# VALIDATION OF CLOCK RECOVERY SYSTEMS IN A SIMULATED ENVIRONMENT

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# AGENDA

- PTP Clock Recovery methods
- Oscillator characteristics
- Clock recovery validation parameters
- A model for validation of clock recovery system with oscillator simulation.
- Advantages of oscillator simulated testing

# PTP Clock recovery methods

# PTP CLOCK RECOVERY COMPONENTS

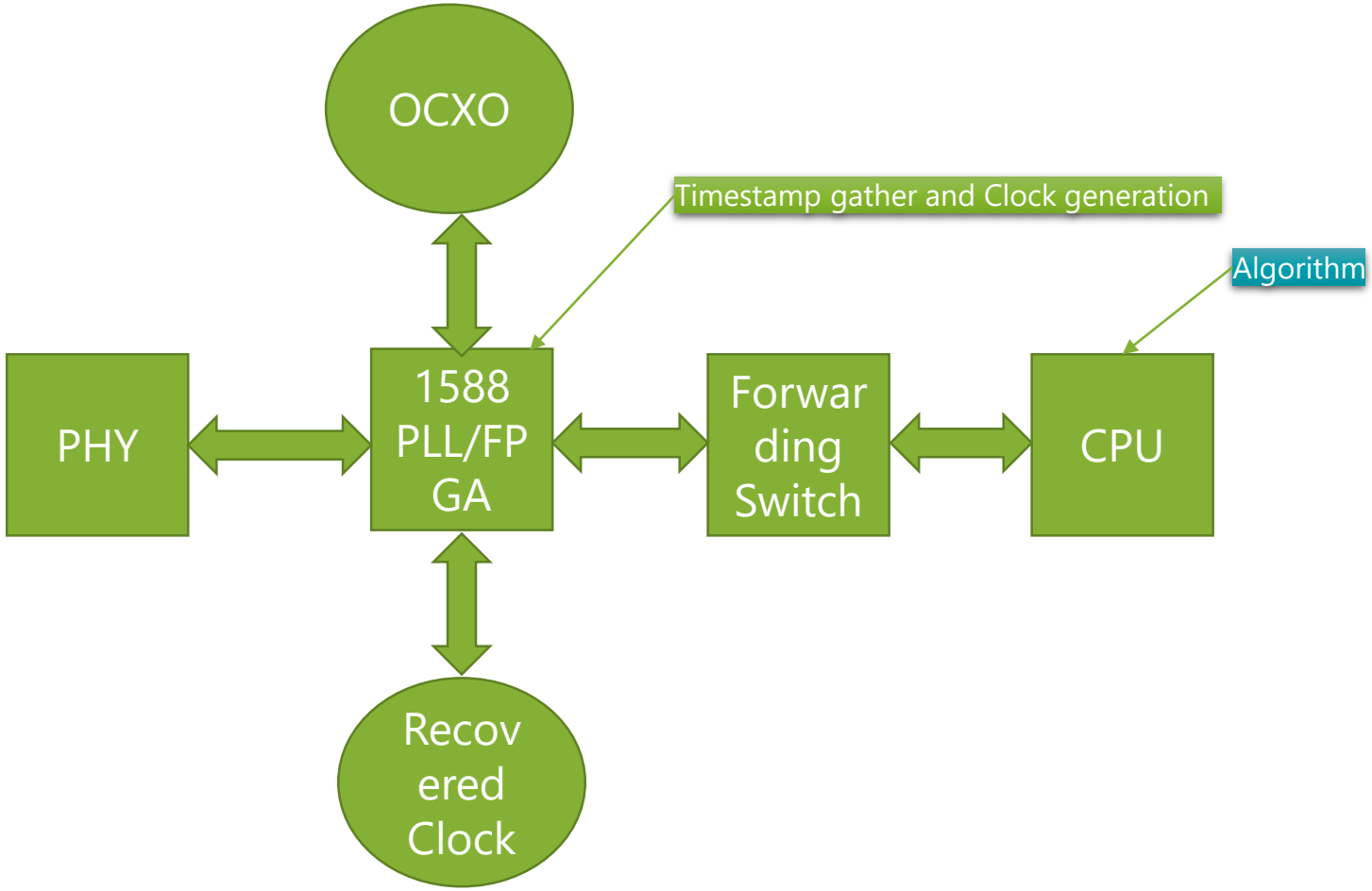
- Clock recovery systems typically comprise of the following
  - Oscillator
  - DPLLs
  - Jitter attenuators, APLLs
  - PTP Servo (s/w)
- PTP stack and other control s/w is not considered integral to the actual clock recovery.

