

USB4 2.0 ENGINEERING CHANGE NOTICE FORM

Title: Gen 4 Link Recovery Timing Constraints Applied to: USB4 Specification Version 2.0

Brief description of the functional changes:

In cases where USB4 Gen 4 Link Recovery is used while tunneled USB3 Gen X or PCIe data transfers are running, the tunneled protocol may experience disconnect events under certain race conditions. For instance, if USB4 Gen 4 Link Recovery begins while tunnelling USB3 Gen X, before the USB3 internal port receives every expected LGOOD (Gen 4 Link Recovery begins with suspension of the USB4 Port receivers), the PENDING_HP_TIMER expires, and the USB3 internal port transitions to the RECOVERY state. If the USB3 Protocol Adapter doesn't block the scheduling of the Ordered Set Tunneled Packet (encapsulating USB3 TS1 ordered sets), the far end's USB3 port's response will be dropped during USB4 Gen 4 Link Recovery, leading to USB3 failure.

Benefits as a result of the changes:

The clarifications in this ECN will allow to significantly decrease the likelihood of tunneled USB3 GenX and PCIe logical link disconnections in the case of USB4 Gen 4 Link Recovery.

An assessment of the impact to the existing revision and systems that currently conform to the USB specification:

NA

An analysis of the hardware implications:

USB4 routers that implement this feature will benefit from stronger resilience to link recoveries. It is suggested to allow extensions to the PCIe and USB3 timeout values when expecting tunneled logical layer acknowledgements.

An analysis of the software implications:

None

An analysis of the compliance testing implications:

None

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Actual Change

(a). 4.4.7 Gen 4 Link Recovery

From Text:

A Router shall do the following to initiate a Gen 4 Link Recovery:

1. Preserve the current Configuration Space and the Router States.
2. Stop Time Sync handshakes by not sending a Delay Response to the Upstream Port for an Intra-Domain Link, or to the remote port in case IDTR is set to 1b.
3. Stop any Transport Layer Packet scheduling other than Idle Packets. Egress Tunneled Packets shall not be dropped.
4. Shut down all enabled receivers.

To Text:

A Router shall do the following to initiate a Gen 4 Link Recovery:

1. Preserve the current Configuration Space and the Router States.
2. Stop any Transport Layer Packet scheduling other than Idle Packets. Egress Tunneled Packets shall not be dropped for Paths with either EFC or ESE Flags set to 1b. Egress Tunneled Packets may be silently dropped for Paths with Flow Control Disabled (both EFC and ESE Flags are set to 0b).
- ~~6.3. Stop Time Sync handshakes by not sending a Delay Response to the Upstream Port for an Intra-Domain Link, or to the remote port in case IDTR is set to 1b.~~
- ~~1. Stop any Transport Layer Packet scheduling other than Idle Packets. Egress Tunneled Packets shall not be dropped.~~
4. Shut down all enabled receivers.

If the initiation of Gen 4 Link Recovery is due to detection of uncorrectable link error (RDE, OSE or DBE):

- Tunneled Packet scheduling shall be stopped as detailed in step 2 above within tRecoveryTLPause from the initiation of Gen 4 Link Recovery.
- All enabled receivers shall be shut down within tRecoveryRxErr from the initiation of Gen 4 Link Recovery

Equation [TBD]. Gen 4 Recovery Packet Scheduling Suspension

$tRecoveryTLPause = PENDING_HP_TIMER_{(USB3\ Gen\ X)} - 7\mu s$

IMPLEMENTATION NOTE:

When using embedded solutions, it's recommended to suspend the internal protocol scheduling operation during Gen 4 Link Recovery. For instance, the USB3 Gen T port may continue transmitting ITP packets, which won't be responded to with a LGOOD_x link command. This could result in the transition to LTSSM.ERROR state, or even multiple ITP packets being transmitted at the end of the Gen 4 Link Recovery operation.

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IMPLEMENTATION NOTE:

The value of PENDING_HP_TIMER is the minimum value as defined in Table 9-7, but the implementation may use the minimum between the actual USB3 Internal Port timeout and the PCIe Reply Timeout.

(b). Table 9-7. USB3 Timers and Timeout Values

From Text:

Table 9-7. USB3 Timers and Timeout Values

Parameter	Value
tPollingSCDLFPSTimeout	60 μ s
tPortConfiguration	40 μ s
PENDING_HP_TIMER	20 μ s
PM_LC_TIMER	20 μ s
PM_ENTRY_TIMER	36 μ s

To Text:

Table 9-7. USB3 Timers and Timeout Values

Parameter	Value
tPollingSCDLFPSTimeout	60 μ s
tPortConfiguration	40 μ s
PENDING_HP_TIMER	Min value: 20 μs, Max value: 100.20 μs
PM_LC_TIMER	20 μ s
PM_ENTRY_TIMER	36 μ s

(c). Table 4-72. Logical Layer Timing Parameters

To Text:

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Table 9-7. USB3 Timers and Timeout Values

Parameter	Description	Min	Max	Units
tRecoveryRxErr	Time from detecting a link error to sending the last bit of ELT_Recovery	-	150	µs

(d). Appendix G Gen 4 Link Recovery Example

From Text:

1. Adapter B detects an error and initiates Gen 4 Link Recovery. It sends an ELT_Recovery Transaction and stops its receiver within tRecoveryRxOff after sending the last bit of the ELT_Recovery Transaction. The transmitter continues to send Idle Packets.

