

# RFI on Technology Issues of Video Frame Rate Conversion between Integer and Fractional Rates

SMPTE TC-10E Integer and Fractional Frame Rate Conversion Study

Submission: isovideo LLC, 27<sup>th</sup> February, 2015

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All numbering corresponds to the questions posed in the original RFI request.

## Experience and Qualifications of Respondent

Keith Slavin has worked for over 30 years in video signal processing, starting at the BBC Engineering Research Department. At Tektronix he won two Technical Emmy awards (for the VM700 and Profile). He also worked at NVIDIA on GPU algorithms. He has 50 patents. He has also authored/co-authored several technology conference papers in the past 3 years. Viarte won one of five prestigious IABM/NAB “Game Changer” awards in 2013.

## Technology Discussion/Explanation

Numbering below corresponds to the original RFI request.

Note: All conversions are file based.

Note: All sequences need to be first downloaded and saved as a file, and then viewed.

### 1. Technologies for the effective conversion of video material to and from the following frame rates:

For all INPUT:OUTPUT ratios:

**isovideo Viarte:** a file-based, GPU-accelerated standards conversion and digital remastering server.

### 2. Conversion of real-world, existing SD and HD content that is interlaced and progressive.

**isovideo Viarte:** a file based GPU-accelerated standards conversion and digital remastering server

**Viarte MC Deinterlacing/inverse-telecine** combined with MC **frame rate conversion**, temporal/spatial noise reduction and edge sharpening **up/down-scaling** from SD to HD (pillarbox), (HD to/from UHD scaling is also supported):

704x480p60ntsc to 1920x1080p50, pillarbox  
[table tennis 704x480i ntsc60 to 1080p50.mp4](#)

704x576p50 to 1920x1080p60ntsc, pillarbox  
[susie 704x576i50 to 1080p ntsc60.mp4](#)  
[harpist 720x576i50 to 1080p ntsc60.mp4](#)

1920x1080i50 to 1920x1080p60ntsc  
[mobcal ter 1920x1080i50 to 1080p60ntsc.mp4](#)  
[stockholm ter 1920x1080i50 to 1080p60ntsc.mp4](#)

1920x1080i60ntsc to 1920x1080p50  
[shields ter 1920x1080i60ntsc to 1080p50.mp4](#)  
[stockholm ter 1920x1080i60ntsc to 1080p50.mp4](#)

Note: "60ntsc" is a filename-friendly abbreviation for 60/1.001

### 3. Conversion technology that deals successfully with the range of artifacts present in real-world material (e.g. noise, compression artifacts, prior frame rate conversion artifacts such as may arise from prior conversion from 50 fps to 60/1.001 fps).

**isovideo Viarte:** a file-based GPU-accelerated standards conversion and digital remastering server

Conversion of "Old Town Cross" (with film/shot noise) from 50p to other fractional frame rates:

[old town cross 1080p50 to 1080p60ntsc hq crf20.mp4](#)  
[old town cross 1080p50 to 1080p120ntsc hq crf20.mp4](#)

Results for three cascaded conversions using lossy compression between stages are available from isovideo on request.

**Viarte noise reduction** uses temporal/spatial methods to deal effectively with shot noise from modern cameras, typically reducing Blu-ray quality compressed file sizes by 30-40% (and up to 72%). Results (which may be available upon request) were presented at the JCT-VT Geneva meeting #111 (February, 2015).

The following files are compressed using CRF=18 (Blu-ray quality) with and without noise reduction. Temporal noise reduction alone gives a 72.07% size reduction in this case, with no discernible loss in spatial resolution.

[old\\_town\\_cross\\_1920x1080\\_50\\_denoise\\_crf18.mp4](#)  
[old\\_town\\_cross\\_1920x1080\\_50\\_no\\_denoise\\_crf18.mp4](#)

17.89 MBytes  
64.06 MBytes

More compressed file conversions will be shown at the live demo (available on [isovideo examples](#) and also on request).

#### **4. Technology for the objective measures of picture quality of the frame rate conversions, especially if such objective measures have been shown to correlate well with subjective measures of quality.**

No submission from **isovideo**.

