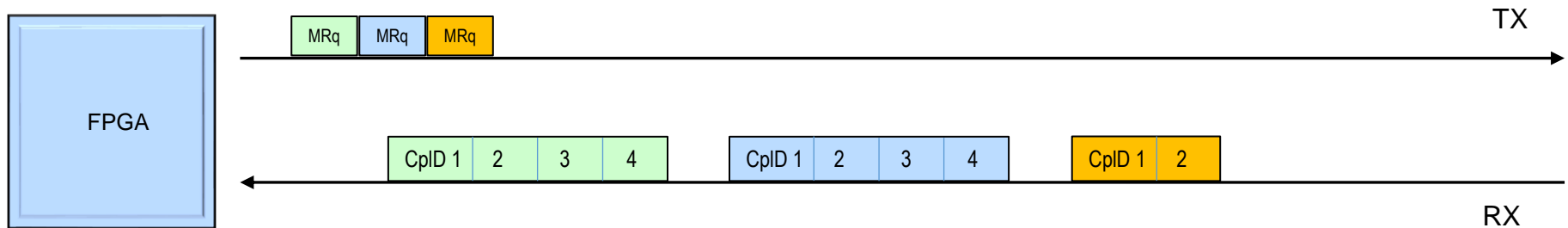


Completion Sorting

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This Application Notes describes the PCI Express protocol rules regarding completions in detail. Since Completions do not have to arrive in the same order as they were requested, the completion sorter contained in the IP frame work has to be used.

Typically the user expects the arrival of completions (answers to read requests) in order:

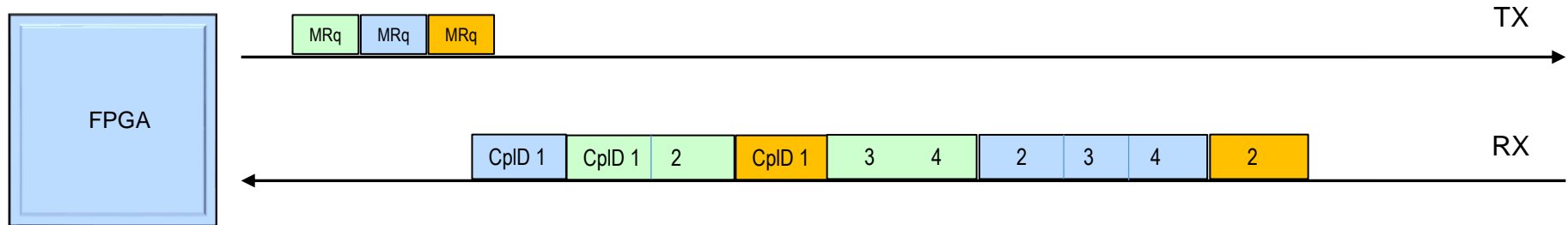


In order:

- Every Read Request (MRq) is answered with several completions (depending on the length of the Request)
- Completions of the same MRq are transmitted in ascending order
- The completions of different read requests arrive in the order they were requested

In cases where all MRq are answered with sub-completions “in order” (as shown above), the Smartlogic “Completion Sorter” is not required.

