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
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Thunderbolt™ 3 In the News

“One port to rule them all: Thunderbolt 3 and USB Type-C join forces”
– CNET; Jun 2, 2015

“What is Thunderbolt 3? The Supercharged Connector Set to Revolutionize Tablets, Laptops, and PCs.”
– Int'l Business Times; Feb 16, 2016

“The future is looking even better for one big reason: Thunderbolt 3”
– PC World*, Sep 18, 2015

“Thunderbolt 3 Explained: Why You Need the World’s Fastest Port.”
– LAPTOP, June 8, 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.
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Industry Terminology

• USB = industry standard for cables, connectors and protocol

• USB-C = reversible connector specification

• 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.

Thunderbolt 3 is bringing Thunderbolt to USB-C
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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 Speed

More Protocols

More Pixels

More Power

40 Gbps – fastest connection

Dual 4K displays
60hz

100W charging
15W device
Not all USB-C Computer Ports Will be Equal

USB 2.0
480 Mb/s
PD Enabled

USB 3.1
5 Gb/s
PD Enabled

USB 3.1
10 Gb/s
PD Enabled

DisplayPort® Multi-Function
5 (or) 10 Gb/s
PD Enabled

Thunderbolt 3 – The USB-C That Does it All
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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
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Key User Experiences

4K Video

External graphics

Single-cable docking

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

4K 4K

Pluggable™ 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

- Graphics Dock
  USB3, GbE, Discrete Graphics with HDMI, VGA, etc.

- Standalone Graphics
  150-250W discrete graphics card for premium gaming
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
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-Z170X-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...
Shipping Thunderbolt™ 3 Devices

Adapters:

- Plugable Thunderbolt™ to Dual HDMI Adapter
- Plugable Thunderbolt™ 3 to Dual DP Adapter
- Startech Thunderbolt ™ 3 Legacy Adapter
- Startech Thunderbolt 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.

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# Announced Thunderbolt™ 3 Devices

<table>
<thead>
<tr>
<th>Dock &amp; Display</th>
<th>Adapters &amp; Cables</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>CalDigit Thunderbolt 3 Dock</td>
<td>Akitio TBT 3 to TBT Adapter</td>
<td>Accusys 12-bay storage</td>
</tr>
<tr>
<td>OWC Thunderbolt 3 Dock</td>
<td>ATTO 40GbE Adapter</td>
<td>CalDigit 4/8-bay RAID storage</td>
</tr>
<tr>
<td>Plugable Thunderbolt 3 Dock</td>
<td>Cable Matters TBT 3 to TBT Adapter</td>
<td>HighPoint 4/8/16-bay RAID storage</td>
</tr>
<tr>
<td>Cable Matters</td>
<td>Cable Matters TBT 3 to TBT Adapter</td>
<td>LaCie 12 Big Thunderbolt™ 3</td>
</tr>
<tr>
<td>Kanex</td>
<td>Kanex Dual DP and HDMI Adapters</td>
<td>OWC PCIe SSD storage</td>
</tr>
<tr>
<td>Kanex</td>
<td>Promise 10GbE adapter (Bus PWR)</td>
<td>Promise 4/6/8-Bay RAID storage</td>
</tr>
<tr>
<td>Promise</td>
<td>Promise 16G Fiber Channel Adapter</td>
<td>Sonnet CFAST 2.0 Card Reader</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sonnet Fusion Thunderbolt 3 PCIe SSD</td>
</tr>
<tr>
<td></td>
<td>OWC PCIe Card Chassis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sonnet PCIe Card Chassis</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Graphics</th>
<th>Charger &amp; Hub</th>
<th>Media</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acer Graphics Dock</td>
<td>Plugable 20Gb/s USB Hub</td>
<td>Blackmagic 4K Extreme</td>
</tr>
<tr>
<td>Asus ROG XG Station 2</td>
<td></td>
<td></td>
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<tr>
<td>PowerColor Devil Box</td>
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<td></td>
</tr>
</tbody>
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# Shipping Thunderbolt™ 3 Cables

<table>
<thead>
<tr>
<th>Length</th>
<th>Thunderbolt™ 3 (20Gb/s) USB-C cable</th>
<th>Thunderbolt™ 3 (40Gb/s) USB-C cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>.5m</td>
<td>![Cable Image]</td>
<td>![Cable Image]</td>
</tr>
<tr>
<td></td>
<td>All .5m cables are Thunderbolt™ 3 (40Gb/s) USB-C cables</td>
<td></td>
</tr>
<tr>
<td>1m</td>
<td>![Cable Image]</td>
<td>![Cable Image]</td>
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<tr>
<td></td>
<td>StarTech.com</td>
<td>belkin</td>
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<tr>
<td></td>
<td>kanex</td>
<td>![Cable Image]</td>
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<tr>
<td>2m</td>
<td>![Cable Image]</td>
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<tr>
<td></td>
<td>StarTech.com</td>
<td>![Cable Image]</td>
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</table>
## Expected Thunderbolt™ 3 Devices

