What is a Digital Filmography Timebase?

Modern digital filmography uses Presentation Time Stamps (PTS) instead of traditional analog FPS for speed calculations. PTS values are represented using a timebase, which is the reciprocal of timescale.

For compatibility with analog films, a timebase respects the FPS. For example, a 25 fps film needs a timebase of at least 1/25. Ffmpeg supports a minimum timebase of 1/15.

A precise resolution requires a timebase that represents one tick of the clock. For instance, a timebase of 1/1000 represents a millisecond.

`Timebase = 1/75; Timescale = 75`		
Frame	pts	pts_time
0	0	0 x 1/75 = 0.00
1	3	3 x 1/75 = 0.04
2	6	6 x 1/75 = 0.08
3	9	9 x 1/75 = 0.12

For simplicity, equations involving PCR, PTS, or DTS provide time values accurate to multiples of (300 × 2^33/system_clock_frequency) seconds. This results from encoding PCR timing with 33 bits of 1/300 of the system clock frequency plus 9 bits for the remainder, and encoding PTS and DTS as 33 bits of the system clock frequency divided by 300.

Thus, 27 Mhz / 300 = 90000 Hz.

The typical use of 90,000 as a common base of calculation is derived from the 90000 Hz value which is divisible by 24, by 25, and by 30 (in each case the result is an integer - thus the math is equally suitable for handling 24 fps, 25 fps, and 30 fps. Historically Quicktime writers have typically used a timescale of 600 as it suffices for the same purpose.

Common timebase values include 1/600, 1/1000, 1/30000, and 1/90000, with 1/1000 being the most prevalent as it equals 1 millisecond. Chapters or markers are usually placed using time in milliseconds, so start times must be converted using the timescale:

Position = ((start/timescale)*1000).

- ***PCR** = **Program Clock Reference***, it is a master clock running at the encoder and used by decoder to sync with the encoder while decoding. Now PCR runs on a 27MHz clock and appears in Transport streams. PTS takes its stamping on 90KHz clock (i.e., 33bit value).
- ***DTS** = **Digital Time Stamp***, is the scaled time value stored as start time.

One key advantage of this system is its ability to maintain synchronization between audio and video streams during playback. By relying on standard timebase values like 1/90000, the system ensures precision across various frame rates and content formats. This also facilitates seamless editing and playback in environments where multiple timebases coexist, such as during live broadcasting or multi-platform content delivery.

Furthermore, the use of a 27MHz clock for PCR and a 90KHz clock for PTS highlights the layered approach to timing precision. While PCR provides a high-frequency reference necessary for decoding synchronization, PTS and DTS offer practical timestamps for managing presentation and decoding order. This division ensures that decoding systems remain robust even under complex conditions, such as network jitter in streaming contexts.

In practical applications, these timing systems allow for reliable conversion between different frame rates and timebases without losing synchronization, making them indispensable for modern multimedia standards like MPEG and H.264. The ability to encode timing information in transport streams accurately is critical for achieving smooth playback across diverse devices and platforms.