# IEEE/IEC 60802 Clock filter

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# Introduction

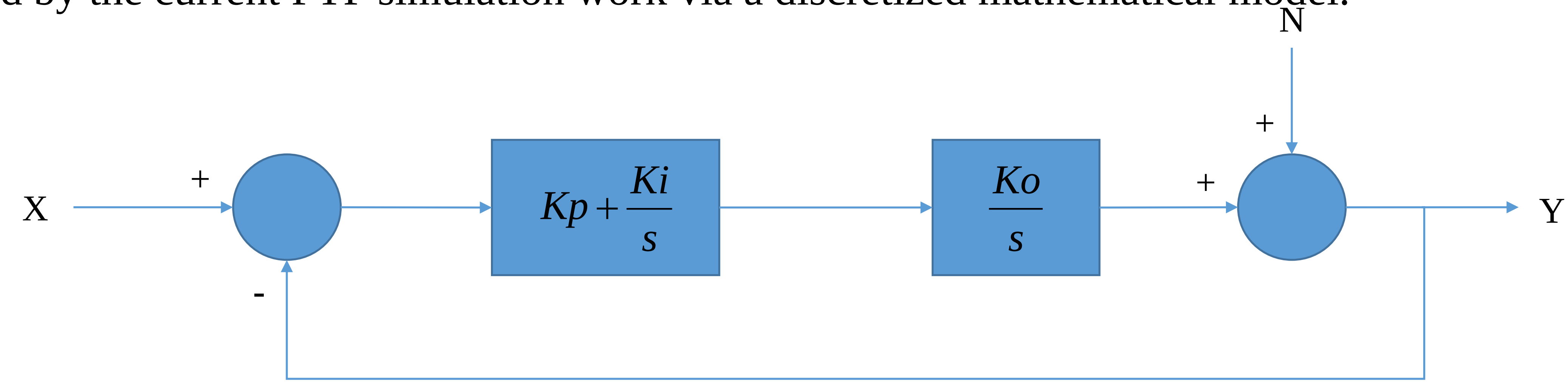
- At one previous meeting, one presentation (60802-Hantel-DTE-Simulation-Input-0821-v04.pdf) proposed to consider a new simulation with relaxed simulation parameters, e.g., 1 degree per 10 second, Sync message rate 1 Hz.

- Then, one question was raised, whether the clock filter bandwidth (2.6Hz) of the current simulation that the Sync message rate is 8 Hz is reasonable for the new simulation of Sync message rate 1Hz.

- This presentation provides some analysis about the clock filter bandwidth vs the Sync message rate.

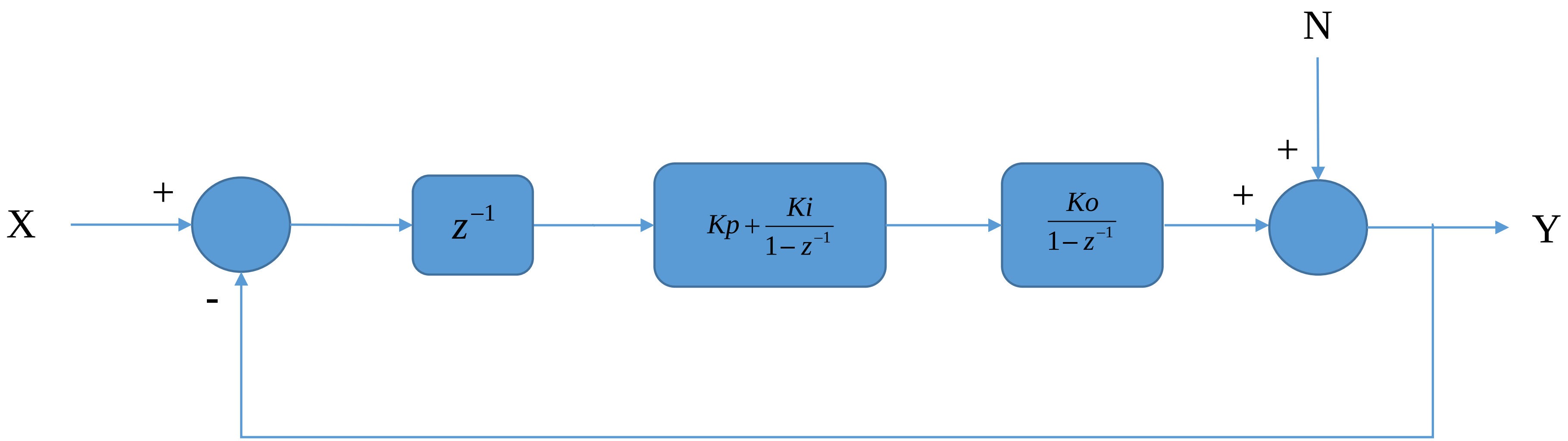
# End-point Clock filter model

- At a PTP end station or a PTP slave clock, it needs to synchronize its time to the GM time represented by the timestamps of Sync or Follow_Up message.
- A clock filter is necessary, in order to decrease the accumulated noise from the PTP chain.
- The figure below is a typical second-order filter model in s domain (analog domain), and it's used by the current PTP simulation work via a discretized mathematical model.



