The science behind the report:

Charge laptops faster, get more port options, and run at cooler temperatures with Dell Business Docks

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 Charge laptops faster, get more port options, and run at cooler temperatures with Dell Business Docks.

On February 12, 2018, we finalized the hardware and software configurations we tested. Updates for current and recently released hardware and software appear often, so unavoidably these configurations may not represent the latest versions available when this report appears. For older systems, we chose configurations representative of typical purchases of those systems. We concluded hands-on testing on February 27, 2018.

Our results

Charge rate testing

When comparing the normalized charge rates of each system with their corresponding USB Type-C dock over a 30-minute period, the Dell Latitude 7390 2-in-1 system and Dell Business Dock - WD15 delivered a 22.81 percent greater charge, in watt hours, over the HP EliteBook x360 1030 G2 with HP Elite USB-C dock, a 20.10 percent greater charge over the Lenovo Yoga 370 and Lenovo ThinkPad USB-C dock, and a 19.51 percent greater charge on the same Dell system when paired with the Belkin USB-C Express Dock 3.1 HD.

The laptop batteries in our tests weren't rated the same: The Dell laptop had the biggest battery with the largest Wh rating, which means we had to do some math to make sure we were comparing battery charge rates fairly. If you start with two buckets, one pint-sized and the other gallon-sized, the pint will be half full much quicker than the gallon. Because we're looking at battery charge percentages, which is based on the size of the bucket, we took capacity into account to figure out the watt hours of charge each system achieved in the 30 minutes of our testing.

Each battery test started with 5% battery remaining instead of 0%. This is because the HP laptop shut down at 5% battery, so we set a 5% shut down threshold for the other systems as well.

Dock	System	System battery size (Wh)	Battery charge at start of test	Percent charge after 30 minutes (median)	Watt hours of charge achieved in 30 minutes	Percent Dell win
Dell Business Dock - WD15	Dell Latitude 7390 2-in-1	60	5%	54%	29.40	N/A
HP Elite USB-C	HP EliteBook x360 1030 G2	57	5%	47%	23.94	22.81%
Lenovo ThinkPad USB-C	Lenovo Yoga 370	51	5%	53%	24.48	20.10%
Belkin USB-C Express Dock 3.1 HD	Dell Latitude 7390 2-in-1	60	5%	46%	24.60	19.51%

When comparing the normalized charge rates of each system with their corresponding Thunderbolt 3 dock over a 30-minute period, the Dell Latitude 7390 2-in-1 system and Dell Business Thunderbolt Dock - TB16 delivered a 22.81 percent greater charge, in watt hours, over the HP EliteBook x360 1030 G2 with HP Elite 90W Thunderbolt 3 dock, and a 15.29 percent greater charge over the Lenovo Yoga 370 and Lenovo ThinkPad Thunderbolt 3 dock. The Belkin Thunderbolt 3 Express Dock HD was unable to charge the test system.

Dock	System	System battery size (Wh)	Battery charge at start of test	Percent charge after 30 minutes (median)	Watt hours of charge achieved in 30 minutes	Percent Dell win
Dell Business Thunderbolt Dock - TB16	Dell Latitude 7390 2-in-1	60	5%	54%	29.40	N/A
HP Elite 90W Thunderbolt 3	HP EliteBook x360 1030 G2	57	5%	47%	23.94	22.81%
Lenovo ThinkPad Thunderbolt 3	Lenovo Yoga 370	51	5%	55%	25.50	15.29%
Belkin Thunderbolt 3 Express Dock HD	Dell Latitude 7390 2-in-1	60	5%	N/A	N/A	N/A

Port types

The tables below compare the port type offerings of the USB Type-C docks and the Thunderbolt 3 docks, respectively. In each case, the Dell docks offered more types of ports for connecting various peripheral devices, compared to the offerings from HP, Lenovo, and Belkin.

