

Thunderbolt™ 3

The USB Type-C* That Does It All

Jason Ziller

CCD Marketing, Intel Corporation

Agenda

- Thunderbolt™ 3 In the News
- USB and Thunderbolt Introduction
- Thunderbolt Overview
- Thunderbolt 3 Features
- Key User Experiences
- Thunderbolt 3 Products
- Thunderbolt 3 Branding
- PC Advocacy
- Summary

Agenda

- Thunderbolt™ 3 In the News
- USB and Thunderbolt Introduction
- Thunderbolt Overview
- Thunderbolt 3 Features
- Key User Experiences
- Thunderbolt 3 Products
- Thunderbolt 3 Branding
- PC Advocacy
- Summary

Thunderbolt™ 3 In the News

***“One port to rule them all:
Thunderbolt 3 and USB
Type-C join forces”***

– CNET; Jun 2, 2015



***“Thunderbolt 3 Explained:
Why You Need the World’s
Fastest Port.”***

– LAPTOP, June 8, 2016



***“The future is looking
even better for one big
reason: Thunderbolt 3”***

– PC World*, Sep 18, 2015



***“Thunderbolt 3 is
everything at once”***

– Cheatsheet, June 11, 2016



***“What is Thunderbolt 3? The
Supercharged Connector Set
to Revolutionize Tablets,
Laptops, and PCs.”***

– Int'l Business Times*, Feb 16, 2016



***“This leads me to believe that
Thunderbolt has well and truly
arrived for the mass market...”***

– Anandtech.com; April 14, 2016



“Dell XPS 13 review: Skylake and Thunderbolt™ 3 make the best a little bit better”

– ars technica*; Jan 20, 2016



That one with the little lightning bolt? **It's the port of the future.**

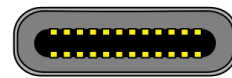
Agenda

- Thunderbolt™ 3 In the News
- **USB and Thunderbolt Introduction**
- Thunderbolt Overview
- Thunderbolt 3 Features
- Key User Experiences
- Thunderbolt 3 Products
- Thunderbolt 3 Branding
- PC Advocacy
- Summary

Industry Terminology

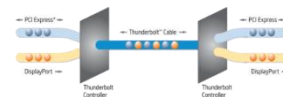
- USB = industry standard for cables, connectors and protocol

- USB-C = reversible connector specification



Type-C

- Thunderbolt™ = protocol that combines data and display



- Thunderbolt 3 = brand that ensures a USB-C connector supports USB3.1, DisplayPort* and Thunderbolt



USB-C Cables and Connectors

- Symmetric and Flip-able/Reversible
- Power delivery up to 100W of power - 20V at 5A
- Supports Alternate Modes – DisplayPort*, Thunderbolt™, Audio etc.



USB-C

USB 3.1
Micro-B

USB 3.1
Standard-A

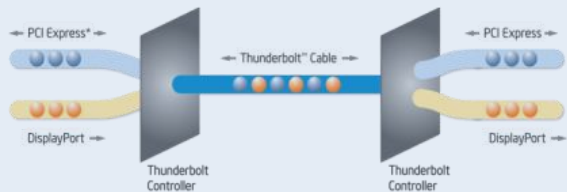


Thunderbolt 3 is bringing Thunderbolt to USB-C

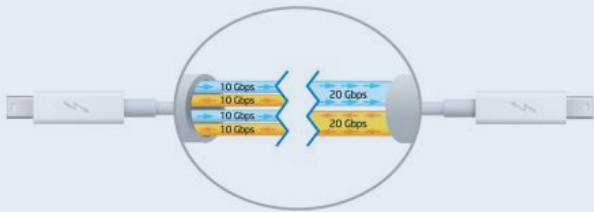
Agenda

- Thunderbolt™ 3 In the News
- USB and Thunderbolt Introduction
- **Thunderbolt Overview**
- Thunderbolt 3 Features
- Key User Experiences
- Thunderbolt 3 Products
- Thunderbolt 3 Branding
- PC Advocacy
- Summary

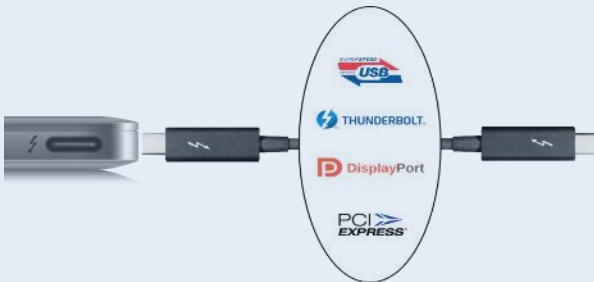
Thunderbolt™ Overview



- Thunderbolt™
 - PCI Express* (PCIe*) and DisplayPort* protocols through a single compact port, 10Gbps



- Thunderbolt 2
 - Doubles the bandwidth, support 4K displays, 20Gbps



- Thunderbolt 3
 - USB-C connector, supports USB 3.1, dual 4K, power delivery, 40Gbps

Thunderbolt™ 3 Brings Thunderbolt to USB-C



The USB-C that does it all.



