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Technology and application

What is Thunderbolt™?
Thunderbolt is an Intel-developed dual-protocol I/O that provides unmatched speeds over copper (up to 3 meter) or optical (up to 100 meter) cables. Dual protocol refers to its ability to support simultaneous data transfer and digital video. Key characteristics of Thunderbolt include:

- Up to 20 Gbps bi-directional data transfer
- Data and video on a single cable
- Daisy chain up to six devices

When should I consider using Thunderbolt versus other connections, e.g. USB, eSATA, ExpressCard?
Thunderbolt is a faster available data transfer protocol, and will be appreciated by users with large, portable data sets such as video files. Moving data between devices, whether moving video files from camera capture card to computer, or from computer to backup drive has never been faster on personal computers.

In general, we anticipate most workstation users will focus on the high data transfer capabilities of Thunderbolt, and continue relying on dedicated display port cables to drive displays.

Using Thunderbolt requires a compatible Thunderbolt port on both the computer and the device.

How does Thunderbolt data transfer speed compare to USB and eSATA?
Thunderbolt specifies up to 20 Gbps data transfer speeds. USB 3.0, which has become the dominant interface on the current generation of workstations, specifies 5 Gbps. eSATA, which is less common at this time, specifies 3 Gbps transfer speeds.

What speed is Thunderbolt?
Thunderbolt is currently available in two generations: Thunderbolt and Thunderbolt 2. Thunderbolt 2 doubles the bandwidth of Thunderbolt. The specified and expected real world data transfer rates for each are:

<table>
<thead>
<tr>
<th></th>
<th>Specified data transfer rate</th>
<th>Expected real world rate (not to be guaranteed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thunderbolt</td>
<td>10 Gbps</td>
<td>We have measured 900 MB/s (7200 Gbps). One should be able to get 10G, even if you add in the DP bandwidth.</td>
</tr>
<tr>
<td>Thunderbolt 2</td>
<td>20 Gbps</td>
<td>We expect to get ~ 1300 MB/s (10.4 Gbps) of PCI traffic. DP 1.2 traffic is 17.4 Gbps so a DP 1.2 stream plus PCI could get close to 20 Gbps.</td>
</tr>
</tbody>
</table>

What types of Thunderbolt devices are available in the market?
The main categories of Thunderbolt devices in the market today are storage, data capture (video and audio), displays, and I/O hubs.

How fast should my device perform when connected to Thunderbolt?
This will depend on whether the device supports Thunderbolt or Thunderbolt 2, and whether it is connected to a Thunderbolt or Thunderbolt 2 port. It will also depend on what else is connected and in use on the Thunderbolt daisy-chain.
Is Thunderbolt fully compatible with Thunderbolt 2?
Typical of generational advancements in other I/O protocols, Thunderbolt 2 extends Thunderbolt compatibility, and cables are interchangeable. The matrix below describes the behavior one can expect when mixed generations are in use:

<table>
<thead>
<tr>
<th>Peripheral</th>
<th>Computer/host</th>
<th>Thunderbolt</th>
<th>Thunderbolt 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thunderbolt</td>
<td>Thunderbolt performance</td>
<td>Thunderbolt performance</td>
</tr>
<tr>
<td>Thunderbolt 2</td>
<td>Thunderbolt performance</td>
<td>Thunderbolt 2 performance*</td>
<td></td>
</tr>
</tbody>
</table>

* In order to achieve Thunderbolt 2 performance all devices between the Thunderbolt 2 enabled computer and the target device on the daisy chain must support Thunderbolt 2.

What are the requirements for cabling?
Thunderbolt devices require Thunderbolt certified cables. The Thunderbolt certified cables can be copper or optical cables, and the cables can be either generation 1 or generation 2 cables. There is no data throughput performance difference in the different type of Thunderbolt cables. The generation 2 cables offer cost and power savings.

Mini-DisplayPort cables cannot be used to connect Thunderbolt devices.

What are the requirements for use with monitors and other devices?
Thunderbolt supports the direct connection of any mini-DisplayPort monitor directly to a Thunderbolt host or device. Additionally, there are adapters on the market available to support mini-DisplayPort conversions to DisplayPort, HDMI, DVI or VGA. A non-Thunderbolt monitor will always be the last device in a Thunderbolt daisy chain.

What are the Thunderbolt security modes? What security mode should I use?
The Thunderbolt host system has 4 security modes also called levels.

• Security level 0 is a legacy mode that allows any Thunderbolt device to connect the host.
• Security level 1 checks for a unique ID on the Thunderbolt device before allowing connection. If the unique ID is not found, then the user is notified to confirm the device before attachment.
• Security Level 2 is a new security level added for Thunderbolt 2 devices and hosts. Security level 2 allows Thunderbolt 2 hosts to write a unique ID to a Thunderbolt 2 device to ensure only specific, approved devices are allowed to connect to the system.
• Security level 3 allows for Display Port only connections, no data connections are allowed.

I plug in my Thunderbolt device and nothing happens, what should I do?
If the device included a power supply, ensure the power supply is plugged in and any device switches are in the "on" position. Thunderbolt devices do require drivers to be loaded for the device. Ensure the correct drivers are loaded for the device. Ensure the Thunderbolt security level is set as expected and if required, ensure the device access is approved via the Thunderbolt software. Ensure the cable used is a Thunderbolt certified cable.

Which operating systems are supported with Thunderbolt?
Windows 7, Windows 8.1 are currently supported. Linux support is expected to be available in early 2014.

