USB Power Delivery ENGINEERING CHANGE NOTICE

Title: Capabilities Mismatch Update

Applied to: USB Power Delivery Specification Revision 3.1 Version 1.3

Brief description of the functional changes proposed:
This ECN clarifies the required response from a Source when it received a Request with the Capabilities Mismatch bit set.

Benefits as a result of the proposed changes:
Ensures predictable response to Requests with the Capability Mismatch bit set.

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:
Little impact as existing Sinks have to deal with unpredictable responses from Sources when they set the Capabilities Mismatch bit. Making that behavior more predictable will only improve things.

An analysis of the hardware implications:
None.

An analysis of the software implications:
None.

An analysis of the compliance testing implications:
Simplifies testing as there is predictable method to get a Source to offer its maximum capabilities.

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Actual Change Requested

(b). Section 1.6, Table 1.1 "Terms and Abbreviations", Page 59

From Text:

Term	Description
PDP Rating	Manufacturer declared PDP for a Source Port. The Port is labeled to indicate its PDP Rating.

To Text:

Term	Description
Guaranteed Capability Port	A Guaranteed Capability Port is always capable of delivering its *Port Maximum PDP* and indicates this by setting its Port Present Capability PDP to be the same as its *Port Maximum PDP* except when limited by the cable's capabilities. This is a static capability.
Managed Capability Port	A Managed Capability Port may have its *Port Present PDP* set to a different value than its *Port Maximum PDP*. Its Port Present PDP value can be dynamic and change during normal operation.
PDP Rating	Manufacturer declared PDP for a Source Port. The PDP Rating is the same as the *Port Maximum PDP*.

(b). Section 6.4.2.3 "Capability Mismatch", Page 155

From Text:

A Capability Mismatch occurs when the Sink cannot satisfy its power requirements from the capabilities offered by the Source. In this case the Sink **Shall** make a **Valid** request from the offered capabilities and **Shall** set the Capability Mismatch bit (see Section 8.2.5.2).

When a Sink returns a Request Data Object in response to Advertised capabilities with this bit set, it indicates that the Sink wants power that the Source cannot provide. This can be due to either a Voltage that is not available or the amount of available current. At this point the Source can use the information in the *Request* Message combined with the contents of the *Sink_Capabilities* Message to ascertain the Voltage and Current required by the Sink for full operation.

In this context a **Valid** *Request* Message means the following:

- The Object position field **Shall** contain a reference to an object in the last received *Source_Capabilities* Message.
- The Operating Current/Power field **Shall** contain a value which is less than or equal to the maximum current/power offered in the *Source_Capabilities* Message.
- If the GiveBack flag is set to zero i.e., there is a Maximum Operating Current/Power field:
  - If the Capability Mismatch bit is set to one:
    - The Maximum Operating Current/Power field **May** contain a value larger than the maximum current/power offered in the *Source_Capabilities* Message's PDO as referenced by the Object position

field. This enables the Sink to indicate that it requires more current/power than is being offered. If the Sink requires a different Voltage this will be indicated by its *Sink_Capabilities* Message.

- o Else if the Capability Mismatch bit is set to zero:
  - The Maximum Operating Current/Power field *Shall* contain a value less than or equal to the maximum current/power offered in the *Source_Capabilities* Message's PDO as referenced by the Object position field.
- Else if the GiveBack flag is set to one i.e., there is a Minimum Operating Current/Power field:
  - o The Minimum Operating Current/Power field *Shall* contain a value less than the Operating Current/Power field.

To Text:

A Capability Mismatch occurs when the Source cannot satisfy the Sink's power requirements based on the Source Capabilities it has offered. In this case the Sink *Shall* make a *Valid* request from the offered Source Capabilities and *Shall* set the Capability Mismatch bit (see Section 8.2.5.2). When a Capabilities Mismatch condition does not exist, the Sink *Shall Not* set the Capabilities Mismatch bit.

When a Sink returns a Request Data Object with the Capabilities Mismatch bit set in response to a *Source_Capabilities* Message, it indicates that it wants more power than the Source is currently offering. This can be due to either a specific Voltage that is not being offered or there is not sufficient current for the voltages that are being offered.

