Cables, Connectors, & Interfaces

SMMUG Presentation

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Display Interfaces

HDMI vs DisplayPort vs DVI vs VGA

HDMI

- These days, virtually all TVs and computer monitors support an HDMI connection. HDMI, which stands for High-Definition Multimedia Interface, shoots both digital audio and video down the same cable. If you are trying to connect something to your television – and that includes computers – you're going to want to use HDMI
- HDMI is used in a very broad array of consumer electronics products, including laptop and desktop computers, mobile devices, the Chromecast dongle, Roku's streaming stick, Blu-ray players, HD cable boxes, and much more – so it's a familiar and appealing format for most folks, and easily the most popular among general consumers

HDMI Continued

- The introduction of 4K/Ultra HD televisions drove HDMI 2.0. HDMI 2.0 can pass video signals with a pixel resolution of 3820 x 2160 at up to 60 frames per second along with up to 32 channels of uncompressed multichannel digital audio, all through the same high-speed HDMI cables that have been around for years. Nothing about the cables or connectors has changed, only the hardware you connect them to. So there's no need to expect to have to buy new cables if/ when you decide to upgrade
- Since HDMI has progressed to this new version, there's now even less reason to go with any of these other types of connections, except in some very specific situations

DisplayPort

A digital display interface developed by the Video Electronics Standards Association (VESA), DisplayPort isn't an option for consumer-level HDTV use. DisplayPort is a perfectly capable option (some would say preferred) for connecting your PC to a computer monitor. With all of the necessary hardware add-ons and software updates, DisplayPort version 1.2 offers a maximum resolution of 3,840×2,160 at 60 FPS, which makes it ready to tackle 4K/Ultra HD content, and passes digital audio as well – just like HDMI. Despite HDMI's prevalence today, DisplayPort boasts a couple of features that position it as a direct alternative – one that has earned its own cult of enthusiasts that swear by the connection type

DisplayPort Continued

Chief among them is DisplayPort's multi-monitor capabilities, which make the format an excellent choice for graphic designers, programmers, and anyone else working with computers all day. Users can daisy-chain up to five monitors together in order to better streamline their working habits. There are many applications for such a setup – perhaps the most obvious and useful is the ability to reference material on one screen while typing on another, eliminating the constant alt-tab madness

DVI

- DVI (Digital Visual Interface) rose to prominence as the standard display connection format around 1999, but over time HDMI has effectively replaced it. DVI is designed to deliver uncompressed digital video and can be configured to support multiple modes such as DVI-D (digital only), DVI-A (analog only), or DVI-I (digital and analog). The digital video signal passed over DVI ends is essentially identical to HDMI, though there are differences between the two formats, namely DVI's lack of an audio signal.

DVI Continued

You won't find DVI on HD televisions or Blu-ray players anymore, but you wouldn't want to use DVI for your flat screen TV anyway, since additional audio cables would be required. But for computer monitors, which often lack speakers anyway, DVI is still a popular option. You'll also find DVI connectors on some older projectors. If you want 4K, though, you'll need to go with HDMI or DisplayPort. There are two different types of DVI connectors, single-link and dual-link. The dual-link DVI connector's pins effectively double the power of transmission and provide higher speed and signal quality. For example, an LCD TV using a single-link DVI connector can display a maximum resolution of 1920×1200 – dual-link's maximum for that same screen is 2560×1600.

VGA

Once the industry standard and now a video connector with one foot already out the door, VGA (Video Graphics Array) is an analog, video-only connection that's rarely seen on TVs anymore, though you'll still find it lingering on older PCs and projectors.

At the end of 2010, a collective of big tech companies such as Intel and Samsung came together to bury VGA, announcing plans to abandon the format and speed up their adoption of HDMI and DisplayPort as default interfaces for PC monitors.

