Welcome to this presentation of the STM32WB clock recovery system. It covers the main features of this module used to control the precision of the USB clock frequency.
The goal of the Clock Recovery System is to obtain a precise-enough clock signal for use by the USB module without the need for an external resonator component, just by simply using the USB traffic as a timing reference. The peripheral's main functions are its ability to trim the internal oscillator on the fly, to benefit from its fine granularity in order to meet the USB protocol requirements and have enough information available for the user to track in early phases any potential issues.
The Key features are:
A selectable synchronization source with programmable prescaler and polarity: External pin, LSE oscillator output or USB SOF packet reception,
The possibility to generate synchronization pulses by software,
An automatic oscillator trimming capability with no need for CPU action,
A manual control option for faster start-up convergence,
A 16-bit frequency error counter with automatic error value capture and reload,
A programmable limit for automatic frequency error value evaluation and status reporting,
Maskable interrupts/events: Expected synchronization (ESYNC), Synchronization OK (SYNCOOK), Synchronization warning (SYNCWARN) or Synchronization or trimming error (ERR).
3 different sources can be selected for the Clock Recovery System:
• an external signal on a GPIO,
• the 32-kHz crystal, or
• the USB start of frame signals can be used as a clock source to create a reference signal to calibrate the HSI 48MHz oscillator.

This reference signal (called SYNC) is used to reload the 16-bit counter and capture the value of the actual countdown. Depending on this value, the HSI 48-MHz clock frequency (HSI48) is fine-tuned to reach the most accurate frequency.
The CRS counter value is reloaded with the RELOAD value on each SYNC event. It starts counting down till it reaches zero. Then it starts counting up to the OUTRANGE limit where it eventually stops (if no SYNC event is received before) and generates a SYNCMISS event.

A SYNC event received when the counter is below the outrange will eventually fine TRIM the HSI48, depending on the FELIM[7:0] value.

If the CRS counter value is below the FELIM limit, no TRIM actions are taken.

If it is between 3 times FELIM and FELIM, the TRIM bit field is incremented or decremented by 1, depending on the counter direction.

If the CRS counter is between 128 times FELIM and 3 times FELIM, the TRIM bit field is incremented or decremented by 2 TRIM steps.
The following interrupts can be activated by the Clock Recovery System:
The Expected synchronization is set when the counter reaches zero and starts counting up.
The Synchronization OK is set when the SYNC event has been received within the expected time window.
The Synchronization warning is set when the SYNC event has been received within the margins of the OK window but not yet in the error range.
The Synchronization or trimming error (TRIMOVF, SYNCMISS, SYNCERR) is set when the SYNC event has been received too early, not received at all, or if the TRIM bit field overflows after an update.
Related peripherals

- Refer to these trainings linked to this peripheral for more information:
  - Universal serial bus full-speed device interface (USB)
  - Reset and clock control (RCC)

You can refer to peripheral training slides related to the USB and RCC modules for additional information.