# PTP CLOCK RECOVERY BASICS

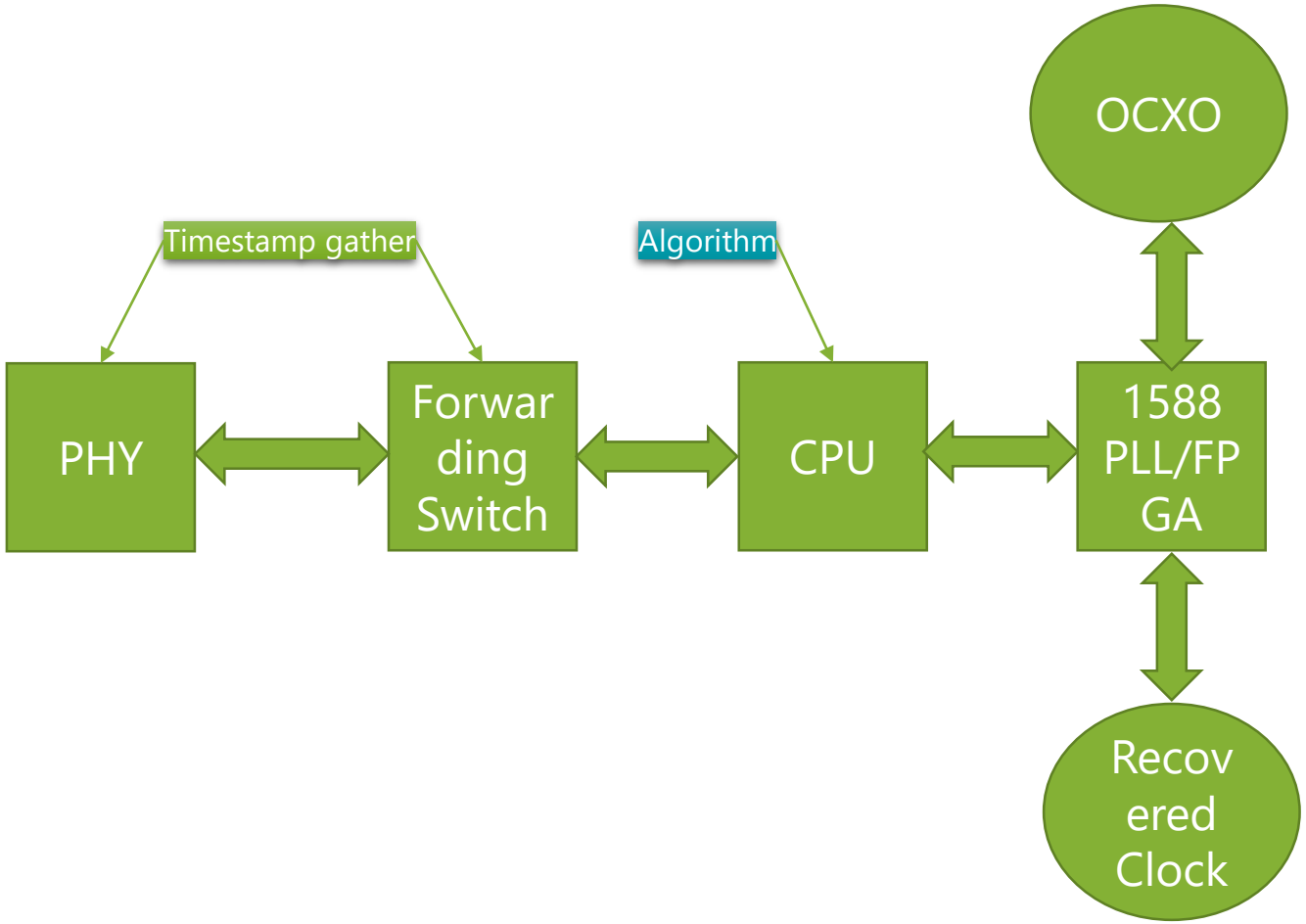
- Two way time transfer capable of achieving
  - 1usec – 10uses in PTP unaware transport
  - 100 ns in PTP aware network
- T1, T4 from PTP master
- T2, T3 from PTP client
- Delay = ((T2-T1) + (T4-T3))/2
- Offset = ((T2-T1) – (T4-T3))/2
- Noise due to PDV/asymmetry is filtered out by packet selection & filtering, and controlling the loop bandwidth of the PLL

