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Osmosis: Asymmetries in Telematic Performance

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Abstract

For the 2022 edition of the NowNet Arts Conference on October 31st, the telematic research team of the Zurich University of the Arts (ZHdK) presented a project entitled OSMOSIS.[2] OSMOSIS was a concert event, highlighting how telematically connected spaces always confront each other asymmetrically. Their telematic connection is part of a continuous space in which information is fragmented and selectively reassembled. Like the biochemical process of osmosis in which molecules diffuse across a cell membrane from one level of concentration to another, in telematic connections certain elements such as sound, physicality, movement, and empathy are diffused across spaces, each being transmitted differently and thus perceived differently at their respective destinations.

Special attention was paid to the decomposition of visual objects and perspective across two separate stages. By arranging two telematically connected spaces within the campus building of the Zurich University of the Arts, the project created a possibility for the audience to visit both sides of the telematic arrangement in two consecutive performances—one side per performance—and therefore perceive the asymmetry between the two "spaces."

In addition to the bidirectional connection between the two spaces, a version of OSMOSIS was broadcasted via OBS and Vimeo to the NowNet Arts Venue using a split screen and a binaural sound mix. A third space was created for the Metaverse. This virtual space included elements of the two performance venues on campus and allowed the online visitors to move cubes via the keyboard of their personal device.

The complexity of the interconnected layers of the performance was a great challenge on the level of technique as well as musical interaction. Focusing on asymmetries in a telematic performance opened up a wide field of possible interactions between distant spaces for future telematic projects.

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[2] A video documenting the performance of OSMOSIS may be viewed on YouTube at https://youtu.be/4kWPe-UgLZI.

Symmetry—Asymmetry

Connecting remote spaces via the network and thereby fragmenting the sonic, visual, and performative aspects of the involved spaces creates extremely complex conditions. The Swiss National Science Foundation (SNSF) research project "Spatial Dis/Continuity in Telematic Performances,"[3] hosted by the ICST as part of the Zurich University of the Arts (ZHdK), aims to explore such aspects and potentials, with a focus on spatial characteristics and their interplay with interconnected locations.

From the performer's perspective, one of the most complex questions to answer is that of the physical and sonic representation of a performance in a remote space. The predominant aspect of disembodiment is a great challenge for the intuition and empathy of the performers playing together over a distance. Starting from the spatial presence in one's own space, one is tempted to imagine the presence in the remote space as being mirrored or symmetrical. For performers, it is very difficult to give up this notion, and any action or reaction must deal with empathy for the remote space.

Dealing with a remote space in interactively networked performances raises the question of what aspects and elements of a site's local performance can be accordingly represented in the remote space, as well as what the appropriate means for staging elements of a remote performance can be, both visual and aural, in order to create a coherent and complete work of art. Accepting the asymmetry of a telematic connection opens a wide field of dramaturgical possibilities for performances. For example, the movement of actors in one room can influence the sound in a distant room via ambisonic sound projection. On the other hand, projections on movable objects instead of static screens can create new inputs for musicians at a distance.

To make such possibilities of interactive playing tangible for an audience, two rooms in one building were connected via a network. Halfway through the performance, visitors switched rooms and saw the same dramaturgy from a different angle perspective. In one of the spaces, visitors were invited to create their own stage setup by placing mobile sound cubes in the room. The other space showed a more traditional theater setting.

Improvisation/Composition in Telematic Settings

The musical material of a trio—bass flute, contrabass, percussion—was entirely improvised, with the bass flutist and contrabassist in one room and the percussionist in the other room. Improvisation as a musical method allows musicians to adjust individually to the stage and acoustic setup of space, projections, and sound. The term "osmosis" in a figurative sense also includes the process of adaptation

[3] "Telematic Performance Format," SNSF research project at Zurich University of the Arts, accessed March 10, 2023, https://networkperformance.space.

to a new situation. This adaptation occurs through the musicians' perception of the overall setting, and the music develops during the performance, instead of following an overall musical composition. The freedom to make individual musical decisions at any time increases the ability to react to the response of distant performers on musical actions. The improvised musical reaction becomes a unifying element within the telematic space.

