Future-proofing a large electronic music realization

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Abstract

A new opera by Philippe Manoury, *Die Letzten Tage der Menschheit* (The Last Days of Mankind) is loosely based on the very unperformable "play" (1915-1922) by Karl Kraus, written in reaction to the first world war. The first public performance was presented by the Opera of Cologne on June 27, 2025. Among the musical forces employed is a monstrous Pure Data (Pd) patch with about 1900 control parameters sequenced using Antescofo. Because of the size of the project, it was possible to devote nearly two years to the development of the electronic realization. From the beginning we decided to develop a continuous integration framework alongside the Pd patch itself to try to ensure the long-term stability of the realization. Using this framework we can sequence the patch automatically through several representative portions of the opera (or, if desired, the entire thing), verifying that, given a standard collection of live audio inputs and control actions, an exactly correct audio output is produced. This acts not only as a check against obsolescence of the Pd patch itself, but as a potent verification mechanism for the software components used, all of which are either open source or in the process of being released as such. As machine architectures and operating systems evolve in the future, it should be reasonably easy to maintain a verifiably correct realization of the electronic sounds used in the opera.

1. Introduction

The electronic music world has long known it has a preservation problem with many facets. Among them is the problem of performing live electronic music in situations that might differ radically from those for which it was first created. As hardware, software, and performance practice evolve over time it becomes impossible to present old electronic music pieces in exactly the form in which they were first performed.

This problem is not specific to electronic music. Classical works of Western concert music are routinely presented on instruments and in performance spaces that do not resemble the original settings. Presenters and performers are well aware that each new presentation of a piece is in reality a new realization of it. But for electronic music it can be much harder to capture the essence of a piece of music using means different from the original ones.

The level of difficulty depends crucially on the nature of the piece. For example, the electronic music of Pierre Boulez has been so carefully documented by Boulez's assistant Andrew Gerzso that it is possible to make an all-new realization of any of his four major electronic works without the need for any of the original hardware or software. At the opposite extreme would be pieces created in studios by composers such as Salvatore

Martirano who build complicated analog patches or even synthesis hardware whose design should be considered an integral part of the music (Rosenboom 20).

Somewhere between these extremes lies a body of work by composers whose realizations are primarily in software. The mere fact that a piece's realization is in software such as Ableton Live does not guarantee its long-term viability, but at least as long as the corporation or other entity that provides the software is in robust shape and keeps a policy of maintaining back-compatibility in successive software releases, existing realizations might be sustainable over a period measured in decades.

For those composers who do not wish to tether their realizations to the fortunes and intentions of software providers, two other options present themselves. First, one can hope to be able to simulate an old environment in modern computers. For example, there are simulations of the classic Macintosh Plus that can run very early, non-copy-protected versions of Max. It is hard to imagine how a modern computer system, running software hundreds or thousands of times larger and more complicated, could be simulated by future systems (to say nothing of modern copy protection which often relies on cryptologically secured handshakes with external servers) but perhaps some future non-human entity will prove up to the task.

A second option is to maintain the entire code base in the form of source code that can be routinely recompiled. Especially if the software in question is maintained as open source and enjoys a wide user base, the likelihood that the software can be maintained despite future changes in hardware and operating systems can be guessed at and planned for. Composers such as Philippe Manoury, Kerry Hagan, and Rand Steiger have made a practice of openly publishing complete electronic realizations of their works. In the latter two cases the realizations depend solely on widely used open-source software. In Manoury's case, there are some remaining dependencies on software components that are not yet open-source, but for which open-source versions are currently being prepared.

In what follows we will take Manoury's massive opera, *Die Letzten Tagen der Menschheit*, as a fairly severe test of my own project, Reality Check (Puckette 24), which adapts the continuous integration methodology, well known to software engineers, to the task of verifying that a live electronic music realization remains correct as time passes and the software platforms inevitably evolve over time.