To Text:

1. Adapter B detects an error and initiates Gen 4 Link Recovery. It stops its receivers and sends an ELT_Recovery Transaction, sending the last bit and stops its receiver within tRecoveryRxOff after the receivers have stopped. ~~sending the last bit of the ELT_Recovery Transaction.~~ The transmitter continues to send Idle Packets.
1. ~~Adapter B detects an error and initiates Gen 4 Link Recovery. It sends an ELT_Recovery Transaction and stops its receiver within tRecoveryRxOff after sending the last bit of the ELT_Recovery Transaction. The transmitter continues to send Idle Packets.~~

From Text:

3. Adapter A receives an ELT_Recovery Transaction. It turns off its transmitter towards Re-timer 1-2 and sends an ELT_Recovery Transaction within tRecoveryResponse after receiving the ELT_Recovery Transaction. The receiver is turned off within tRecoveryRxOff after sending the ELT_Recovery Transaction.

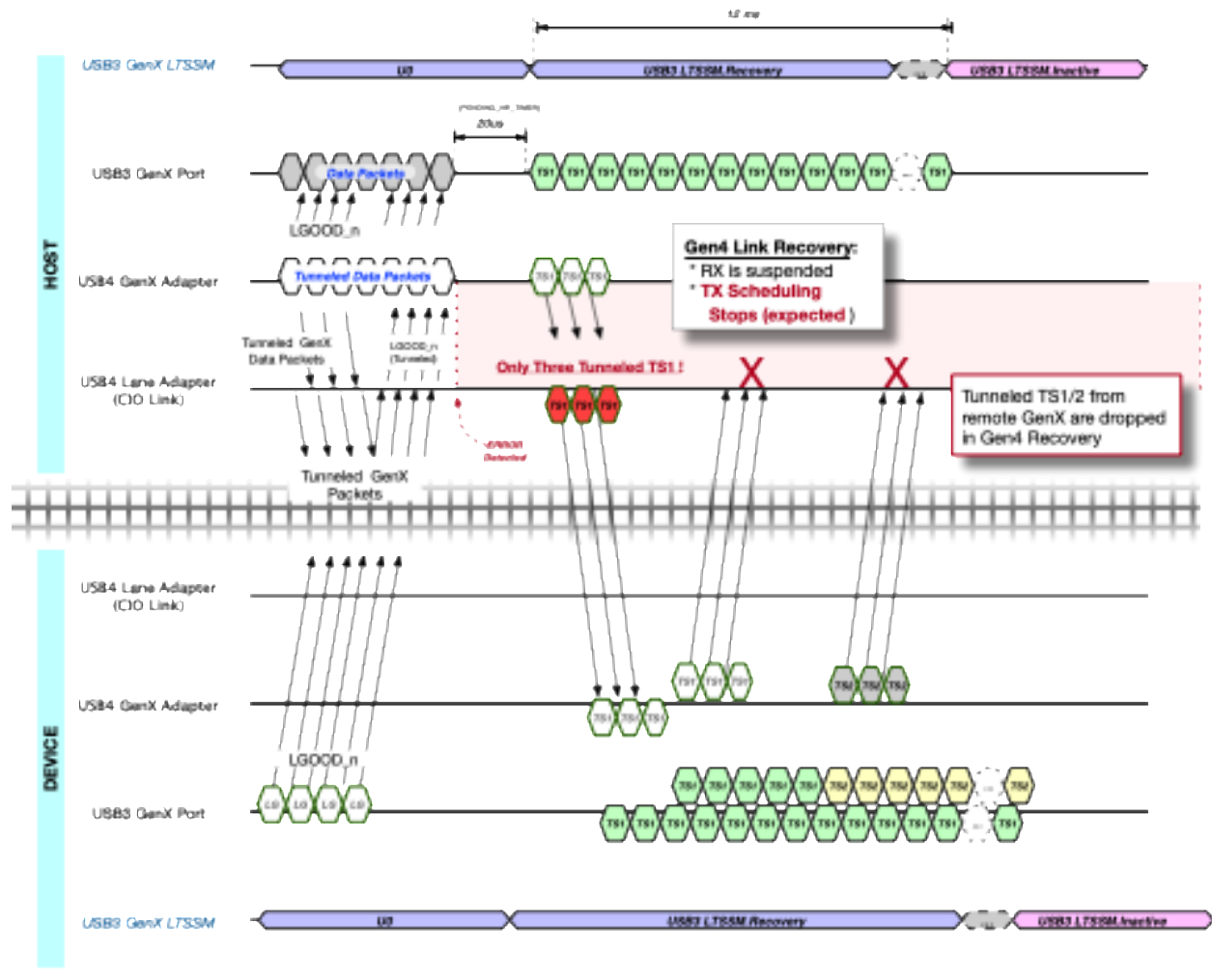
To Text:

