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Sync Variations: For Sixteen Isolated Electric Violin Players and a Programmed Network System

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ELAD SHNIDERMAN[1]

Project Overview

Sync Variations is a collaboration between the composer and sound artist Elad Shniderman, the physicist Moti Fridman, and his colleagues Nir Davidson and Shir Shahal. An article on the scientific research aspect of this project was published in *Nature Communications*.[2] This article focuses on the musical performance and score.

The project is the product of a unique interaction between musicians through a custom-programmed network system. This system simulates the network environment of the internet in many ways. However, the piece has not yet been performed over the internet, which naturally will be the next step in this project. In this project, "synchronization" is defined as the operation or activity of two or more things at the same time or rate. "Chaos" is defined as complete disorder and confusion.

Introduction

In nature, many ensembles demonstrate synchronized behavior. Thousands of fireflies blinking, schools of fish swimming as a group, the singing of crickets, and even the synchronization of menstrual cycles of women living in the same household are all such ensembles. In physics, synchronization appears from the largest to smallest scales: from clusters of galaxies to subatomic particles, from slow-coupled planets to ultrafast-coupled lasers.

All these synchronized phenomena require coupling between the different components of the ensemble. Their own synchronization depends on the specific parameters of the system. In many cases, it is possible to shift the system from a synchronized state into a chaotic state by changing

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[2] Fridman, Moti et al., "Synchronization of Complex Human Networks," *Nature Communications* 11 (2020): 1–10. https://doi.org/10.1038/s41467-020-17540-7. A short documentary on *Sync Variations* is available to watch in the "additional files" section of the "Sync Variations" article download page.

a single parameter. The transition from a synchronized ensemble to chaotic behavior is not abrupt but arises after splitting the entire system into more and more synchronized clusters.

When introducing human nature into a coupled physical system, the situation becomes even more interesting. In some cases, people can behave as simple oscillators; in other cases, they enrich the system thanks to their complicated psychology. This is the main focus of this piece. We demonstrate the unique conflict between synchronization and chaos in an ensemble of people while investigating new and novel aspects of interaction within complex human networks.[3] We do this by connecting sixteen violin players through a programmed network that was carefully designed especially for this project. This system gives us the control over who will hear whom, when they will hear each other, and what will be the coupling strength of this connectivity.

Forms of Interaction

In this piece:

> We study the synchronization between professional violin players in complex human networks with full and accurate control over the network connectivity, coupling strength of each connection, and delay between players. We set 16 isolated electric violin players to repeatedly play a musical phrase. We collect the output from each violin and control the input to each player via noise cancellation headphones. The players cannot see or hear each other apart from what is heard in their headphones. All the players start playing the first phrase with the help of an external rhythmical beat, to verify that they all start with the same playing period and phase. The rhythmical beat is stopped after the first phrase, and the only instruction to the players is to try to synchronize their rhythm to what they hear in their headphones.[4]

At this point, we establish a chain of connectivity between the players and begin to incorporate delays in the system of communication.

Connectivity

[3] In this article, "we" refers to the researchers who worked on the scientific research project and performance leading to *Sync Variations*, Moti Fridman, Nir Davidson, Daniel Weymouth, Hamootal Duadi, Inbar Siboni, Ateret Wurzberg, Shir Shahal, and the author of this article, Elad Shniderman, who served as composer. Shnidernman's contributions to the project also include writing the code and designing the sound system for the *Sync Variations* performance experiment.

[4] Shahal, Shir et al., "Synchronization of Complex Human Networks," *Nature Communications* 11 (2020): 2.

The player can never hear the ensemble as a whole but only certain players based on different chains of communication (fig 1).

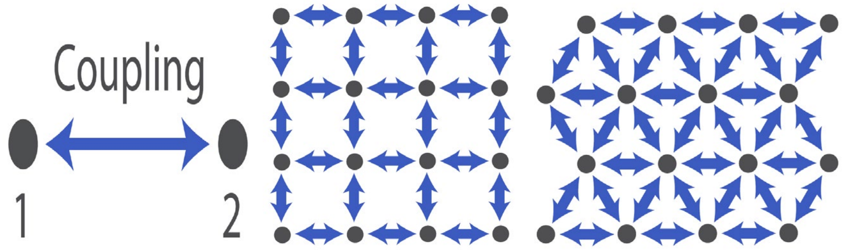


Figure 1: Models of three possible communication chains in *Sync Variations*. Diagram by Moti Fridman.

Delay

The delay changes constantly in a linear mode from zero to four seconds, the latter being the length of the melody. The length of time it takes to transition between delays can vary, but in this piece is set to four minutes.

