The science behind the report:

Remote workers can get a better experience by running applications locally with an Intel Core processor-powered laptop with Intel vPro technology

This document describes what we tested, how we tested, and what we found. To learn how these facts translate into real-world benefits, read the report Remote workers can get a better experience by running applications locally with an Intel Core processor-powered laptop with Intel vPro technology.

We concluded our hands-on testing on January 12, 2021. During testing, we determined the appropriate hardware and software configurations and applied updates as they became available. The results in this report reflect configurations that we finalized on January 5, 2021 or earlier. Unavoidably, these configurations may not represent the latest versions available when this report appears.

Our results

Table 1: Results of our productivity testing. We report all time in seconds.

Tasks	Dell® Latitude® 5310	Dell Wyse 5070 client using VDI session
Microsoft Word Tests - Multitasking with 5 open web browser tabs, open Outlook, and Zoom running in background		
Opening a large document (92 MBs)	1.5	11.7
Find and replace	2.1	4.4
Microsoft Excel - Multitasking with 5 open web browser tabs, open Outlook, and Zoom running in background		
Open a large Excel File (94 MBs)	27.8	81.0
Recalculating the spreadsheet	3.9	12.9
Microsoft PowerPoint - Multitasking with 5 open web browser tabs, open Outlook, and Zoom running in background		
Opening a large PowerPoint file (180 MBs)	36.4	105.0
Export PowerPoint to PDF	12.7	38.9

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Table 2: Results of our video conferencing testing. We report results in frames per second (FPS).

Tasks	Dell Latitude 5310	Dell Wyse 5070 client using VDI session
Zoom meeting with screen share enabled - No other tasks running in background		
Video	30	19
Screen sharing	24	3
Zoom meeting with screen share enabled, 5 open browser tabs, and Outlook running in the background		
Video	27	19
Screen sharing	21	1
Zoom meeting with screen share enabled, 5 open browser tabs, Outlook running in the background, and opening a large PowerPoint file to share		
Video	27	20
Screen sharing	19	1

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System configuration information

Table 3: Detailed information on the system we tested.

System configuration information	Dell Latitude 5310	Dell Wyse 5070
Processor		
Vendor	Intel®	Intel
Name	Core™	Celeron®
Model number	i7-10610U	J4105
Core frequency (GHz)	1.80	1.50
Number of cores	4	4
Memory		
Amount (GB)	8	8
Type	DDR4	DDR4
Speed (MHz)	2,667	2,400
Graphics		
Vendor	Intel	Intel
Model	UHD Graphics	UHD Graphics
Storage		
Vendor	Samsung	Not available
Model number	PM991	Not available
Amount (GB)	256	64
Type	NVMe™	SATA flash drive
Connectivity/expansion		
Wired internet	Via USB-C to Ethernet converter	Realtek PCIe GbE Family Controller
Wireless internet	Intel Wi-Fi 6 AX201 Wireless Car	None
Bluetooth	Bluetooth 5.0	None
USB	1 x USB 3.2 Gen 1 with Powershare 1 x USB Type C 3.2 Gen 2 1 x USB 3.2 Gen 1	1 x USB-C Port 1 x USB 3.0 Port 2 x USB 2.0 Ports 4 x USB 3.0 Ports
Video	Intel UHD Graphics	Intel UHD Graphics
Operating system		
Vendor	Microsoft	Microsoft
Name	Windows 10 Pro	Windows 10 Enterprise LTSC
Build number or version	10.0.18363	10.0.17763
BIOS		
BIOS name and version	Dell 1.3.0	Dell 1.7.1

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How we tested

Building the WVD Environment

We started with an active Microsoft Azure subscription with Azure Active Directory Domain services configured with our domain. We purchased licenses for Enterprise Mobility + Security, Office 365 E5, and Windows Defender for Endpoint. We created a user and applied the licenses for Office 365 E5 and Enterprise Mobility + Security E5.

We ran all updates on the Latitude 5310. We also disabled the write-filter on our Wyse client, ran all updates, installed the Windows Desktop Client, and then re-enabled the write filter. While video conferencing, our Wyse client used a Spedal 920 webcam, which closely matched the specifications of the camera on our Latitude 5310.

We built an Azure WVD desktop pool using Azure instances and provisioned one VM with 2 vCPUs, 8 GB of RAM, 1 OS disk with 127 GB, 500 max IOPS, and premium SSD disks for the thin client WVD sessions.

We completed testing for the following Office productivity scenarios:

- Using only the Latitude 5310
- Using the Latitude 5310 connected to the WVD session
- Using the Wyse client connected to the WVD session

For each test, we restarted the system, completed the steps detailed below to prepare for multitasking tasks, and completed the Word, Excel, and PowerPoint scenarios. We repeated this process for a total of three runs. We used the following files:

- For the Word test, we used a 89 MB .docx file with 10400 words and 38 pages.
- For the Excel test, we used a 92 MB .xlsm file with 759,000 cells with functions.
- For the PowerPoint test, we used a 180 MB .pptx file with 33 slides.