More
Protocols



More
Speed



40 Gbps – fastest connection

More
Pixels



Dual 4K displays
60hz

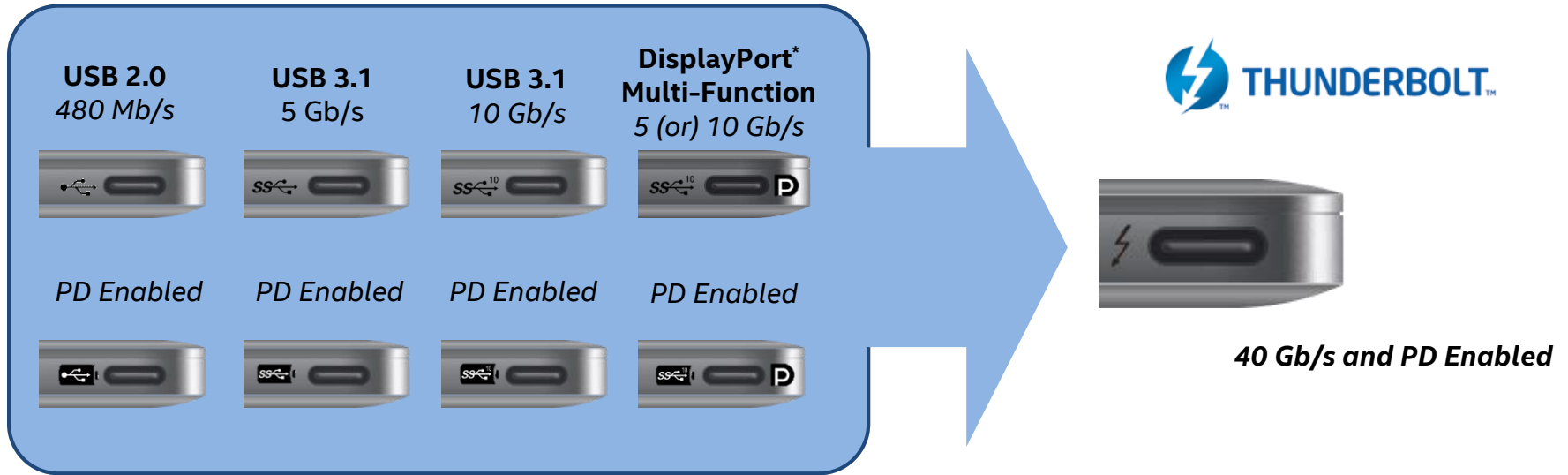
More
Power



100W
charging

15W
device

Not all USB-C Computer Ports Will be Equal



Thunderbolt 3 – The USB-C That Does it All

Agenda

- Thunderbolt™ 3 In the News
- USB and Thunderbolt Introduction
- Thunderbolt Overview
- **Thunderbolt 3 Features**
- Key User Experiences
- Thunderbolt 3 Products
- Thunderbolt 3 Branding
- PC Advocacy
- Summary