The Musical Product

We incorporated a single delay into the system, which created a large number of localized relationships based on coupling and delay. This chain of communication introduces complexity into the system, which at first causes chaos, but eventually the system synchronizes. From then on, any change in the delay will not affect the system's overall stability. However, every system—in this case, "system" refers to each chain of connectivity—we checked reached this point of stability in a very different way. For example, some players altered their periodicity, e.g., how rapidly they move through a phrase, in order to find a stable solution to the coupled network. In other cases, they deleted connections by ignoring frustrating signals. For this reason, the setup of the piece should allow an audience to simultaneously explore the ensemble as a whole and the unique behavior of any individual player. Therefore, there are two ways to perform this piece:

1. As a live event in a non-frontal setup where the audience is free to move around the venue.
2. As a 16-channel video and sound installation.

The Listening Experience

The product of this piece is not a demonstration of a scientific fact but an esthetic product that also serves as data for scientific investigation. This data tells us a story about the unique behavior of human networks and of humans in networks; the story is already there in the musical product and in the listening experience. It is there in the extreme accelerando and ritenuto; it is there when players make mistakes while struggling to reach synchronization; it is there when the system fixes itself and goes from chaos to synchronization and we can feel a strong excitement of resolution such as we feel when a very intense harmonic progression reaches its destination. The unique nature of this product is an outcome of the fact that the composition is only partially derived by the decision of the composer or the individual player but mostly depends on the behavior of the human network that is longing to reach stability.

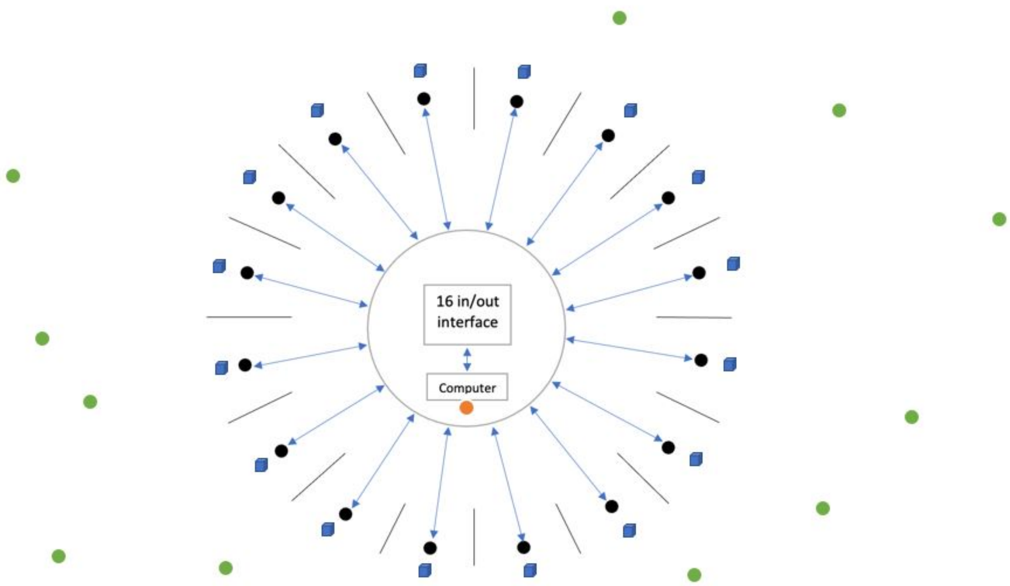


Figure 2: Setup for live performance. Diagram by author.

1. ● Electric violinist with noise cancelling headphones facing out of the circle
2. ■ Speaker which is playing the direct sound produced by the violinist beside it
3. ● Conductor
4. ● Audience (movable)
5. ⟷ Input/output cables
6. —— Vision divider

* The circle staging is optional

Notes on Setup

When done as a live piece, the setup should allow the audience to simultaneously explore the ensemble as a whole and the unique behavior of any individual player. Therefore, the audience should be able to move freely in the same space where the performers are staged.

The Role of the Conductor

- Communicating with the player with an in-system microphone in order to begin and end every section
- Controlling the programmed network

