May 2022

SHARED USB-A, USB-C POWER AND CHARGING ECOSYSTEM BASED ON DEVCE LANDSCAPE

HP INC

Shared USB-A, USB-C Power and Charging Ecosystem based on Device Landscape

Abstract:

USB Type-A and USB Type-C have separate power and charging specifications under the USB Implementers Forum, Inc (USB-IF). There is no way for Type-A ports to share a power budget with Type-C ports due to limitations in the specifications. Additionally, in many applications that have a strict power budget, it is not possible to supply every USB port on the host system with the necessary power to classify it as a charging or power delivery port. The circuit outlined in this document allows for every port – Type-A or Type-C – on a system to become a charging-capable or power-delivery capable port without expanding or taking a greater percentage of the host system's power budget.

Article:

This disclosure relates to the field of computer architecture. USB Type-A and USB Type-C have separate power and charging specifications under the USB Implementers Forum, Inc (USB-IF). Type-A ports use BC1.2 (Battery Charging 1.2) to supply additional power and charging capabilities. Type-C ports can benefit from the PD3.0 (Power Delivery 3.0) spec for even more expanded power capabilities. PD3.0 also gives the ability for a PPS (programmable power supply) that can redirect power amongst Type-C ports dependent on system defined settings. However, there is no way for Type-A ports to share a power budget with Type-C ports due to limitations in the specifications. Additionally, in many applications that have a strict power budget, it is not possible to supply every USB port on the host system with the necessary power to classify it as a charging or power delivery port.

The circuit outlined in this document allows for every port – Type-A or Type-C – on a system to become a charging-capable or power-delivery capable port without expanding or taking a greater percentage of the host system's power budget.

Previously, on the system side, the power budget would need to be expanded to support additional BC or PD ports. Or, USB-IF outlines a programmable power source (PPS) specification in the Power Delivery 3.0 spec which was a provision that allowed Type-C ports to share a power budget amongst themselves. Alternatively, from the user side, an external hub could be added to plug in multiple charging/PD devices at once, but the power would get divided between the inputs and the user would lose full charging/power-delivery capacity. Otherwise, the user would just need to wait to add additional charging/PD devices until the charging/PD ports were available again on the system.

The problem would be solved by allowing a host system to redirect charging/power capabilities to different ports based on devices connected. Figure 1 details the workflow of the system when a new USB device is introduced to the system.

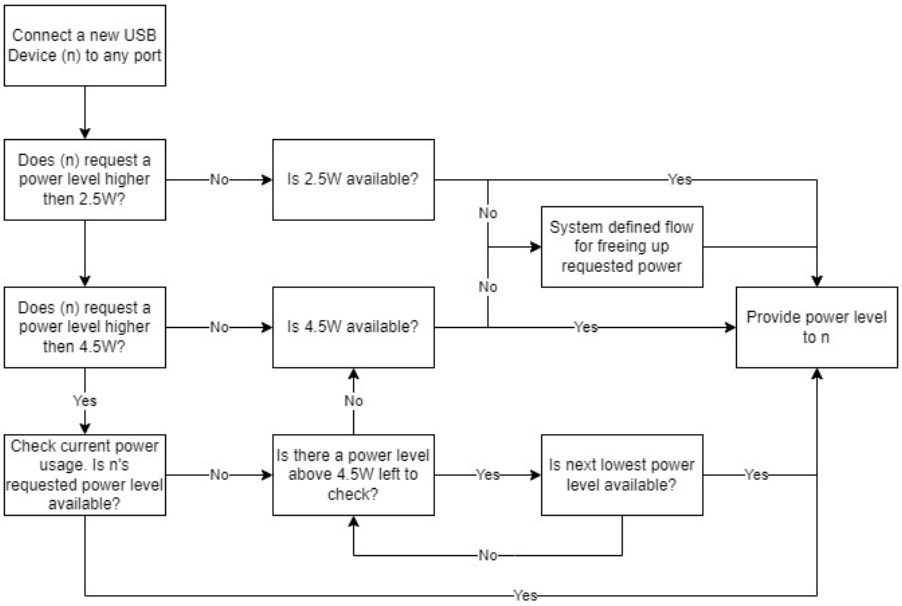

Figure 1: Flow Diagram

The implementation of this invention is further described below and outlined in the block diagram (Figure 2).

