

Driver	SigmaTel 5.10.5067.0	SigmaTel 5.10.5067.0	SigmaTel 5.10.5067.0	SigmaTel 5.10.5067.0
Ethernet				
Vendor and model number	Intel PRO/1000 PM	Intel PRO/1000 PM	Intel 82566DM Gigabit	Intel 82566DM Gigabit
Driver	Intel 9.4.17.0	Intel 9.4.17.0	Intel 9.4.6.0	Intel 9.4.6.0
Optical drive(s)				
Vendor and model number	Lite-On DVDRW SHOW-1673S	Lite-On DVDRW SHOW-1673S	Slimtype DVDRW SLW-8315	Slimtype DVDRW SLW-8315
Type	DVD-RW	DVD-RW	DVD-RW	DVD-RW
Dual/Single layer	Dual	Dual	Dual	Dual
USB ports				
Number	6	6	8	8
Type	USB 2.0	USB 2.0	USB 2.0	USB 2.0
IEEE 1394 ports				
Number	1	1	2	2
Monitor				
Type	Plug & Play	Plug & Play	Plug & Play	Plug & Play

Figure 25: Detailed system configuration information for each of the four test systems.

Appendix B – Instructions for running the application scenarios

This appendix summarizes the script for each application scenario and explains how we manually tested and timed each of those scenarios. Though the vast majority of our discussions in this report focus on the results of the automated tests, we verified that manually performing the same functions yielded results similar to those of the automated scripts.

As the instructions below reflect, to get the most consistent possible timings and to make our hand-timed actions more like the ones the automated scripts perform, we sometimes chose to follow procedures for launching applications that were different from those typical users would follow. (See Appendix C for additional information on scripting issues.) When we made such choices, we also independently verified that the typical user procedures would still show similar results.

Consequently, we are confident that the performance benefits the Intel vPro Technology-based PCs delivered in these scenarios are benefits that users can expect to realize in real work situations and are not artifacts of the measurement or scripting technology.

We ran all application scenarios five times on each of the four systems under test, and we reported the median of those runs. Each time we reboot the system, we wait 10 seconds after the last hourglass has disappeared to make sure the system is in a consistent state.

The following subsections, which assume you have already completed all of the setup work in the Test Methodology section, describe how to run each of the individual scenarios.

Sharing data for a sales report

The applications involved

- Microsoft Office Communicator 2005 (Trial version)
- Microsoft Office Excel 2003 (Service Pack 2)
- Microsoft Office Outlook 2003 (Service Pack 2)
- Network Associates' McAfee VirusScan Enterprise version 8.0i

The data files involved

- Excel2MinMacro.xls, a formula-rich 2.56MB Excel file
- Sales2002a.XML, a 68.5MB XML report we created from an Access database

The script

This scenario requires two scripts: one for the system under test, and one for the system that receives the file the system under test sends via Microsoft Office Communicator. We start the script for the receiving system first. That script waits until the system under test sends a message requesting permission to send the file, waits 8 seconds (the time a real user might take to read and consider the message), and then accepts the request.

The script for this scenario performs the following tasks on the system under test:

1. Open Excel2MinMacro.xls.
2. In Office Communicator, select Actions > More > Send a File.
3. Highlight the contact you want to send the file to.
4. Press OK.
5. In the Send a File dialog, find and select Sales2002a.XML. (We did not time these first five tasks, because they occur outside the multitasking section of the script.)
6. Start the timer for the first background task. (Add 8 seconds to the timer, because the receiving system will wait 8 seconds before agreeing to accept the file, and the task does not start until the receiving system agrees to accept the file.).
7. Click the Open button in the Send a file dialog in Office Communicator.
8. On the Office Communicator window, select Actions > Send E-Mail.
9. Highlight the first contact.
10. Start the timer for the second background task, and press F9 in Excel to start the manual calculation.