However, a performance of such complexity still requires some dramaturgical framework. In OSMOSIS, the overall direction was steered by project manager Patrick Müller. The various scenes of the performance were displayed as cues via individual iPads.

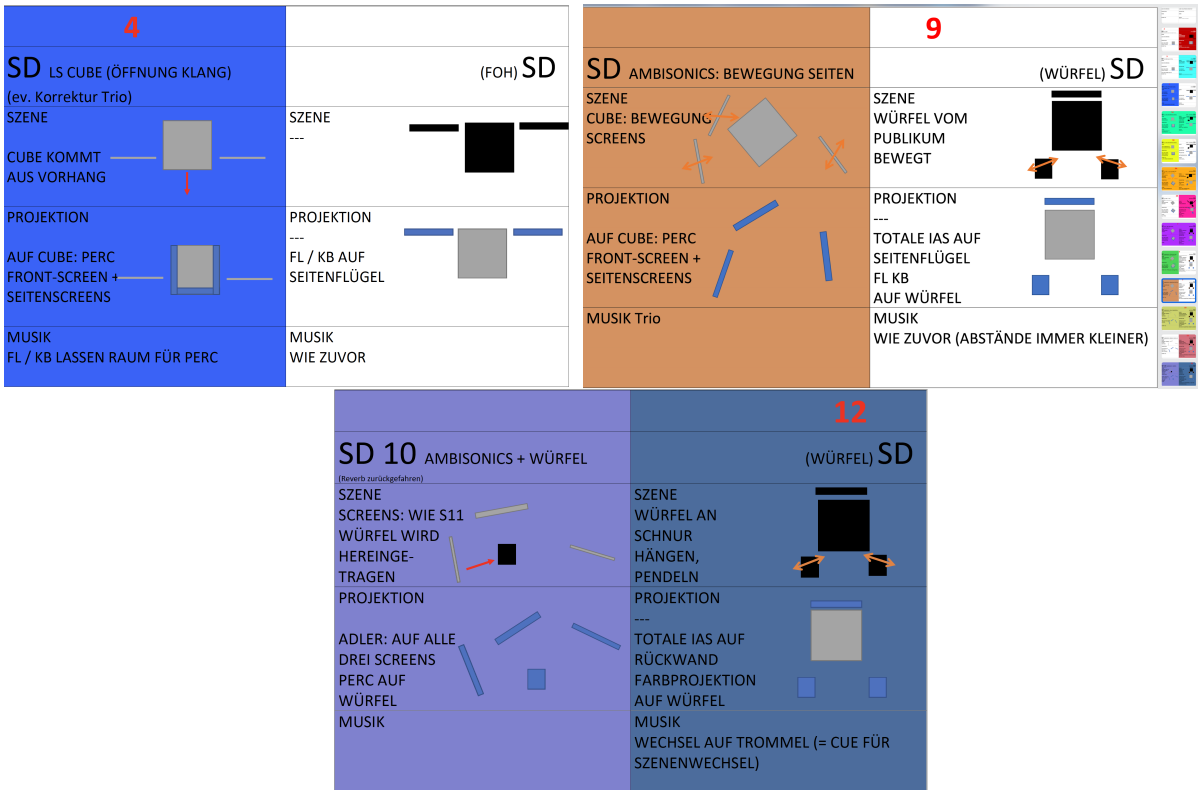

Figure 1: Three scenes with movements of elements on stage as displayed on iPads.