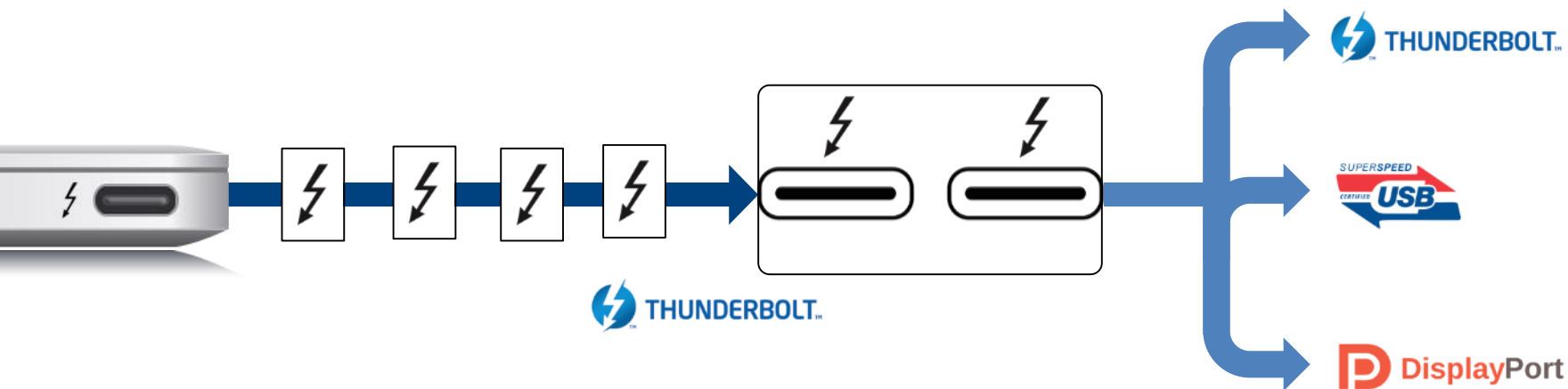
More Protocols



**More protocols than
any other I/O controller**

**Connect any dock, device or display,
including billions of USB devices**

Thunderbolt™ Daisy-Chain

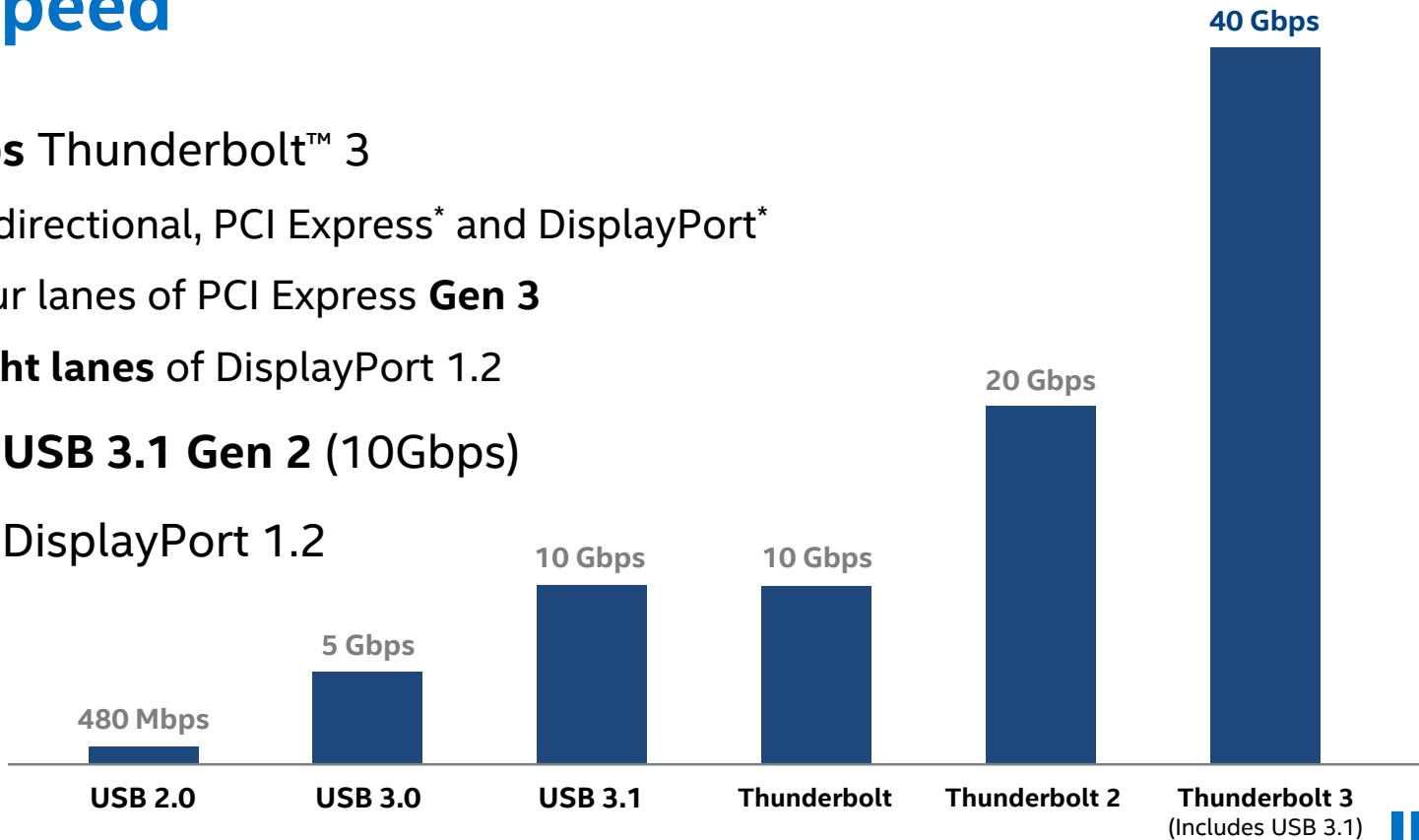


Daisy-chain up to six Thunderbolt devices

Open Thunderbolt port operates the **same as computer port** and supports Thunderbolt, USB, or DisplayPort* devices

More Speed

- **40Gbps Thunderbolt™ 3**
 - Bi-directional, PCI Express* and DisplayPort*
 - Four lanes of PCI Express **Gen 3**
 - **Eight lanes** of DisplayPort 1.2
- Native **USB 3.1 Gen 2 (10Gbps)**
- Native DisplayPort 1.2