The Programmed Network System

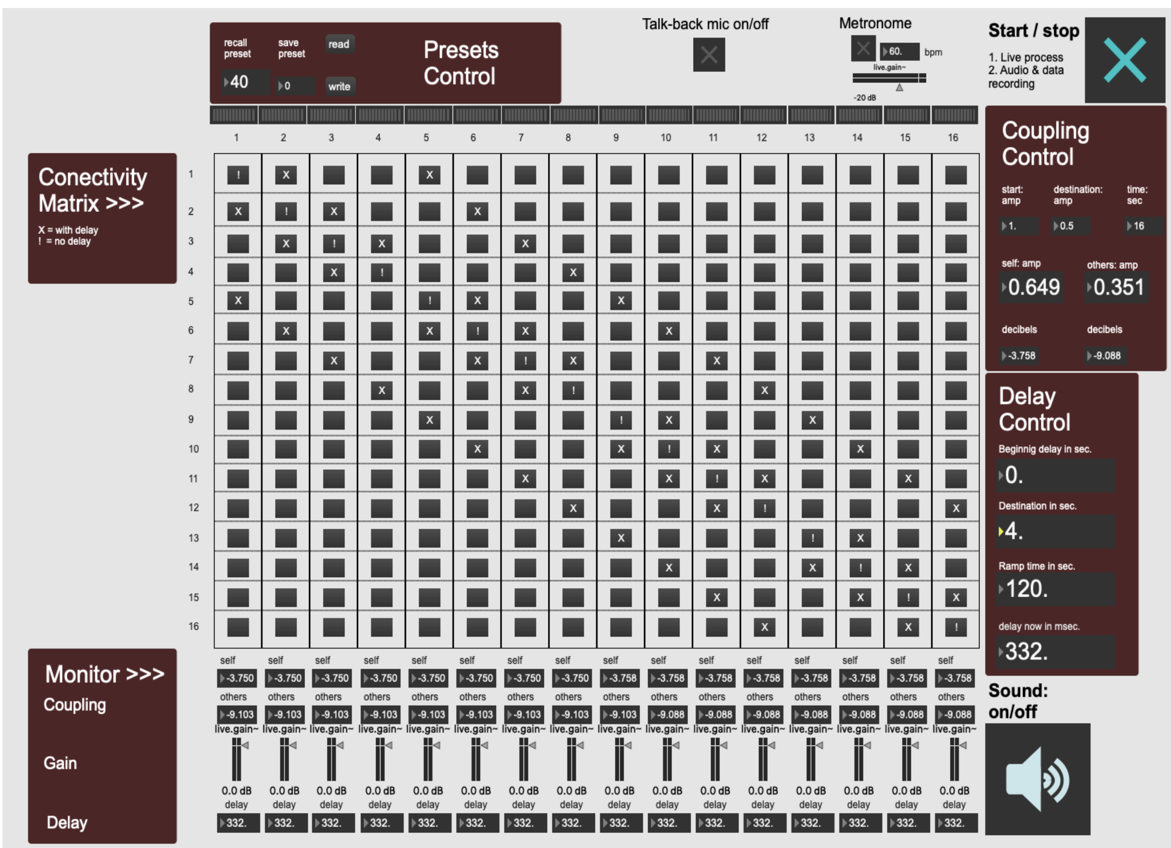


Figure 3: The system was designed in Max/MSP; patch available from the author.

Notes on the Programmed Network System Patch

- The patch includes the presets of this specific piece but is flexible enough to be changed on the fly.
- The volume and the delay change are programmed to be linear in a scale between 0 to 1 (minimum to maximum).
- When the process starts, the patch records sixteen audio channels and the data of the delay and coupling. This is made for the scientific research aspect of the project. However, the audio recording for the performance is made with different software.
- The balance between the players is set by an external audio interface and mixer.