11. Wait 5 seconds. This delay mimics the time a typical user might wait after confirming one task has started before moving to another.
12. Start the timer for the foreground task, and press OK on the Send email dialog.
13. Wait 3 seconds. This delay mimics the time a typical user might wait after confirming one task has started before moving to another.
14. At this point the receiving system is accepting the file, so a progress bar for the send file task displays on both systems.
15. Stop the timer for the first background task when the send file progress bar goes away.
16. Stop the timer for the foreground task when the system displays the Untitled Message addressed to the contact you selected for this message.
17. Stop the timer for the second background task when the Excel manual calculation finishes, which is when the Excel status bar says Ready.
18. Close Excel without saving the file, and close all but the main Office Communicator window. (We did not time these tasks, because they occur outside the multitasking section of the script.)

The script for the receiving system performs the following tasks on that system:

1. Wait until the system under test sends a message via Office Communicator requesting permission to send a file.
2. Wait 8 seconds, and accept that request. Office Communicator on the system under test then sends the file.

The manual process

In addition to the system under test, this scenario requires a second system that is also running Office Communicator 2005. The second system will receive the file that the test system sends. The process for setting up that system is the same as for setting up the test systems.

First, prepare each system by following these steps once:

1. Open Office Communicator.
2. Select Contacts > Add Contact to open the Contacts Setup wizard.
3. Enter the user name of the system you will be calling during testing.
4. Select Next through the remaining wizard options, thus keeping the defaults for each one.
5. Select Contacts > Add Contact to open the Contacts Setup wizard.
6. Enter the user name of an offline system you will be calling during testing. (This must be the second contact name.)
7. Select Next through the remaining wizard options, thus keeping the defaults for each one.
8. Copy Sales2002a.XML to the desktop.
9. Create a desktop shortcut to Excel2MinMacro.xls.
10. Make sure you have set up Outlook with the same user name as the one you're using for Office Communicator.
11. Open Outlook.
12. Make sure Outlook has HTML and Word as formats for email messages.
13. Put Excel into windowed mode, if necessary, by clicking the Restore Down button in the upper right.
14. Position the Excel window so it does not overlap the Office Communicator window.
15. Close Excel and Outlook.

To execute the test, follow these instructions. You will need two stopwatches.

1. Reboot both systems.
2. On the system that is going to receive the file, set the Office Communicator status to Online.
3. On the system under test,
    a. Open the Excel spreadsheet.
    b. In Office Communicator, select Actions > More > Send a File.

c. Highlight the contact you want to send the file to; it should be the receiving system.
d. Click OK.
e. In the Send a File dialog, click Desktop.
f. Select Sales2002a.XML.
g. Click the Open button.
h. In the Office Communicator window, select Actions > Send E-Mail.
i. Highlight the offline contact.

4. Go to the system that is going to receive the file, and accept the file. A confirmation window will appear. Leave that window in place.
5. Go back to the system under test.
6. To make it easier to get times, we included in the Excel file a macro that runs the manual calculation and shows the elapsed time on the Excel status bar. Start the macro by pressing Alt-a. If you prefer to time the task with a stopwatch, press F9 to start the manual calculation, and start the stopwatch.
7. Wait 5 seconds. This delay mimics the time a typical user might wait after confirming one task has started before moving to another.
8. Press OK on the Send email dialog. Start the stopwatch for the send email task.
9. Wait 3 seconds. This delay mimics the time a typical user might wait after confirming one task has started before moving to another.
10. Go to the system receiving the file you're sending. Click OK on the confirmation window, and start the stopwatch for the send file task. A green progress bar displays.
11. The send file task is done when the green progress bar goes away. Stop the timer for the send file task then.
12. On the system under test, stop the timer for the send email task when the system displays the Untitled Message addressed to the contact you selected for this message.
13. If you pressed F9 to start the Excel manual calculation, the task is done when the spreadsheet status bar says Ready, so stop the stopwatch then. If you used the macro, it displays in the Excel status bar the elapsed time for the calculation.
14. Close Excel without saving the file.
15. Close all but the main Office Communicator window.

