

USB Type-C™電力傳輸技術解析

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Agenda



- **USB Overview**
- **USB Type-C™ PD System Overview**
- **New Features**
- **Certification**
- **Summary**

Agenda



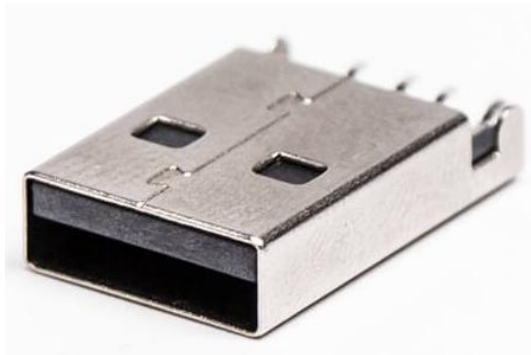
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What We Want is...



Power Charging

Wired



Wireless



The New USB Technologies

New USB technologies provide the Best Experience for Charging and Performance for every conceivable platform and device.

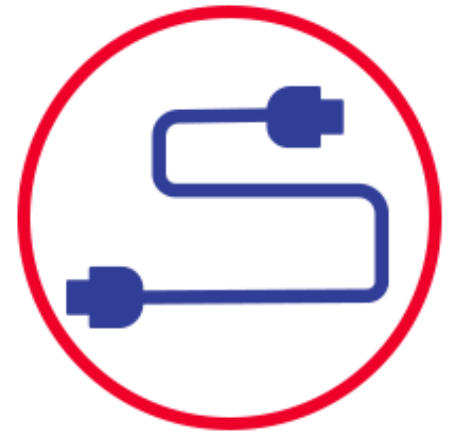
The key advantages for your customers are:



Charging

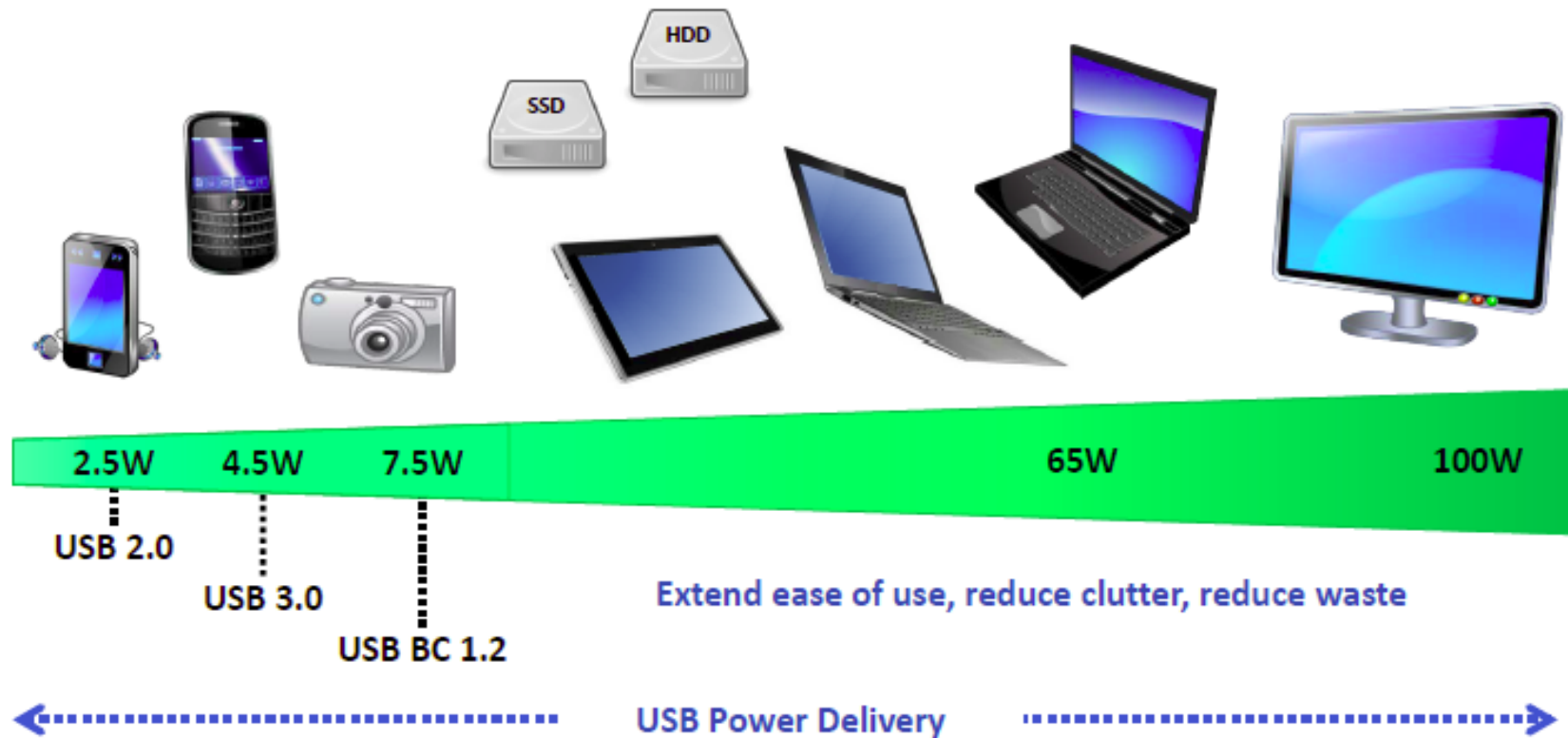


Performance



Convenience

USB Charging- Power Delivery



- Power increased to ~100W

PD 2.0 to PD 3.0

- Improved Collision avoidance scheme
 - Use Rp/Rd to indicate Source/Sink transmission
- Deprecated BFSK
 - Revision 2.0 support will still be permitted
- Extended messages
 - Up to 260 bytes
 - Chunking into existing packet sizes enabled for compatibility
- Additional alerts, capabilities and status
 - Support for IEC 63002 power supply standards
 - Battery capabilities/status
- Support for Direct Charge
 - Programmable Power Supplies