#### **5. Information regarding the level of computational complexity and processing time of real-time and non-real-time frame rate conversions.**

For file-based conversion, throughput depends on quality level, image size, and image content.

Multiple Viarte servers can automatically use isovideo's proprietary splitting technology to achieve much higher throughput rates than real-time (detailed analysis of performance may be available upon request).

#### **6. Information regarding the latency of conversion in live usage**

Latency is about 0.1 seconds.

#### **7. The visibility of artifacts or quality degradations in output video during slow motion and freeze frame effects that may be utilized after the conversion**

**Broadcast quality mode examples** – faster than real-time:

50 fps -> 60/1.001:

[crowd\\_run\\_1080p50\\_to\\_1080p60ntsc\\_fast\\_crf20.mp4](#)  
[park\\_joy\\_1080p50\\_to\\_1080p60ntsc\\_fast\\_crf20.mp4](#)

Measured Conversion  
Speed Relative to  
Real-time

+13%  
+14%

## Cinema quality mode examples

50 fps -> 60/1.001:

[crowd run 1920x1080 50 to 1080p ntsc60 hq crf20.mp4](#)  
[old town cross 1920x1080 50 to 1080p ntsc60 hq crf20.mp4](#)  
[park joy 1920x1080 50 to 1080p ntsc60 hq crf20.mp4](#)  
[in to tree 1920x1080p50 to 1080p hq ntsc60crf20.mp4](#)

ntsc60i/50 fps -> 24/1.001 with added simulated motion-blur:

[crowd run 1920x1080 50 to 1080p ntsc24 180degrees.mp4](#)  
[stockholm ter 1920x1080 ntsc60i to 1080p ntsc24 240degrees.mp4](#)

50 /ntsc60i → 100/120 (crf=20)

[crowd run 1920x1080 50 to 1080p 120.mp4](#)  
[park joy 1920x1080 50 to 1080p 120.mp4](#)  
[stockholm ter 1920x1080 ntsc60i to 1080p 120.mp4](#)  
[shields ter 1920x1080 ntsc60i to 1080p 120.mp4](#)  
[mobcal ter 1920x1080 ntsc60i to 1080p 100.mp4](#)

Examples using 120 fps sources was shown at the live demonstration on March 18, 2015.

## 8. The analysis of accurate audio/video synchronization as well as accurate timed metadata elements such as ancillary data (such as ancillary time code and closed captions) and linear time code.

A/V relative delay adjustment is available.  
Timecode is exactly recalculated for FRC.  
Closed captions are passed through.

## 9. The effects of multiple generations of frame rate conversion

The example links below show the results from converting in three stages:

50 -> 60/1.001 -> 50 -> 60/1.001 fps (crf=20)  
[crowd run 1920x1080p50-60ntsc-50-60ntsc 3pass.mkv](#)

## Requested Points of Additional Information

- Real-time conversion rates are given for broadcast-quality examples above.
- **Viarte** motion-compensated FRC judder is nearly invisible compared with linear-blending techniques. Judder does not occur on camera pans or normal motion of larger objects (judder perception is related to object area). The result is that neither judder nor artifacts are visible at normal playback speeds and viewing distances.

No pulldown motion judder occurs in pulldown from 60i -> 24p with **Viarte** scene change detection, and consequent FRC from 24p to other rates.

- Duplicated frames can be detected and removed. Dropped input frames may lead to some motion judder, but no persistent effects beyond that represented by the time interval lost in the dropped input frame.

**isovideo** has demonstrated live conversion at the open forum meeting on March 18th, 2015, and can give demonstrations again at its booth at NAB show, April 13-16<sup>th</sup>, 2015. Please contact isovideo at [info@isovideo.com](mailto:info@isovideo.com) to reserve a demo.

The RFI presentation is at:

[http://isovideo.com/isovideo\\_SMPTE\\_RFI\\_presentation\\_2015.pdf](http://isovideo.com/isovideo_SMPTE_RFI_presentation_2015.pdf)

## Intellectual Property Disclosure

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