Preparing slides for a customer presentation

The applications involved

- Microsoft Office Excel 2003 (Service pack 2)
- Microsoft Office PowerPoint 2003 (Service pack 2)

The data files involved

- Content.ppt, a 33.5MB PowerPoint presentation
- Sales2002a1.xls, a 1.79MB spreadsheet

The script

The script for this scenario performs the following tasks:

1. Open Sales2002a1.xls.
2. Select Data>Subtotals from the Excel menu
3. Fill in the Subtotal dialog as follows:
   - In the At each change in: box, select Size.
   - In the Use function: box, select Sum.
   - In the Add subtotal to: box, check Quantity, and make sure nothing else is checked.
   - Remove the checkmark for Replace current subtotals.

(We did not time these first three tasks because they occur outside the multitasking section of the script.)

4. Start the timer for the background Excel task, and press OK.
5. Start the timer for the first foreground task, and open Content.ppt.
6. Stop the timer for the foreground task when PowerPoint has finished opening Content.ppt.
7. Start the timer for the second foreground task, and select View\Slide Sorter in PowerPoint.
8. Stop the timer for the second foreground task when PowerPoint displays all the slide images.

9. Stop the timer for the background task when the Excel progress bar goes away.
10. Close Excel and PowerPoint. (We did not time these two tasks because they occur outside the multitasking section of the script.)

The manual process

First, prepare each system by following these steps once:

1. Start PowerPoint 2003.
2. Put PowerPoint into windowed mode, if necessary, by clicking the Restore Down button in the upper right.
3. Position the PowerPoint window on the right side of the screen.
4. Exit PowerPoint.
5. Start Excel 2003.
6. Put Excel into windowed mode, if necessary, by clicking the Restore Down button in the upper right.
7. Position the Excel window on the left side of the screen.
8. Exit Excel.
9. Create a shortcut to Sales2002a1.xls on the desktop. Position the shortcut icon on the left side of the screen.
10. Create a shortcut to Content.ppt on the desktop. Position the shortcut icon on the left side of the screen.

To execute the test, follow these instructions. You will need three stopwatches.

1. Reboot the system.
2. Open Sales2002a1.xls using the desktop shortcut you created.
3. Select Data/Subtotals from the Excel menu.
4. Fill in the Subtotal dialog as follows:
   - In the At each change in: box, select Size.
   - In the Use function: box, select Sum.
   - In the Add subtotal to: box, check Quantity and make sure nothing else is checked.
   - Remove the checkmark for Replace current subtotals.
5. Start the stopwatch, and press OK.
6. Start the second stopwatch and double-click the Content.ppt desktop shortcut.
7. Stop the second stopwatch when PowerPoint has finished opening Content.ppt.
8. Start the third stopwatch, and select View>Slide Sorter from the PowerPoint menu.
9. Stop the third stopwatch when PowerPoint displays all the slide images.
10. Stop the first stopwatch when the Excel progress bar goes away.
11. Close Excel and PowerPoint.

Collaborating on product development

The applications involved

- Adobe Acrobat Standard 7.0.8
- Microsoft Office Communicator 2005 (trial version)
- Microsoft Office Excel 2003 (Service Pack 2)
- Microsoft Office Word 2003 (Service Pack 2)
- Webroot Spy Sweeper version 4.5.9 (build 709) using Spyware Definitions v 745 (14-day trial)

The data files involved

- Excel2MinMacro.xls, a formula-rich 2.88 MB Excel file
- ProjectA1.XML, an 11 MB XML document with pictures and graphics.

