USB Type-C™ represents breakthrough connectivity

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The USB Type-C standard's high bandwidth and simple plug revolutionizes how we interact with electronics, creating opportunities for sleeker designs.

USB Type-C – the next-generation connector interface – will change the way we interact with electronics and deliver breakthrough capability in how we receive and transmit data. Its power, data and video options, robustness, and ease of use will provide unprecedented opportunities for end users, designers and manufacturers in markets ranging from personal electronics, mobile and computing to automotive, industrial and the Internet of Things.

Universal serial bus (USB) connections have become ubiquitous as we charge and interact with our smartphones, computers, digital cameras, printers and a host of other devices. Building on the solid foundation of previous USB generations, Type-C's ability to consolidate power, data and video on one foolproof cable promises to be the most important development in connectivity since the introduction of the standard two decades ago.

Type-C's cable will enable designers and manufacturers to create thinner and more elegant products, as well as facilitate the development of emerging technologies, offer the capacity for future versions of the standard and support scalable power charging. Consumers will be able to carry only one cable for USB ports instead of several. This USB connector will look and perform differently than earlier versions of the standard.

Connectors

USB Type-C is simple to use and plug in. Both ends of the cable look and perform exactly the same. The connector itself, similar in size to the current USB 2.0 Micro-B, can be plugged in straight or flipped. Its convenient and foolproof design solves a real-world problem faced by USB users everywhere – existing USB cables can only be plugged in one way.

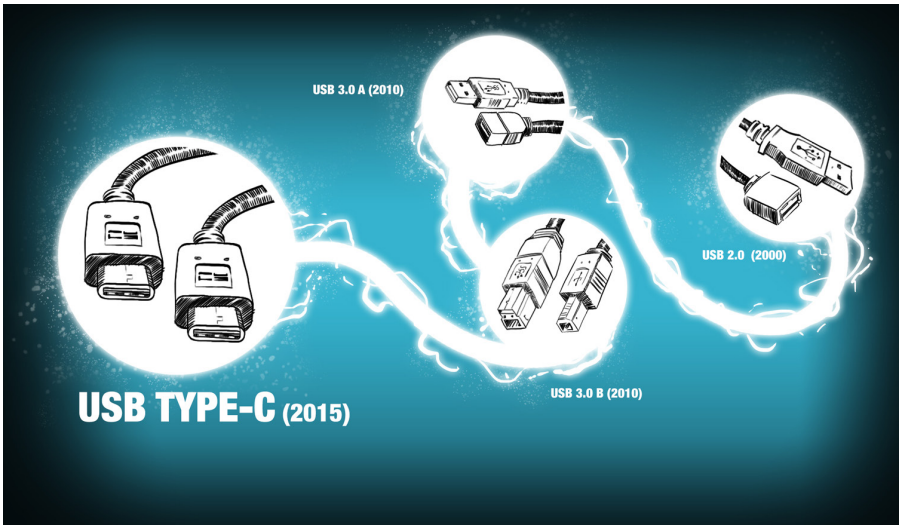

Figure 1: The first USB 2.0 port was made available in 2000. The standard has since evolved to include USB Type-C.

However, if there is a need, the cable can be designed to accommodate a legacy USB plug on one end and a Type-C plug on the other end. Adapters will be available on the market to help end users make a smooth transition from devices using current USB standards to the Type-C standard.

A single USB Type-C connector can deliver functions that several connectors provide today in our electronic gadgets. Take, for example, a laptop. It has one power barrel jack connector that is used to charge the device using a power brick. It has a video connector such as DisplayPort or HDMI that we use to connect a display. It has a USB connector that we use to connect USB peripherals such as a hard disk, flash drive, and so on. It also has an audio connector that gives us connectivity for headphones. Imagine one Type-C connector that delivers the same capabilities served by four (barrel jack, USB, DisplayPort and audio) discrete connectors. This truly reflects the universal capability of the Type-C connector, while delivering a sleek and uncluttered end-product design. The Type-C connector and cable is designed for data rates of up to 20 Gbps, making it forward-looking for years to come.

At its inception USB interface brought data and power into one connector. As the interface evolved the data throughput grew from the original USB1.0 12 Mbps to the latest USB 3.1 G2 10 Gbps. Power delivery through V_{BUS} also increased with add-on battery-charging capabilities. However, high throughput audio/visual (A/V) interface remained separate. Some solutions, for example Thunderbolt™ and DockPort, tried to bring A/V into the mix using familiar connectors (such as DisplayPort). However, breakthrough traction in the market was never achieved. Apple introduced the Lightning™ connector which provides flippability that users like, but it lacks USB SuperSpeed (SS) and high-resolution video capabilities.

USB Type-C brings together all of the desired features of a unified connector, effectively merging data, audio, video and power into one interface. These functions are defined in a way that they can be used in a modular fashion. The interface can be used as a legacy USB-only mode with USB data and default power. The interface can be used with an optional USB Power Delivery (PD) protocol to further enhance power and possibly enable an alternate-mode video.