HDMI

HDMI Versions

HDMI VERSION	1.0	1.1	1.2	1.3	1.4	2.0
Date initially released	12/9/02	5/20/04	8/22/05	6/22/06	6/5/09	9/4/13
Maximum Bandwidth (Gbps)	4.95	4.95	4.95	10.2	10.2	18
Maximum Resolution	1600×1200p60	1600×1200p60	1600×1200p60	2048×1536p75	4096×2160p24	4096×2160p60
Maximum LPCM Audio Channels	8 Channels	8 Channels	8 Channels	8 Channels	8 Channels	32 Channels
Maximum Audio Sampling Rate	768kHz	768kHz	768kHz	768kHz	768kHz	1536kHz

HDMI 1.0

Release date: December 2002

- **Specs:**
- Single-cable digital audio/video connection with a maximum bitrate of 4.9Gbps
- Supports up to 165Mpixels/sec video (1080p at 60Hz or UXGA)
- 8-channels of 192kHz/24-bit audio (PCM)

- **Abstract:** The original HDMI v1.0 spec was and remains sufficient for most purposes. The reason is that it is a solid backwards-compatible format that can , through PCM audio handle all of the high definition audio formats present today. DSD and DVD-audio cannot be natively sent over HDMI 1.0. What HDMI 1.0 fails to do, is account for additional bandwidth provided by Deep Color (10- 12 and 16-bit color depths). It also does not support the new xvYCC color space.

HDMI 1.1

Release date: May 2004

- **Specs:**
- Added support for DVD Audio
- Slight mechanical and electrical spec changes

- **Abstract:** HDMI 1.1 simply added the ability for the system to transmit DVD-Audio signal over the cable from the player to the receiving device. If both devices are rated to v1.1 then a DVD-Audio signal can be sent and received. Please note that by "DVD-Audio" we mean the high resolution audio format, not the audio present on a typical DVD disc.

HDMI 1.2

Release date: August 2005

- **Specs:**
- Added DSD (Direct Stream Digital) support, allowing native transmission of Super Audio CD (SACD) content at up to 8 channels
- Enabled and acknowledged an HDMI Type A connector for PC-based sources
- Permitted PC sources to use native RGB color-space with the optional ability to also support the YCbCr color space for consumer electronics applications
- Mandated that HDMI 1.2 and later displays support low-voltage sources such as those found with PCI Express technology (the current display interface standard for PC video cards)

- **Abstract:** HDMI 1.2 was the biggest jump since the introduction of HDMI. It really brought the PC market into focus and was developed and announced so as to compete better with the emerging VESA DisplayPort standard. For those still clinging to their universal DVD players, HDMI v1.2 finally delivered the promise of a true one-cable solution for all current high-definition audio sources.

HDMI 1.3

Release date: June 2006

- Increased single-link bandwidth to 340 MHz (10.2 Gbps)
- Optionally supports 10-bit, 12-bit, and 16-bit "Deep Color" per channel (over one billion colors) up from 8-bit
- Allowed the use of xvYCC color space (previously just sRGB or YCbCr)
- Incorporated automatic audio "lip" syncing capability
- Supported output of native Dolby TrueHD and DTS-HD Master Audio streams for external decoding by AV receivers
- Made available a new Type C "mini" connector for devices such as camcorders
- Added gamut Metadata transmission capability
- Added Reference Cable Equalizer mandate to high frequency displays to recapture degraded copper cable signal
- **Abstract:** To be plain, this update was a complete disaster. First of all, nobody asked for HDMI 1.3, except perhaps the companies behind the new high definition audio formats. This makes 1.3 irrelevant for audio. What made HDMI 1.3 such as disaster was the increased bandwidth requirements - which hit an already suffering cable market with new requirements for digital signal transmission. Before HDMI 1.3, it was almost impossible to get a non-active copper HDMI cable to pass 1080p at distances greater than 50 feet. After HDMI 1.3, with the addition of Deep Color, that distance shrank to less than 20 feet, causing industry-wide failures on installed cabling systems.

HDMI 1.4

Release Date: May 2009

- **Specs**:
- Ethernet over HDMI: Adds support for Ethernet over HDMI for connected devices.
- Audio Return Channel: Allows an HDMI-connected TV with a built-in tuner to send audio data "upstream" to a surround audio system, eliminating the need for a separate audio cable.
- 3D Support: Defines input/output protocols for major 3D video formats, paving the way for true 3D gaming and 3D home theater applications.
- Support for 4K x 2K resolution (3840 x 2160) at 24Hz, 25Hz, and 30Hz and 4096 x 2160 at 24Hz.
- Real-time signaling of content types between display and source devices enables a TV to optimize picture settings based on content type
- Additional Color Spaces – Adds support for sYCC601, AdobeRGB, and AdobeYCC601, which are used in digital photography and computer graphics
- HDMI Micro Connector – A new, smaller connector for phones and other portable devices, supporting video resolutions up to 1080p.
- Automotive Connection System – New cables and connectors for automotive video systems, designed to meet the unique demands of the motoring environment
- **Abstract:** A major update that brings support for 3D, Ethernet network, bi-directional audio communications, and increased support of digital photography and digital computer color space standards.