Programmable Power Supply

Table 10-7 Programmable Power Supply PDOs and APDOs based on the PDP

PDP (W)	5V fixed	9V fixed	15V fixed	20V fixed	5V Prog	9V Prog	15V Prog	20V Prog
$x \leq 15W$	PDP/5	-	-	-	PDP/5	-	-	-
$15 < x \leq 27W$	3A	PDP/9	-	-	3A or PDP/5 ²	PDP/9	-	-
$27 < x \leq 45W$	3A	3A	PDP/15	-	PDP/5 ¹	3A or PDP/9 ²	PDP/15	-
$45 < x \leq 100W$	3A	3A	3A	PDP/20	-	PDP/9 ¹	3A or PDP/15 ²	PDP/20 ²

Notes:

1. This PPS APDO is Optional.
2. The PPS *May* offer more than 3A when a 5A cable is present.

Table 10-8 Programmable Power Supply Voltage Ranges

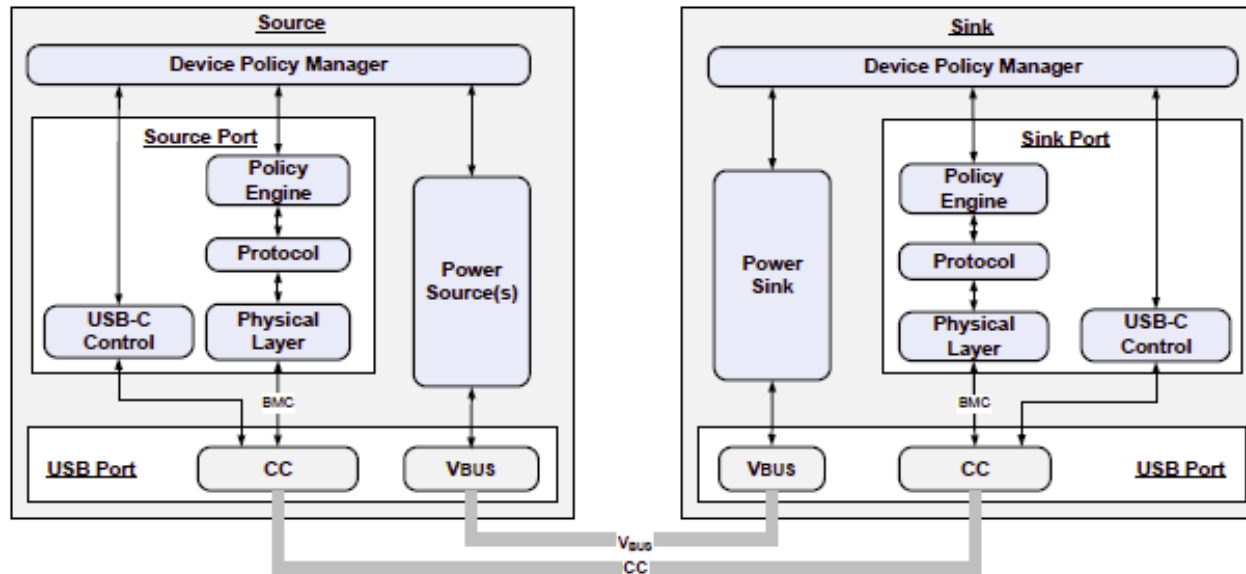
	Fixed Nominal Voltage			
	5V Prog	9V Prog	15V Prog	20V Prog
Maximum Voltage	5.9V	11V	16V	21V
Minimum Voltage	3V	3V	3V	3V

