From Score to System: Composing with Distributed Networks in the Sync Platform

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ABSTRACT

Sync is a distributed performance platform that re-imagines composition as a dynamic real-time system. It empowers composers to shape music through spatial logic, evolving instructions, and responsive performer networks, adaptive behavior and multidirectional development. Based in systems theory, generative design, and spatial computing, Sync establishes a new paradigm where interaction, emergence, and distributed listening become central compositional tools. This paper presents conceptual models and practical strategies for composing with networks, behaviors, and space as core musical materials.

Keywords

Distributed Composition, Networked Performance, Spatial Sound, Generative Systems, Emergence, Real-time Music, Systemic Music, Algorithmic Composition

1. RESPONSIVE DISTRIBUTED SCORE

Traditional music composition is rooted in the centrality of the score: a fixed, linear framework where each performer's part is predefined and synchronized in time. Whether guided by a conductor or a sequencer, ensemble performance typically operates within a hierarchical structure, oriented toward a front-facing audience. The composer, in this model, is the architect of a static plan: what happens, when, and to whom.

Sync offers an alternative: it frames composition as the design of a responsive system. In Sync, each performer becomes a node in a distributed network, receiving individualized instructions in real time. These instructions can be deterministic or rule-based, enabling both precision and variation. The audience is immersed inside the system, surrounded by sound that unfolds dynamically, shaped by proximity, spatial relations, and performer interaction.

This shift invites new kinds of compositional thinking, many of which draw parallels to fields like data science, mathematics, and systems theory. For instance, if we imagine a performance grid as a 5×5 matrix, each position is not just a location in space but a potential source of sound, instruction, and interaction. Composers might define rules based on proximity, vector direction, matrix transformation, or graph traversal, creating music that unfolds according to abstract structures rather than fixed notation.

Fractal systems are one possible approach, enabling recursive developments across scales, but so too are statistical models, Markov chains, cellular automata, or linear algebraic transformations. Harmony, rhythm, and gesture become emergent properties of relationships: between nodes, between space and time, and between performer and audience.

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2. FROM NOTATION TO SYSTEM

Sync deploys many outputs simultaneously: performers are arranged in a grid or network, each receiving individualized instructions. Notes, phrases, and behaviors can follow predefined sequences or be computed, distributed, and rendered dynamically. This approach reframes composition as a form of structural thinking, where relationships between nodes determine how sound unfolds across space and time.

A 5×5 grid of performers becomes a matrix of musical potential. Rows, columns, diagonals, and localized clusters each acquire compositional significance. A composer might trigger notes along the first row and transpose voices in the third column, loop a motif diagonally with accelerating tempo, activate only those nodes adjacent to silence, or mirror gestures across the grid's central axis. These operations emerge from transformations applied to data structures.

Sync supports multiple structural models for composition. Fractal logic enables recursive development across multiple scales, graph networks define custom topologies and node relationships, cellular automata allow behaviors to evolve based on local conditions, and matrix operations shift musical values dynamically in response to systemic rules.

Through this lens, Sync becomes a tool for designing music as a living architecture, shaped by flow, transformation, and interaction.

3. HARMONY AS SPATIAL FIELD

In Sync harmony is a spatial phenomenon. Each performer acts as a localized emitter of sound, and their arrangement in space forms harmonic relationships that change with proximity and distribution.

This spatial harmonic relationship is best understood via the metaphor of additive color mixing. Just as overlapping light sources blend into new colors depending on their hue and intensity, overlapping musical voices in Sync create perceptual mixtures. A major triad formed by three surrounding nodes might feel radiant and stable, while a suspended or dissonant set produces tension that varies depending on the listener's position within the field (see Figure 2).

This expands harmony from a symbolic model (intervals, function, progression) into a topological model that is shaped by directionality, density, and spatial diffusion. Sync