4K Video

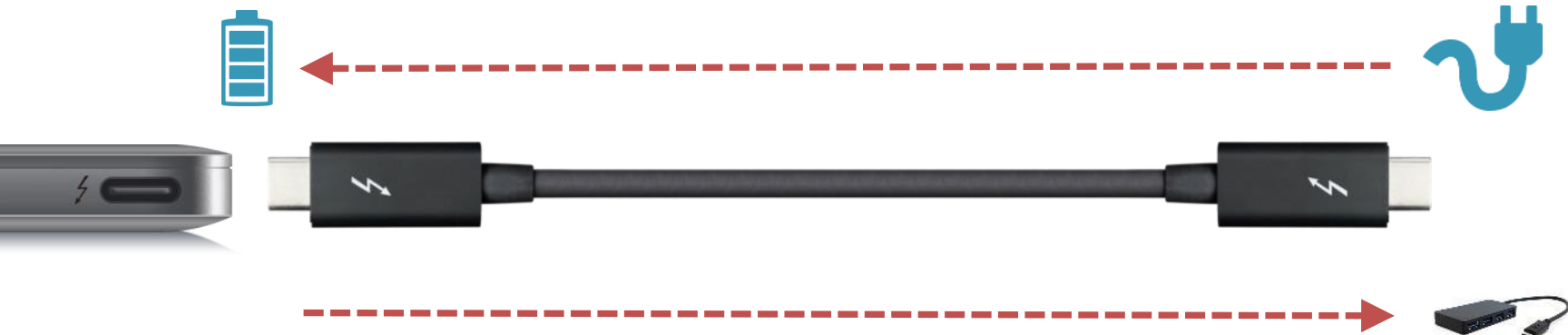


- Large displays with amazing detail
- Twice the video bandwidth of any other cable
- 2 streams (eight lanes) of DisplayPort* 1.2
- Single-cable connection for two 4K 60Hz or a 5K 60Hz display

More Power

Up to 100W System Charging

- For single-cable docking according to USB-PD spec



15W to bus-powered devices

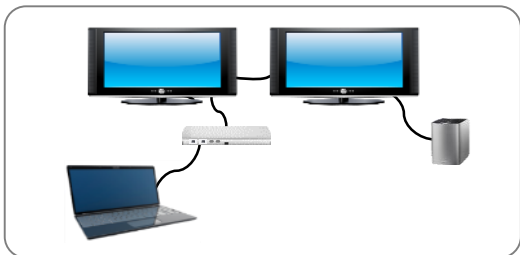
- Higher speed and capacity storage
- Portable displays
- High-performance adapters

Agenda

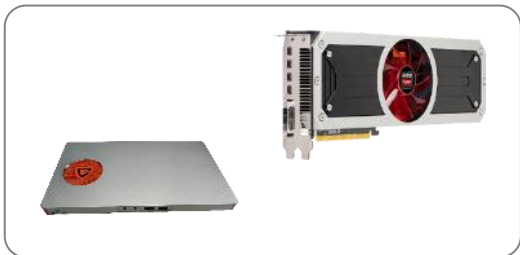
- Thunderbolt™ 3 In the News
- USB and Thunderbolt Introduction
- Thunderbolt Overview
- Thunderbolt 3 Features
- **Key User Experiences**
- Thunderbolt 3 Products
- Thunderbolt 3 Branding
- PC Advocacy
- Summary

Key User Experiences

4K Video



Single-cable docking



External graphics



Thunderbolt™ Networking

Thunderbolt™ 3 Delivers Best USB Type-C* Docking

Fastest USB



Single-Cable Docking

- 40Gbps Data + 4K Video + 100W PC Charging
- Only way to get 4K + data from one USB-C
- Two uncompressed 4K displays

← 100W PC Charging



Plugable* Thunderbolt 3 Dock

Dell* Thunderbolt Dock



HP Zbook* Dock



Docks with Thunderbolt™ 3

- Many mainstream dock options, standard docks will be time-to-market
 - Dual 4K, fastest USB, notebook charging, external graphics, etc.
 - Connect any Thunderbolt™, USB 3.1 (10Gb/s), or display devices
- Optional system charging or power charge through

Standard



Graphics



Travel



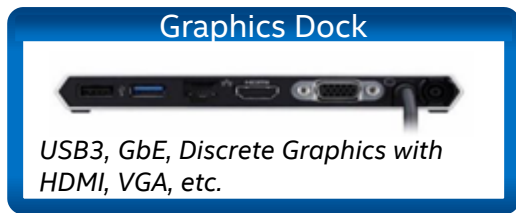
Charging



Up to 100W

Thunderbolt™ External Graphics

- External graphics solution that supports hot plug & surprise removal of cable on dedicated PC-device
 - External graphics can connect to external monitor, or be routed back to notebook screen
- Working with both AMD* and NVIDIA* on external graphics solutions



