STAGGERING THE ENABLEMENT OF USB PORTS ON START UP AND RESTORE

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STAGGERING THE ENABLEMENT OF USB PORTS ON START UP AND RESTORE

OVERVIEW
USB ports on the computer typically consist of USB Type A, USB Type A Charging and USB Type C. USB Type C ports have variations that can deliver larger values of power and current (up to 15W at 5V/3A). To control power, a USB port can be allowed full power, allowed reduced power, or the power can be disabled. The power, voltage, and current breakdown of each port is as follows:

<table>
<thead>
<tr>
<th></th>
<th>Voltage</th>
<th>Current</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB C</td>
<td>5V</td>
<td>3A</td>
<td>15W</td>
</tr>
<tr>
<td>USB C (Reduced)</td>
<td>5V</td>
<td>1.5A</td>
<td>7.5W</td>
</tr>
<tr>
<td>USB A CHG</td>
<td>5V</td>
<td>1.5A</td>
<td>7.5W</td>
</tr>
<tr>
<td>USB A CHG (Reduced)</td>
<td>5V</td>
<td>0.9A</td>
<td>4.5W</td>
</tr>
<tr>
<td>USB A</td>
<td>5V</td>
<td>0.9A</td>
<td>4.5W</td>
</tr>
</tbody>
</table>

Given the evolution in today’s technology and the desire of the consumer, more USB ports are included on the computer. Due to this, a significant level of power is capable of being consumed by the USB ports alone. If all USB ports are enabled concurrently, such as on startup, high instantaneous current draw can shut down the Power Supply Unit (PSU). To protect against such events, the goal is to prevent the ability of all USB ports from being enabled concurrently. This way it takes longer for all USB ports to be enabled, allowing time for the system to react to drastically high increases in current.

SYSTEMS WITH MULTIPLE PORTS
Consider a system that contains the following list of USB ports:

1. USB A               4.5W
2. USB A               4.5W
3. USB A               4.5W
4. USB A               4.5W
5. USB A Charging      7.5W
6. USB C               15W
7. USB C               15W
8. Thunderbolt (USB C) 15W

Total = 70.5W

Due to increases in the number of USB ports, the ports alone can consume more or all of the power available in the power supply. If enabled concurrently, introducing high current spikes into the system can cause a shut down.

If the ports dominate system power consumption, then any effort to control power of the processor or other subsystems will not be sufficient enough to lower power consumption. The only way to control this is to control power to the ports.
OCP Current Spike Management
(EPS 65W, 3.3A rated, 4.5A peak)

System Current Draw

Time (sec)
rough estimate to show proof of concept

PROCHOT Asserted

Total system current draw
Processor current
Port current

1A
2A
3A
4A
5A

4.5A Peak current value
3.33A Rated current value

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SOLUTION TO STAGGER ENABLING OF USB PORTS

The solution is to stagger the enabling of the high-powered ports in order to provide time for the system to respond to high current spikes and prevent the PSU from shutting down due to OCP (Over current protection). Figure identifies the port power timing behavior;

USB Type C (Front) → [3 secs later] Type A Charging (Front) → [7 secs later] Type C Option (Rear)

Example of USB Timing Diagram

Figure 1: Example of timing diagram for restoration procedure

The idea is that once a port is enabled, the delay is to allow time for system power average functions to converge onto the higher relative instantaneous power value. This way, if turning on a USB port will cause the system to exceed the rated power supply value, power average functions will react quickly to take action. The time difference in delay is done to ensure there has been enough time for power average functions to converge; when dealing with high power values close to the rated value, it is even more important to react quickly as to protect the PSU from OCP.

The strategy to stagger enabling of the ports will occur during system start up when going from cold boot or off condition to an on condition. When system is in a sleep state there is little to no power being consumed by the system, except for a tiny amount by PSU itself. Therefore, the USB ports are free to consume as much power as. Only when moving out of a “sleep” state to an “on” state will the staggering of enabling of the ports procedure be needed as the system is starting to consume high current to turn on all needed subsystems.

Summary of Staggering procedure

- Occurs at system start up or once minimized power event ends to restore ports
- Ports are enabled according to a priority table (example Figure )
• There is a delay between port enable (vary by EPS load potential)
• As ports enable, at any time, System power management can reduce/disable ports if necessary

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