The script

The tester starts a call in Office Communicator by hand and then launches the script. The script for this scenario performs the following tasks:

1. Open Excel2MinMacro.xls.

2. Select Adobe PDF > Convert to Adobe PDF from the Excel menu. The Save Adobe PDF File As dialog displays.
3. Open Spy Sweeper, and select the Sweep Now button. (We did not time these first three tasks because they occur outside the multitasking section of the script.)
4. Start the timer for the first background task, and select the Start button to start the Spy Sweeper background task.
5. Wait 5 seconds. This delay mimics the time a typical user might wait after confirming one task has started before moving to another
6. Start the timer for the second background task, and select Save on the Save Adobe PDF File As dialog,
7. Wait 5 seconds. This delay mimics the time a typical user might wait after confirming one task has started before moving to another
8. Start the timer for the foreground task, and open ProjectA1.XML.
9. Stop the timer for the foreground task when Word displays ProjectA1.XML and the page counter in the Word status bar shows 1/10.
10. Stop the timer for the second background task (Acrobat conversion) when Adobe Acrobat opens and displays the PDF file.
11. Stop the timer for the first background task when the Spy Sweeper status window reports that the scan is done.
12. Exit all open applications. (We did not time these tasks because they occur outside the multitasking section of the script.)

The manual process

First, prepare each system by following these steps once:

1. Open Spy Sweeper.
2. Select the Options button.
3. On the Program Options tab, uncheck all checkboxes except Load at Windows Startup.
4. On the Sweep Options tab, uncheck all checkboxes, and select the radio button for Only Sweep Folders Where Threats Are Known to Reside.
5. Start Word.
6. Put Word into windowed mode, if necessary, by clicking the Restore Down button in the upper right.
7. Position the Word window so it fills up the upper-right quarter of the screen.
8. Start Excel.
9. Put Excel into windowed mode, if necessary, by clicking the Restore Down button in the upper right.
10. Position the Excel window over the Word window.
11. Open Acrobat.
12. Put Acrobat into windowed mode, if necessary, by clicking the Restore Down button in the upper right.
13. Position the Acrobat Window in the upper-left quarter of the screen.
14. Create a desktop shortcut to Excel2MinMacro.xls.
15. Create a desktop shortcut to ProjectA1.XML.
16. Close Word, Excel, and Acrobat.
17. Open Office Communicator
18. Select Contacts > Add Contact to open the Contacts Setup wizard.
19. Enter the user name of the system you will be calling during testing.
20. Select Next through the remaining wizard options, thus keeping the defaults for each one.
21. After you've finished adding the contact, close Office Communicator.
22. To send the voice sample through the VoIP 1:1 call during the test, you will need an additional system, which we call the monitoring station, that is not otherwise part of this test.
    a. The monitoring station will need to contain the female test voice file that it will play during the test.
    b. Connect the monitoring station to the system under test with an audio cable. The audio cable should run from the speaker out port of the monitoring station to the microphone input port on the system under test. This arrangement enables the monitoring station to mimic someone speaking into a microphone during the Office Communicator voice call.
    c. The monitoring station will also capture and monitor the audio that the other call participant receives. To enable it to do that, connect a stereo cable from the speaker out port of the system

receiving the call (the 1:1 Call Participant in the diagram below) to the line in port of the monitoring station.