2. The opera in brief

The opera (which we'll refer to as “DLT”) is only just not quite Wagnerian in duration and forces employed. Based on an immense “play to be produced on Mars” by Karl Kraus, the opera runs in two parts, comprising 3-1/2 hours of music that Manoury wrote over a period of four years. It was presented in summer 2025 by the Opera of Cologne. To date there are no plans to present it again, and if it is indeed seen again it might be in three years or perhaps after lying fallow for a century or two.

The score calls for a 90-piece orchestra (too large for a traditional orchestra pit; they are variously sited onstage and to the right and left of the audience), a sixty-person chorus, 11 solo singers and two actors. The Cologne production relied heavily on live video combining mobile camera inputs and prepared video files, projected onto about ten screens that could be raised and lowered during the performance, along with a reconfigurable set. The live electronic sounds were synchronized with the orchestra using a series of cues sent from a

silent keyboard played by one of the orchestra members. Although most of the electronic sounds were synthetic, on two occasions the voices of singers or actors were processed live, and also used to trigger synthetic responses that were directly synchronized with the performers, bypassing the silent keyboard. The electronic sounds were spatialized over a hexagonal speaker array.

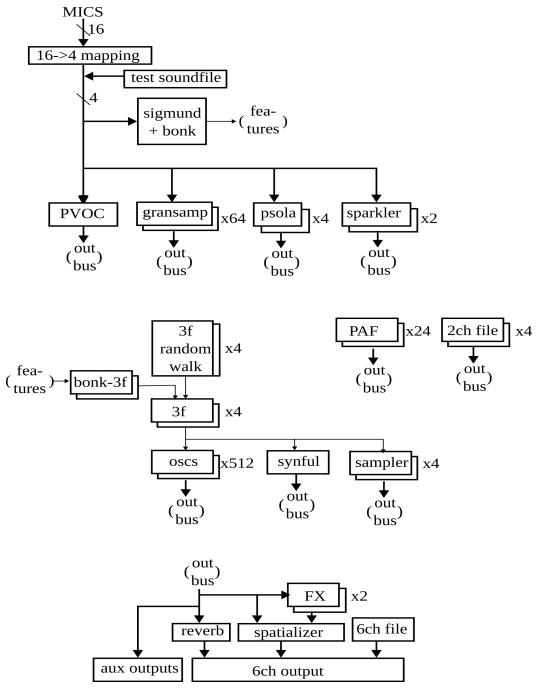
All the voices and some of the instruments were amplified using a combination of fixed and headset microphones totaling about 64 channels of live inputs, of which 13 (the soloists' and actors' headset mics) were sent on to the computers creating the electronic sounds. There were two of these running in parallel, to provide a backup in case one of them failed. The computers also sent OSC messages to the lighting controller so that changes in lighting could synchronize with the music.

3. What is the piece and what is the production?

Perhaps more than in any other art form, operatic works are presented differently by different directors and casts in different productions in different venues. Peter Sellars's production of Don Giovanni would have surprised an audience from Mozart's time. In any new production the one point of stability is the score, to which new producers bring new approaches and styles over the centuries. In the case of DLT, there are two points of hoped-for stability: the score and the electronic realization.

This realization is implemented using Pure Data, an open-source environment under development since 1996 that is primarily used for real-time audio synthesis and processing. The "patch" is in the form of a network of interacting objects connected by virtual patch cords, that provide not only audio signal processing but also a collection of real-time control algorithms, controlled by about 1900 parameters, mostly numerical. These parameters are managed by a sequence of large scripts that is interpreted by Antescofo (Cont 2008). The scripts were authored by Manoury as he composed the opera score.

A block diagram of the audio synthesis, processing and analysis is shown on the following page:



Block diagram of the audio processing and synthesis modules used to realize DLT's electronic part.