<table>
<thead>
<tr>
<th>Device Type</th>
<th>&lt;$100</th>
<th>$100-$200</th>
<th>$200-$300</th>
<th>&gt;$300</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adapters, Card Readers and Hubs</td>
<td>• Thunderbolt™ (TBT) 20Gb/s USB hub</td>
<td>• 8x SD card reader</td>
<td>• Enterprise dock</td>
<td>• 10GbE BASE-T adapter</td>
</tr>
<tr>
<td></td>
<td>• Dual HDMI® 2.0 adapter</td>
<td>• SxS card reader</td>
<td>• Mobile graphics dock</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Dual SATA adapter</td>
<td>• P2 card reader</td>
<td>• VR graphics dock</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• TBT3 to TBT Adapter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• 4x SD card reader</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Docks</td>
<td>• Travel/Mini dock</td>
<td>• Standard PC dock</td>
<td>• 4K display dock (Consumer)</td>
<td>• 5K display dock (Creation)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Mobile graphics dock</td>
<td>• QHD display dock (Corporate)</td>
</tr>
<tr>
<td>Storage</td>
<td>• Mobile storage enclosure</td>
<td>• Desktop storage enclosure</td>
<td>• Mobile NVM Express* (NVMe) SSD (512GB)</td>
<td>• HW RAID storage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Desktop storage enclosure</td>
<td>• Thunderbolt NAS</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• HW RAID storage</td>
<td>• Mobile NVMe SSD (1TB, 2TB)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>• Thunderbolt shared storage</td>
</tr>
<tr>
<td>AV Equipment</td>
<td>• HDMI 2.0 video capture</td>
<td>• KVM Switch</td>
<td>• Video Interface</td>
<td>• Video Interface</td>
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<tr>
<td></td>
<td></td>
<td>• Video Interface</td>
<td>• Audio Interface</td>
<td>• Audio Interface</td>
</tr>
<tr>
<td>PCI Express*</td>
<td>• Audio Interface</td>
<td></td>
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<tr>
<td>Expansion Chassis</td>
<td></td>
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</table>

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

<table>
<thead>
<tr>
<th>Name</th>
<th>Logo</th>
<th>Icon</th>
<th>Product</th>
<th>Placement†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thunderbolt™ 3</td>
<td><img src="image" alt="Logo" /></td>
<td><img src="image" alt="Icon" /></td>
<td>Computer</td>
<td><img src="image" alt="Computer" /></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Device</td>
<td><img src="image" alt="Device" /></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Cable</td>
<td><img src="image" alt="Cable" /></td>
</tr>
</tbody>
</table>

†See Thunderbolt TLUG for specific trademark usage guidelines

Look for Thunderbolt icon on **certified** products and cables.
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2017 PCs with Thunderbolt™ 3

- **Full Performance**
  - x4 PCIe* + x2 DP

- **Universal Charging**
  - 3A or 5A

- **Device Power**
  - 15W for bus power

- **Two Ports**
  - More USB Type-C* devices

- **eGFX Ready**

- **Certification & Interoperability**

- **Mini/Travel, Standard & Graphics Docks**

- **4K**

Deliver Thunderbolt™ 3 Full Brand Promise
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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 IOTTS05 — Low-power Wake-up Radios for IoT: Standards and Technology
  *Level 2 Room 2008*
Thank You
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BackUp
## Benefits of Two Thunderbolt™ 3 Ports

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<thead>
<tr>
<th>Usage</th>
<th>Port 1</th>
<th>Port 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. System charging + device or display</td>
<td>Power supply</td>
<td>Device or display</td>
</tr>
<tr>
<td>2. Multiple Thunderbolt™ devices</td>
<td>End point device</td>
<td>End point device</td>
</tr>
<tr>
<td>3. Display + data device</td>
<td>Display</td>
<td>Data device</td>
</tr>
<tr>
<td>4. Multiple USB 3.1 devices</td>
<td>USB 3.1 device</td>
<td>USB 3.1 device</td>
</tr>
<tr>
<td>5. Thunderbolt Networking (10GbE)</td>
<td>Computer 1</td>
<td>Computer 2</td>
</tr>
</tbody>
</table>
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


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


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