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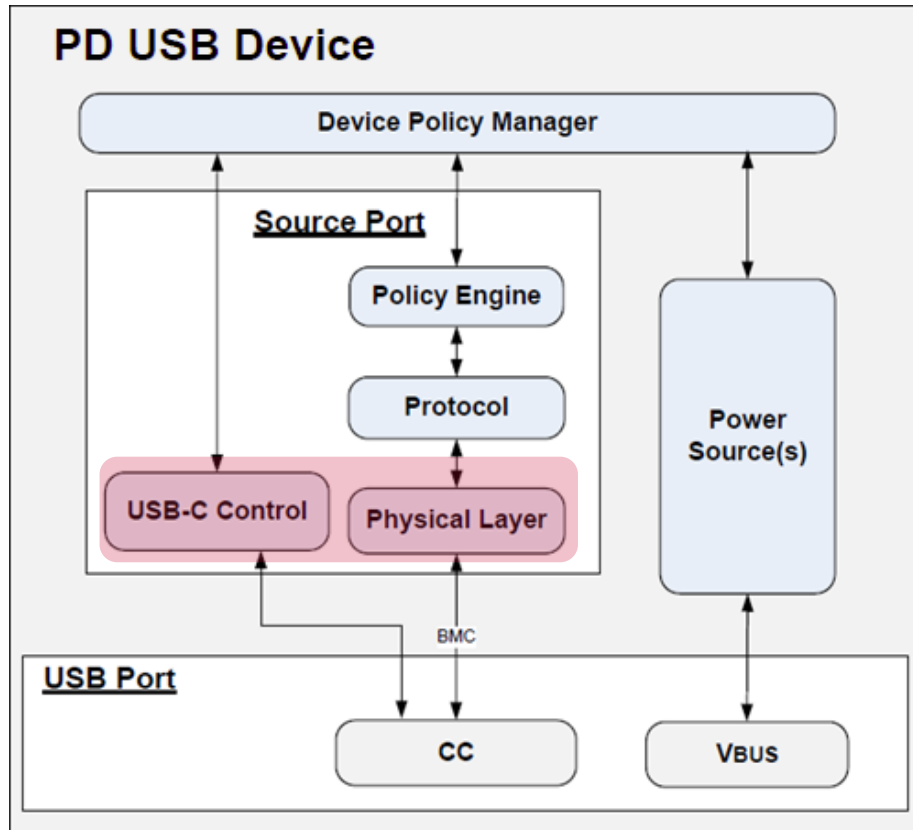
- USB Overview
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Power Delivery System Overview



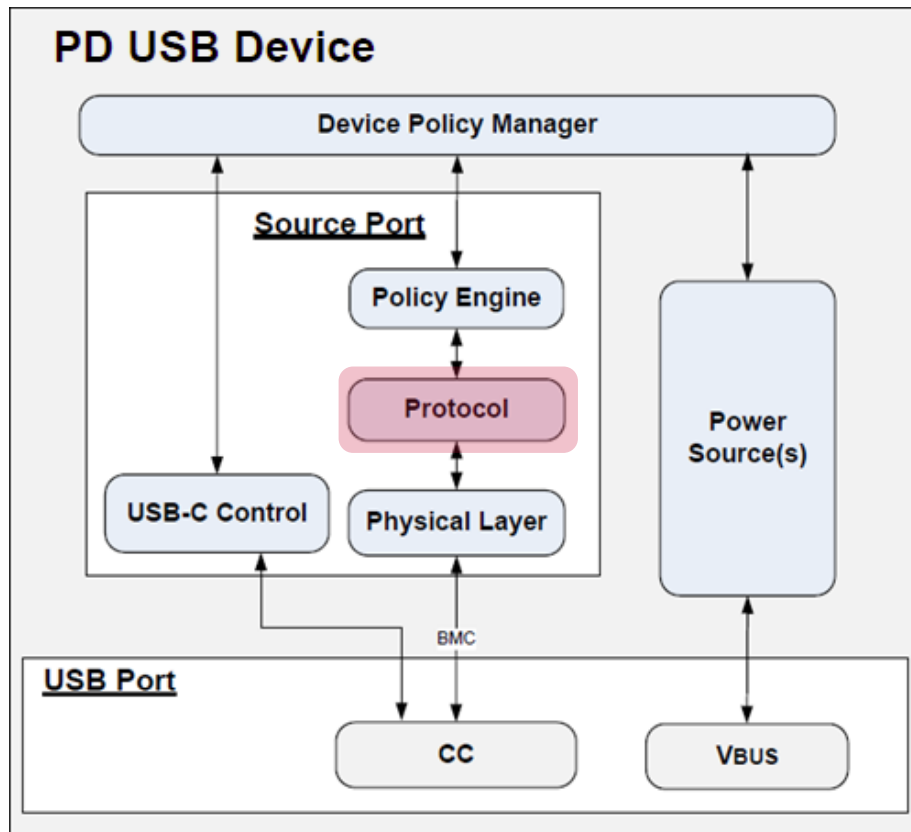
- **USB-C Control**
 - State Operation (attach/detach)
- **Physical Layer (Ch. 5)**
 - Port to Port over CC wire
 - Collision Avoidance
- **Protocol Layer (CH. 6)**
 - Handles retries, message construction and chunking
- **Power Source/Sink (Ch. 7)**
 - Controls power transitions
- **Device Policy (Ch. 8)**
 - **Policy Engine**
 - Devices the Atomic Message Sequences
 - **Device Policy Manager**
 - Handles PD across multiple ports
 - Makes decisions on how to allocate power
 - Talks to Power Source/Sink and Cable Detection

