



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

Ice Lake with **integrated** Thunderbolt 3

2020

Tiger Lake with integrated Thunderbolt 4 **NEW**

Thunderbolt 4 offers the **most complete** version of USB-C **NEW**

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 years³

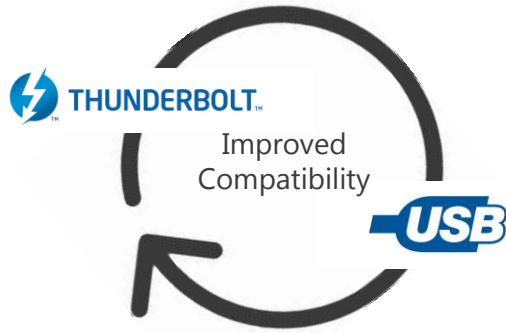
¹July 6, 2020 - Acer 14" Swift 3 Laptop at <https://www.bhphotovideo.com>

²July 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>

³March 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 port¹
- 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

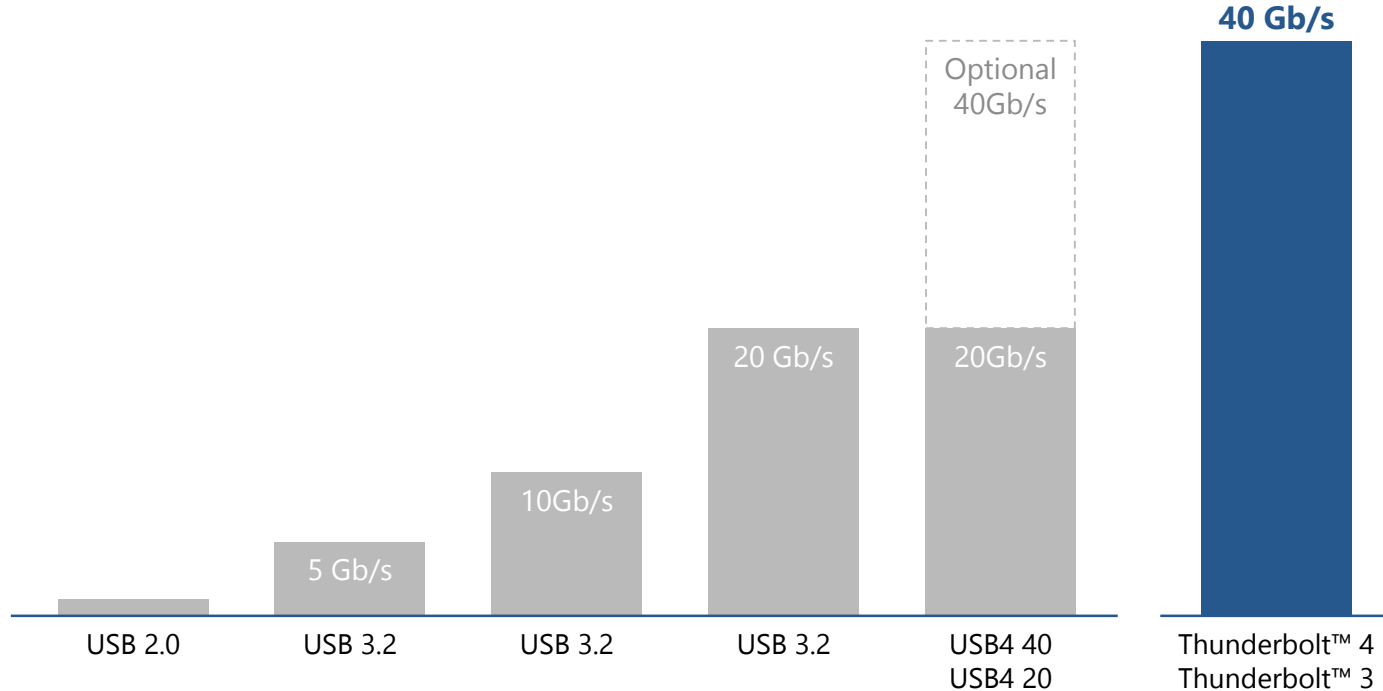
DisplayPort

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

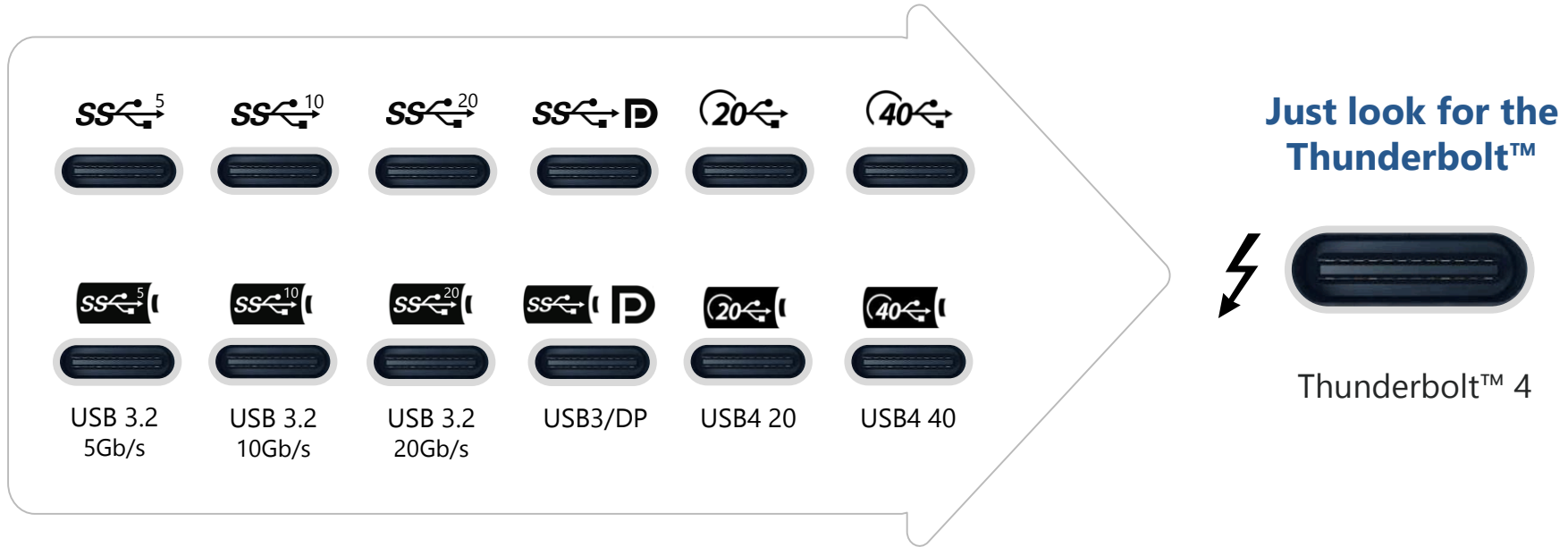
Thunderbolt is Always 40Gb/s

Consistent performance keeps you fast



Computer port simplification

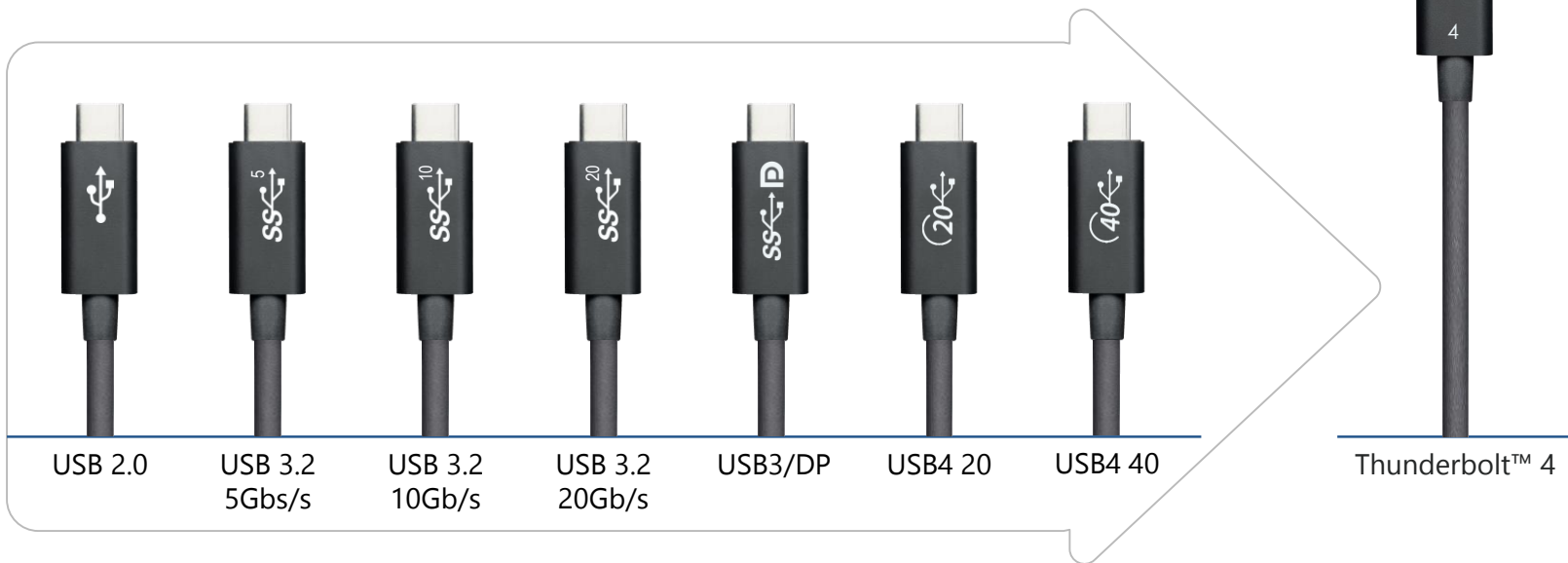
One Thunderbolt 4 universal computer port can replace these other ports for hassle-free connectivity to any of your favorite accessories



