Thunderbolt™ 4

July 8, 2020
A decade of Thunderbolt innovation

2010
Combined high-speed **video and data** onto a single connector (10Gb/s)

2013
Speed increase (20Gb/s)

2015
Combined high-speed video and data with power onto a **USB-C connector** (40Gb/s)

2017
**Native Windows support for Thunderbolt**

2019
Thunderbolt protocol **specification contributed** by Intel to be used in USB4

2020
**Tiger Lake** with integrated Thunderbolt 4 NEW

- Thunderbolt 4 offers the **most complete** version of USB-C NEW
- Ice Lake with **integrated** Thunderbolt 3
- Thunderbolt 4 **certification includes** USB4 testing NEW
Thunderbolt momentum

- **Hundreds of millions** of Thunderbolt 3 computers and accessories shipped
  - Windows computers with Thunderbolt 3 starting at $679\(^1\)
  - Intel NUC with Thunderbolt 3 starting at $399\(^2\)

- **High demand** for Tiger Lake-based consumer and commercial products

- Thunderbolt required for code name **Project Athena** Intel innovation program

- **Broad OS platform support** – Windows, MacOS, and Linux

- Dock market growing ~10% a year with **Thunderbolt docks growing at ~20%** \(^3\)

- **Thunderbolt dock mix** expected to **grow from ~25-40%** over next few years \(^3\)

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\(^1\) July 6, 2020 - Acer 14” Swift 3 Laptop at [https://www.bhphotovideo.com](https://www.bhphotovideo.com)

\(^2\) July 6, 2020 - Intel NUC BOXNUC8i3BEK1 Barebone System ($329) + Intel 660p Series M.2 2280 512GB PCIe NVMe 3.0 ($69) at [https://www.newegg.com](https://www.newegg.com)

\(^3\) March 2020 - Based on Intel internal research and projections
Thunderbolt 4 and USB4 products

- **Thunderbolt** is a high-speed protocol that can dynamically adjust data and video bandwidth depending on the device and/or application. It’s now the **basis of the USB4 protocol specification**.

- Thunderbolt 4 and USB 4 products will use the same underlying protocol specification to improve compatibility for USB-C based products.

Thunderbolt 4 will offer the **most complete** version of USB-C with a required superset of capabilities not required by USB4.
What’s new in Thunderbolt™ 4
Same industry leading 40Gb/s performance and more

**Double the minimum video and data requirements of Thunderbolt 3**

- Video: Support for two 4K displays or one 8K display
- Data: PCIe at 32 Gb/s for storage speeds up to 3,000 MB/s

**Expanded End-to-End Solution Capabilities**

- Accessories with four Thunderbolt ports
- Universal 40Gb/s cables up to 2 meters in length
- Required PC charging on at least one computer port
- Required PC wake from sleep when computer is connected to a Thunderbolt dock
- Required Intel VT-d based direct memory access (DMA) protection

**USB4 Specification Compliant**

1For thin and light notebooks that require less than 100W to charge
How Thunderbolt 4 is different than Thunderbolt 3

Thunderbolt™ 4

INCREASES MINIMUM PERFORMANCE REQUIREMENTS
EXPANDS END-TO-END SOLUTION CAPABILITIES
USB4 SPECIFICATION COMPLIANT

Thunderbolt™ 3

USB 2.0
USB 3.2
USB4 compatible
DisplayPort
PCIe

Mandatory Certification for All Shipping Computers, Accessories and Cables to Offer a Consistent User Experience Across a Wide Range of Product Types and Manufacturers
Thunderbolt is Always 40Gb/s
Consistent performance keeps you fast
Computer port simplification

One Thunderbolt 4 universal computer port can replace these other ports for hassle-free connectivity to any of your favorite accessories.

USB 3.2 5Gb/s
USB 3.2 10Gb/s
USB 3.2 20Gb/s
USB3/DP
USB4 20
USB4 40

Just look for the Thunderbolt™ 4
Cable simplification
One Thunderbolt 4 universal cable can replace these other cables to make cable selection fast and easy.
### Brand simplification

Thunderbolt brand continues to be simple

<table>
<thead>
<tr>
<th>Name</th>
<th>Logo</th>
<th>Icon</th>
<th>Port</th>
<th>Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thunderbolt™ 4</td>
<td><img src="image" alt="Logo" /></td>
<td><img src="image" alt="Icon" /></td>
<td><img src="image" alt="Port" /></td>
<td><img src="image" alt="Cable" /></td>
</tr>
</tbody>
</table>
Intel® Virtualization Technology for Directed I/O
Committed to continuously improving security over the Thunderbolt port

Thunderbolt™ 4 computer ports will be required to support Intel VT-d based DMA protection solutions
Thunderbolt 4
Truly universal cable connectivity solution for work and play

**Truly Universal**
Most complete and future proof version of USB-C

**Effortless Connectivity**
More ways to connect accessories than ever before

**Secure & Manageable**
Intel VT-d based DMA protection

**Always Fast**
40Gb/s for connecting to powerful Thunderbolt docks, monitors, fast storage and more

**Notebook Charging**
Required on at least one computer port

**Mandatory Certification**
Consistent user experience across a wide range of product types and manufacturers

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1. For thin and light notebooks that require less than 100W to charge
How Thunderbolt 4 is different than other solutions
Based on minimum solution requirements so people know what they are getting