Type-C PD System Overview – USB-C and PHY



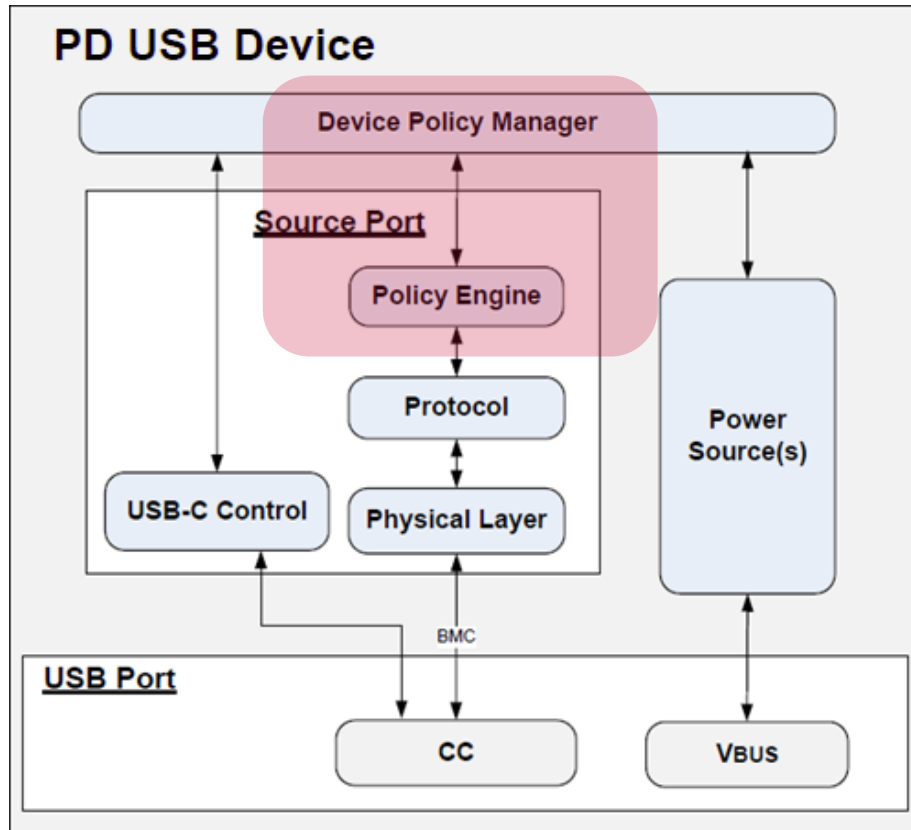
- BMC Signaling on CC wire
- CRC-32 used to detect data corruption
- Attach/Detach indicates
 - Source (Rp asserted)
 - Send Source Capabilities
 - Waits for GoodCRC and Request
 - Times out: Hard Reset
 - Sink(Rd asserted)
 - V_{BUS} : Source attached
 - Responds with GoodCRC and send a request
 - V_{BUS} Removed:
 - PR_SWAP: connection retained
 - Hard Reset
 - Detached

Type-C PD System Overview – Protocol



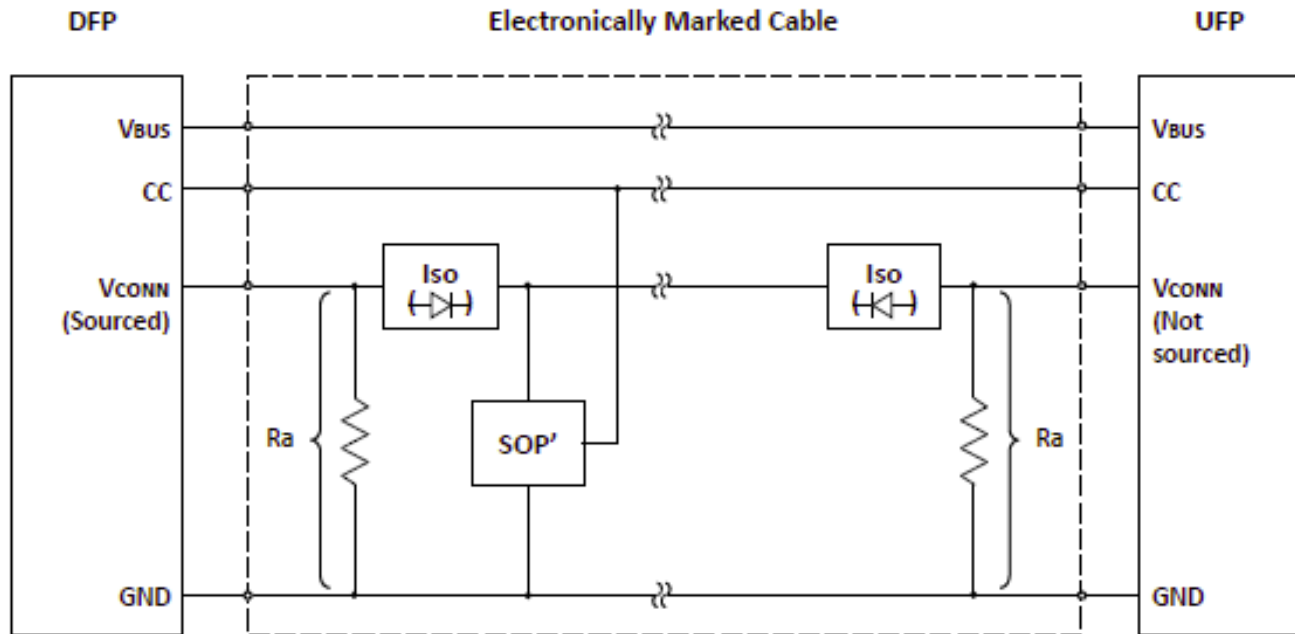
- Directed by Policy Engine
 - Constructs message passes to PHY
- Receives messages from PHY
 - Deconstructs message and passes back to Policy Engine
- Ensures reliable communications
 - Timeouts
 - Retries
 - GoodCRC