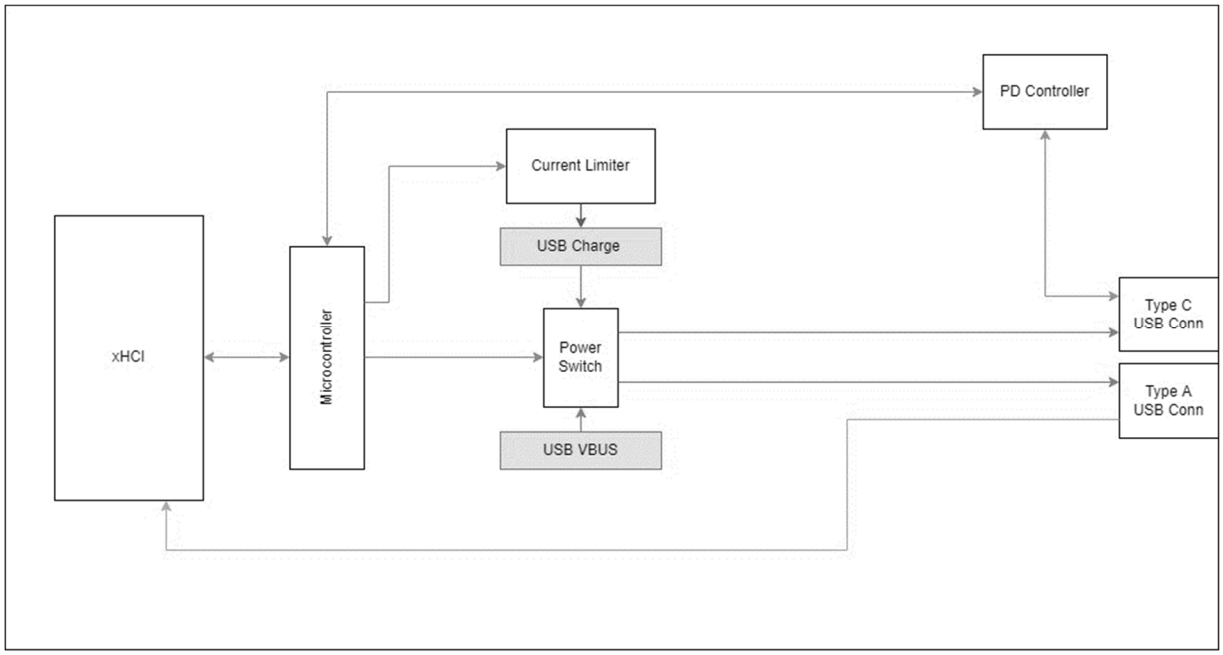

Figure 3: Block Diagram

A power switch(s) can be used to control the power delivered to the ports. At a minimum, the system is required to be able to provide 2.5W to any USB1/2.0 device and 4.5W to any USB3.0 device to ensure functionality. However, the power switch(s) will also have access to additional USB power rail(s) that can supply greater charging/power deliver wattage as designated by the system. The power switch(s) will be

controlled by a microcontroller that can set-up the switch(s) configuration based on the number of devices connected, the power requirements of each device, and the system port landscape/power ratings.

The microcontroller can gain the USB landscape information needed to configure the power switch through communication channels such as SMBus, I2C, and/or CC lines from a PD Controller and/or the Host Controller. The microcontroller will also need to communicate back to the PD Controller to let it know what power levels are available and being assigned.

The USB Charge Rail(s) can be generated through various implementations. One implementation is using programmable current limit devices where the output of the current limiter can be set by the microcontroller. Another implementation is by having a separate current limiter for each rail option and having the microcontroller trigger the enable pins on the current limiters as different rails are requested. If greater then 5V is desired to reach power levels above 25W, an LDO or programmable LDO may be used. The PD3.0 PPS specification could also be used to enhance this implementation but is not required. While more implementations are possible, the important commonality is that all output rails share the same power source and cannot exceed the max power budgeted. The microcontroller will know the max power available and which rails are available and be programmed with set options when a new device is introduced to the landscape. The system designer will need to make the decision of what power levels they would like available based on desired USB functionality, power budget, and voltage(s) available.

A few example device landscape configurations that could be supported by this disclosure are shown below. The below example would allow the system to advertise the abilities to support BC1.2, PD3.0, and laptop charging.

Table 1. Device Landscape Configuration Examples

Max Total Power	Available Power Levels	Ports	Config 1	Config 2	Config 3	Config 4
50 W	2.5 W	USB-A	4.5 W	NC	4.5 W	7.5 W
	4.5 W	USB-A	4.5 W	NC	4.5 W	7.5 W
	7.5 W	USB-A	7.5 W	NC	NC	7.5 W
	15 W	USB-A	7.5 W	NC	NC	7.5 W
	25 W	USB-C	15 W	50 W	15 W	15 W
	50 W	USB-C	NC	NC	25 W	4.5 W
		USB-C	NC	NC	NC	NC
		USB-C	NC	NC	NC	NC

NC = Not Connected

With this design, a user could apply higher power levels to multiple devices without the need for unplugging and spend less time finding the specified charging port(s). From a system perspective, the host could advertise and support expanded functionalities without having to comprise a strict power budget to support these additional capabilities.

Disclosed by Katie Lenz, Peter Seiler, Najy Faour, and Kartavya Patel, HP Inc.