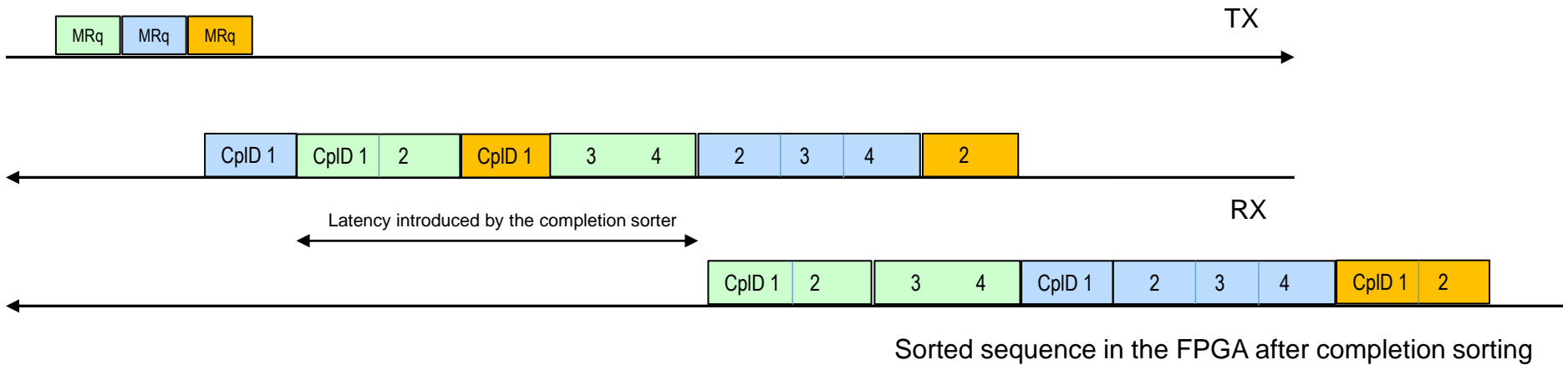
However the PCIe Express protocol rules DO not specify that incoming completions have to arrive in order ! The following sequence can occur and is legal :



Out of order :

- The PCIe spec allows, that the arriving completions can be “out of order” as shown above
- The payload of completions that belong to the same MRq will be always in linear ascending sequence
- Completions can arrive before completions belonging to previous read requests (blue completions vs green completions)

In such cases, the Smartlogic “Completion Sorter” inside the core has to be activated, in order to make sure that the payload is in correct sequence.



The picture above shows the basic sorting algorithm of the completion sorter.

The completions leave the completion sorter when all completions that belong to the same read request were received.

The completion sorter is informed by the “Tag field” about the transmit order of the read request.

Parameter	Meaning	Allowed values
DMA_Read_cpl_sort_use_sorter_ram_c	Selects, if the Completion sorter is active (true) or not (false)	True or false
DMA_Read_cpl_sort_MRRS_log2_c	Informs the completion sorter on the log2 of the maximum read request size in order to calculate RAM resources	7 to 12
DMA_Read_cpl_sort_used_tag_width_c*	Selects the maximum out of order distance between 2 completions that can be sorted. This affects the amount of sorter RAM needed. Important for the out of order distance is $2^{**}DMA_Read_cpl_sort_used_tag_width_c$. Example : Selecting 4 allows sorting for an out of order distance of 16	1-4
DMA_Read_cpl_sort_BRAM_mode_c	Selects, whether BlockRAMs (true) or distributed RAM cells / MLAB cells (false) are used for the completion sorter RAM.	True or false For 64-Bit architecture always select true
DMA_Read_non_ext_tags_max_RAM_segments_c	Number of memory segments for non extended mode	2 (do not change)
DMA_Read_ext_tags_max_RAM_segments_c	Number of memory segments for extended mode	16 (do not change)

* When extended Tag usage is de-activated, it is recommended to set this parameter to 1 (=log2(DMA_Read_non_ext_tags_max_RAM_segments_c)). If extended Tags are used, it is recommended to set this parameter to 4.

DMA Status 0 (BAR0, Offset 0x1008) provides these status bits:

- Bit 16 : Completion Length Error

This Bit is set to '1' in case an inbound completion is greater than the maximum completion length specified with `DMA_Read_cpl_sort_MRRS_log2_c`. In this case check the correct setting of this parameter. This bit is sticky until a reboot of the endpoint.

- Bit 17 : Completion Sorter Data Error

This Bit informs the user that the inbound completions exceeded the completion sorter's sorting capabilities and that data was corrupted. The data amount however remains correct (i.e. no data was deleted by the completion sorter). This bit is sticky until a reboot of the endpoint.

- Bit 23:18 : Sorter Error number

These 6 Bits count the number of completion sorter data errors. If the counter reaches 0x3F it remains at this value. The value is sticky until reboot of the endpoint.

- Bits 27:24 : Sorter Statistic

These 4 bits inform the user on the maximum out of order distance of two completions. If for example the received completion order is 1, 4, 2, 3, 5, 6, ... The sorter statistic will report 3 ($4-1=3$)