

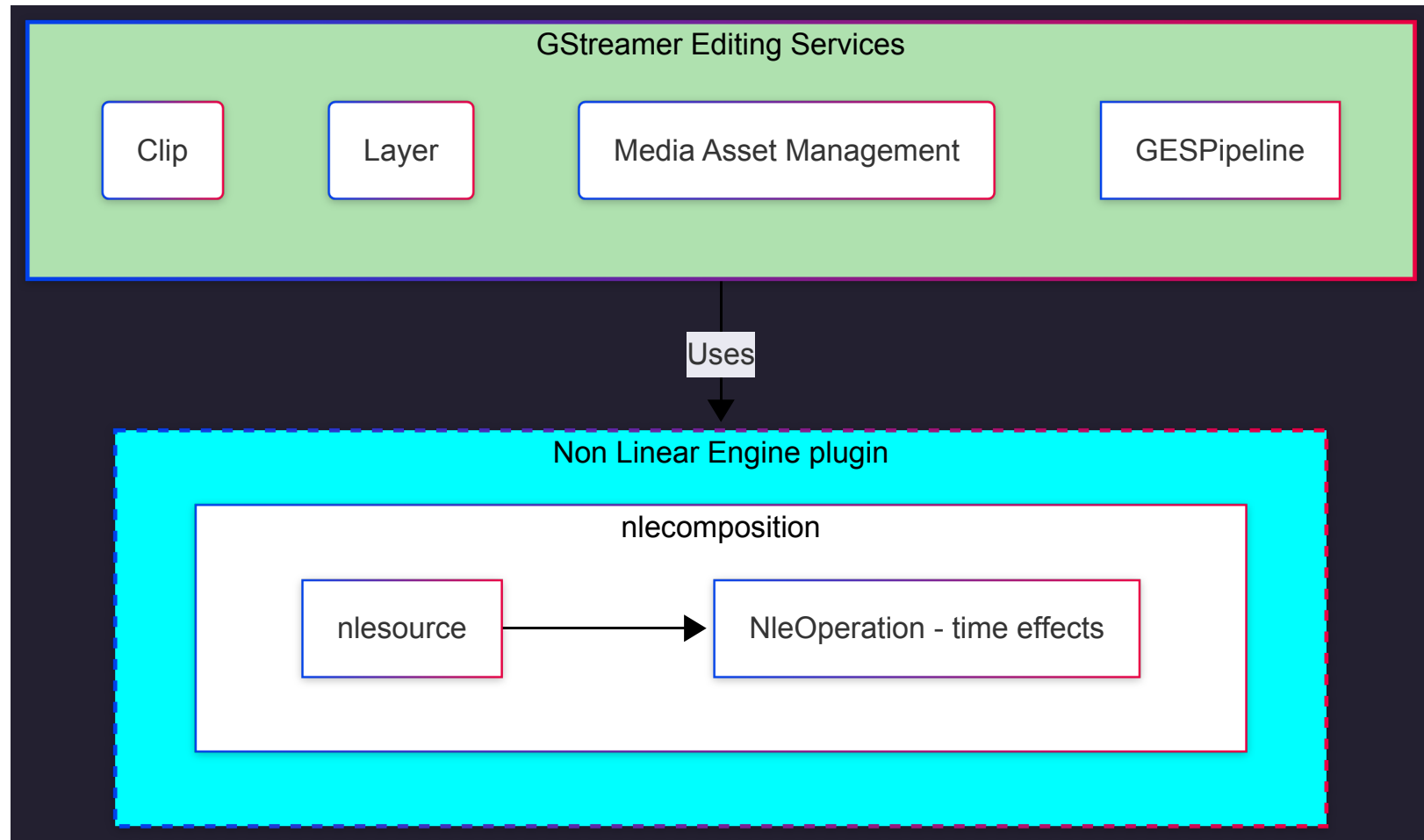
Time Remapping in GStreamer Editing Services

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Agenda

- What is time remapping?
- Foundational concepts and architecture
- Implementation across the stack
 - Video (videorate)
 - Audio (pitch)
 - NLE integration
- Reverse playback support
- Synchronization challenges
- Future work

GES and NLE Overview



What is Time Remapping?

- Playing media at different speeds
- **0.5x rate**: 10 seconds of input → 20 seconds of output (slow motion)
- **2.0x rate**: 10 seconds of input → 5 seconds of output (fast forward)
- **Reverse**: Play backwards through the stream
- Can be applied per-clip in a timeline

Time Effects in GES

- Proper time coordinate transformations when rate $\neq 1.0$
- Allow **any element** to be a time effect
- Users can implement their own time remapping elements
- API is ready for non-linear time remapping

GES API: registering time effects

- Which properties affect timing
- Forward transformation: $f(t)$ (timeline $\rightarrow$ media time)
- Inverse transformation: $f^{-1}(t)$ (media $\rightarrow$ timeline time)

Constraints Monotonic, reversible, $f(0) = 0$

Should we add APIs in some way in `GstElement` to avoid needing this API in GES?

NLE: Non-Linear Engine

- Time effects `nleoperation` must have `in-point = 0`
 - `nleghostpad` can't undo in-point shift on rate changing effects
- Once GES sets up time effects, they work automatically
 - Seeks flow upstream, time effects transform them
 - Segments flow downstream, time effects apply inverse

Upstream Time Effect Elements

- **videorate**: Video time remapping
- **pitch**: Audio time remapping

videorate

- Originally designed for framerate conversion
- **2013**: `rate` property added for GES time remapping
- **Problem**: Confused upstream/downstream time domains
 - Refactored to fully decouple time domains

Audio: pitch Element

- Uses SoundTouch library for time stretching and pitch shifting
- **2024**: Loïc Le Page added reverse playback support
- **2025**: Priming solution for artifacts at cut points
 - Seek extra samples before cuts for SoundTouch context
- Comprehensive test suite (0.1x to 5x rates)

Reverse Playback in sources

- `reverse` property on `nlesource`
- Exposed in GES as child property on clip
 - Activates for all media types together
- Implementation: reverses rate in seeks internally
 - Adds `identity` with `single-segment=true` to re-segment stream
 - Uses `scaletempo` for audio to reverse samples
- Keeps reverse playback local to the clip
- Works with time remapping: reverse at 0.5x, etc.

Future Work

- Make time remapping properties controllable
 - Handle seeks/segments with time-varying rates
 - Requires computing integrals over rate curves
 - Enables smooth speed transitions during playback
- Frame interpolation for video
- Better audio quality for time stretching
 - Implement an SBSMS based element ?
- Performance optimizations

Conclusion

- Time remapping is now stable in GES
- Constant rate changes work reliably
- Reverse playback supported
- Framework ready for dynamic rates

Questions ?

Thank You