We also collected data to measure Zoom performance for the previous three scenarios with three different levels of system utilization:

- Zoom meeting with screen share enabled - No other tasks running in background
- Zoom meeting with screen share enabled, 5 open browser tabs, and Outlook running in the background
- Zoom meeting with screen share enabled, 5 open browser tabs, Outlook running in the background, and opening a large PowerPoint file to share

Using the Zoom application's internal metrics, we captured 30 seconds of data at 5 second intervals for the following scenarios. We used the median results in each category for our metrics.

Adding virtual network

1. Navigate to the Virtual networks page.
2. Click New.
3. On the Basics page, enter the following Instance details:
   - Name: `adds.net`
   - Region: `East US`
4. On the IP addresses page, keep the default.
5. On the Review + Create page, click Create.

Adding the WVD host pool

1. Navigate to the Windows Virtual Desktop services page.
2. Click Create a host pool.
3. Create a virtual network.
4. On the Basics Page, select your own options for Subscription and Resource Group here and in other sections. Enter the following (note that we selected East US as we completed testing in Durham, NC):
   - Location: `East US`
   - Validation Environment: `No`
   - Host pool type: `Pooled`
   - Max session limit: `3`
   - Load balancing algorithm: `Breadth-first`

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5. On the Virtual Machines Page, click Yes, and enter the following:

- Name prefix: `VM0`
- Virtual Machine Location: `East US`
- Image type: `Gallery`
- Image: `Windows 10 Enterprise multi-session, Version 20H2 + Microsoft 365 Apps`
- Virtual machine size: `Standard_D2s_v3`
- Number of VMs: `1`
- OS disk type: `Premium SSD`
- Virtual network: `aadds-vnet`
- Subnet: `adds-subnet (10.0.0.0/24)`
- Network security group: `Basic`
- Public inbound ports: `No`
- Specify domain or unit: `Yes`
- Domain to join: [Your domain]
- OU: [leave blank]
- AD domain join UPN (with password): `domainjoin@domain.site`
- Virtual machine Administrator account (with password): `vmadmin`

6. On the Workspace Page, click Yes.
7. Under the To this workspace dropdown, click Create new. Enter `workspace01`, and click OK.
8. On Review and Create, click Create.
9. Continue once the Host Pool creation has finished.

Adding users to the application group

1. In the Host pools section, click the newly created host pool.
2. Under Application groups, click the application group for the newly created host pool.
3. Click Assignments.
4. Click Add.
5. Select the user01@domain.site and administrator account, and click select.

Configuring the Remote Desktop settings

1. In the Host pools section, click the newly created host pool.
2. Under Settings, select RDP Properties.
3. Select Advanced, and enter the following information:

```
audiocapturemode:i:1;camerastoredirect:s:*;devicestoredirect:s:;redirected video capture encoding
quality:i:2;redirectcomports:i:1;usbdevicestoredirect:s:*;compression:i:1;drivestoredirect:s:;use
multimon:i:0;videoplaybackmode:i:0
```

Configuring VM security options

1. Download the Windows Desktop 64-bit client from https://go.microsoft.com/fwlink/?linkid=2068602
2. Complete the installation using the default settings.
3. Open the Remote Desktop application.
4. Click Subscribe, and log in using the administrator account for your Windows Virtual Desktop client.

Configuring VM security options

1. Connect to the WVD system using an administrator account and the Windows Desktop Client.
2. Download and extract dgreadiness_v3.6.zip directory to c:\temp.
3. Launch PowerShell as Administrator, and change the directory to C:\temp\dgreadiness_3.6
4. Run the script by typing: `.\DG_Readiness_Tool_v3.6.ps1 -Capable`.
5. Once complete, reboot the system.
6. Repeat steps 2 through 4 once.
7. Again, repeat steps 2 through 4 but use `-Enable` instead of `-Capable`.
8. Open Group Policy Editor.
9. Navigate to Computer Configuration, Administrative Templates, System, Device Guard.
10. Right-click Turn on Virtualization Based Security, and select Edit.

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11. Set the options as follows, and click OK.

- Turn On Virtualization Based Security: Enabled
- Select Platform Security Level: Secure Boot and DMA Protection
- Virtualization Based Protection of Code Integrity: Enabled without lock
- Credential Guard Configuration: Enabled without lock
- Secure Launch Configuration: Enabled

12. Open Registry Editor.
13. Navigate to HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\DeviceGuard\Scenarios.
14. Right-click, and create a new key named SystemGuard as a Dword(32bit) with Value 1.