Type-C PD System Overview – Device Policy



- Device Policy Manager
 - Manages resource
 - Reserved power
 - Reclaimed power
 - Interacts with the policy engine, power supply, cable detect, and system policy manager
- Policy Engine
 - Interacts with the Protocol Layer and Device Policy Manager

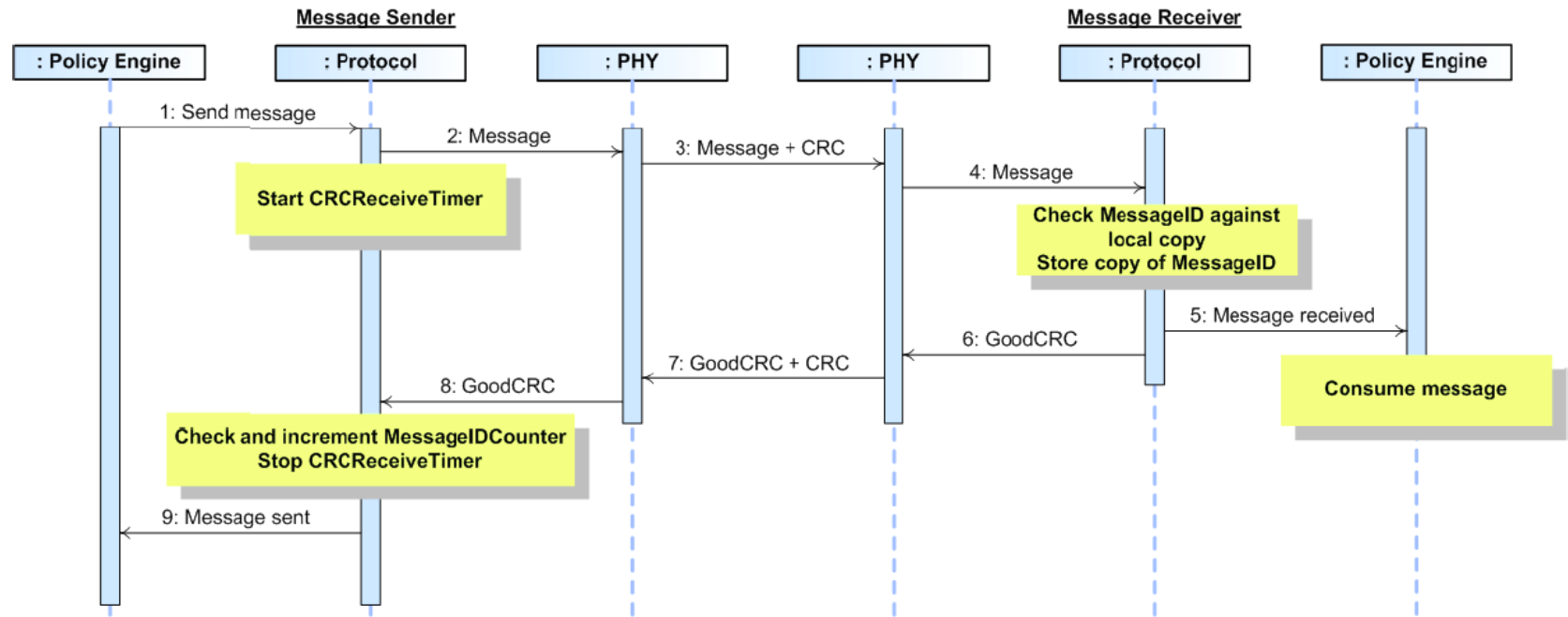
Type-C PD System Overview – e-Marked Cable



Discover Identity used to get cable information

- USB Support
 - USB 2.0
 - USB 3.1 Gen 1
 - USB 3.1 Gen 2
- V_{CONN} Required
- V_{BUS}
 - Current capability
 - Voltage
- HW/FW version
- VDO version
- Cable Connectors
- Cable Latency

Type-C PD System Overview – Protocol



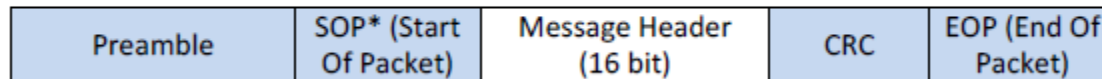
- Defines Types of Message:
 - Control Messages
 - Data Messages (28 bytes Payload)
 - Extended Data Message (256 bytes Payload)
- Packet is acknowledged with a response (GoodCRC)

- Defines Message Usage:
 - Negotiating Power Contracts
 - V_{CONN} /Data/Power role swapping
 - Alerts/status/extended capabilities/identity
 - Alt-mode entry/exit
 - Authentication

Message Type and Contain

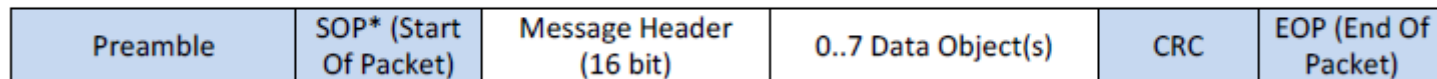
Control Message

Figure 6-1 USB Power Delivery Packet Format including Control Message Payload



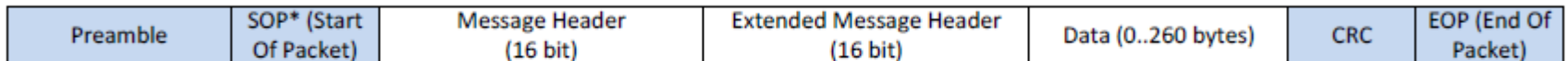
Data Message

Figure 6-2 USB Power Delivery Packet Format including Data Message Payload

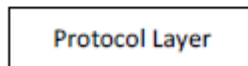
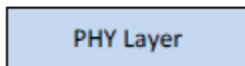