Fragmentation of Objects

The fragmentation of the sonic and visual components of a performance on stage was deliberately made visible by allowing the central projection surface on the stage of the Immersive Arts Space (IA-Space)—a cube—to be deconstructed and displayed as a fragmented object. Joel de Giovanni, responsible for the visuals, designed a detachable mobile cube for image projections. The cube can be disassembled into three individual projection surfaces. Due to tracking of the cube elements and projection mapping, three different perspectives on the percussion player in the distant space can be projected individually on the three screens of the fragmented cube. The mapping of the auditory

changes that resulted from the deconstruction of the distant object (cube with built-in percussion instruments) was achieved via the ambisonic sound system.

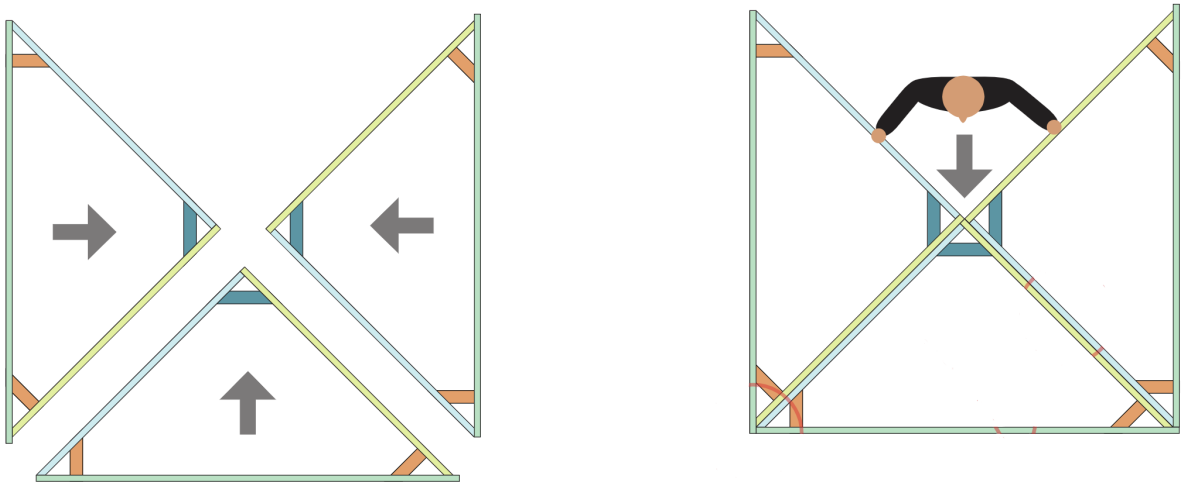

Figure 2: Mobile dismountable cube for the projection (Design by Joel De Giovanni).

Figure 3: IA-Space with fragmented cube.

Setting of Spaces 1 and 2

1. IA-Space

The Immersive Arts Space of Zurich University of the Arts is equipped with a full 36-speaker ambisonic surround system as well as a motion capturing and projection mapping system called

SPARCK (**SP**atial **A**ugmented **R**eality **C**onstruction **K**it)[4] developed by Martin Fröhlich at the Institute for Computer Music and Sound Technology. Furthermore the space is equipped with a motion-capture system, projectors, and a PA system. For the audience of OSMOSIS the IA-Space was arranged in the traditional setting of a concert venue with several rows of seats, on stage a double Bass and a Bass flute. Due to Ambisonics the sound projection was very flexible.

In the middle of the stage there was a projection on a cube with a 2m side length, displaying a percussionist playing in the remote space. Thanks to the projection mapping system Sparck the cube could be moved and taken apart without distorting the projection on its surfaces.

[4] *SPARCK* ,cross-platform media and virtual reality package for the creation of interactive spatial augmented reality installations. "SPARCK," TecArtLab, accessed March 10, 2023, https://tecartlab.com/sparck/.