USB-C docks

	 Dell Business Dock - WD15	 HP Elite USB-C	 Lenovo ThinkPad USB-C	 Belkin USB-C Express Dock 3.1 HD
Powered USB 3.0	✓	✗	✓	✗
USB 3.0	✓	✓	✓	✓
Additional USB 3. Type-C	✗	✓	✓	✓
DisplayPort	✗	✓	✓	✗
Mini DisplayPort	✓	✗	✗	✗
HDMI	✓	✓	✗	✓
VGA	✓	✗	✓	✗
RJ-45 Ethernet	✓	✓	✓	✓
3.5mm combo audio	✓	✓	✓	✓
3.5mm speaker out	✓	✗	✗	✗

Thunderbolt 3 docks

	 Dell Business Thunderbolt Dock - TB16	 HP Elite 90W Thunderbolt 3	 Lenovo ThinkPad Thunderbolt 3	 Belkin Thunderbolt 3 Express Dock HD
Powered USB 3.0	✓	✓	✓	✗
USB 3.0	✓	✓	✓	✓
Additional Thunderbolt 3	✓	✓	✓	✓
DisplayPort	✓	✓	✓	✓
Mini DisplayPort	✓	✗	✗	✗
HDMI	✓	✗	✓	✗
VGA	✓	✓	✓	✗
RJ-45 Ethernet	✓	✓	✓	✓
3.5mm combo audio	✓	✓	✓	✓
3.5mm speaker out	✓	✗	✗	✗

Thermal testing

We measured the surface temperature of each dock under stress, simulating a set of simultaneous tasks an office worker may perform while using a dock with their system. These simultaneous tasks included attaching two USB load testers to the USB 3.0 ports (intended to mimic a phone and tablet charging) and connecting dual displays running at the maximum resolution supported by the dock/system—streaming an HD video through wired Ethernet to one display and running an office productivity workload on the other display. We also connected a keyboard and mouse. We used a thermal camera to capture the hottest surface temperature on top of each dock at 10-minute intervals for a total of 30 minutes during the sample workload. Ambient temperature during testing remained constant between 72 and 73°F (22.2-22.8°C).

When comparing the surface temperatures of each USB Type-C dock after 30 minutes of work, the Dell Business Dock - WD15 ran 10°F/5.5°C cooler than HP Elite USB-C dock, and 11°F/6.1°C cooler than Lenovo ThinkPad USB-C dock. The Belkin USB-C Express Dock 3.1 HD supported only a single display and required a USB dongle to provide sufficient USB ports to connect the keyboard and mouse in addition to the USB load testers. This means the Dell Business Dock - WD15 did more work than the Belkin dock by also running a second display while maintaining the same temperature.

Dock	System	Median surface temperature under workload (°F/°C)		
		10 minutes	20 minutes	30 minutes
Dell Business Dock - WD15	Dell Latitude 7390 2-in-1	93.6/34.2	99.1/37.3	102.0/38.9
HP Elite USB-C	HP EliteBook x360 1030 G2	98.2/36.8	108.0/42.2	112.0/44.4
Lenovo ThinkPad USB-C	Lenovo Yoga 370	102.0/38.9	109.0/42.8	113.0/45.0

Dock	System	Median surface temperature under workload (°F/°C)		
		10 minutes	20 minutes	30 minutes
Belkin USB-C Express Dock 3.1 HD	Dell Latitude 7390 2-in-1	92.1/33.4	100.0/37.8	102.0/38.9

When comparing the surface temperatures of each Thunderbolt 3 dock after 30 minutes of work, the Dell Business Thunderbolt Dock - TB16 ran 39.8°F/22.1°C cooler than the HP Elite 90W Thunderbolt 3 dock, 9.8°F/5.4°C cooler than the Lenovo ThinkPad Thunderbolt 3 dock, and 3.2°F/1.8°C cooler than the Belkin Thunderbolt 3 Express Dock HD. The Belkin Thunderbolt 3 Express Dock HD required a USB dongle to provide sufficient USB ports to connect the keyboard and mouse, in addition to the USB load testers. Additionally, the Belkin Thunderbolt 3 Express Dock HD was unable to charge the Dell system. This means the Dell Business Thunderbolt Dock - TB16 dock delivered a lower temperature than the Belkin dock while doing more work by also charging the system connected to it.

Dock	System	Median surface temperature under workload (°F/°C)		
		10 minutes	20 minutes	30 minutes
Dell Business Thunderbolt Dock - TB16	Dell Latitude 7390 2-in-1	93.0/33.9	93.9/34.4	93.2/34.0
HP Elite 90W Thunderbolt 3	HP EliteBook x360 1030 G2	119.0/48.3	128.0/53.3	133.0/56.1
Lenovo ThinkPad Thunderbolt 3	Lenovo Yoga 370	92.5/33.6	98.6/37.0	103.0/39.4
Belkin Thunderbolt 3 Express Dock HD	Dell Latitude 7390 2-in-1	88.5/31.4	93.6/34.2	96.4/35.8

Dock and system configuration information

The tables below presents detailed information on the docks and systems we tested.