Acknowledgements

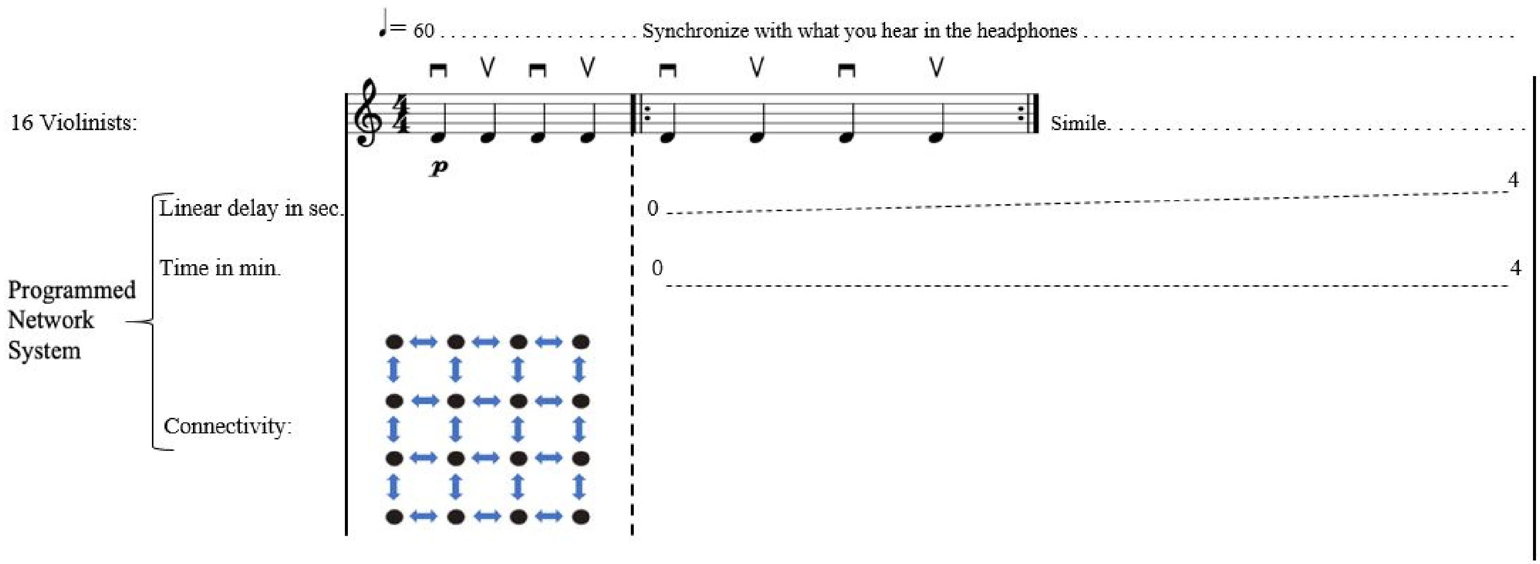
I would like to thank the following people for their contributions to this project: My main collaborator on this project, professor Moti Fridman, and the scholars from his lab at the Faculty of Engineering at Bar-Ilan University, Shir Shahal and Hamootal Duadi; professor Nir Davidson from the Weizmann Institute of Science; the Fetter Museum of Nanoscience and Art, Institute of Nanotechnology and Advanced Materials at Bar-Ilan University and its staff, professor Yuval Garini, Tal Yizrael, and Tamar Shpilman for their generous support that made *Sync Variations* possible; at Stony Brook University, professors Daniel Weymouth, Margaret Schedel, Daria Semegen, and Judith Lochhead for their significant teaching, guidance, belief and support along this amazing journey; professor Ruben Seroussi who advised and guided me in this project, as well as in other projects in the past and, most likely, in the future as well; Suzy De Lowe for helping me make any text I write clearer and more accurate; Shahar Dor for his deep understanding of choreography and art; all the outstanding and dedicated violinists who have participated in this ongoing project; and last but not least, my dear family: my parents Mali and Yosi Shniderman, my in-laws Jack and Helene De Lowe, my three daughters Maayan Ohr, Thea, and Emanuela, and my beloved life partner Lana.

Works Cited

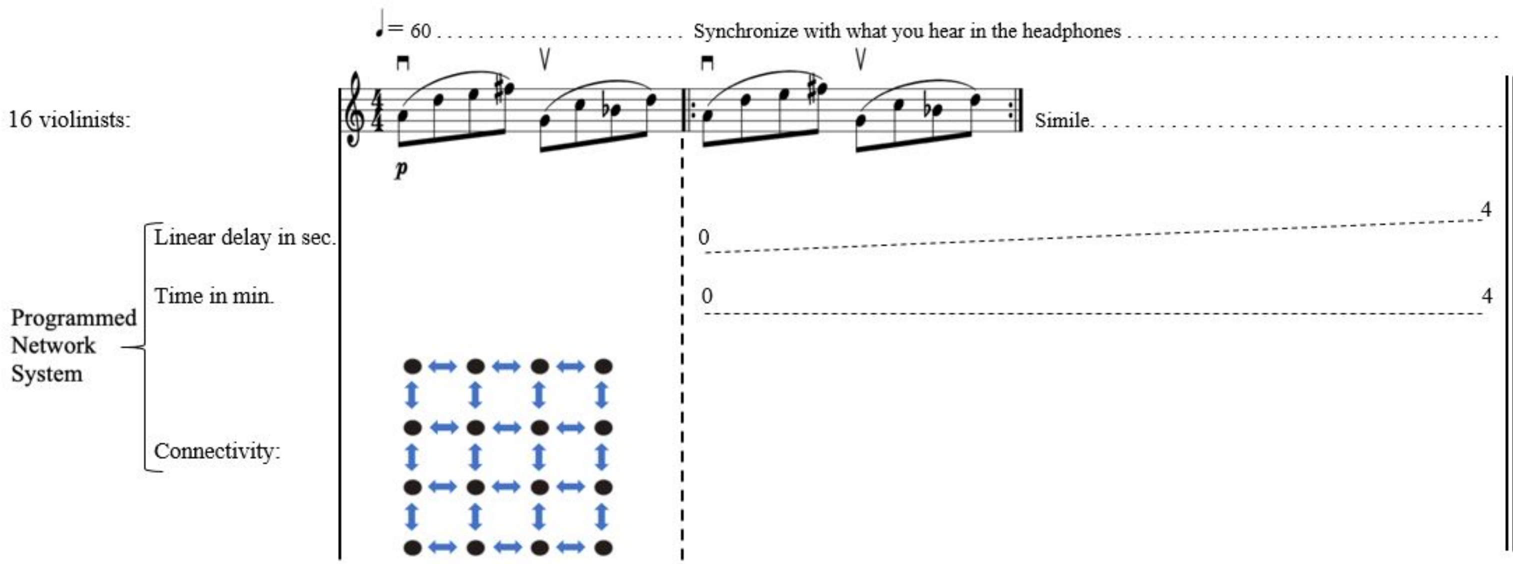
Fridman, Moti, Nir Davidson, Daniel Weymouth, Elad Shniderman, Hamootal Duadi, Inbar Siboni, Ateret Wurzberg, and Shir Shahal. "Synchronization of Complex Human Networks." *Nature Communications* 11 (2020): 1–10. https://doi.org/10.1038/s41467-020-17540-7.