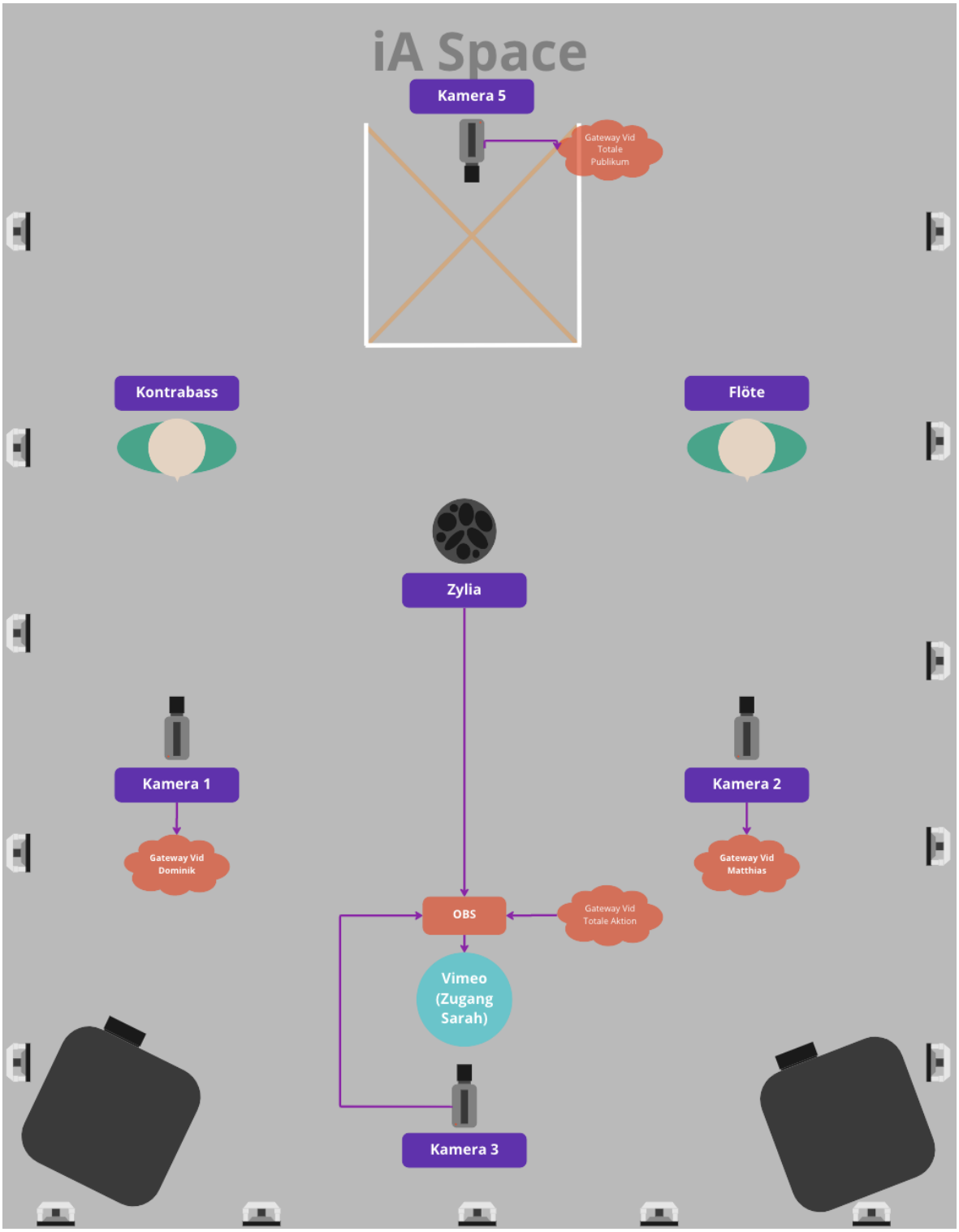

Figure 4: IA Space (1) (Design by Joel De Giovanni).

Figure 5: Audience setup at the Immersive Arts Space.