Cable simplification





One Thunderbolt 4 universal cable can replace these other cables to make cable selection fast and easy

Just look for the
Thunderbolt™



Brand simplification

Thunderbolt brand continues to be simple

Name	Logo	Icon	Port	Cable
Thunderbolt™ 4	 THUNDERBOLT™			

Intel® Virtualization Technology for Directed I/O

Committed to continuously improving security over the Thunderbolt port

Solution Brief



Thunderbolt™ Security – Helps Keep Your Computer Ports More Secure

As part of Intel's Security-First Pledge, we are committed to continuously improving security over the Thunderbolt™ port.



Summary

Intel® Virtualization Technology for Directed I/O (VT-d), specialized hardware capabilities built into Intel processors is the foundation for DMA protection on Thunderbolt ports that helps prevent physical DMA attacks. These solutions block peripheral devices from unauthorized access to system memory.

Leading operating systems such as Windows, MacOS, and Linux have already implemented DMA protection using Intel VT-d technology.

Intel's Thunderbolt 4 certification requires VT-d based DMA protection. It is strongly recommended on computers with Thunderbolt 3 ports and has been enabled on PCs, where supported, since 2019.

Intel recommends standard security practices to reduce the risk of physical attacks. Such practices include using only trusted peripherals and preventing unauthorized physical access to computers. Hard disk drive encryption and a BIOS password can provide additional protection.

In Detail

With USB-C connector-based computer ports that provide PCI Express (PCIe) protocol, users can connect PCIe devices to the computer just as if they were installed internally. Such devices include portable and desktop storage, external graphics, memory card readers, ethernet adapters and other PCIe-based devices.

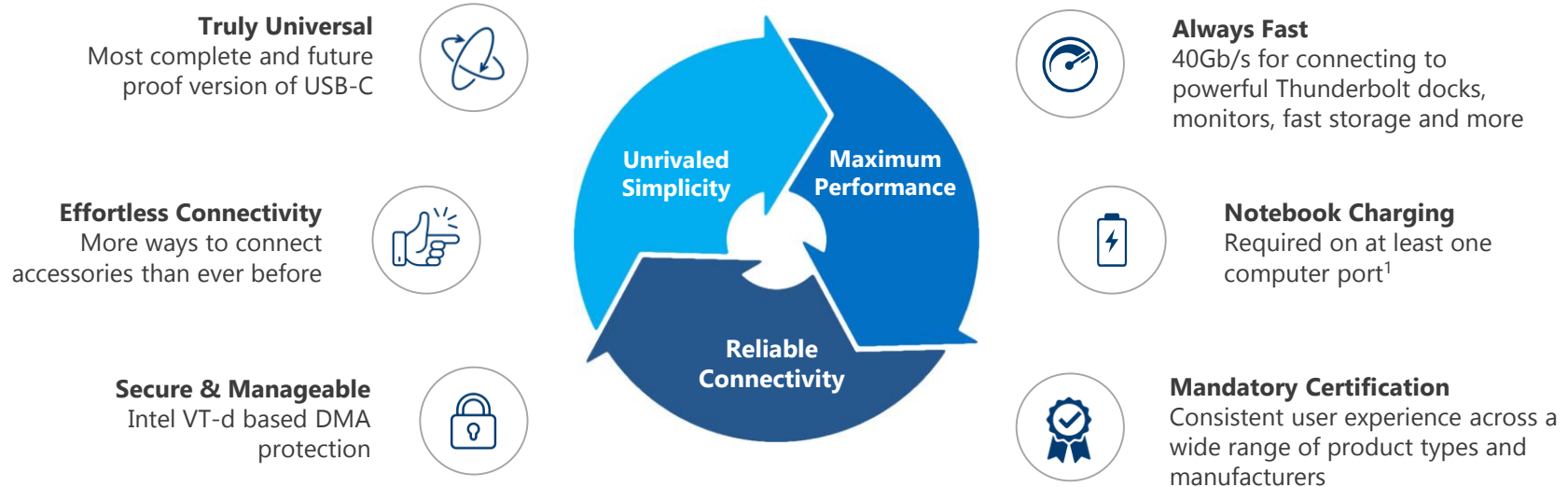
PCIe devices are unique because they are capable of Direct Memory Access (DMA), which enables fast and efficient access to the system memory without involving the processor. However shared memory between all the different devices in the system including those that are externally connected via the USB-C port may present a security risk if not properly protected.