Sync Variations:
For Sixteen Isolated Electric Violin Players and a Programmed Network System

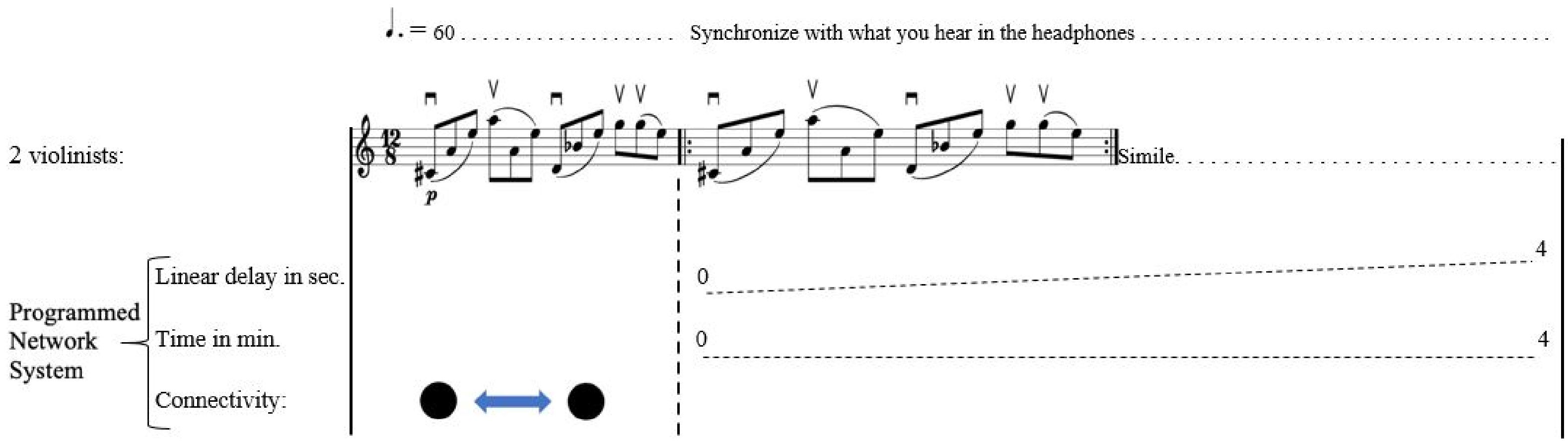
I
(Cubic Drone)