What does a “Windows certified” Thunderbolt system mean?
A Windows certified Thunderbolt system has undergone extensive testing to ensure any Thunderbolt device, with the correct drivers, will function correctly on the Windows host.

What does a “certified” Thunderbolt device mean?
A certified Thunderbolt device has undergone extensive testing to ensure the device will interoperate with all Thunderbolt certified host systems.
How do I chain Thunderbolt devices together for best performance?
Thunderbolt allows daisy chaining of up to 6 devices. A DP++ monitor can be placed at the end of a daisy chain. For best performance, Thunderbolt 2 devices should be placed at the start of the daisy chain. Devices that require high throughput could be placed in a daisy chain with no additional devices. The total available bandwidth (10 Gbps for Thunderbolt and 20 Gbps² for Thunderbolt 2) will be shared between all devices in the Thunderbolt daisy chain. DP1.2 monitors should not be placed on a Thunderbolt 2 daisy chain with other devices requiring high throughput performance.

What is the best connection choice for various displays and Thunderbolt devices?
HP Workstation systems have multiple DisplayPort compliant outputs available to the end user. It is recommended the user connect DisplayPort display to DisplayPort outputs and Thunderbolt devices to the Thunderbolt connectors. Direct connections of like devices to like connectors will give the end user the highest performance available on the HP Workstation.

Product strategy

Why has HP decided to add Thunderbolt?
Thunderbolt represents a revolutionary step forward in I/O connectivity. Thunderbolt I/O is revolutionary in both its flexibility and in its performance capability. Since our initial shipments of the desktop Z Workstation platforms in April 2012, we have continued to listen to our evolving customer needs for higher performance and more flexible I/O connectivity. Pursuant to these customer needs and the value that Thunderbolt technology represents, HP is adding Thunderbolt 2 capability to our Z230 SFF, Z230 Tower, Z420, Z620 and Z820 Workstations.

Why has HP decided to add Thunderbolt as an add-in card rather than an integrated solution?
Thunderbolt technology represents a revolutionary yet emerging next step in I/O technology. As Thunderbolt is still emerging, its entire ecosystem and customer base continues to expand. Providing significant technology advancements at critical adoption points is a key to HP’s workstation product strategy. HP Workstation customers also place a very high value on hardware stability. Considering these factors HP worked with Intel, to provide an innovative solution that can be optionally included in Z230 SFF, Z230 Tower, Z420, Z620 and Z820 Workstation configurations.

Why did HP choose to implement a card with only a single port?
Several design decisions were made which resulted in a single Thunderbolt port on the add-in card. The Thunderbolt specification requires power delivery to any attached bus powered device, two Thunderbolt ports gives the potential for two bus powered devices to be plugged at the same time doubling the power requirements and exceeding the power delivery available from the PCIe slot. Additionally, two Thunderbolt ports would require two DisplayPort inputs. Two DisplayPort connectors and two Thunderbolt connectors would not physically fit on a half-height PCIe card. HP’s desire was for a single card that would fit in multiple workstation platforms including some small form factor systems.

Which slots support the Thunderbolt card?
The Thunderbolt add-in card is designed to function in the Z820 slot #5; in the Z420 and Z620 slot #3; and in the Z230 SFF and Z230 Tower slot #4.

Can I add two Thunderbolt cards into my system?
No. Two Thunderbolt add-in cards in one system are not supported at this time.

Can I operate Thunderbolt without the “DP loop-back external cable” connected?
The Thunderbolt interface includes a DisplayPort stream on all Thunderbolt connectors. The external DP loop-back provides the DisplayPort stream input to the Thunderbolt add-in card. While PCI data would still pass through the Thunderbolt daisy chain, without the external DP loop-back cable the Thunderbolt card will not be able to provide the DP stream to downstream devices.

Can the HP Thunderbolt add-in card be used in other competitor’s systems?
No. The Thunderbolt card requires a specific BIOS and system specific use of GPIOs. Because of these specifics, the card may not function in other HP Desktop PCs either.
What are the plans to support Thunderbolt on HP Z Displays?
All HP Z Displays have DisplayPort inputs. All Thunderbolt source ports on workstations can drive a DisplayPort input on a monitor. The user needs a mini-DP to DP cable (the mini-DP connector plugs into the workstation Thunderbolt connector and the DP connector plugs into the monitor DP input). All HP Z Displays are tested for this Thunderbolt operation.

Workstation platform Thunderbolt offerings

Which systems will Thunderbolt be offered on?
The following systems will support Thunderbolt:

<table>
<thead>
<tr>
<th>Thunderbolt</th>
<th>Thunderbolt 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP Z Workstations</td>
<td></td>
</tr>
<tr>
<td>(Z230 SFF, Z230 Tower, Z420, Z620, Z820)</td>
<td>Via PCIe add-in card</td>
</tr>
<tr>
<td>HP ZBooks</td>
<td></td>
</tr>
<tr>
<td>(ZBook 15, ZBook 17)</td>
<td>Single port</td>
</tr>
<tr>
<td></td>
<td>Available mid 2014</td>
</tr>
</tbody>
</table>

Learn more about Thunderbolt and the HP Z family of products at hp.com/zworkstations

Footnotes

1 Thunderbolt 2 is standard on HP ZBook 15 and 17 Mobile Workstations and is available via an optional add-in card on HP Desktop Workstations. Thunderbolt is new technology. Thunderbolt cable and Thunderbolt device (sold separately) must be compatible with Windows. To determine whether your device is Thunderbolt Certified for Windows, see thunderbolttechnology.net/products
2 Applies to Thunderbolt 2.

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