Extended Message

Figure 6-3 USB Power Delivery Packet Format including an Extended Message Header and Payload



Legend:



Control Message

Bits 4...0	Message Type	Sent by	Description	Valid Start of Packet
0 0000	<i>Reserved</i>	N/A	All values not explicitly defined are <i>Reserved</i> and <i>Shall Not</i> be used.	
0 0001	<i>GoodCRC</i>	Source, Sink or Cable Plug	See Section 6.3.1.	SOP*
0 0010	<i>GotoMin</i>	Source only	See Section 6.3.2.	SOP only
0 0011	<i>Accept</i>	Source, Sink or Cable Plug	See Section 6.3.3.	SOP*
0 0100	<i>Reject</i>	Source or Sink	See Section 6.3.4.	SOP only
0 0101	<i>Ping</i>	Source only	See Section 6.3.5.	SOP only
0 0110	<i>PS_RDY</i>	Source or Sink	See Section 6.3.6.	SOP only
0 0111	<i>Get_Source_Cap</i>	Sink or DRP	See Section 6.3.7.	SOP only
0 1000	<i>Get_Sink_Cap</i>	Source or DRP	See Section 6.3.8.	SOP only
0 1001	<i>DR_Swap</i>	Source or Sink	See Section 6.3.9	SOP only
0 1010	<i>PR_Swap</i>	Source or Sink	See Section 6.3.10	SOP only
0 1011	<i>VCONN_Swap</i>	Source or Sink	See Section 6.3.11	SOP only
0 1100	<i>Wait</i>	Source or Sink	See Section 6.3.12	SOP only
0 1101	<i>Soft_Reset</i>	Source or Sink	See Section 6.3.13	SOP*
0 1110- 0 1111	<i>Reserved</i>	N/A	All values not explicitly defined are <i>Reserved</i> and <i>Shall Not</i> be used.	
1 0000	<i>Not_Supported</i>	Source, Sink or Cable Plug	See Section 6.3.14	SOP*
1 0001	<i>Get_Source_Cap_Extended</i>	Sink or DRP	See Section 6.3.15	SOP only
1 0010	<i>Get_Status</i>	Source or Sink	See Section 6.3.16	SOP only
1 0011	<i>FR_Swap</i>	Sink ¹	See Section 6.3.17	SOP only
1 0100	<i>Get_PPS_Status</i>	Sink	See Section 6.3.18	SOP only
1 0101	<i>Get_Country_Codes</i>	Source or Sink	See Section 6.3.19	SOP*
1 0110- 1 1111	<i>Reserved</i>	N/A	All values not explicitly defined are <i>Reserved</i> and <i>Shall Not</i> be used.	

Note 1: In this case the Port is providing *vSafe5V* however it will have Rd asserted rather than Rp and sets the *Port Power Role* field to Sink, until the Fast Role Swap AMS has completed.



Data Message

Bits 4...0	Type	Sent by	Description	Valid Start of Packet
0 0000	<i>Reserved</i>		All values not explicitly defined are <i>Reserved</i> and <i>Shall Not</i> be used.	
0 0001	<i>Source_Capabilities</i>	Source or Dual-Role Power	See Section 6.4.1.2	SOP only
0 0010	<i>Request</i>	Sink only	See Section 6.4.2	SOP only
0 0011	<i>BIST</i>	Tester, Source or Sink	See Section 6.4.3	SOP*
0 0100	<i>Sink_Capabilities</i>	Sink or Dual-Role Power	See Section 6.4.1.3	SOP only
0 0101	<i>Battery_Status</i>	Source or Sink	See Section 6.4.5	SOP only
0 0110	<i>Alert</i>	Source or Sink	See Section 6.4.6	SOP only
0 0111	<i>Get_Country_Info</i>	Source or Sink	See Section 6.4.7	SOP only
0 1000-0 1110	<i>Reserved</i>		All values not explicitly defined are <i>Reserved</i> and <i>Shall Not</i> be used.	
0 1111	<i>Vendor_Defined</i>	Source, Sink or Cable Plug	See Section 6.4.4	SOP*
1 0000-1 1111	<i>Reserved</i>		All values not explicitly defined are <i>Reserved</i> and <i>Shall Not</i> be used.	