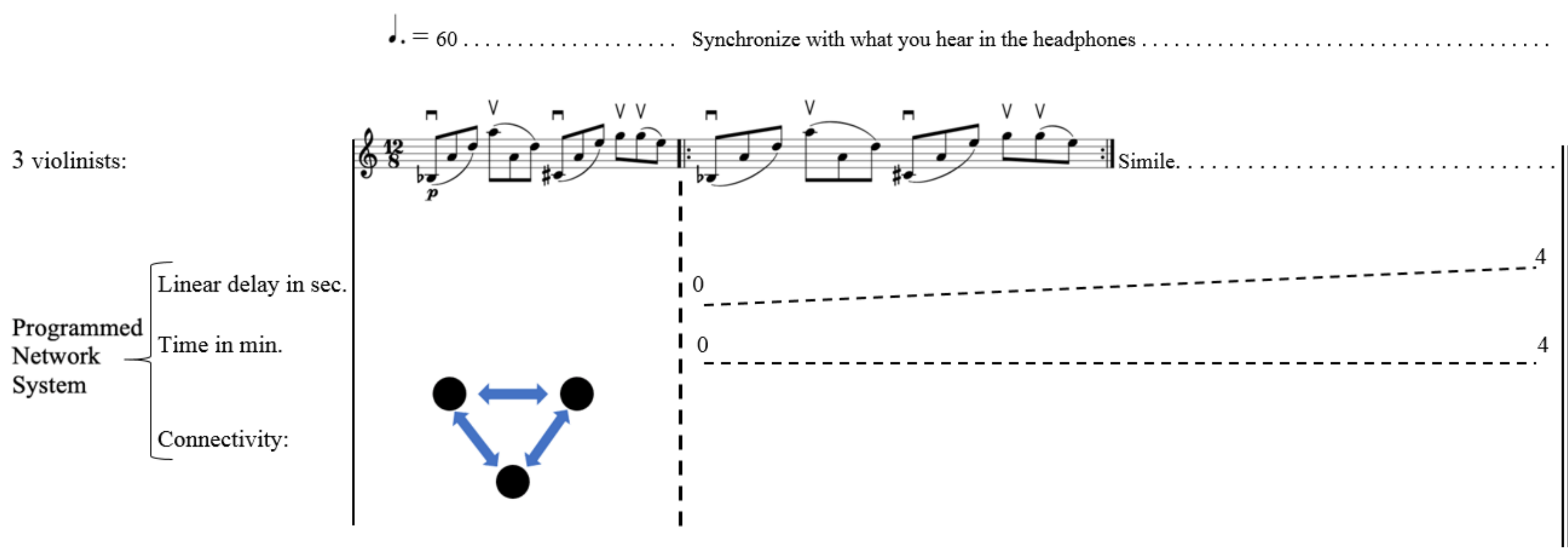
II
(Cubic)


♩= 60
Synchronize with what you hear in the headphones
16 violinists:
p
Simile.
Programmed Network System
Linear delay in sec.
0
4
Time in min.
0
4
Connectivity:

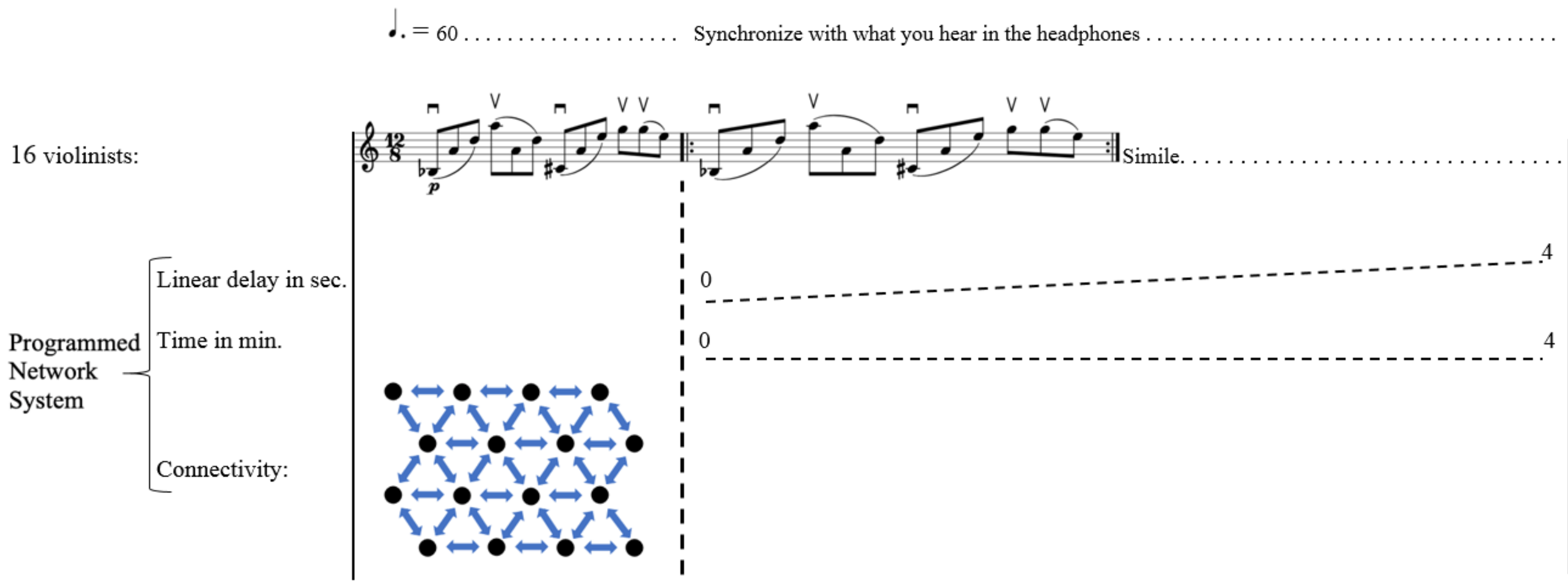
III
(Duo)