OR



HDMI

DisplayPort



Thunderbolt™ Networking

Ethernet Emulation over Thunderbolt

- Peer-to-Peer communication between computers
- Bridging or routing between multiple computers
- Behaves as if systems were connected with Ethernet
 - Uses existing OS network and sharing infrastructure
 - File, print, share internet connection, etc...
- Connect Mac*/PC/Linux* to Mac/PC/Linux



Only PC I/O to offer >10Gbps network data transfer speed

VR with Thunderbolt™ 3

- Amplify VR experiences by connecting a VR headset to Thunderbolt™ external graphics
- Backpack PC with 1m Thunderbolt 3 (40Gb/s) cable connected directly to VR HMD – single cable for 4K video, data, & power
- 5m Thunderbolt 3 (40Gb/s) USB-C optical cable under development
 - One, long thin cable for dual 4K 60Hz, low latency, and VR HMD power



Thunderbolt 3 External Desktop Graphics



Backpack PC

Agenda

- Thunderbolt™ 3 In the News
- USB and Thunderbolt Introduction
- Thunderbolt Overview
- Thunderbolt 3 Features
- Key User Experiences
- **Thunderbolt 3 Products**
- Thunderbolt 3 Branding
- PC Advocacy
- Summary

Announced PCs with Thunderbolt™ 3



Acer®
Predator 17



Acer
Predator 17x



ASUS® Maximus
VIII Extreme



ASUS ROG
G501VW



ASUS ROG
G752VL



ASUS ROG
G752VT



ASUS ROG
G752VY



ASUS ROG
GX700VO



ASUS Z170-
PREMIUM



Dell™
Alienware 13



Dell
Alienware 15



Dell
Alienware 17



Dell XPS 12
2-in-1



Dell XPS 13



Dell XPS 15



Gigabyte® GA-
X99P-SLI



MSI GS40
Gaming
Notebook



MSI GS60
Gaming
Notebook



MSI GT72
Gaming
Notebook



MSI GT80
Gaming
Notebook



MSI Vortex G65



Gigabyte GA-
X170-EXTREME



Gigabyte
GA-Z170X-
Gaming 1



Gigabyte
GA-Z170X-
Gaming 7



Gigabyte
GA-Z170X
Gaming 7-EU



Gigabyte
GA-Z170X-
Gaming GT



Intel® NUC
NUC6i7KYK



Lenovo®
IdeaPad Y900



The New Razer®
Blade



Razer Blade
Stealth



VAIO® S11

Announced PCs with Thunderbolt™ 3 Cont...



Acer® TravelMate
P648



ASUS ZenBook
Pro UX501VW



Dell® Latitude
E5570



Dell Latitude
12 2-in-1 7275



Dell Latitude 13
7370



Dell Precision
15 3000 Series
(3510)



Dell Precision
15 5000 Series
(5510)



Dell Precision
15 7000 Series
(7510)



Dell Precision
17 7000 Series
(7710)



Dell XPS 12
2-in-1



Dell XPS 13



Dell XPS 15



Gigabyte® GA-
X99P-SLI



GIGABYTE GB-
BSi5T-6200



GIGABYTE GB-
BSi5HT-6200



GIGABYTE GB-
BSi7T-6500



GIGABYTE GB-
BSi7HT-6500



HP® EliteBook
Folio



HP Elite X2
1012G1



HP Spectre



HP Z1 G3
Workstation



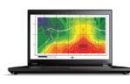
HP ZBook
15G3



HP ZBook
Studio Mobile
Workstation



Lenovo®
ThinkPad P50



Lenovo
ThinkPad P70



MSI® WS60
Workstation
Notebook



MSI WT72
Workstation
Notebook

Shipping Thunderbolt™ 3 Devices

Adapters:



Plugable
Thunderbolt™ 3 to
Dual HDMI Adapter



Plugable
Thunderbolt™ 3 to
Dual DP Adapter



Startech
Thunderbolt™ 3
Legacy Adapter



Startech
Thunderbolt™ 3
Dual DP
Adapter



Kanex
Thunderbolt™ 3 Legacy
Adapter



Startech
Thunderbolt™ 3 to
Dual HDMI Adapter



Lintes Thunderbolt™ 3
Legacy Adapter

Docks:



HP ZBook
Dock



Dell TB15
Dock



Razer Core External
Graphics Dock



Startech
Dock

PCI Express & Storage:



AKiTiO Thunder3
Duo Pro



AKiTiO Thunder3
PCI Express SSD



AKiTiO Thunder3
Quad

















AKiTiO Thunder3
PCIe Box

Note, other names and brands may be claimed as the property of others.