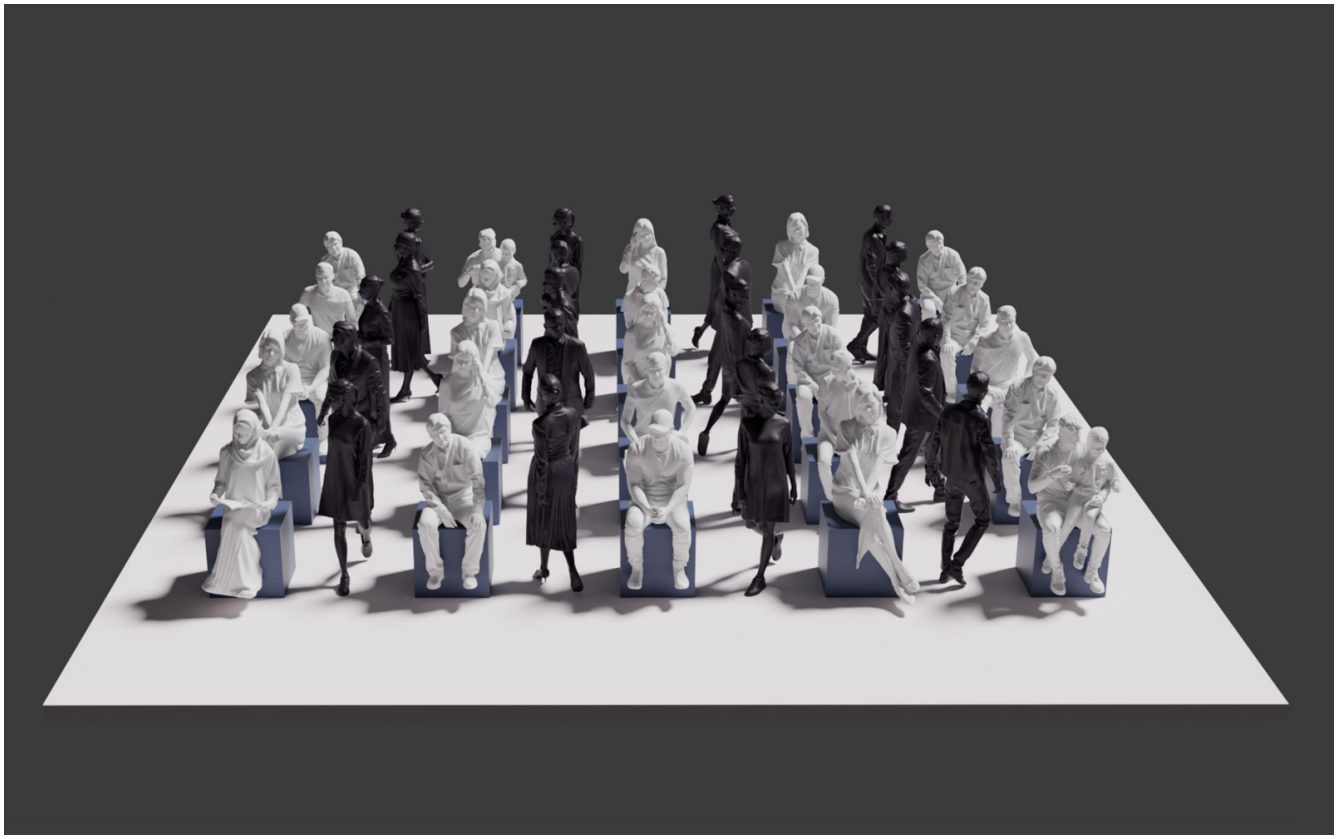

Figure 1: Rendering of the Sync spatial performance grid. The performers, represented as black figures, are placed among or around the white figures of the audience, creating an omni-directional sonic landscape.

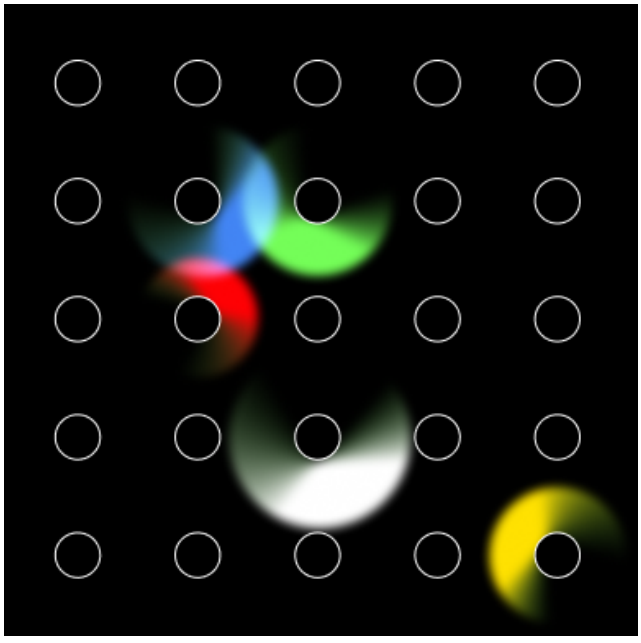

Figure 2: Spatial harmony illustrated through additive color mixing. Each white circle represents a performer emitting sound. Overlapping colored regions simulate harmonic blending, where proximity and arrangement create perceptual mixtures of tone, analogous to light mixing.

allows for control over which performers emit which voices, when they do so, and how these voices relate across time. A chord can be spatialized across the room, fragmented and reassembled as the audience moves through it. Nodes can shift roles, transpose material, or modulate locally.