♩. = 60
Synchronize with what you hear in the headphones
2 violinists:
Simile.
Programmed Network System
Linear delay in sec.
0
4
Time in min.
0
4
Connectivity:

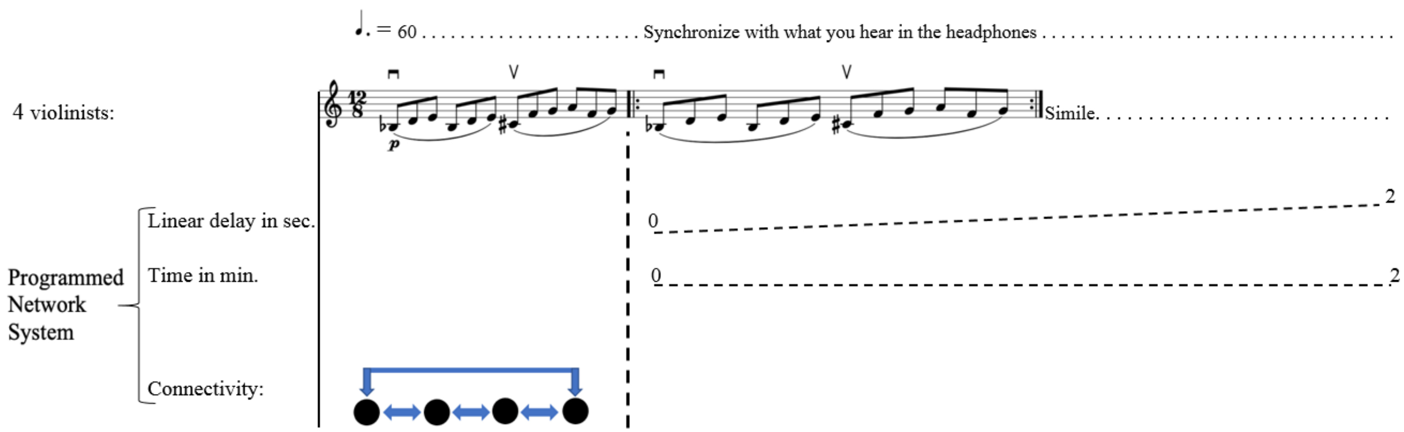
IV
(Trio)