23. Figure 26 shows the systems and connections this scenario requires.

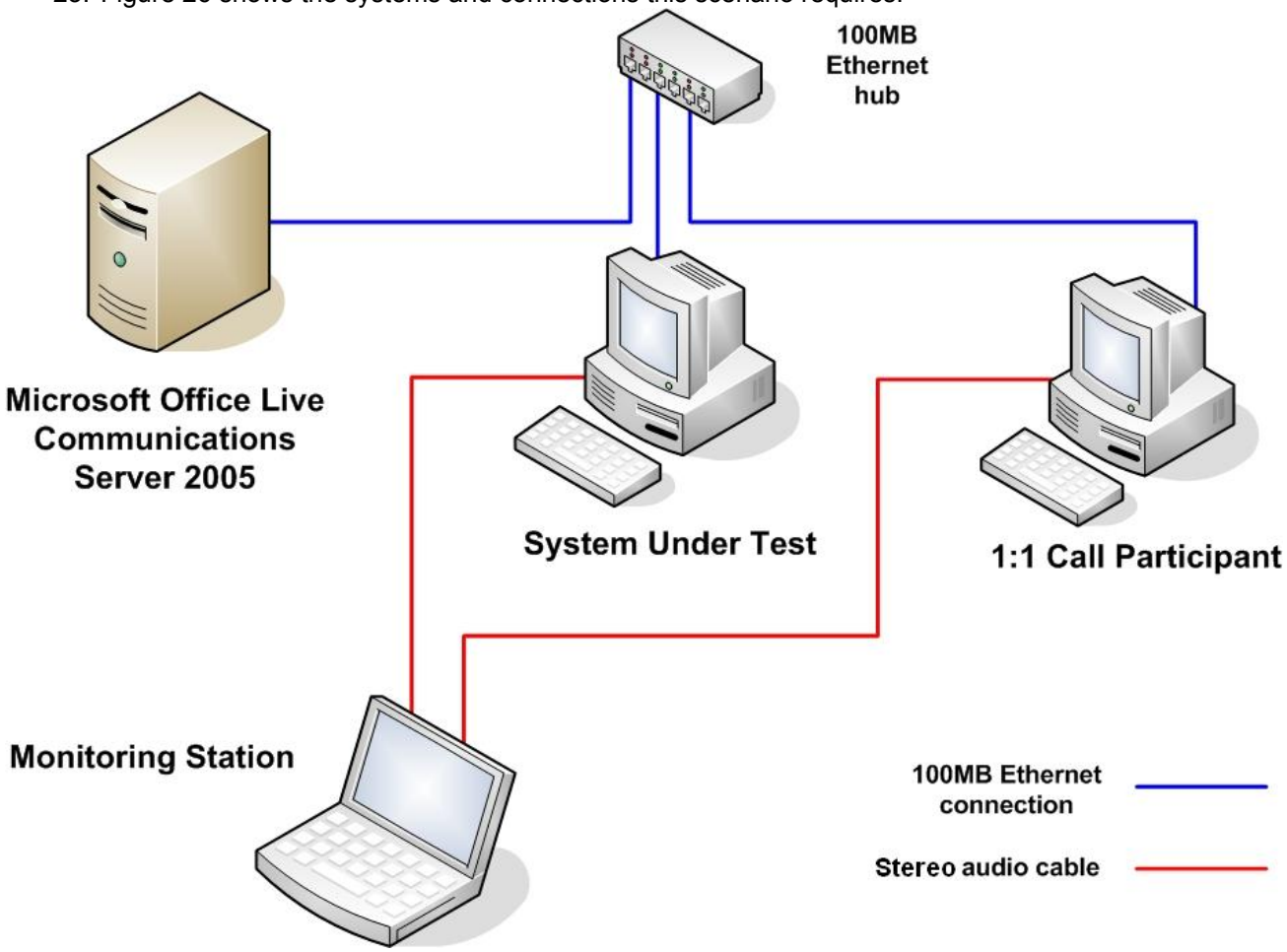

Figure 26: System configuration for the Microsoft Office Communicator 2005 voice call in the collaborating on product development scenario.

To execute the test, follow these instructions. You will need two stopwatches.

1. Reboot the system under test and the 1:1 call participant system.
2. Start the VoIP 1:1 call between the systems by opening Office Communicator on the system under test.
3. In the Office Communicator window, right-click the contact you want to call. This action opens a Selection menu.
4. Choose Call.
5. On the system receiving the call, click Accept to begin the call between the two computers.
6. After Office Communicator has established the call, begin playing the voice sample on the monitoring station so the voice sample plays throughout the call.
7. Double-click the Excel2MinMacro.xls desktop shortcut.
8. Select Adobe PDF > Convert to Adobe PDF from the menu. The Save Adobe PDF File As dialog displays.
9. Open Spy Sweeper, and select the Sweep Now button.
10. Select the Start button to start the Spy Sweeper background task. Spy Sweeper will report the elapsed time for the scan, so you do not need to stopwatch this task.
11. Wait 5 seconds. This delay mimics the time a typical user might wait after confirming one task has started before moving to another