Enabling Windows Defender for Endpoint on the virtual machine

1. Navigate to securitycenter.windows.com.
2. In Microsoft Defender Security Center, navigate to Settings, then Onboarding.
3. Select Windows 10 as the operating system, Local Script (for up to 10 devices), then click Download package.
4. Copy the file onto the local system, right-click, and run as administrator.
5. After the command completes, run the detection test using the command in Microsoft Defender Security Center to verify that the system is configured correctly.

Setting up the hand-timing scenarios

Installing the Windows Desktop Client

Complete the following steps on both the Latitude and Wyse client with the write filter disabled.

1. Download the Windows Desktop 64-bit client from https://go.microsoft.com/fwlink/?linkid=2068602
2. Complete the installation using the default settings.
3. Open the Remote Desktop application.
4. Click Subscribe, and log in using your user account for your Windows Virtual Desktop client.

Enabling macros using Excel

Complete the following steps on both the Latitude and Windows Virtual Desktop client.

1. Launch Microsoft Excel.
2. Click File→Options→Trust Center→Trust Center Settings→Macro Settings. Select Enable all macros, and click OK.
3. Close Microsoft Excel.
4. Shut down the system.

Capturing data for the hand-timing scenarios

Preparing for multitasking tasks

We completed the following tasks.

1. From a different computer on the same network, start a Zoom meeting and send the invitation link to the system under test.
2. From the system under test, connect to the Zoom meeting.
3. From the host, designate the user of the system under test as host.
4. From the system under test, verify that audio and video send, and that the other computer receives them.
5. Share the screen of the system under test.
6. Open Microsoft Edge, and open facebook.com, wikipedia.org, amazon.com, youtube.com, and google.com.
7. Open Outlook.
8. Type `Cmd.exe /c start /wait Rundll32.exe advapi32.dll,ProcessIdleTasks`. Do not interact with the system until the command completes, and wait five minutes before running the test.

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Opening a Microsoft Word document and performing a word replacement while multitasking

1. Simultaneously start the timer and launch Word by clicking on the test Word document.
2. Stop the timer when the Word document has fully loaded, as indicated by the words "Page 1 of 38 10473 words" appearing, and record the results.
3. Press CTRL + H to bring up the Find/Replace dialog box.
4. In the Find What field type I.
5. In the Replace With field type TEST.
6. Simultaneously start the timer and select Replace All.
7. Stop the timer when the replacement complete window appears.
8. Close the Word document. Do not save changes.

Opening a Microsoft Excel spreadsheet and performing a number crunch calculation while multitasking

1. Simultaneously start the timer and launch Excel by clicking on the test Excel spreadsheet.
2. Stop the timer when the Excel spreadsheet has fully loaded, and record the results.
3. Press CTRL + R to start the calculation. This macro causes designated cells to randomize, recalculates the functions in the rest of the cells, and then outputs the time to complete that task in seconds.
4. Record the output.
5. Close the Excel spreadsheet.

Opening a Microsoft PowerPoint slide deck and exporting to PDF while multitasking

1. Simultaneously start the timer and launch PowerPoint by clicking on the test PowerPoint slide deck.
2. Stop the timer when the PowerPoint slide deck has loaded, as indicated by all 33 slides appearing in the side bar, and record the results.
3. Click File→Export→Create PDF/XPS.
4. Start the timer and click Publish.
5. Stop the timer when the system creates the PDF, and record the results.

Capturing Zoom data

Zoom meeting with screen share enabled - No other tasks running in background

1. Complete the steps from "Preparing for multitasking tasks" from steps 1 through 5, and then skip to step 8 to run the Process Idle tasks command.
2. In the Zoom meeting, open Settings.
3. Change to the statistics tab.
4. At 5 second intervals, screen capture the stats on Overall, Audio, Video, and Screen Sharing.

Zoom meeting with screen share enabled, 5 open browser tabs, and Outlook running in the background

1. Complete the steps from "Prepping for Multitasking tasks" from steps 1 through 8.
2. In the Zoom meeting open it settings.
3. Change to the statistics tab.
4. At 5 second intervals, screen capture the stats on Overall, Audio, Video, and Screen Sharing.

Zoom meeting with screen share enabled, 5 open browser tabs, Outlook running in the background, and opening a large PowerPoint file to share

1. Complete the steps from "Prepping for Multitasking tasks" from steps 1 through 8.
2. Launch PowerPoint by clicking on the test PowerPoint slide deck. Do not wait for it to load.
3. In the Zoom meeting, open Settings.
4. Change to the statistics tab.
5. At 5 second intervals, screen capture the stats on Overall, Audio, Video, and Screen Sharing.

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Read the report at http://facts.pt/ffN9zVy ▶

This project was commissioned by Intel.

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