# PTP Implementations

# CENTRALIZED/ALL IN ONE



# DISCRETE CLOCK RECOVERY



# STANDARD DEFINED PTP MODEL

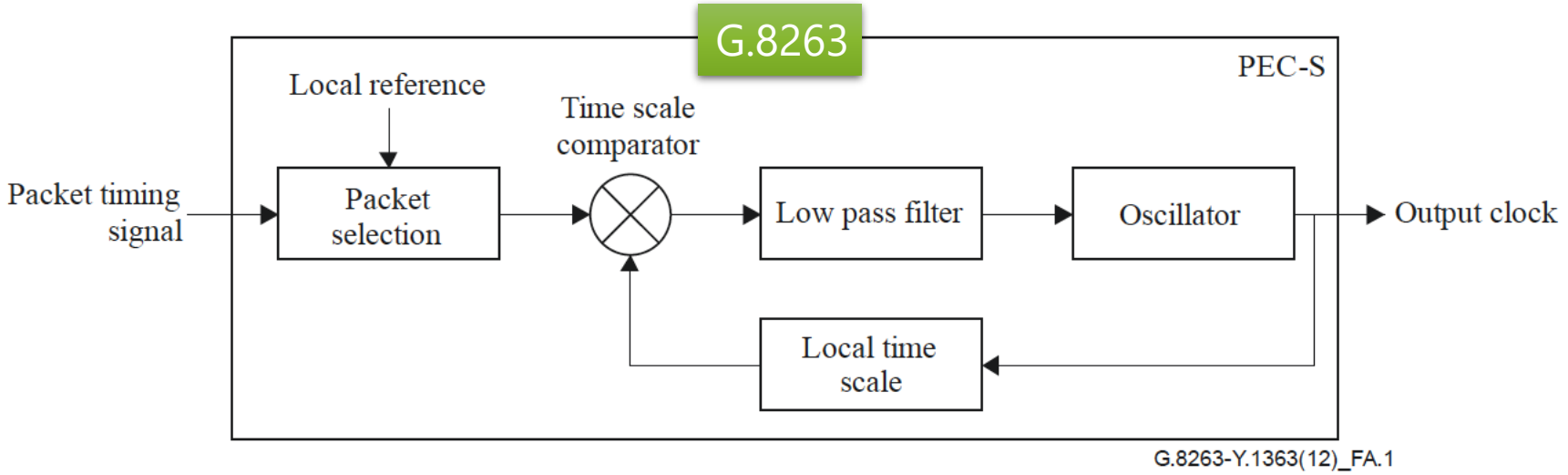



**Figure A.1 – Functional model of a packet-based equipment clock – slave – frequency (PEC-S-F)**

# Oscillator Characteristics

# OSCILLATOR CHARACTERISTICS

- Regardless of the PTP clock recovery system design, an oscillator is used as the system clock for the clock recovery solution
- The choice of oscillator depends on the performance requirements of the PTP PLL and the loop bandwidth of the PTP
- The oscillator performance, both deterministic and non-deterministic will determine if the clocking solution would be able to meet the performance requirement (MTIE, TDEV) of the synchronization standard.
- Deterministic factors are oscillator aging, and temperature stability
- Non-deterministic factors are environment factor, and noise (stochastic) of the oscillator.