12. Select Save on the Save Adobe PDF File As dialog, and start a stopwatch for this second background task.
13. Wait 5 seconds. This delay mimics the time a typical user might wait after confirming one task has started before moving to another.
14. Double-click the ProjectA1.XML desktop shortcut, and start a stopwatch for this foreground task.
15. Stop the stopwatch for the XML open foreground task when Word displays the file and the page counter in the Word status bar shows 1/10.
16. Stop the stopwatch for the Acrobat conversion background task when Adobe Acrobat opens and displays the PDF file.
17. Get the time for the Spy Sweeper task from the status box at the bottom of its window.
18. Exit Acrobat, Excel, Word, and Spy Sweeper.
19. Stop the Office Communicator 1:1 call by clicking the red square in the Call window.
20. Delete the PDF file you created.

Collaborating on a marketing campaign presentation

The applications involved

- Microsoft Office Communicator 2005 (Trial version)
- Microsoft Office Word 2003 (Service Pack 2)
- Network Associates' McAfee VirusScan Enterprise version 8.0i
- Adobe Acrobat 7.0 Version 7.0.8

The data files involved

- C:\Program Files\Adobe\Acrobat 7\Setup Files\AcroStan\ENU, a 164MB folder. To keep the script time reasonable, we scanned only this one folder. The folder contains a large compressed (CAB) file and an installer file.
- ProjectA1.doc, an 8.18MB Word document with uncompressed pictures

The script

The script for this scenario performs the following tasks:

1. Select Actions > More > Start Sharing… in the Office Communicator window. This window opens automatically when you boot your system.
2. Highlight the first contact on the Start Sharing dialog that displays.
3. Open the VirusScan console.
4. Select the Acrobat scan task. (We did not time these first four tasks because they occur outside the multitasking section of the script.)
5. Start the timer for the first background task, and click Start.
6. Wait 5 seconds. This delay mimics the time a typical user might wait after confirming one task has started before moving to another
7. Start the timer for the second background task, and open ProjectA1.doc.
8. Wait until Word displays the document title in its Window, start the timer for the foreground task, and then click the OK button on the Start Sharing window.
9. Stop the timer for the foreground task when Office Communicator opens a Conversation window that shows an instant message saying your contact is being invited to the data sharing session.
10. Stop the timer for the second foreground task when the Word document status bar shows a page count of 1/42.
11. Stop the timer for the first background task when the VirusScan status window shows that the scan is done.
12. Exit Word, the Office Communicator Conversation window, and the VirusScan Console. (We did not time these tasks because they occur outside the multitasking section of the script.)

The manual process

First, prepare each system by following these steps once:

1. Start Word.
2. Put Word into windowed mode, if necessary, by clicking the Restore Down button in the upper right.

3. Position the Word window so it takes up roughly the right half of the screen horizontally and the middle two-thirds vertically.
4. Exit Word.
5. Start the McAfee VirusScan Console from the Start menu.
6. Position the Console on the upper right side of screen. Leave room above it for a row of icons.
7. Select Task > New On-Demand Scan Task.
8. Name the task Acrobat.
9. The VirusScan On-Demand Scan Properties – Acrobat dialog appears. If it does not, right-click the Acrobat task name.
10. Click Remove twice to remove the two item names in the list box on that dialog. Click Yes on the confirm dialog that appears after each deletion.
11. Click Add, and scroll down to Drive or Folder.
12. Click Browse, and browse to C:\Program Files\Adobe\Acrobat 7\Setup Files\AcroStan\ENU.
13. Click OK to close the Browse for Folder dialog.
14. Click OK to close the Add Scan Item dialog.
15. Click the Detection tab.
16. Check the two checkboxes under Compressed Files.
17. Click OK.
18. Exit VirusScan Console.
19. Office Communicator should load on system startup. Position its window on the left side of the screen.
20. In the upper right corner of the screen, create a desktop shortcut to ProjectA1.doc.
21. In the upper right corner of the screen, create a desktop shortcut to the VirusScan Console.