2. "Aktionsraum"

The setting of this space had the character of an installation rather than a traditional concert. Visitors were moving freely in the space. On one hand there was the direct sound of the local musician—a percussionist—whose instrument was built inside a metal frame in the shape of a cube with a side length of two meters. Metal Instruments were placed to the left, Skin Instruments to the back, and Wood Instruments to the right. On the other hand a FoH speaker system was in use. In addition to that, two mobile sound sources in the shape of small cubes with built-in loudspeakers were provided. They also served as small surfaces for audiovisual projections of the musicians from the remote space. The cubes could be carried around by the visitors. The actions in this space were coordinated and directed by Benjamin Burger.

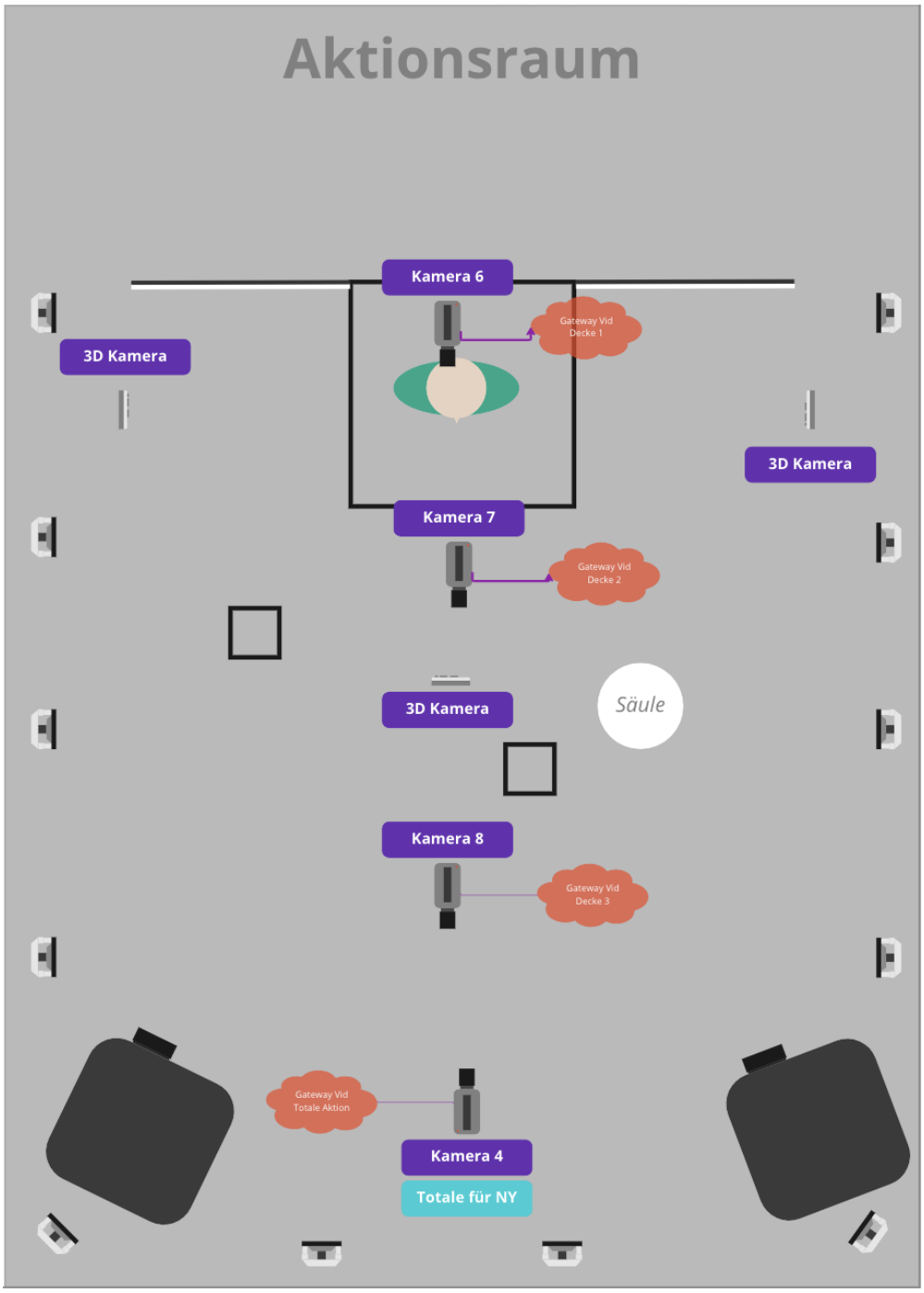

Figure 6: "Aktionsraum" Space (2) (Design by Joel De Giovanni).