Announced Thunderbolt™ 3 Devices

Dock & Display	Adapters & Cables	Storage
<p>CalDigit Thunderbolt 3 Dock OWC Thunderbolt 3 Dock Plugable Thunderbolt 3 Dock</p>	<p>Akitio TBT 3 to TBT Adapter ATTO 40GbE Adapter Cable Matters TBT 3 to TBT Adapter Cable Matters Dual DP and HDMI Adapters Kanex TBT 3 to TBT Adapter Kanex Dual DP and HDMI Adapters Promise 10GbE adapter (Bus PWR) Promise 16G Fiber Channel Adapter</p> <p>OWC PCIe Card Chassis Sonnet PCIe Card Chassis</p>	<p>Accusys 12-bay storage CalDigit 4/8-bay RAID storage HighPoint 4/8/16-bay RAID storage LaCie 12 Big Thunderbolt™ 3 OWC PCIe SSD storage Promise 4/6/8-Bay RAID storage Sonnet CFAST 2.0 Card Reader Sonnet Fusion Thunderbolt 3 PCIe SSD</p>
Graphics	Charger & Hub	Media
<p>Acer Graphics Dock Asus ROG XG Station 2 PowerColor Devil Box</p>	<p>Plugable 20Gb/s USB Hub</p>	<p>Blackmagic 4K Extreme</p>

Shipping Thunderbolt™ 3 Cables

Length	Thunderbolt™ 3 (20Gb/s) USB-C cable	Thunderbolt™ 3 (40Gb/s) USB-C cable
.5m	 <p>All .5m cables are Thunderbolt™ 3 (40Gb/s) USB-C cables</p>	  
1m	    	 <p>Coming Soon!</p>
2m	  	 <p>Coming Soon!</p>

Expected Thunderbolt™ 3 Devices




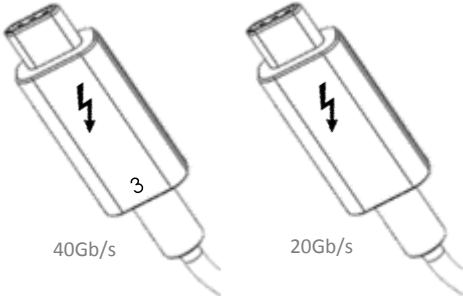
Device Type	<\$100	\$100-\$200	\$200-\$300	>\$300
Adapters, Card Readers and Hubs	<ul style="list-style-type: none"> Thunderbolt™ (TBT) 20Gb/s USB hub Dual HDMI* 2.0 adapter Dual SATA adapter TBT3 to TBT Adapter 4x SD card reader 	<ul style="list-style-type: none"> 8x SD card reader SxS card reader P2 card reader 		<ul style="list-style-type: none"> 10GbE BASE-T adapter
Docks	<ul style="list-style-type: none"> Travel/Mini dock 	<ul style="list-style-type: none"> Standard PC dock 	<ul style="list-style-type: none"> Enterprise dock Mobile graphics dock VR graphics dock 	<ul style="list-style-type: none"> 4K display dock (Consumer) 5K display dock (Creation) QHD display dock (Corporate)
Storage	<ul style="list-style-type: none"> Mobile storage enclosure 	<ul style="list-style-type: none"> Desktop storage enclosure 	<ul style="list-style-type: none"> Mobile NVMe Express* (NVMe) SSD (512GB) Desktop storage enclosure HW RAID storage 	<ul style="list-style-type: none"> HW RAID storage Thunderbolt NAS Mobile NVMe SSD (1TB, 2TB) Thunderbolt shared storage
AV Equipment	<ul style="list-style-type: none"> HDMI 2.0 video capture 	<ul style="list-style-type: none"> KVM Switch Video Interface Audio Interface 	<ul style="list-style-type: none"> Video Interface Audio Interface 	<ul style="list-style-type: none"> Video Interface Audio Interface
PCI Express* Expansion Chassis			<ul style="list-style-type: none"> Expansion chassis (multiple) Desktop graphics chassis 	

Thunderbolt 3 also connects to **every** display and **billions** of USB devices

Agenda

- Thunderbolt™ 3 In the News
- USB and Thunderbolt Introduction
- Thunderbolt Overview
- Thunderbolt 3 Features
- Key User Experiences
- Thunderbolt 3 Products
- **Thunderbolt 3 Branding**
- PC Advocacy
- Summary