HDMI 2.0

Release Date: September 2013

- **Specs:**
- Increases bandwidth to 18Gbps
- Resolutions up to 4K@50/60 (2160p), (4 times the clarity of 1080p/60 video resolution)
- Up to 32 audio channels
- Up to 1536kHz audio sample frequency
- Simultaneous delivery of dual video streams to multiple users on the same screen
- Simultaneous delivery of multi-stream audio to multiple users (Up to 4)
- Support for the wide angle theatrical 21:9 video aspect ratio
- Dynamic synchronization of video and audio streams
- Updated CEC extensions for more expanded command and control of consumer electronics devices through a single control point
- Support for 4:2:0 chroma subsampling
- Support for 25 fps 3D formats
- Backward compatible with high speed (category 2) HDMI cables
- **Abstract:** This is a major update that increases bandwidth to 18Gbps and includes support for 4k video—including dual video to the same display to multiple users. Audio is increased from 8 to 32 channels including simultaneous delivery of multichannel audio to a maximum of four users. Audio sample frequency is increased to 1536kHz.

HDMI 2.1

- The physical connectors and cables look the same as today's.
- Improved bandwidth from 18Gbps (HDMI 2.0) to 48Gbps (HDMI 2.1).
- Can carry resolutions up to 10K, frame rates up to 120fps.
- New cables required for higher resolutions and/or frame rates.
- Spec is still being finalized, expected to publish April-June 2017.
- First products could arrive late 2017, but many more will ship in 2018.

DisplayPort

DisplayPort

- **DisplayPort** is a digital display interface developed by the Video Electronics Standards Association (VESA). The interface is primarily used to connect a video source to a display device such as a computer monitor, though it can also be used to carry audio, USB, and other forms of data
- VESA designed it to replace VGA, DVI, and FPD-Link. DisplayPort is backwards compatible with VGA, DVI and HDMI through the use of passive and active adapters

Comparison Between HDMI and DisplayPort

Spec	HDMI	DisplayPort
Max Resolution	4K @ 30Hz (HDMI 1.4a) 4K @ 60Hz (HDMI 2.0)	4K @ 60Hz (DP 1.2) 8K @ 30Hz (DP 1.3 4:4:4) 8K @ 60Hz (DP 1.3 4:2:0)
Audio	Supported	Supported
HDCP	Supported	Supported
Multiple Video Streams	Not Supported	Supported
Locking Connectors	Special cables only (few exist)	Yes
Max Cable Length	>30 meters @ 1080p >10 meters @ 4K	3 meters max Longer distances possible depending on resolution and bit depth
Products Containing This Interface	Typically consumer sources and most displays	Typically PCs, some desktop monitors and few larger format displays