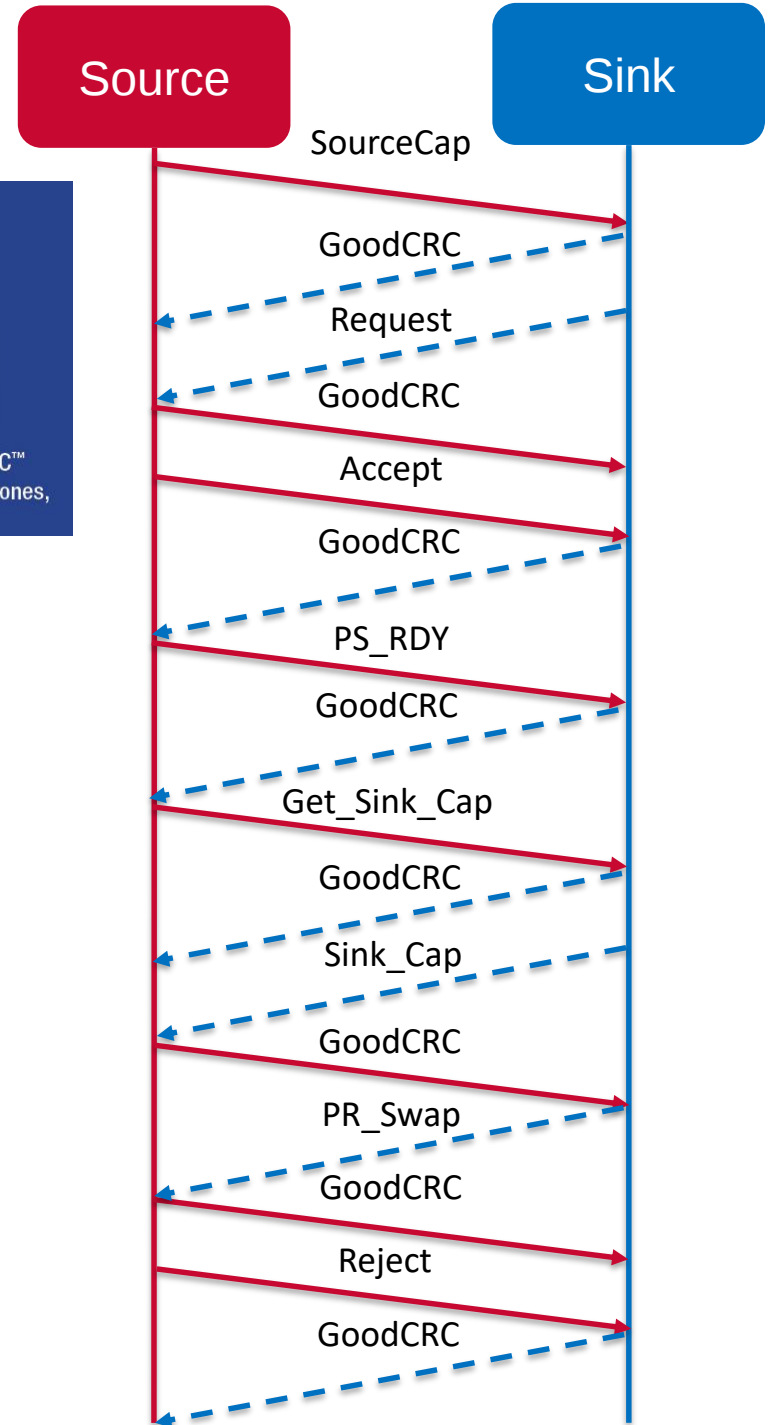
Extended Message

Bits 4...0	Type	Sent by	Description	Valid Start of Packet
0 0000	<i>Reserved</i>		All values not explicitly defined are <i>Reserved</i> and <i>Shall Not</i> be used.	
0 0001	<i>Source_Capabilities_Extended</i>	Source or Dual-Role Power	See Section 6.5.1	SOP only
0 0010	<i>Status</i>	Source or Sink	See Section 6.5.2	SOP only
0 0011	<i>Get_Battery_Cap</i>	Source or Sink	See Section 6.5.3	SOP only
0 0100	<i>Get_Battery_Status</i>	Source or Sink	See Section 6.5.4	
0 0101	<i>Battery_Capabilities</i>	Source or Sink	See Section 6.5.5	SOP only
0 0110	<i>Get_Manufacturer_Info</i>	Source or Sink	See Section 6.5.6	SOP*
0 0111	<i>Manufacturer_Info</i>	Source, Sink or Cable Plug	See Section 6.5.7	SOP*
0 1000	<i>Security_Request</i>	Source or Sink	See Section 6.5.8.1	SOP*
0 1001	<i>Security_Response</i>	Source, Sink or Cable Plug	See Section 6.5.8.2	SOP*
0 1010	<i>Firmware_Update_Request</i>	Source or Sink	See Section 6.5.9.1	SOP*
0 1011	<i>Firmware_Update_Response</i>	Source, Sink or Cable Plug	See Section 6.5.9.2	SOP*
0 1100	<i>PPS_Status</i>	Source	See Section 6.5.10	SOP only
0 1101	<i>Country_Info</i>	Source, Sink or Cable Plug	See Section 6.5.12	SOP*
0 1110	<i>Country_Codes</i>	Source, Sink or Cable Plug	See Section 6.5.11	SOP*
0 1111 - 1 1111	<i>Reserved</i>		All values not explicitly defined are <i>Reserved</i> and <i>Shall Not</i> be used.	

Example



No	T/D	SOP Type	Port Role	Msg Type
21	T	SOP	DFP/Source	SourceCap
21	T	SOP	DFP/Source	SourceCap
21	D	SOP	UFP/Sink	GoodCRC
21	D	SOP	UFP/Sink	Request
21	T	SOP	DFP/Source	GoodCRC
21	T	SOP	DFP/Source	Accept
21	D	SOP	UFP/Sink	GoodCRC
21	T	SOP	DFP/Source	PS_RDY
21	D	SOP	UFP/Sink	GoodCRC
21	T	SOP	DFP/Source	Get_Sink_Cap
21	D	SOP	UFP/Sink	GoodCRC
21	D	SOP	UFP/Sink	SinkCap
21	T	SOP	DFP/Source	GoodCRC
21	D	SOP	UFP/Sink	PR_Swap
21	T	SOP	DFP/Source	GoodCRC
21	T	SOP	DFP/Source	Reject
21	D	SOP	UFP/Sink	GoodCRC



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Power Brick

- USB Type-C™ only Power Bricks
 - USB Type-C™ is allowed to provide up to 3A at 5V
 - Power Bricks are being developed that only use USB Type-C™ power.