3. Adapter A receives an ELT_Recovery Transaction. It turns off its transmitter towards Re-timer 1-2 and sends an ELT_Recovery Transaction within tRecoveryResponse after receiving the ELT_Recovery Transaction. it. ELT_Recovery Transaction is sent, with the last bit delivered within tRecoveryRxOff after the ~~The~~ receivers is-are turned off ~~within tRecoveryRxOff after sending the ELT_Recovery Transaction.~~

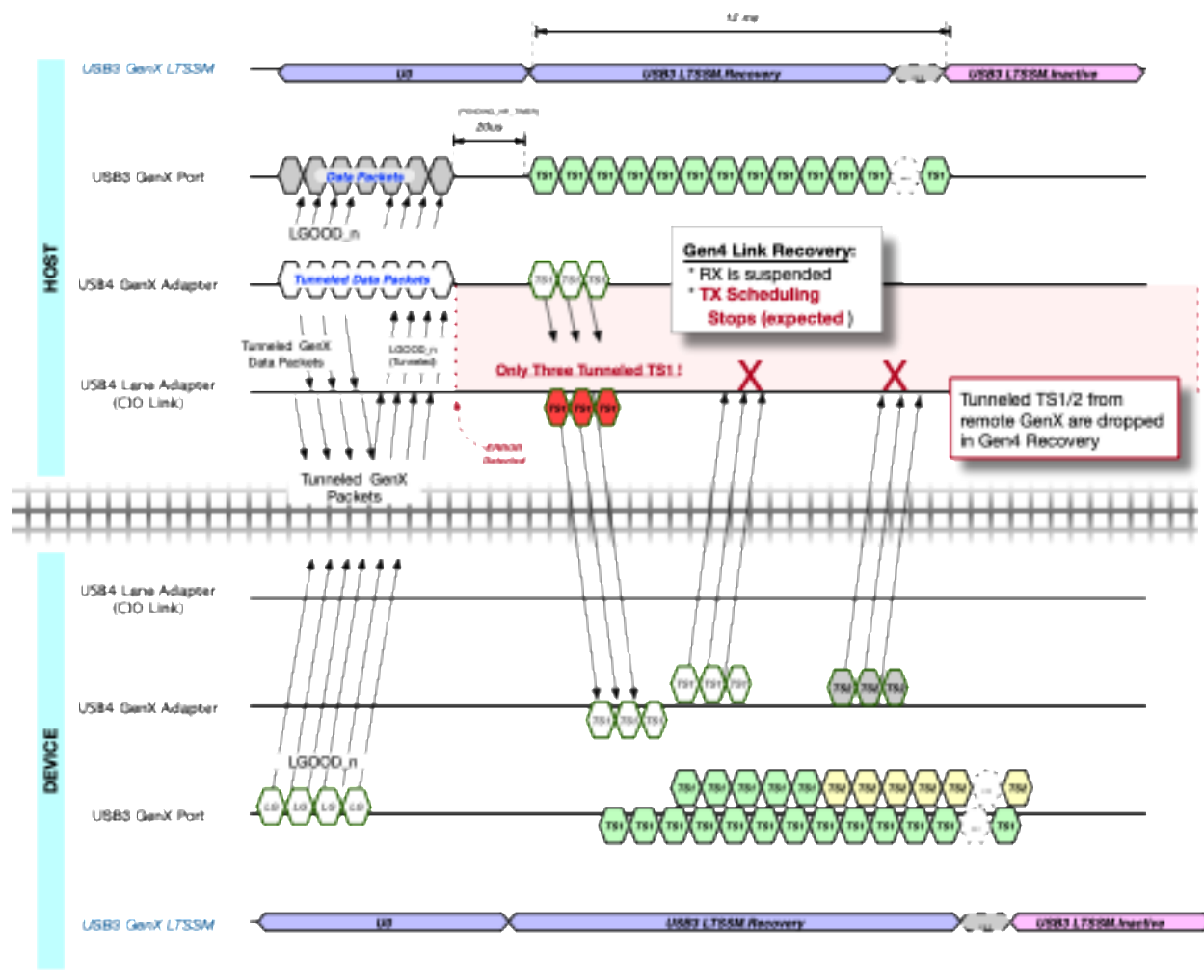
(e). ECN INFORMATIVE

The below diagram provides an example in the case of USB3 Gen X tunneling.

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