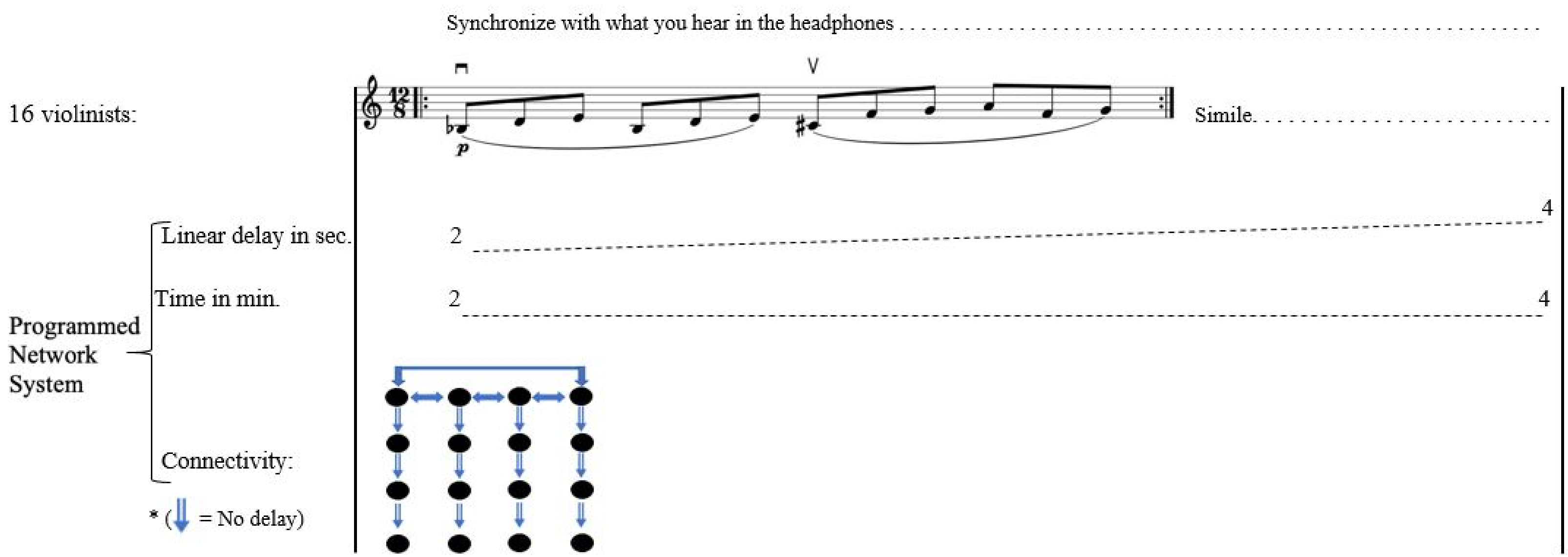

= 60 . . . . Synchronize with what you hear in the headphones . . . .
3 violinists:
Simile. . . . .
Programmed Network System
Linear delay in sec.
Time in min.
Connectivity:
0
4
0
4

V
(Hex)

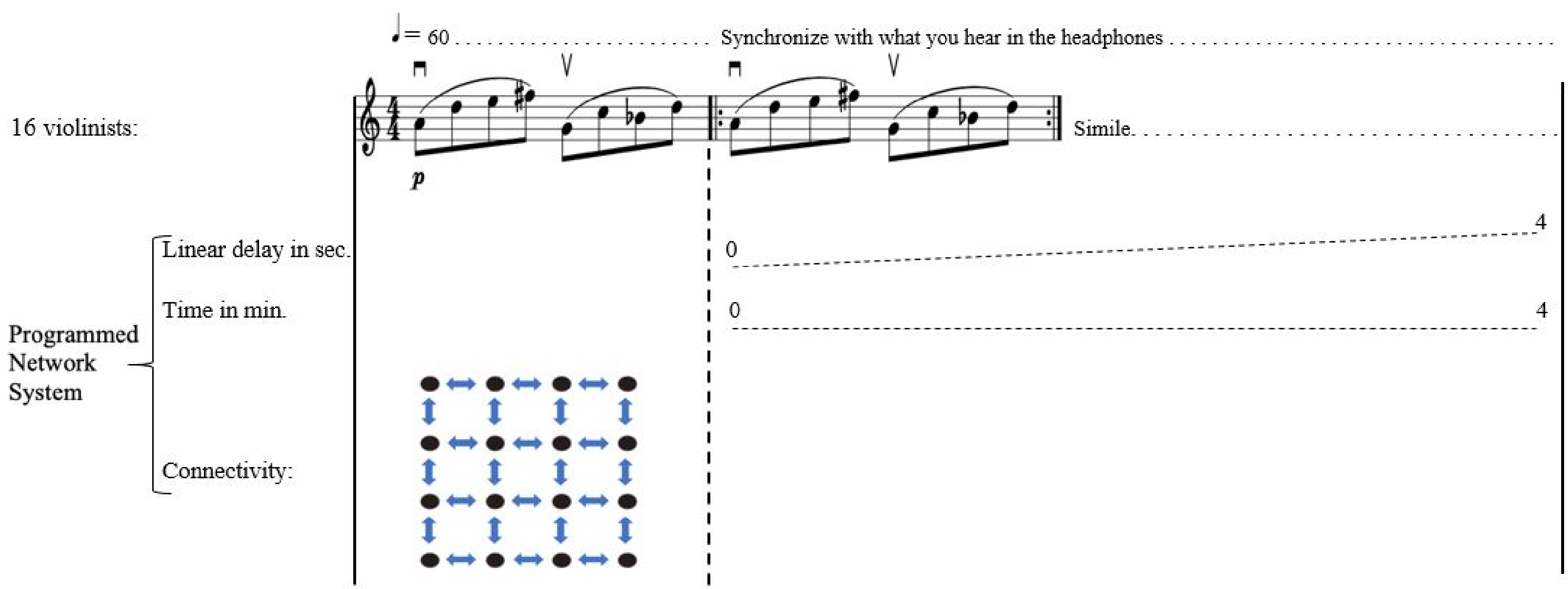

= 60 . . . . Synchronize with what you hear in the headphones . . . .
16 violinists:
12
8
p
Simile. . . . .
Programmed Network System
Linear delay in sec.
0
4
Time in min.
0
4
Connectivity:

VI
(Quartet + 12)




Synchronize with what you hear in the headphones . . . .
16 violinists:
p
Simile. . . . .
Linear delay in sec.
2
4
Time in min.
2
4
Programmed
Network
System
Connectivity:
* (= No delay)

VII
(Cubic)


= 60
Synchronize with what you hear in the headphones
16 violinists:
p
Simile.
Linear delay in sec.
0
4
Time in min.
0
4
Programmed
Network
System
Connectivity:

VIII
(Cubic Drone)