Security for Thunderbolt computer ports is hardware-based and built on Intel's Virtualization Technology for Directed I/O (Intel VT-d), an Intel processor technology that provides IO virtualization (often referred to as IO Memory Management Unit or IOMMU). One of VT-d technology's features is DMA remapping (DMA-r) which is used for DMA protection by operating systems and BIOS. DMA-r helps protect the system memory by providing

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



¹For 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

		Thunderbolt™ 4	Thunderbolt™ 3	USB4	USB3/DP
Unrivaled Simplicity	One universal computer port	•	•		
	Universal 40Gb/s cables up to 2 meters in length	•			
	Accessories with four Thunderbolt ports	•			
Maximum Performance	Minimum PC speed requirements	40Gb/s	40Gb/s	20Gb/s	10Gb/s
	Minimum PC video requirements	Two 4K displays	One 4K display	One display (No Minimum)	One display (No Minimum)
	Minimum PC data requirements	PCIe 32 Gb/s USB 3.2 - 10Gb/s	PCIe 16 Gb/s USB 3.2 - 10Gb/s	USB 3.2 - 10Gb/s	USB 3.2 - 5Gb/s
	Required PC charging on at least one computer port ¹	•			
	Required PC wake from sleep when computer is connected to a Thunderbolt dock	•			
	Minimum PC port power for accessories	15W	15W	7.5W	4.5W
	Thunderbolt Networking	•	•		
Reliable Connectivity	Mandatory certification for all shipping computers, accessories and cables	•	•		
	Cable testing and cable quality audits for Thunderbolt cable manufacturers	•	•		
	Required Intel VT-d based DMA protection	•			
	USB4 Specification	Compliant	Compatible	Compliant	Compatible

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



Two Port Docks



Two Port Monitors



Portable Storage, Enclosures



Power Supply Docks



Adapters



Desktop Storage



Audio Interfaces



Video Interfaces



External Graphics

THUNDERBOLT 4



Four Port Compact Docks **NEW**



Four Port Docks **NEW**



Multi-Port Monitors **NEW**

Thunderbolt 4 modern docks

Thunderbolt 4 docks offer up to four Thunderbolt 4 ports to simplify connectivity and redefine the modern workspace