Data Interfaces

USB

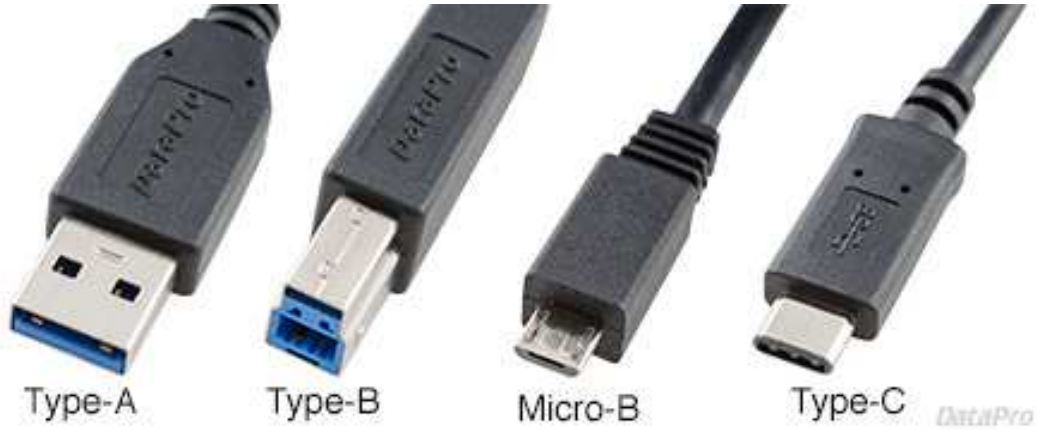
USB

USB, short for Universal Serial Bus, is an industry standard initially developed in the mid-1990s that defines the cables, connectors and communications protocols used in a bus for connection, communication, and power supply between computers and electronic devices. It is currently developed by the USB Implementers Forum (USB IF).USB was designed to standardize the connection of computer peripherals (including keyboards, pointing devices, digital cameras, printers, portable media players, disk drives and network adapters) to personal computers, both to communicate and to supply electric power. It has become commonplace on other devices, such as smartphones, PDAs and video game consoles.USB has effectively replaced a variety of earlier interfaces, such as parallel ports, as well as separate power chargers for portable devices.

USB Versions

Version	Speed	Bits/sec	Notes
USB 1.x	Low Speed (LS) Full Speed (FS)	1.5 Mbps 12 Mbps	
USB 2.0	High Speed (HS)	480 Mbps	
USB 3.0	SuperSpeed (SS)	5 Gbps	Also called USB 3.1 Gen1
USB 3.1	SuperSpeed+ (SSP)	10 Gbps	Also called USB 3.1 Gen2

USB-C



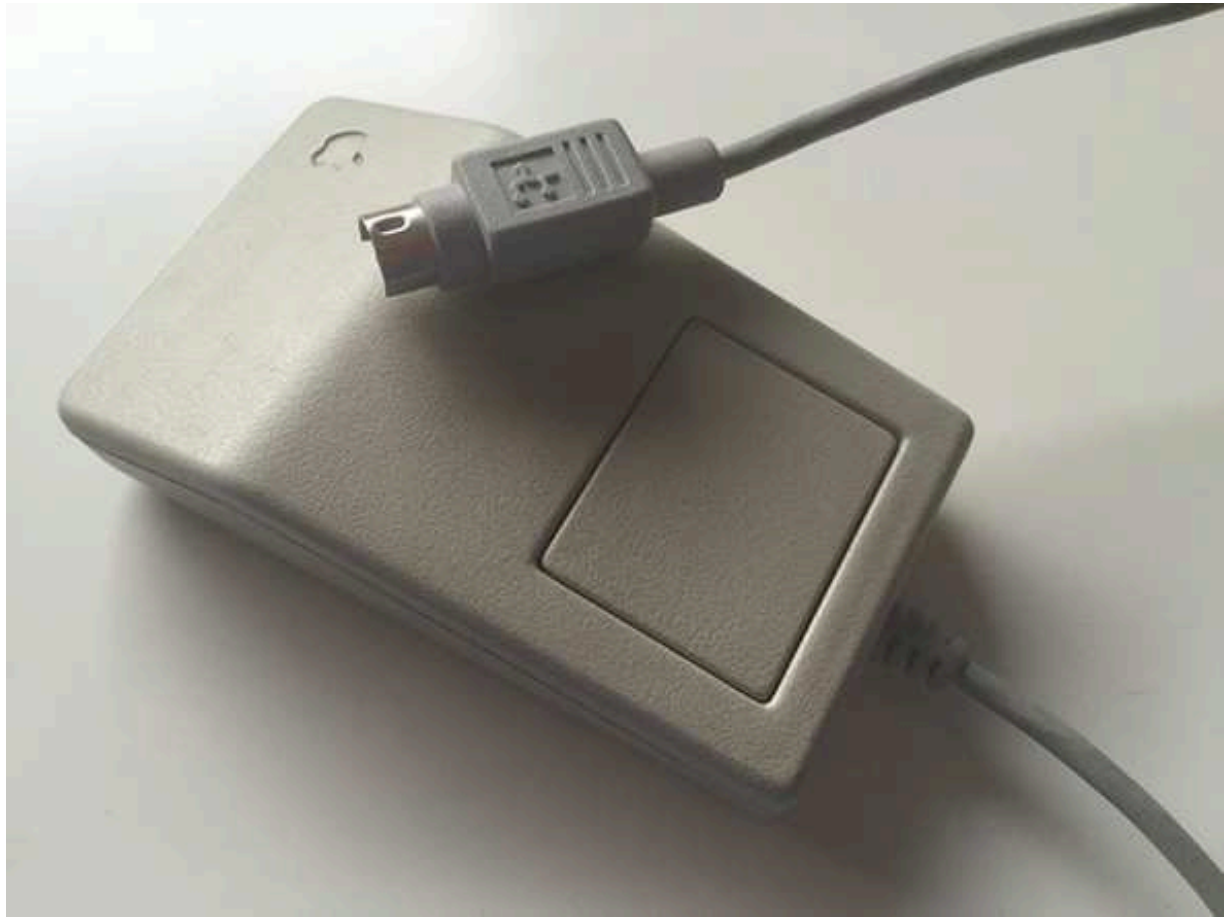
USB-C is the emerging industry-standard connector for transmitting both data and power. The USB-C connector was developed by the USB Implementers Forum, the group of companies that has developed, certified, and shepherded the USB standard. It counts more than 700 companies in its membership, including Apple, Dell, HP, Intel, Microsoft, and Samsung. This is why USB-C has been so readily accepted by PC manufacturers. Earlier Apple-promoted (and developed) Lightning and MagSafe connectors, which had limited acceptance beyond Apple products are soon to be completely obsolete.