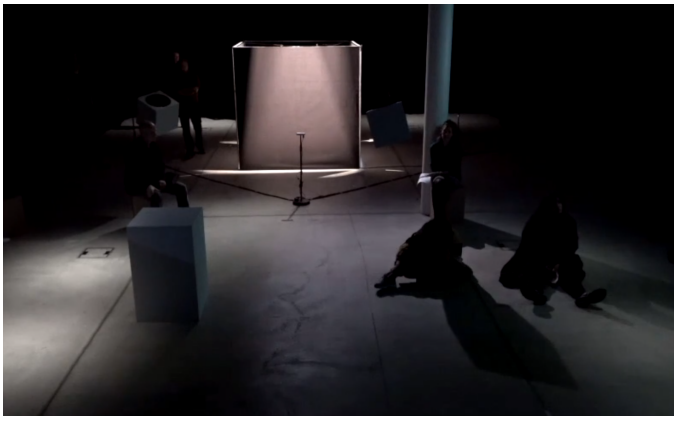

Figure 7: Percussion cube covered.

Figure 8: Percussion cube open with projection on two small cubes.

Figure 9: Musicians stage setting at "Aktionsraum."

Technical Setup

During the live performance of OSMOSIS, about 30 data streams were sent via a server for motion capture, video, and audio between the involved spaces. In addition to direct sound and image transmission, motion tracking data of the moving objects on stage was generated. This data was used to control the sound and projection in the remote room. The tracking data of the cube objects in one space influenced the sound diffusion in the ambisonic system of the second space, as well as the

projection onto the moving objects. Various software was used in parallel to handle the multiple data streams.

The Telemersive Gateway[5] is a peer-to-peer application based on MaxMSP. It allows one to converse with multiple peers across different networks. A central server, called the Telemersive Router,[6] allows one to create virtual rooms where all peers can share their available resources.

The TPF-Client[7] is a low-latency multi-channel audio transmission software based on the AoO (Audio over OSC) protocol. It was developed at ZHdK by Roman Haefeli and Johannes Schütt. In the context of telematic concerts it is usually combined with a DAW, Ardour or Reaper.

Ultragrid[8] is a software for low latency, high-quality video network transmissions that handled the numerous bidirectional video data streams.

For the projection of video streams on the movable objects objects, SPARCK[9] was used. SPARCK is a software for motion tracking and video projection, developed in 2014 by Martin Fröhlich at ICST, ZHdK.

The effort for the project was substantial and various technical problems became apparent during the work. They were mainly clock issues and protocol problems between the local Dante Network and the TPF client. The solution to that issue was that in the network settings of the main computer Dante had to be listed first.

Signal Routing: IA Space

All the microphone and speaker lines were connected over a Yamaha mixing console to the computers by Dante. The speaker settings could be arranged by the coloured Radar of the Ambisonic plug-in. A wireless connection was used for mobile speakers.

[5] *Telemersive Gateway*, GitLab repository, accessed March 2, 2023, https://gitlab.zhdk.ch/telemersion/telemersive-gateway.
[6] *Telemersive Router,* GitLab repository, accessed March 2, 2023, https://gitlab.zhdk.ch/telemersion/telemersive-router.
[7] *TPF-Client*, GitHub repository, accessed March 2, 2023, https://github.com/zhdk/tpf-client
[8] *Ultragrid,* Ultragrid official website, accessed March 2, 2023, http://ultragrid.cz.
[9] *SPARCK*, GitHub repository, accessed March 10, 2023, https://github.com/immersive-arts/Sparck2. See also https://tecartlab.com.