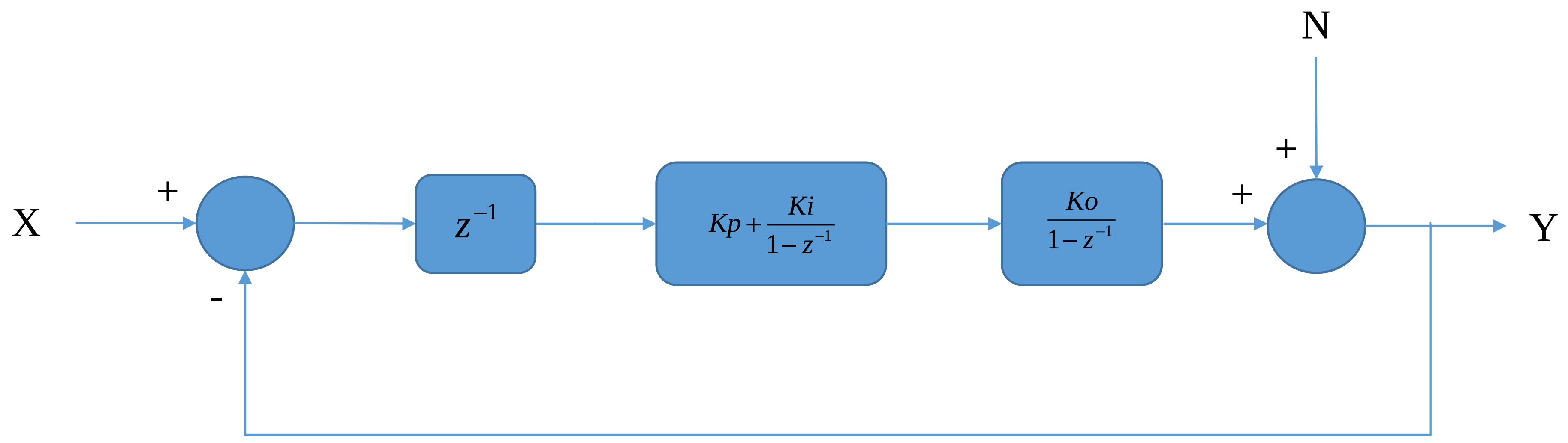

X： Input signal
N： Local clock signal
Y： Output signal

# A traditional implementation of clock filter




- This figure is a traditional implementation in z domain (digital domain) corresponding to the typical second-order filter in s domain (analog domain).
- The model is similar with the one of s domain in the figure of previous slide, and $1/(1-z^{-1})$ is seen as 1/s, which is an integrator operation.
- The $z^{-1}$ is a delay function, and the unit is the input signal interval (or sampling interval). It's unavoidable, because the difference of X and Y cannot immediately be used to adjust the current Y signal.
- And one limitation of this model is that the ratio of the clock filter bandwidth to the input signal rate (or sampling rate) should be at most 1/π, or 1/10 (typical used), in order to guarantee the stability of the phase locked loop.
- Therefore, if the sync message rate is 1Hz, then the clock filter bandwidth should be at most 1/ π (0.318 Hz) or typically 1/10 (0.1Hz)

# Consideration of the local oscillator noise




$$Y = X \times H + N \times (1 - H)$$

- H is the noise transfer function of the clock loop
- H is a low-pass filter
- 1 – H is a high-pass filter

- The authors of this presentation thought, for the end-point clock filter model, the current PTP simulation work got the output Y from the input X after the clock filter, and the local noise N was not considered (or N is zero).
- Because the current clock filter bandwidth is about 2.6hz, which is a bit low, the noise of local oscillator N may need to be considered by 60802 simulation work.
- This may need an oscillator noise model (mainly random noise) for the simulation input. Possibly a model under constant temperature is sufficient, because the model for the variable temperature is already available.

# Proposal

- Propose the end-point filter bandwidth, which is used by simulation, to be equal or less than 1/10 times of the Sync message rate.
- Consider the effect of the local oscillator to the end-point clock

# Thank you