Power Brick

- Can only be use with chargers with one or more:
 - USB Type-C receptacles or with a captive USB Type-C cable



USB Charger Logo

- USB Chargers that do not support PPS will use the existing logo
- USB Charger that support PPS will use the new “Certified USB Fast Charger” logo



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Type-C™ Power Delivery 2.0 Certification

1. QuadraMAX

<http://www.usb.org/developers/estoreinfo/>

2. Communication Engine MOI (Tested by at least 1 solution)

- MQP PDT <http://www.mqp.com/pd.htm>
- Granite River Labs - GRL-USB-PD Oscilloscope based and USB-PD-C1 USB Type-C Test Controller Compliance Solution <http://graniteriverlabs.com/usb-pd>
- Granite River Labs - GRL-USB-PD-C2 USB Type-C Power Delivery Tester <http://graniteriverlabs.com/usb-pd-c2/>
- Teledyne LeCroy - Voyager M310P Protocol Analyzer / Exerciser / Compliance Test Platform <http://teledynelecroy.com/protocolanalyzer/protocoloverview.aspx?seriesid=556&capid=103&mid=511>

3. Deterministic MOI (Tested by at least 1 solution)

- Ellisys USB Explorer™ 350 Protocol Analyzer, Generator, and Compliance Test System <http://ellisys.com/products/usbex350/index.php>
- Granite River Labs - USB Power Delivery and Type-C™ Tester and Analyzer (GRL-USB-PD-C2) <http://graniteriverlabs.com/usb-pd-c2/>



Type-C™ Power Delivery 3.0 Certification

1. QuadraMAX

<http://www.usb.org/developers/estoreinfo/>

2. Communication Engine MOI

- MQP PDT <http://www.mqp.com/pd.htm>
- Granite River Labs - GRL-USB-PD-C2 USB Type-C Power Delivery Tester
<http://graniteriverlabs.com/usb-pd-c2/>
- Teledyne LeCroy - Voyager M310P Protocol Analyzer / Exerciser / Compliance Test Platform
<http://teledynelecroy.com/protocolanalyzer/protocoloverview.aspx?seriesid=556&capid=103&mid=511>

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- Ellisys USB Explorer™ 350 Protocol Analyzer, Generator, and Compliance Test System
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<http://graniteriverlabs.com/usb-pd-c2/>



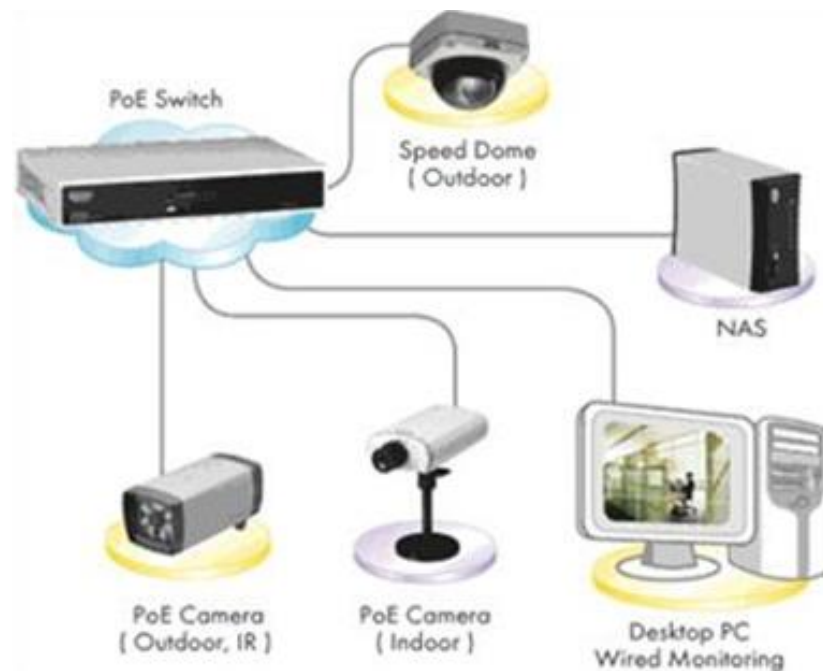
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Power is Getting Larger

- 2011: UPoE (Cisco)
 - 60 watts
- 2011: PoH
 - Power over HDBaseT
 - 100 watts
- 2015: Type-C PD
 - 100W
- 2017?: IEEE 802.3bt
 - High power PoE or PoE++
 - 90 watts
- Future:
 - 200 watts?



Issue found in Market ...



Why UL 9990?



UL Safety Program for ICT Power Cables

- UL Safety Certification for ICT Power Cable Assembly (UL 9990)



One Stop Services both Safety and Performance

HDMI™



DisplayPort™

UHD BT™
ASE



POH™
Power over HDBaseT



Q & A

