1.2 Implementation of the WR calculations

In practice, $delay_{MS}$ is obtained in the following steps:

1. fixed delays (Δ_{txm}, Δ_{rxs}, Δ_{txs}, Δ_{rxm}) and alpha parameter (α) are provided as calibration parameters.

2. more tricky calculations, requiring floating point, are performed only once on the WR Switch (WRS) and are precomputed for the WR PTP Core (WRPC), resulting in fixed-point int32 alpha (fix_α).

3. easy in fixed-point math calculations, $delay_{MS}$ is calculated from $delay_{MM}$ using fix_α and Δ_{txm}, Δ_{rxs}, Δ_{txs}, Δ_{rxm}, where $delay_{MM} = (t_4 - t_1) - (t_3 - t_2)$

The implemented calculations are summarized in the table. Of course, bit-shifting is used for division and multiplication by 2 (e.g. $\cdot 2^{40}$).

Num	Calculation	WRS	WRPC
1	$\alpha_{neg} = \frac{1}{\alpha+1} - 1$	α_{neg} (double) is computed in HAL from α (double)	α and α_{neg} are used in pre-computation of fix_α
2	$fix\_\alpha = (\frac{1+\alpha}{2+\alpha} - \frac{1}{2}) \cdot 2^{40}$	fix_α (int32) computed in HAL from α (double)	fix_α (int32) precomputed by hand
3	$delay_{MS} = [fix\_\alpha \cdot (delay_{MM} - \Delta)] \cdot \frac{1}{2^{40}} + \frac{1}{2} \cdot (delay_{MM} - \Delta) + \Delta_{txm} + \Delta_{rxs}$	$delay_{MS}$ (int64) calculated in int64 fixed-math from int32 values	

The second formula can be easily traced back to the original formula:

$$delay_{MS} = [fix\_\alpha \cdot (delay_{MM} - \Delta)] \cdot \frac{1}{2^{40}} + \frac{1}{2} \cdot (delay_{MM} - \Delta) + \Delta_{txm} + \Delta_{rxs} \quad (11)$$

$$delay_{MS} = [2^{40} \cdot (\frac{1+\alpha}{2+\alpha} - \frac{1}{2}) \cdot (delay_{MM} - \Delta) \cdot \frac{1}{2^{40}} + \frac{1}{2} \cdot (delay_{MM} - \Delta) + \Delta_{txm} + \Delta_{rxs} \quad (12)$$

$$so \quad (13)$$

$$delay_{MS} = (delay_{MM} - \Delta) \cdot (\frac{1+\alpha}{2+\alpha} - \frac{1}{2} + \frac{1}{2}) + \Delta_{txm} + \Delta_{rxs} \quad (14)$$

$$so \quad (15)$$

$$delay_{MS} = (delay_{MM} - \Delta) \cdot (\frac{1+\alpha}{2+\alpha}) + \Delta_{txm} + \Delta_{rxs} \quad (16)$$

$$(17)$$