Branding

Name	Logo	Icon	Product	Placement†
Thunderbolt™ 3			Computer	
			Device	
			Cable	

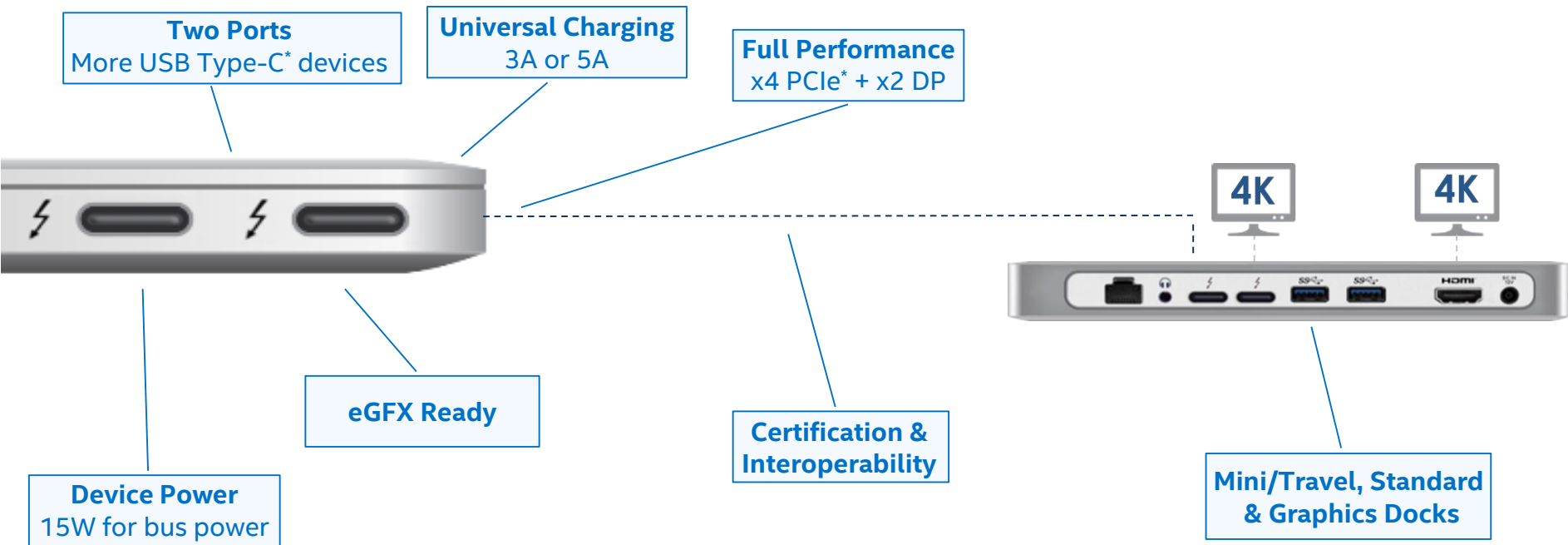
†See Thunderbolt TLUG for specific trademark usage guidelines

Look for Thunderbolt icon on **certified** products and cables

Agenda

- Thunderbolt™ 3 In the News
- USB and Thunderbolt Introduction
- Thunderbolt Overview
- Thunderbolt 3 Features
- Key User Experiences
- Thunderbolt 3 Products
- Thunderbolt 3 Branding
- **PC Advocacy**
- Summary

2017 PCs with Thunderbolt™ 3



Deliver Thunderbolt™ 3 Full Brand Promise

Agenda

- Thunderbolt™ 3 In the News
- USB and Thunderbolt Introduction
- Thunderbolt Overview
- Thunderbolt 3 Features
- Key User Experiences
- Thunderbolt 3 Products
- Thunderbolt 3 Branding
- PC Advocacy
- Summary

Thunderbolt™ Summary

- Thunderbolt™ 3 is the USB-C that does it all, providing:
 - Connection to every dock, display, and Thunderbolt and USB devices
 - Single cable docking with full bandwidth to devices and dual 4K displays
 - External graphics to enhance notebook, mini-PC, and AIO
- Thunderbolt ecosystem is starting to ramp, with 30 devices announced, and 100 devices in the pipeline
- Exciting new Thunderbolt 3 usage models coming such as Virtual Reality

Additional Sources of Information

- A PDF of this presentation is available from our Technical Session Catalog: www.intel.com/idfsessionsSF. This URL is also printed on the top of Session Agenda Pages in the Pocket Guide.
- Thunderbolt Community on the show floor – [Booth 900](#)

Technical Sessions in Connectivity Track

Tuesday, August 16, 2016

11:00 AM – 12:00 PM *CONTS04* — Tools and Methodologies for High Speed Differential I/O Lossy Channel Receiver Test Calibration
Level 2 Room 2008

1:15 PM – 3:15 PM *CONTS01* — USB Type-C* – Enabling and Extending the USB Connector of the Future **Level 2 Room 2008**

4:00 PM – 5:00 PM *CONTS02* — Simplified Platform Power Measurement Using USB Type-C* Interface to Drive Software Power Optimization **Level 2 Room 2008**

Wednesday, August 17, 2016

11:00 AM – 12:00 PM *CONBZ02* — Intel's Connected Home Infrastructure **Level 2 Room 2007**

11:00 AM – 12:00 PM *VSETS02* — Display Connectivity with Intel® Core™ Processors **Level 2 Room 2009**

1:15 PM – 2:15 PM *CONBZ03* — Thunderbolt™ 3 – The USB Type-C* that Does It All **Level 2 Room 2007**