USB-C Continued

- What's USB-C's Relationship to USB 3.1?
  - The default protocol with the new USB-C connector is USB 3.1, which, at 10Gbps, is theoretically twice as fast as USB 3.0. The minor wrinkle is that USB 3.1 ports can also exist in the original, larger shape; these ports are called USB 3.1 Type-A. But it's much more common to see USB 3.1 ports with USB-C connectors.
- USB-C supports sending simultaneous video signals and power streams, which offers an enormous amount of flexibility in terms of what you're able to do. This means that you can connect to and power a native DisplayPort or HDMI device, or connect to almost anything else assuming you have the proper adapter and cables. The USB Implementers Forum also recently announced that it's updating the USB-C spec to include audio, which means the headphone jack could be heading the way of the dodo on computers just as it already is on the Apple iPhone 7

Apple's history of abandoned cables

ADB - The Apple Desktop Bus



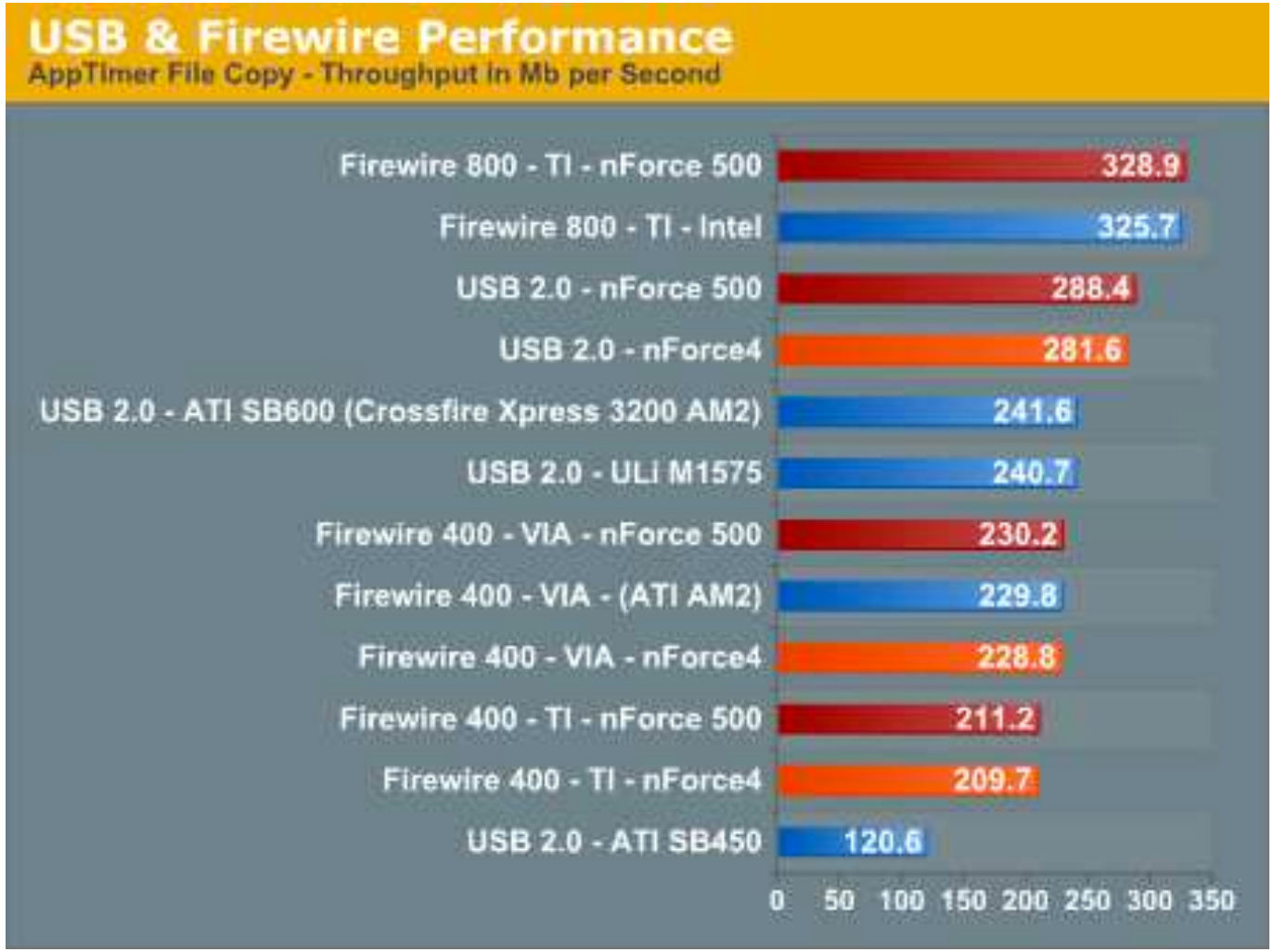
FireWire

It's really called IEEE 1394 .

Apple developed this in conjunction with an IEEE P1394 Working Group. The first Macs to use FireWire were in 1999 and even from then to its demise in 2014, it wasn't on every Apple computer.

FireWire was specifically intended to be the replacement for SCSI and strictly speaking its own replacement is Thunderbolt.

FireWire Performance



Apple 30-Pin Dock Connector

USB

- The Universal Serial Bus was developed in 1996 by companies such as Compaq, IBM and Intel, but it is everywhere today because of Apple. If you take a look at your iPhone right now, you won't see a USB socket but turn that Lightning cable around: the bit that goes into your wall plug is USB.
- The original USB wasn't as fast as FireWire but it was good and it became a standard across every computer and every device so there comes a tipping point: every new device now has to have USB because every peripheral has one. It's a brave company that would walk away from USB now.

Thunderbolt