Dock	Dell Business Dock - WD15	Dell Business Thunderbolt Dock - TB16	HP Elite USB-C Dock	HP Elite 90W Thunderbolt 3 Dock
Docking interface	USB-C	USB-C/Thunderbolt	USB-C	USB-C/Thunderbolt
Display ports	VGA, Mini DisplayPort, HDMI	VGA, DisplayPort, Mini DisplayPort, HDMI, Thunderbolt	(2) DisplayPort, HDMI, USB 3.1 Type C	VGA, (2) DisplayPort, Thunderbolt
Dimensions (inches)	6.10 x 4.30 x 0.83	5.70 x 5.70 x 2.05	7.79 x 2.71 x 0.87	9.06 x 2.24 x 0.69
Weight (lbs.)	0.93	1.63	0.77	0.50
USB ports	(3) USB 3.0 (2) USB 2.0	(3) USB 3.0 (2) USB 2.0	(2) USB 3.0 (2) USB 2.0	(4) USB 3.0
Maximum power delivery	130W for Dell devices, 60W for non-Dell devices	130W for Dell devices, 60W for non-Dell devices	60W	60W

Dock	ThinkPad USB-C Dock	ThinkPad Thunderbolt 3 Dock	Belkin USB-C Express Dock 3.1 HD	Belkin Thunderbolt 3 Express Dock HD
Docking interface	USB-C	USB-C/Thunderbolt	USB-C	USB-C/Thunderbolt
Display ports	VGA, (2) DisplayPort, USB 3.1 Type C	VGA, (2) DisplayPort, HDMI, Thunderbolt	HDMI, USB 3.1 Type C	DisplayPort, Thunderbolt
Dimensions (inches)	6.73 x 3.15 x 1.28	8.66 x 3.15 x 1.18	8.17 x 3.47 x 1.21	8.17 x 3.40 x 1.20

Dock	ThinkPad USB-C Dock	ThinkPad Thunderbolt 3 Dock	Belkin USB-C Express Dock 3.1 HD	Belkin Thunderbolt 3 Express Dock HD
Weight (lbs.)	0.64	0.55	0.77	0.83
USB ports	(3) USB 3.0 (2) USB 2.0	(5) USB 3.0	(3) USB 3.0	(3) USB 3.0
Maximum power delivery	60W	60W	60W	85W

System	Dell Latitude 7390 2-in-1	HP EliteBook x360 1030 G2	Lenovo Yoga 370
Processor			
Vendor	Intel®	Intel	Intel
Model number	Core™ i5-8350U	Core i5-7200U	Core i5-7200U
Core frequency (GHz)	1.70	2.50	2.50
Number of cores	4	2	2
Cache	6MB L3	3MB L3	3MB L3
Memory			
Amount (GB)	16	8	4
Type	LPDDR3 SDRAM	DDR4 SDRAM	DDR4 SDRAM
Speed (MHz)	2,133	2,133	2,133
Integrated graphics			
Vendor	Intel	Intel	Intel
Model number	HD Graphics 620	HD Graphics 620	HD Graphics 620
Storage			
Amount (GB)	512	256	256
Type	SSD	SSD	SSD
Connectivity/expansion			
Wireless internet	802.11ac	802.11a/b/g/n/ac	802.11ac
Bluetooth	4.0	4.2	4.1
USB	2 x 3.0	2 x 3.0	2 x 3.0
Thunderbolt	2 x 3.1	1 x 3.1	1 x 3.1
Video	1 x HDMI	1 x HDMI	1 x HDMI
Battery			
Type	Lithium-polymer	Lithium-polymer	Lithium-polymer
Size	4 cell	3 cell	4 cell
Rated capacity (Wh)	60	57	51
Display			
Size (in.)	13.3	13.3	13.3
Type	LED-backlit with IPS technology	LED-backlit with IPS technology	LED-backlit with IPS technology

System	Dell Latitude 7390 2-in-1	HP EliteBook x360 1030 G2	Lenovo Yoga 370
Resolution	1,920 x 1,080	1,920 x 1,080	1,920 x 1,080
Touchscreen	Yes	Yes	Yes
Operating system			
Vendor	Microsoft®	Microsoft	Microsoft
Name	Windows® 10 Pro	Windows 10 Pro	Windows 10 Pro
Build number or version	10.0.16299	10.0.16299	10.0.16299
BIOS			
BIOS name and version	Dell Inc. 1.0.0	HP P80 01.14	Lenovo R0HET41W 1.21
Dimensions			
Height (in.)	0.75	0.59	0.72
Width (in.)	12.00	12.48	12.34
Depth (in.)	8.26	8.6	8.75
Weight (lbs.)	3.12	2.82	3.03

How we tested

Testing power and charge rate

When testing power and charge rate, we used each dock with each of the three systems. We measured the charge rate on each of the three systems with their corresponding Thunderbolt 3 and USB Type-C docks and the Dell system with the two Belkin docks.