To execute the test, follow these instructions. You will need two stopwatches.

1. Reboot the system.
2. Select Actions > More > Start Sharing… in the Office Communicator window that automatically appears.
3. Highlight the first contact on the Start Sharing dialog that displays.
4. Open the VirusScan console using its desktop shortcut.
5. Select the Acrobat scan task.
6. Click Start. You do not need a stopwatch for this task because VirusScan reports the elapsed time.
7. Move the Scan Progress window to the lower right corner of screen, and wait until the scan time is at five seconds (the time displays in the status bar at bottom of the Scan Progress window). This delay mimics the time a typical user might wait after confirming one task has started before moving to another.
8. Double-click the ProjectA1.doc desktop shortcut, and start the stopwatch for this second background task.
9. Wait until Word displays the document title in its Window, and then immediately click the OK button on the Start Sharing window. Start the stopwatch for the Office Communicator foreground task when you click that button.
10. Stop the Office Communicator task stopwatch when Office Communicator opens a Conversation window that shows an instant message saying your contact is being invited to the data sharing session. The window usually pops up without this message and then after a short delay redraws with Instant Message and Sharing Controls.
11. If the Word document does not have focus, click it.
12. Stop the stopwatch for the Word background task when the Word document status bar shows a page count of 1/42.
13. The status bar in VirusScan gives you the elapsed time for that first background task.
14. Exit Word, the Office Communicator Conversation window, and the VirusScan Console.

Appendix C – Issues in script development

To the best of our knowledge, despite its age IBM's Visual Test 6.5 remains the tool most widely used today for constructing application-based benchmarks and performance tests for PCs running various versions of Microsoft Windows. We have used this product (and previous versions of it) for many years to build performance tests. The tool does, however, have some stated limitations that unavoidably affect the way one develops performance tests with it.

First, the product's own documentation notes that its primary goal is to be a tool for automating application testing, not a benchmark development system. Consequently, the granularity of some of its functions and the way some of its functions behave are not ideal for benchmark development.

IBM also does not officially support Visual Test 6.5 for the Windows XP operating system. Because Windows XP is the leading and most current desktop version of Windows today, we nonetheless felt it was essential to use that operating system in our tests.

The presence of any scripting tool has the potential to affect the performance of a system. The tool unavoidably must, for example, occupy some memory and consume some processing power. Consequently, developing a performance-measurement script with such a tool involves maintaining a delicate balance between using the tool to automate typical real user behavior and minimizing the effects of the tool on system performance. To make sure the results of our scripts were accurate, we also hand-timed each of the functions we scripted.

To minimize these limitations and problems, we sometimes had to use scripting techniques that would achieve the same results as typical user behavior but not exactly mirror that behavior. Such techniques include inserting delays to mimic user think time and launching applications with a click on the OK button of a pre-filled Run command line. The hand timing instructions we provide in Appendix B reflect those techniques, so following those instructions will yield results similar to those the scripts produce. Whenever we had to use one of these alternative techniques, we manually verified that doing so did not materially alter the way the system behaved and that real users performing the same actions in more typical ways would see the type of dual-core processor technology benefits that we describe.

The timings the scripts produce also inevitably contain some variability. This variability is a result of the combination of the tool's limitations and the generally asynchronous nature of the many processes Windows XP and other modern operating systems have running at any given time.

Finally, though one of the goals of this effort was to produce reliable scripts, we were not trying to build bulletproof benchmarks for wide distribution and use. We developed the scripts to mimic user behavior on our specific test systems; on different systems the scripts might show different levels of benefit from a dual-core processor or even fail to work. So, although the scripts are as reliable, self-contained, and free of system dependencies as we could reasonably achieve within the project's timeframe, they do sometimes fail or encounter problems. Should a problem occur, rebooting the system and running the script again will generally yield a good result.

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