4. MOTION, FLOW AND SPATIAL LISTENING

The music is distributed in space and capable of movement through it. The system treats space as an active dimension of composition, where motion is articulated through the sequence, transformation, or displacement of sound sources across the performer grid(see Figure 3).

Movement can be expressed in many ways. A melodic figure can travel horizontally across a row of performers, rotate around the audience, or ripple diagonally through the grid. A harmonic field can shift as one node drops out and another takes its place. Even silence can move, a rest traveling through the grid like a shadow.

This introduces a new kind of listening based on trajectory, perspective, and spatial memory. Because each node is independent, motion becomes a property of the system: a function of sequence, interaction, or displacement.

5. SYSTEM DESIGN AND EXPERIENTIAL LOGIC

Sync integrates sonic behavior, spatial choreography, and performer coordination into a unified compositional system. Performers are positioned around and among the audience, forming a living, omni-directional soundfield. Each performer holds a mobile device delivering real-time cues—visual

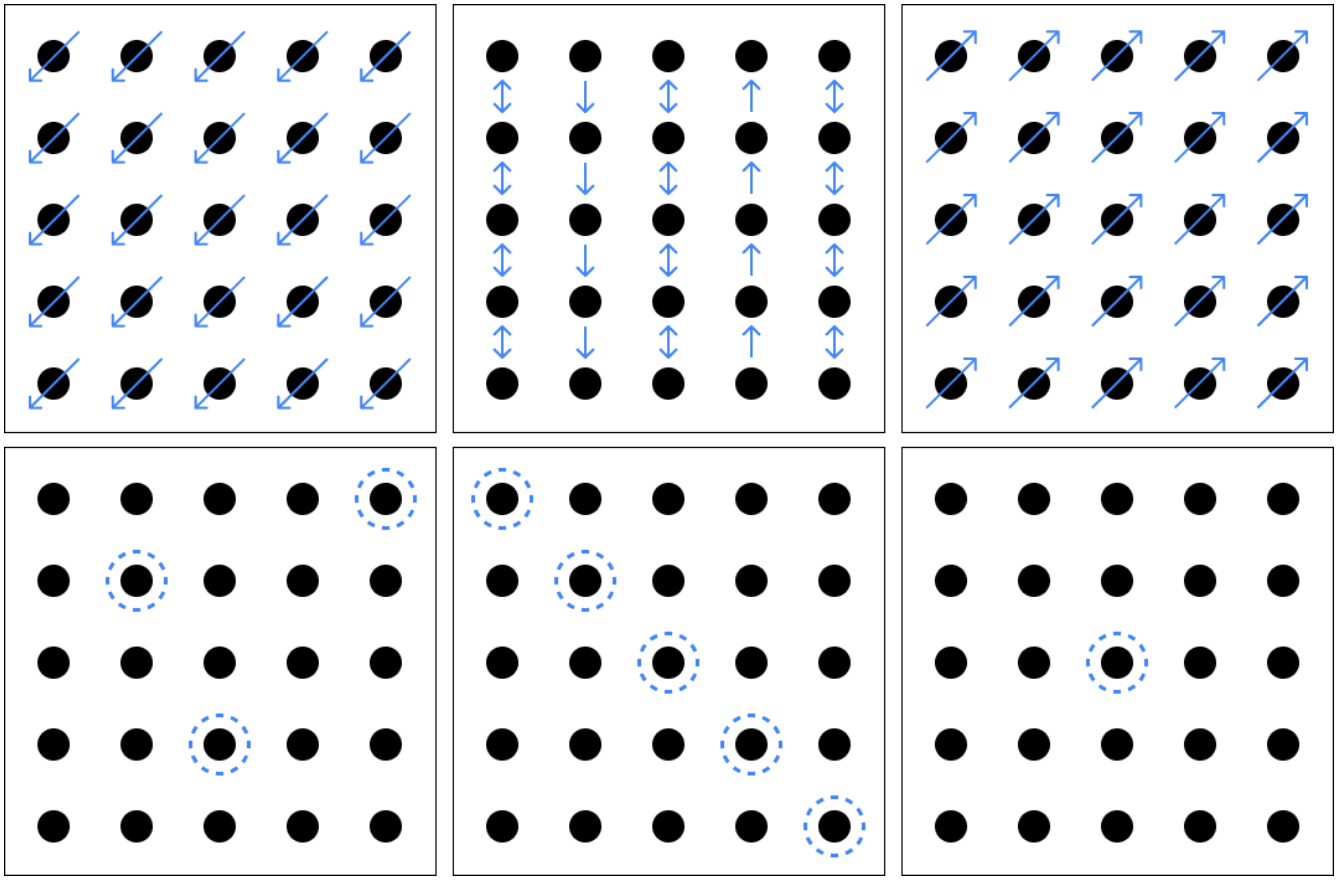

Figure 3: Top Row: Performers execute directional movements (rotations, vertical shifts, and diagonal gestures) guided by real-time mobile prompts. Bottom Row: Highlighted circles indicate active roles or featured sonic gestures, shifting focal points across the group.

signals, waveform pulses, and color prompts—generated by the system in response to spatial logic and timing conditions.