- **Thunderbolt** is the brand name of a hardware interface developed by Intel that allows the connection of external peripherals to a computer. Thunderbolt 1 and 2 use the same connector as Mini DisplayPort (MDP), whereas Thunderbolt 3 uses USB Type-C. It was initially developed and marketed under the name **Light Peak**, and first sold as part of a consumer product on February 24, 2011.
- Thunderbolt combines PCI Express (PCIe) and DisplayPort (DP) into one serial signal, and additionally provides DC power, all in one cable. Up to six peripherals may be supported by one connector through various topologies.

Lightening

- **Lightning** is a proprietary computer bus and power connector created by Apple Inc. Introduced on September 12, 2012, to replace its predecessor, the 30-pin dock connector, the Lightning connector is used to connect Apple mobile devices like iPhones, iPads, and iPods to host computers, external monitors, cameras, USB battery chargers, and other peripherals. Using 8 pins instead of 30, Lightning is significantly more compact than the 30-pin dock connector and can be inserted with either side facing up. However, unless used with an adapter, it is incompatible with cables and peripherals designed for its predecessor.

Thunderbolt 3 = USB-C

Transferring data at speeds of up to 40 Gbps, which is two times faster than Thunderbolt 2 and eight times faster than USB 3, Thunderbolt 3 delivers the fastest connection to any dock, display, or device. You can also daisy-chain up to six Thunderbolt devices through a single port without needing a hub or a switch. So connecting a storage device to your computer, and then a display to your storage device, works as it's meant to — with powerful throughput.

And with the integration of USB-C, convenience is added to the speed of Thunderbolt to create a truly universal port.

Where does all this leave us?

Dongles…Lots of ‘em

Thunderbolt 3 (USB-C) to Thunderbolt 2 Adapter

$29.00

USB-C to USB Adapter

$9.00

USB-C Digital AV Multiport Adapter

$49.00