Setting up the test

1. Plug in the dock under test.
2. Turn on the first system.
3. Ensure the system display does not automatically turn off or go to sleep.
    a. Go to Control Panel→Hardware and Sound→Power Options→Edit Plan Settings.
    b. Set Turn off the display to Never for both On battery and Plugged in options.
    c. Set Put the computer to sleep to Never for both On battery and Plugged in options.
4. Ensure the system turns off only when the battery is depleted
    a. Go to Control Panel→Hardware and Sound→Power Options→Edit Plan Settings.
    b. Click Change advanced power settings.
    c. In the Advanced Settings menu, click Battery→Low battery action, and set On Battery to Do Nothing.
    d. Under Critical battery action, set On battery to Shut Down.
5. Set the critical battery level to the lowest common percent level across all systems.
    a. Under Power Options→Advanced Settings, click Battery→Critical battery level.
    b. Set the On battery critical battery level to 5 percent.
6. Download and install 3DMark (v2.3.3693).
7. Repeat steps 1 through 6 for each system.

Testing charge rate

1. Using 3DMark, drain each system battery until the system shuts off.
    a. Open 3DMark and run any of the available benchmarks.
    b. Run benchmarks until the system shuts off.
2. Connect the system to the dock as soon as the battery depletes and the system starts to shut down.
3. Start a timer for 30 minutes.
4. After 30 minutes, disconnect the system from the dock.
5. Turn on the system, move the cursor to scroll over the battery icon on the right side of the taskbar, and record the battery percentage

level.

6. Repeat steps 1 through 5 twice more for each system on each dock (USB-C/Thunderbolt docks from Dell, HP, Lenovo, and Belkin).

Testing thermal management

When testing thermal management, we used each OEM-branded dock with its corresponding OEM-branded system (i.e., Dell with Dell, HP with HP, etc.). We also tested the Belkin docks with the Dell system. The goal was to maximize power draw from dock using a real-world scenario and therefore maximizing the load on the system. We used a FliR thermal camera to measure surface temperature. For each dock, we captured a thermal baseline prior to connecting anything or conducting the stress test. We attached two USB load testers, connected to USB 3.0 extension cables to isolate any heat generated by the load testers from the dock. The USB load testers were set to draw 4.5 watts (.9A x 5V) to mimic typical USB devices charging (such as a phone or tablet).

Setting up the test

1. Ensure the system does not go to sleep or shut off its display automatically while plugged in and on battery.
    a. Go to Control Panel→Hardware and Sound→Power Options→Change when computer sleeps.
    b. Set Turn off the display to Never for both On battery and Plugged in options.
    c. Set Put the computer to sleep to Never for both On battery and Plugged in.
2. Download and install 3DMark (v2.3.3693).
3. Download and install PCMark 10 (v1.0.1275).
4. Repeat steps 1 through 3 for each system.

Testing thermal management with load

1. Connect keyboard, mouse, Ethernet, and two displays to the dock under test.
2. Using 3DMark, drain the system battery to 10% or less.
3. Connect the system to the dock, along with two USB load testers attached to USB 3.0 extension cables, ensuring that network connectivity is going through wired Ethernet. After the system is connected, close the lid. This will run the video feed to the attached display.
4. Simultaneously start a high-definition streaming video on the system on one display and PCMark on the other display to mimic office productivity tasks and start the timer.
    a. Run the PCMark 10 Express benchmark.
    b. If benchmark ends before the full 30 minutes, restart the PCMark 10 Express benchmark.
5. Using the FliR camera, measure and record thermal readings at three different time intervals:
    a. 10 minutes
    b. 20 minutes
    c. 30 minutes
6. Unplug all the components from the dock, and let the dock cool down to the baseline temperature.
7. Repeat steps 1 through 6 twice more for each dock.

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

This project was commissioned by Dell Technologies.