Audience members may be blindfolded, shifting attention inward and enhancing sensitivity to spatial, harmonic, and rhythmic dynamics. Rather than observing from a distance, the audience becomes immersed within the performance topology: sound emerges from proximity, choreography, and synchronized behaviors. Technology remains discreet. Performers use mobile devices minimally, allowing focus to remain on sonic coordination and spatial presence.

The system is designed around several key compositional aims. First, spatialized harmony enables musical voices to emerge from all directions, creating enveloping harmonic fields that shift and evolve. Second, real-time synchronization allows performers to respond to live cues with precision, facilitating tight coordination across the spatial grid. Third, guided immersion is achieved as the system choreographs layered textures of vocal and instrumental sound, producing a meditative yet dynamic experience. Finally, systemic simplicity ensures that the interface remains minimal and intuitive, empowering performers to engage deeply while maintaining perceptual clarity for the audience.

Sync turns the group into an instrument, space into a score, and real-time logic into a shared compositional flow.

6. SYNC PLATFORM OVERVIEW

Sync is implemented as a distributed system using Node.js for the server, WebSocket communication for real-time messaging, and a web-based frontend for performer interfaces. Each performer connects as a node to the server, receiving instructions computed on the fly based on spatial logic, structural rules, or algorithmic processes.

The system is designed to support up to 30 simultaneous performers over Wi-Fi, with synchronization handled via Ableton Link and OSC protocols for interoperability with external sound software. The platform is modular, scalable, and designed for low-latency networked performance.

7. SCALING SYNC: TOWARD LARGE-SCALE DISTRIBUTED PERFORMANCE

While the current Sync system supports up to 25–30 performers within a single Wi-Fi network, its modular architecture is designed for expansion. A scalable solution involves deploying multiple Sync instances across separate Wi-Fi clusters, each managing a localized group of performers. These clusters can be connected via Ethernet to a central control machine, forming a distributed architecture where each computer acts as a conductor for its group.

In this model, each local Sync instance synchronizes its performers using Ableton Link, while a master node coordinates inter-group behavior via MIDI or OSC. This allows high-level control over timing, triggering, and scene progression, while preserving low-latency communication within each cluster.

Although not yet tested at full scale, this design enables synchronization across 60, 90, or more performers distributed over multiple zones. It opens up possibilities for polyphonic,

polyspatial, and polymetric musical structures, where different clusters can perform independent roles or layered variations of a shared score.

Such distributed systems are critical for expanding Sync into immersive environments, large venues, or telematic performances. They offer a path forward for composers working at the intersection of technology, space, and collective sound behavior.

8. CONCLUSION

Sync introduces a new compositional space—a fundamentally different way of organizing sound. It encourages composers to think in terms of systems: structured environments where relationships, behaviors, and distributions generate musical form. This shift opens new dimensions in time, space, and interaction. Rather than relying on a static score, Sync operates as a dynamic network, treating behavior, proximity, and flow as compositional materials.

By engaging with data structures, real-time logic, and spatial distribution, composers are invited to think like system designers. Harmony becomes an immersive field, rhythm unfolds as a dialogue between local and global patterns, motion is treated as a musical phrase, and form arises as an emergent structure shaped by interaction and behavior.

As we move into an era defined by responsive systems, spatial computing, and hybrid performance environments, Sync offers a framework for composing with networks, rules, and distributed presence. It provides the tools to create musical experiences that are immersive, interactive, and spatially aware—experiences that transcend the limitations of the page or the timeline.

For composers and performance artists seeking to move beyond fixed formats, Sync opens a door not only to new sounds, but to new ways of conceptualizing sound itself.

Ethical Standards

This research did not involve human participants or personal data. All design and technical work was conducted in alignment with the ethical principles of the NIME community.

Acknowledgments

This project was independently developed, with thanks to collaborators and testers who contributed feedback on the Sync system's development and performance. For video documentation, visit `https://mrcavallari.com/sync/`.