<table>
<thead>
<tr>
<th></th>
<th>Thunderbolt™ 4</th>
<th>Thunderbolt™ 3</th>
<th>USB4</th>
<th>USB3/DP</th>
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</thead>
<tbody>
<tr>
<td><strong>Unrivaled Simplicity</strong></td>
<td></td>
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<tr>
<td>One universal computer port</td>
<td>●</td>
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<tr>
<td>Universal 40Gb/s cables up to 2 meters in length</td>
<td>●</td>
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<tr>
<td>Accessories with four Thunderbolt ports</td>
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<tr>
<td><strong>Maximum Performance</strong></td>
<td></td>
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<tr>
<td>Minimum PC speed requirements</td>
<td>40Gb/s</td>
<td>40Gb/s</td>
<td>20Gb/s</td>
<td>10Gb/s</td>
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<tr>
<td>Minimum PC video requirements</td>
<td>Two 4K displays</td>
<td>One 4K display</td>
<td>One display (No Minimum)</td>
<td>One display (No Minimum)</td>
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<tr>
<td>Minimum PC data requirements</td>
<td>PCIe 32 Gb/s USB 3.2 - 10Gb/s</td>
<td>PCIe 16 Gb/s USB 3.2 - 10Gb/s</td>
<td>USB 3.2 - 10Gb/s</td>
<td>USB 3.2 - 5Gb/s</td>
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<td>Required PC charging on at least one computer port</td>
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<tr>
<td>Minimum PC port power for accessories</td>
<td>15W</td>
<td>15W</td>
<td>7.5W</td>
<td>4.5W</td>
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<tr>
<td>Thunderbolt Networking</td>
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<tr>
<td><strong>Reliable Connectivity</strong></td>
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<tr>
<td>Mandatory certification for all shipping computers, accessories and cables</td>
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<tr>
<td>Cable testing and cable quality audits for Thunderbolt cable manufacturers</td>
<td>●</td>
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<td>Required Intel VT-d based DMA protection</td>
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<td>USB4 Specification</td>
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<td>Compatible</td>
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1For thin and light notebooks that require less than 100W to charge
Thunderbolt family of accessories

Thunderbolt 4 computers and cables are a fully compatible extension to existing Thunderbolt 3 accessories and cables.
Thunderbolt™ 4 modern docks
Thunderbolt™ 4 docks offer up to four Thunderbolt 4 ports to simplify connectivity and redefine the modern workspace
Thunderbolt accessory configurations
More Thunderbolt ports and more ways to connect than ever before

**More Thunderbolt Computer Ports**
- Notebook Charging
- Thunderbolt, USB or DP accessory

**Multi-port Accessory Architecture**
- Notebook
- Thunderbolt 4 modern dock
- SSD
- Thunderbolt, USB or DP accessory

**Daisy Chain Accessory Architecture**
- Notebook
- Lowest Latency Audio Interface
- Highest Bandwidth Video Capture
- Desktop Storage
- Monitors
- Thunderbolt, USB or DP accessory

1For thin and light notebooks that require less than 100W to charge
Thunderbolt 4 cable innovation

World’s first universal cable line-up from top to bottom

- NEW

<table>
<thead>
<tr>
<th>Length</th>
<th>Cable Image</th>
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<td>0.2m</td>
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<tr>
<td>0.8m</td>
<td><img src="image2" alt="0.8m Cable" /></td>
</tr>
<tr>
<td>2.0m</td>
<td><img src="image3" alt="2.0m Cable" /></td>
</tr>
<tr>
<td>~5-50m [Future]</td>
<td><img src="image4" alt="Future Cable" /></td>
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</table>
Thunderbolt Developer Update

- Intel’s upcoming mobile PC processors, code-named “Tiger Lake,” will be the first to integrate Thunderbolt 4.

- Intel® 8000 series Thunderbolt 4 controllers coming later this year:
  - JHL8540 and JHL8340 host controllers for computer makers
  - JHL8440 device controller for accessory makers

- Thunderbolt 4 developer kits and certification testing are now available.

- The first Thunderbolt 4 computers and accessories are expected to be available later this year, including laptops based on Intel’s innovation program code-named “Project Athena.”
Summary

- Intel introduces Thunderbolt 4 and new Thunderbolt controllers, compatible with hundreds of millions of Thunderbolt 3 PCs and accessories already available.

- Thunderbolt 4 builds on Thunderbolt 3 by increasing minimum performance requirements, expanding solution capabilities and adding USB4 compliance.

- For the first time....
  - Thunderbolt 4 docks offer up to four Thunderbolt ports for the modern workspace.
  - Longer Thunderbolt 4 universal cables up to 2 meters for fast and easy cable selection.

- Upcoming “Tiger Lake” mobile processors will be the first to integrate Thunderbolt 4. The first Thunderbolt 4 computers and accessories are expected to be available later this year.