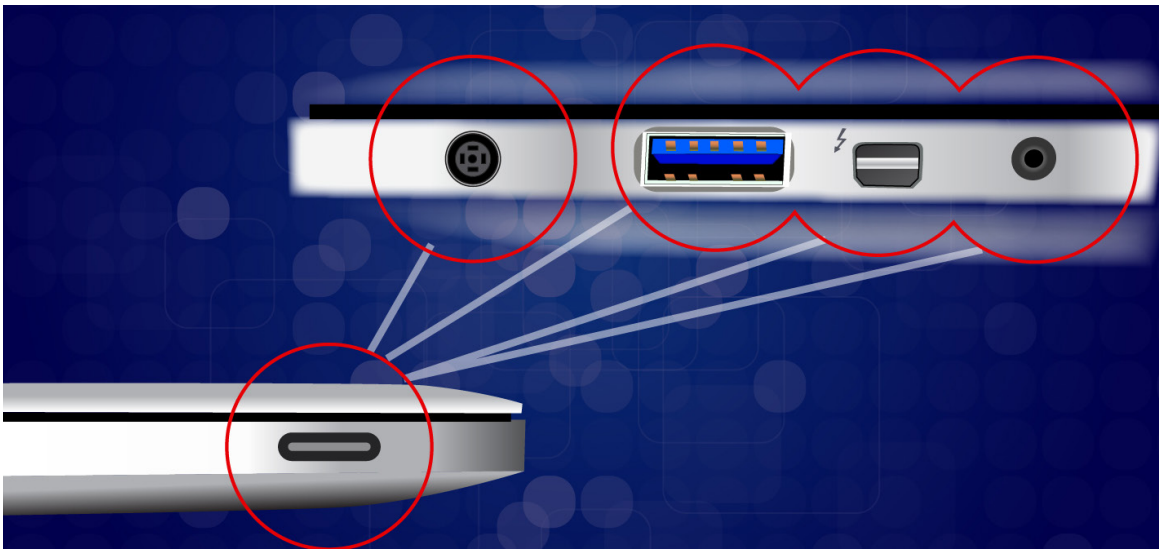

Figure 2. Simplicity of design, enabled by USB Type-C.

Power capacity

Type-C delivers more power than any previous USB version. The interface introduces native power capability of 15 watts, which is six times the standard USB 2.0 charging rates and 1.5 times the fastest USB battery charging (BC) 1.2 rate. While 15 watts is probably adequate for most smartphones and tablets, standard cables coupled with USB PD enable 60 watts over a standard cable, and power charging of up to 100 watts on specially marked cables. This makes it possible to charge and power a variety of devices such as notebooks, tablets and a broad category of devices that, until now, was not possible over USB. Under the Type-C standard USB power is now bi-directional, allowing a single device to operate as either a power sink or source.

Alternate mode

The biggest advancement in the USB standard is its ability to support alternate mode, which enables a guest protocol to be put on the cable. This feature exchanges USB data, power and another protocol, which typically is video. The most widely known protocols to date are DisplayPort, Mobile High-Definition Link (MHL), Thunderbolt and PCI-Express. Alternate mode allows you to transmit uncompressed video across the cable while maintaining USB 2.0 data and Type-C and PD charging capabilities.

Type-C solutions

USB Type-C connectors are defined with symmetry. The plug can be connected straight or flipped. The cable can be inserted from either side. These flexibilities require signal multiplexers (Mux). Basic Type-C implementation requires channel configuration (CC) functions that allow a host and client device to discover each others' attachment.

A CC controller function provides the mechanisms for a Type-C port to identify itself as a downstream facing port (DFP), upstream facing port (UFP), or dual-role port (DRP) – depending on the desired system behavior. In a default configuration, a DFP provides up to 15W power through 5V V_{BUS}. USB PD protocol is required to provide or consume power beyond 15W. USB PD is also required for entering and exiting an alternate mode contract.

The flexibility of USB Type-C comes with diverse implementations in many different applications. Depending on the applications, an electronic gadget can take on different data, A/V and power roles. *Table 1* summarizes some example use cases. Type-C port implementation will vary, depending on these preferences.

Class	Example	Data Role	A/V Role	Power Role
Always source (power)	Charger	NA	NA	Source
Always source	Desktop	Host	Source	Source
Usually source (power)	Power bank	NA	NA	Dual role w/ Try.SRC
Usually source	Laptop	Host	Source	Dual role w/ Try.SRC
Dual	Tablet	Dual role	Source	Dual
Usually sink	Phone	Dual role	Source	Dual role w/ Try.SRC
Always sink	Portable drive	Device	NA	Sink

Table 1. Type-C applications and their roles

Implementing a Type-C connector in a basic USB 2.0 configuration only requires a CC controller. Supporting USB 3.1 requires an additional data mux. A USB PD device provides the added functions of enhanced power and alternate mode video.

Fast adoption

We believe the market will move quickly to incorporate USB Type-C into end equipment. The computer industry is the earliest adopter as notebooks, desktops and peripherals were introduced during the 2015 holiday season.