Thunderbolt™ 4 Compact Dock

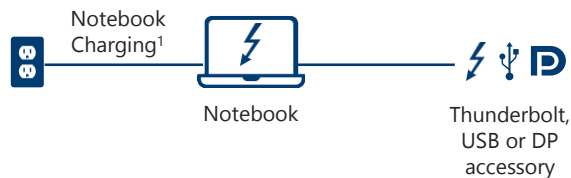


Thunderbolt™ 4 Dock

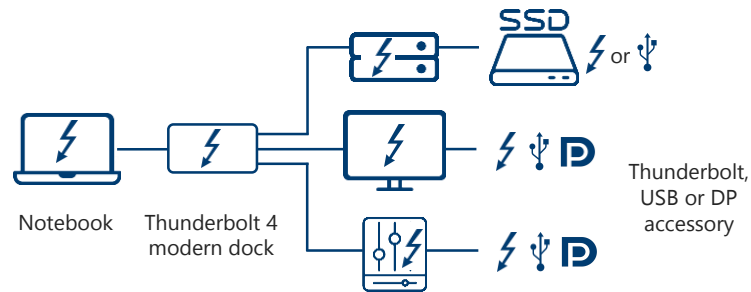
Thunderbolt accessory configurations

More Thunderbolt ports and more ways to connect than ever before

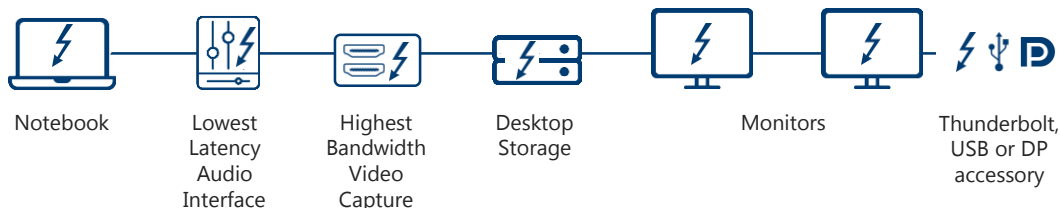
More Thunderbolt Computer Ports



Multi-port Accessory Architecture ^{NEW}



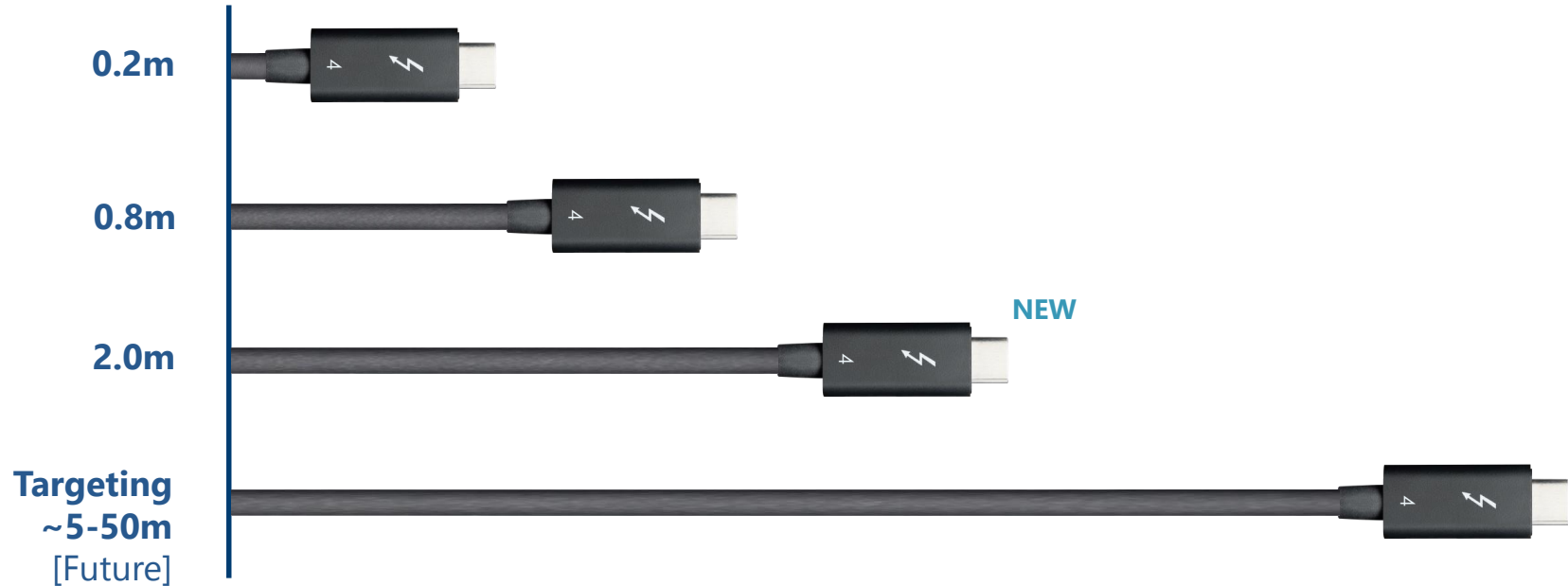
Daisy Chain Accessory Architecture



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



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.



Intel technologies may require enabled hardware, software or service activation.
No product or component can be absolutely secure.
Your costs and results may vary.

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