The external dependencies of the patch are Pure Data, Antescofo, and Synful, a synthesis module available as a VST plug-in. Pure Data is open source and looks likely to be maintainable for a long period of time (nobody can say how long just yet). Both Antescofo and Synful are available for free but neither is open source as of yet. There is an ongoing project at IRCAM to provide a long-lasting open-source implementation of Antescofo, and since a fair number of pieces in the IRCAM repertory depend on it there is an excellent chance it will be available, like Pure Data, for the foreseeable future.

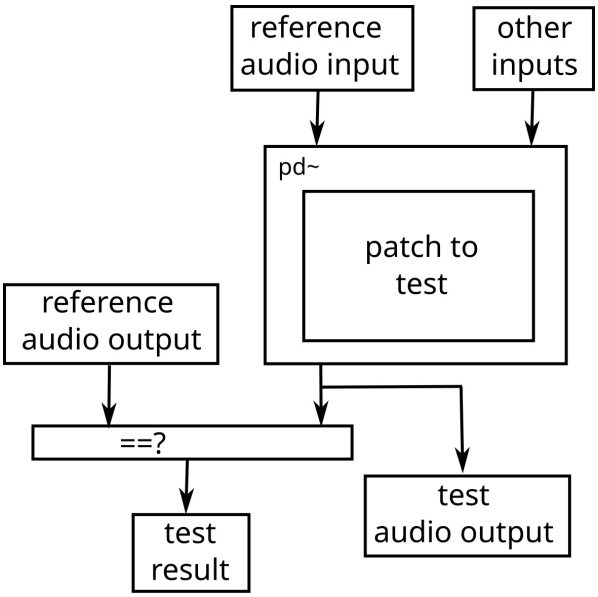
The third component, Synful (Lindemann 2008) is used to synthesize string instruments. It is available for free and there is an effort underway to provide it as well as an open-source library (either as a VST plug-in or, better, as a Pure Data external object). The long-term survival of this package will depend on its attracting a large base of users (as Antescofo and Pure Data now have). If this never comes to pass the alternative will be to seek out different synthesis packages for future productions.

4. Planning for future performances

Any future performance of DLT will require a large effort on the part of a presenting organization, musicians, a director, a conductor, video artists, and more. It is therefore not unreasonable to expect that some effort will be put into the electronic part as well. In particular the patch will have to be modified to accommodate new lighting plans, new speaker layouts, and new synchronization inputs.

At the same time, it seems essential to be able to reproduce exactly the workings of the patch used in the original production as a template for future ones, especially considering that the composer considers the Antescofo scripts as he wrote and tested them to be an integral part of

the musical composition. Here we turn to Reality Check, which allows us to run the original patch (and any later versions) virtually in order to check its correctness. The design of Reality Check is show here:



Block diagram of Reality Check.

The "patch to test" is the realization of the electronic part of the opera, incorporating Pure Data, Antescofo, and Synful. Reality Check presents the patch with a test input (not the real inputs from a performance; they are not public domain and we need the test to rely only on freely distributable sources) and checks that the output is the same, up to a margin of error, as the output had been at the time the test was designed. If not, there is work to do to figure out and correct the discrepancy, but it is at least possible to keep the patch working identically as it had worked at the time of the original production.

5. Conclusion

The role of the score as the center of any opera production is, in this opera, somewhat extended to include the realization of an electronic layer that becomes part of the orchestration of the work. The electronic part would be hard or impossible to recreate from other documents (such as recordings or composers' notes) but relies on the ability to recreate the software environment that produces it. It would also not suffice to merely record the electronic audio generated during a performance, since the electronics must be synchronized and in some cases directly generated using inputs from live performers. However, if an electronic contribution to an opera performance is to be considered permanent, in the way that the written score is, there must be a facility in place to maintain it for a time period comparable to that over which the paper score and its copies can be kept intact. We can't claim to have accomplished this for certain but we hope to have created a situation in which the preservation of the electronic part is not only feasible but can even be considered a small part of the overall task of maintaining an opera as a part of the repertory.

6. References

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