The mobile phone industry will be a close second. All original equipment manufacturers (OEMs) and original design manufacturers (ODMs) that we have talked with say they are very excited about the prospect of USB Type-C and what it brings to the table. Most all of them have multiple projects in progress to incorporate the interface into their platforms.

USB Type-C will allow mobile phones to do more. In the past a smartphone's sleek design could not allow for video connectors such as DP or HDMI. Now that is changing. We can use a small dock with a Type-C phone allowing it to truly become a full-featured personal computer on our desk with connected high-resolution monitor, keyboard, mouse and external hard disk.

The automotive industry is undergoing an enormous transition as it offers much more technology to improve safety, increase efficiency and reliability, and enable more user-friendly interaction with the vehicles we drive. We believe the automotive industry will introduce Type-C ports in new vehicles at least as quickly as previous USB generations were introduced. The convenience of reversible plugs and utility of at least 15 watts of power will be very attractive for drivers.

Type-C will also open the door to many other opportunities for the automotive industry. Passengers will be able to upload playlists and high-resolution video while their phones are charging. They will be able to watch videos on bigger screens during road trips. And they will be able to manage their lives more conveniently as applications deliver traffic data in real time and tell them where the cheapest gas can be found – without fiddling with phones.

Personal electronics such as cameras, video recorders, drones and many other devices will move quickly to Type-C as the fastest way to transmit data and video and deliver more power than previous generations have been able to deliver.

The ability to consolidate cables in environments such as operating rooms should prove attractive to the medical field. Type-C would enable medical professionals the ability to have access to better resolution on computer displays used for micro-surgeries and to transfer data faster during critical procedures.

New opportunities

A key feature of Type-C is its ability to deliver more power to our devices. Delivering a minimum of 15 watts with the capacity of up to 100 watts,Type-C will also change the way the power is delivered.

Many builders are installing electrical outlets with current-generation USB ports today. In an effort to keep up with where the market is headed, the companies developing these plugs will want to provide Type-C outlets tomorrow. This option is just around the corner.

Even more profoundly, we'll see the decoupling of power supplies from end products. For example, notebook computers no longer will be sold with power bricks. Type-C cables will replace them, lowering the overall cost of products. Adapters will work with mobile phones, notebook computers, cameras and many other products. For example, if a 15-watt adapter doesn't deliver enough power, you will be able to buy a 45-watt or 60-watt adapter, which will also support devices with lower power requirements. The additional power capabilities will encourage many end equipment manufacturers

not using a USB connector today to adopt Type-C for power. Streaming players, set-top boxes, toys, personal care and healthcare electronics are just a few to mention.

Data capabilities also will increase tremendously. We will move from a connector that could deliver from 5 to 10 gigabits per second. Customizations such as Thunderbolt alternate mode will provide capabilities for up to 40 gigabits – a huge jump from current standards.

With next-generation capabilities in power and data, the way we interact with our computers will change. Your new notebook may not have a built-in graphics card because the Type-C cable will have enough bandwidth to deliver uncompressed graphics. We will be able to carry super-thin computers at work, then take them home, plug them into a dock and enjoy the full effect of a high-end graphics card.

Type-C will open up opportunities for universal docks, better through-put, self-powered devices and many more end-equipment and yet-to-be-discovered innovations.

Leadership

TI's involvement with USB standards began when USB was introduced 20 years ago. We have designed, manufactured and sold parts for USB generations ever since. When the initial conversations about USB Type-C began in 2013, we were there as a member of the USB Implementers Forum and USB 3.0 Promoter Group to help lead the way as the standard evolved. Then when Type-C was announced, TI introduced several parts to support the new standard.

Since the USB standard was introduced, TI developed a full, end-to-end complement of products to meet any Type-C application, including designs for mobile phones, tablets, notebook computers, televisions, docking stations and many other devices. We introduce products regularly for entry-level, mid-level and premium applications. TI released several devices that provide USB Type-C controller functions, including TUSB320, TUSB322, and TPS25810. HD3SS3220 is a Type-C controller with integrated SuperSpeed Mux. TI also released several muxes to support Type-C applications including HD3SS3212 and HD3SS460. The TPS65982 and TPS65986 are fully integrated USB PD port controllers, including support for both data and power paths, a complete solution for many Type-C applications. TI also has a large portfolio of power and protection solutions from which systems designers can choose. For more information visit TI's USB Type-C web page.

Additionally, we offer a long list of reference designs as well as online support through our TI E2E™ Community USB forum, which provides a direct portal to TI engineers who can answer questions about Type-C products and designs. Our internal compliance validation suite is available to help customers ensure that their designs are compliant with the new standard.

Conclusion

USB Type-C will definitely make life easier. This sleek, simple connector will reduce the number of cables we carry, transform the concept of plug-and-play, and give designers and manufacturers unprecedented opportunities to develop innovations that will improve our lives and enhance the ways we live, work and play.

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6. Visit the TI E2E™ USB forum where engineers can ask questions and help each other solve engineering problems.
7. Download these datasheets: TUSB320, TUSB322, TPS25810, HD3SS3220, HD3SS3212, HD3SS460, TPS65982, TPS65986

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