Sources whose *Port Reported PDP* is less than their *Port Present PDP* (see Section 6.4.11"Source_Info Message") *Shall* respond to the Requests with the Capabilities Mismatch bit set as follows. The Source within 2 seconds of the *PS_RDY* Message *Shall* send a new Source Capabilities Message (a *Source_Capabilities* Message or an *EPR_Source_Capabilities* Message depending on operating mode) that offers either:

1. The maximum power the Source can supply at this time as reported by the *Port Present PDP* or
2. Enough power to satisfy the Sink's requirements based on the power actually required by the Sink for full operation from either the:
   - o *Sink_Capabilities_Extended* Message (Sink Operational PDP in SPR Mode or EPR Sink Operational PDP in EPR Mode) or
   - o *Sink_Capabilities* or *EPR_Sink_Capabilities* Message if the *Sink_Capabilities_Extended* Message is not supported by the Sink.

To prevent looping, Sources *Should Not* send a new *Source_Capabilities* or *EPR_Source_Capabilities* Message in response to subsequent Request Messages with the Capabilities Mismatch flag set until its Port Present PDP changes.

Once a Guaranteed Capability Source that has responded to a Capabilities Mismatch, it *Shall Not* subsequently send out another *Source_Capabilities* Message at a lower PDP unless the power required by the Sink (as indicated in its *Sink_Capabilities* Message or *Sink_Capabilities_Extended* Message) has also been reduced. Sources wishing to manage their power *May* periodically check *Sink_Capabilities* and/or *Sink_Capabilities_Extended* to determine whether these have changed.

In this context a *Valid Request* Message means the following:

- The Object position field *Shall* contain a reference to an object in the last received *Source_Capabilities* Message.
- The Operating Current/Power field *Shall* contain a value which is less than or equal to the maximum current/power offered in the *Source_Capabilities* Message.
- If the GiveBack flag is set to zero i.e., there is a Maximum Operating Current/Power field:
  - o If the Capability Mismatch bit is set to one:
    - The Maximum Operating Current/Power field *May* contain a value larger than the maximum current/power offered in the *Source_Capabilities* Message's PDO as referenced by the Object position field. This enables the Sink to indicate that it requires more current/power than is being offered. If the Sink requires a different Voltage this will be indicated by its *Sink_Capabilities* Message.
  - o Else if the Capability Mismatch bit is set to zero:

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- The Maximum Operating Current/Power field **Shall** contain a value less than or equal to the maximum current/power offered in the *Source_Capabilities* Message's PDO as referenced by the Object position field.
- Else if the GiveBack flag is set to one i.e., there is a Minimum Operating Current/Power field:
    - The Minimum Operating Current/Power field **Shall** contain a value less than the Operating Current/Power field.

(c). Section 6.4.11 "Source_Info Message", Page 199

From Text:

The *Source_Info* Message **Shall** be sent in response to a *Get_Source_Info* Message. The *Source_Info* Message contains one Source Information Data Object (SIDO).

The *Source_Info* Message returns a SIDO whose format **Shall** be as shown in Figure 6-35 and Table 6-51. The *Number of Data Objects* field in the *Source_Info* Message **Shall** be set to 1.
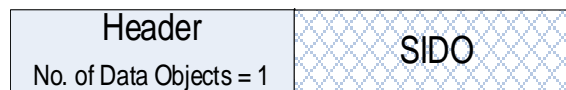
Figure 6-35 Source_Info Message

Table 6-51 Source_Info Data Object (SIDO)

Bit(s)	Field	Description
B31	*Port Type*	0 = Shared Capacity Port 1 = Assured Capacity Port
B30…24	*Reserved*	**Shall** be set to zero
B23…16	*Port Maximum PDP*	Power the port is designed to supply
B15…8	*Port Present PDP*	Power the port is presently capable of supplying
B7…0	*Port Reported PDP*	Power the port is actually advertising

6.4.11.1   Port Type Field

Port Type is a static field that **Shall** be used to indicate whether the amount of power the port can provide is fixed or can change dynamically. An Assured Capacity Port maps to the *[USB Type-C 2.0]* Assured Capacity port and the Shared Capacity Port maps to the *[USB Type-C 2.0]* Shared Capacity port. However, the *[USB Type-C 2.0]* definitions are specific to chargers while this field is applicable to all Source ports.

6.4.11.2   Port Maximum PDP Field

Port Maximum PDP is a static field that **Shall** indicate the maximum amount of power the Port is designed to deliver. An Assured Capability Port (as indicated by the *Port Type* field being set to '1') **Shall** always be capable of supplying this amount of power at any time. A Shared Capability Port (as indicated by the *Port Type* field being set to '0') **Shall** be able to offer this amount of power at some time and at all times when it is the only one in the group of Ports that is supplying power.