2:30 PM – 3:30 PM *CONTS03* — Shape the Personal Home Gateway: Flexible Design for the Connected Home **Level 2 Room 2007**

4:00 PM – 5:00 PM *IOTT05* — Low-power Wake-up Radios for IoT: Standards and Technology **Level 2 Room 2008**

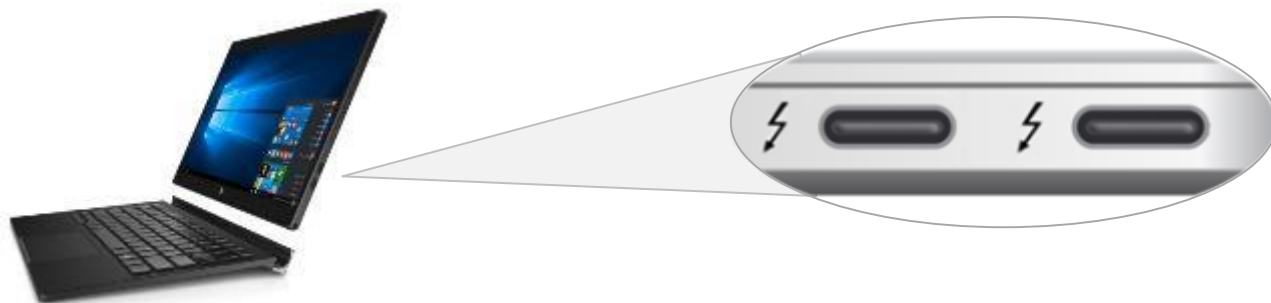
Thank You

Legal Notices and Disclaimers

- Intel technologies' features and benefits depend on system configuration and may require enabled hardware, software or service activation. Performance varies depending on system configuration. No computer system can be absolutely secure. Check with your system manufacturer or retailer or learn more at intel.com.
- Tests document performance of components on a particular test, in specific systems. Differences in hardware, software, or configuration will affect actual performance. Consult other sources of information to evaluate performance as you consider your purchase. For more complete information about performance and benchmark results, visit <http://www.intel.com/performance>.
- Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products. For more complete information visit <http://www.intel.com/performance>.
- Cost reduction scenarios described are intended as examples of how a given Intel-based product, in the specified circumstances and configurations, may affect future costs and provide cost savings. Circumstances will vary. Intel does not guarantee any costs or cost reduction.
- This document contains information on products, services and/or processes in development. All information provided here is subject to change without notice. Contact your Intel representative to obtain the latest forecast, schedule, specifications and roadmaps.
- No license (express or implied, by estoppel or otherwise) to any intellectual property rights is granted by this document.
- Statements in this document that refer to Intel's plans and expectations for the quarter, the year, and the future, are forward-looking statements that involve a number of risks and uncertainties. A detailed discussion of the factors that could affect Intel's results and plans is included in Intel's SEC filings, including the annual report on Form 10-K.
- All products, computer systems, dates and figures specified are preliminary based on current expectations, and are subject to change without notice. The products described may contain design defects or errors known as errata which may cause the product to deviate from published specifications. Current characterized errata are available on request.
- Intel does not control or audit third-party benchmark data or the web sites referenced in this document. You should visit the referenced web site and confirm whether referenced data are accurate.
- © 2016 Intel Corporation. Intel, the Intel logo, Thunderbolt, the Thunderbolt logo and others are trademarks of Intel Corporation in the U.S. and/or other countries.
- *Other names and brands may be claimed as the property of others.

BackUp

Benefits of Two Thunderbolt™ 3 Ports



Usage	Port 1	Port 2
1. System charging + device or display	Power supply	Device or display
2. Multiple Thunderbolt™ devices	End point device	End point device
3. Display + data device	Display	Data device
4. Multiple USB 3.1 devices	USB 3.1 device	USB 3.1 device
5. Thunderbolt Networking (10GbE)	Computer 1	Computer 2

Thunderbolt™ External Graphics

- External graphics solution that supports hot plug & surprise removal of cable on dedicated PC-device
- Working with both AMD* and NVIDIA* for external graphics solutions



AMD launches Xconnect*, partners with Intel, Razer* to drive desktop gaming on laptops

<http://www.extremetech.com/gaming/224526-amd-launches-xconnect-partners-with-intel-razer-to-drive-desktop-gaming-on-mobile-hardware>

Razer Core sounds amazing for those who need to own a laptop but want to do some hefty gaming at home

<http://www.pcworld.com/article/3019369/hardware/the-razer-core-can-boost-any-thunderbolt-3-equipped-laptop-with-an-external-gpu.html>

Intel Skull Canyon is the NUC of your dreams – Intel® Core™ i7 6770HQ, DDR4, NVMe Express*, Thunderbolt™ 3

<http://betanews.com/2016/03/17/intel-skull-canyon-nuc-core-i7-6770hq-ddr4-nvme-thunderbolt-3/>