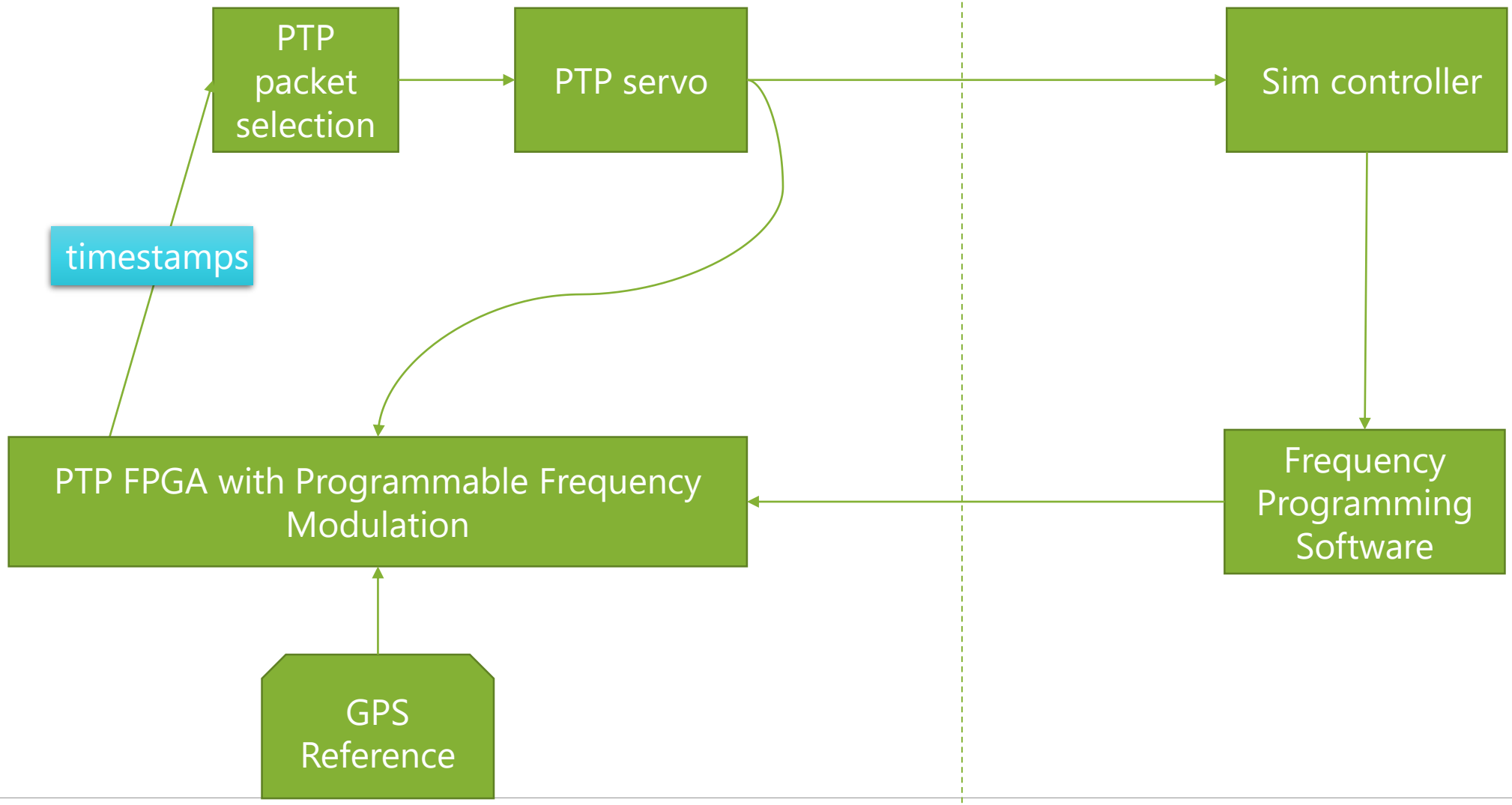
# Clock recovery validation

# PTP SOLUTION EVALUATION WITH OSCILLATOR H/W

- Typically done by testing the actual oscillator hardware with the PLL closed loop.
- Require control and manipulation of the following factors
  - Temperature
  - Airflow
  - Vibration
- But don’t have any control on the following factors
  - Oscillator noise,
  - Short term frequency jumps/instability

# A model for validation of clock recovery system with oscillator simulation.

# SIMULATION DESIGN



# Advantages of oscillator simulated testing

# EVALUATION OF THE PTP SOLUTION WITH OSCILLATOR SIMULATION

- Better control on the evaluation of the performance
- Test non-standard and indeterministic behavior of the oscillator
- Test along with packet clock HRM model and network PDVs.
- Able to catch corner case unlocking behavior of the PTP servo
- Able to test holdover performance
- Faster turnaround time for servo algorithm trials.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