The *Port Maximum PDP* **Shall** be the same as the larger of the Source PDP Rating and the EPR Source PDP Rating in the *Source_Capabilities_Extended* Message.

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6.4.11.3 Port Present PDP Field

The *Port Present PDP* field *Shall* indicate the amount of power the port is presently capable of offering. An *Assured* port *Shall* always set the value to its Port Maximum PDP. A *Shared* port *Shall* set this to the amount of power it has available to offer at this time.

6.4.11.4 Port Reported PDP Field

The *Port Reported PDP* field *Shall* track the amount of power the Port is offering in its *Source_Capabilities* Message or *EPR_Source_Capabilities* Message. The *Port Reported PDP* field may be dynamic or static depending on the Port's other characteristics such as shared/assured, SPR/EPR mode, its power policy etc.

Note: The *Port Reported PDP* field is computed as the largest of the products of the Voltage times current of the fixed PDOs returned in the *Source_Capabilities* Message or *EPR_Source_Capabilities* Messages.

To Text:

The *Source_Info* Message *Shall* be sent in response to a *Get_Source_Info* Message. The *Source_Info* Message contains one Source Information Data Object (SIDO).

The *Source_Info* Message returns a SIDO whose format *Shall* be as shown in Figure 6-35 and Table 6-51. The *Number of Data Objects* field in the *Source_Info* Message *Shall* be set to 1.

The *Port Maximum PDP*, *Port Present PDP*, *Port Reported PDP* and the *Port Type* are used to identify capabilities of a Source port.
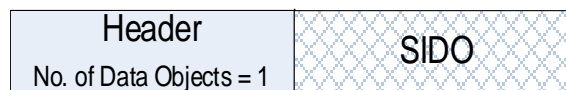
Figure 6-35 Source_Info Message

Header	SIDO
No. of Data Objects = 1	

Table 6-51 Source_Info Data Object (SIDO)

Bit(s)	Field	Description
B31	*Port Type*	0 = Managed Capability Port 1 = Guaranteed Capability Port
B30...24	*Reserved*	*Shall* be set to zero
B23...16	*Port Maximum PDP*	Power the port is designed to supply
B15...8	*Port Present PDP*	Power the port is presently capable of supplying
B7...0	*Port Reported PDP*	Power the port is actually advertising

6.4.11.1 Port Type Field

Port Type is a static field that *Shall* be used to indicate whether the amount of power the port can provide is fixed or can change dynamically.

A Guaranteed Capability Port *Shall* always report its *Port Maximum PDP* equal to its *Port Present PDP* when the correct cable is used (e.g., 5A for Sources with PDPs greater than 60W or EPR Capable for EPR capable Sources). A Managed Capability Port is not required to have its *Port Maximum PDP* equal to its *Port Present PDP*.

6.4.11.2 Port Maximum PDP Field

Port Maximum PDP is a static field that *Shall* indicate the maximum amount of power the Port is designed to deliver. A Guaranteed Capability Port (as indicated by the *Port Type* field being set to '1') *Shall* always be capable of supplying this amount of power. A Managed Capability Port (as indicated by the *Port Type* field being set to '0') *Shall* be able to offer this amount of power at some time.

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The *Port Maximum PDP* **Shall** be the same as the larger of the Source PDP Rating and the EPR Source PDP Rating in the *Source_Capabilities_Extended* Message.

6.4.11.3   Port Present PDP Field

The *Port Present PDP* is a Static field when the *Port Type* is Guaranteed Capability and is dynamic when the *Port Type* field is Managed Capability. It **Shall** indicate the amount of power the port is presently capable of supplying.   A Guaranteed Capability port **Shall** always set its *Port Present PDP* to be the same as its *Port Maximum PDP* except when limited by the cable's capabilities. A Managed Capability Port **Shall** set its *Port Present PDP* to the amount of power it has available to offer at this time which may be limited by the cable's capabilities.

6.4.11.4   Port Reported PDP Field

The *Port Reported PDP* field **Shall** track the amount of power the Port is offering in its *Source_Capabilities* Message or *EPR_Source_Capabilities* Message. The *Port Reported PDP* field may be dynamic or static depending on the Port's other characteristics such as Managed Capability/Guaranteed Capability, SPR/EPR mode, its power policy etc.

Note: The *Port Reported PDP* field is computed as the largest of the products of the Voltage times current of the fixed PDOs returned in the *Source_Capabilities* Message or *EPR_Source_Capabilities* Messages.