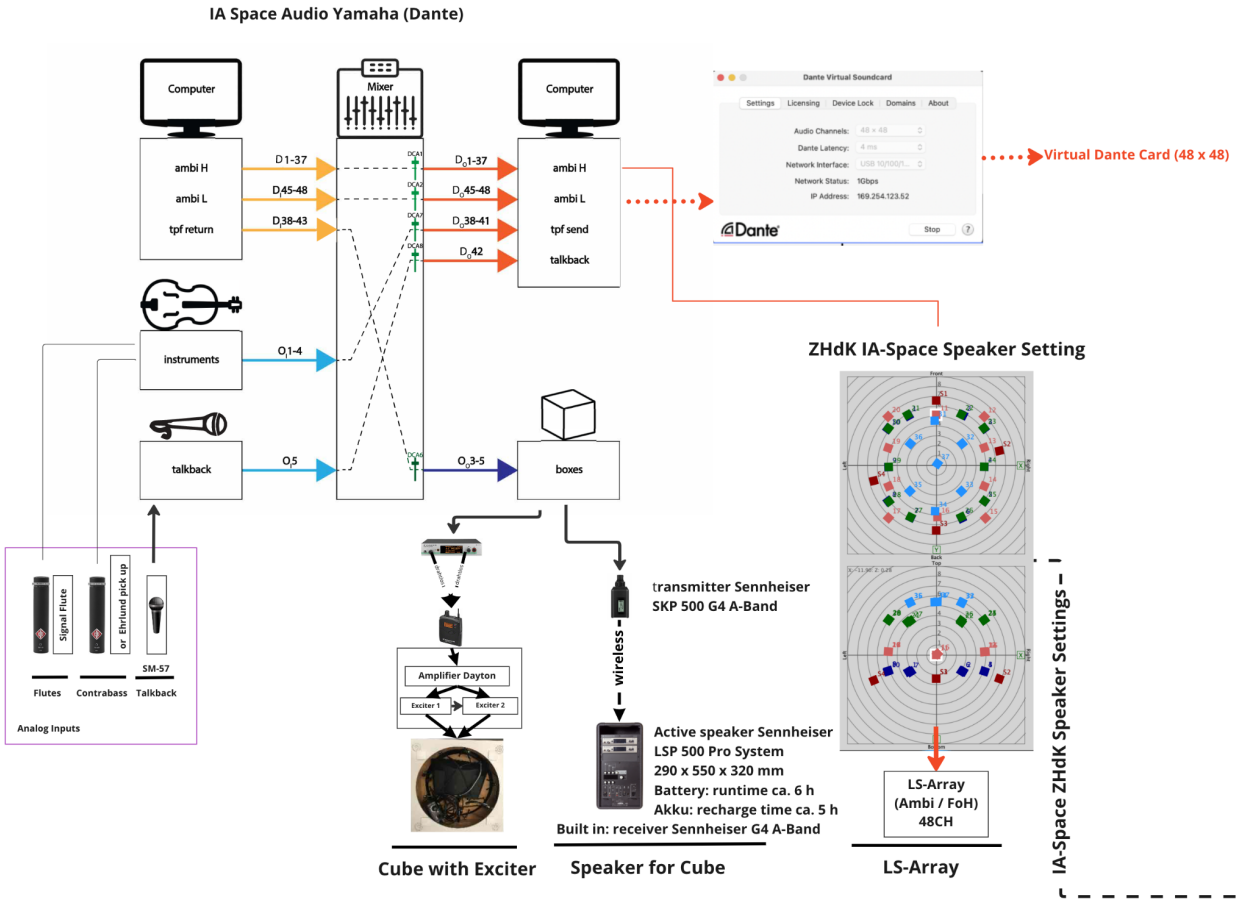

Figure 10: IA-Space, Audio signal routing Yamaha/Dante, sound cube, live musicians (Design by Johannes Schütt).

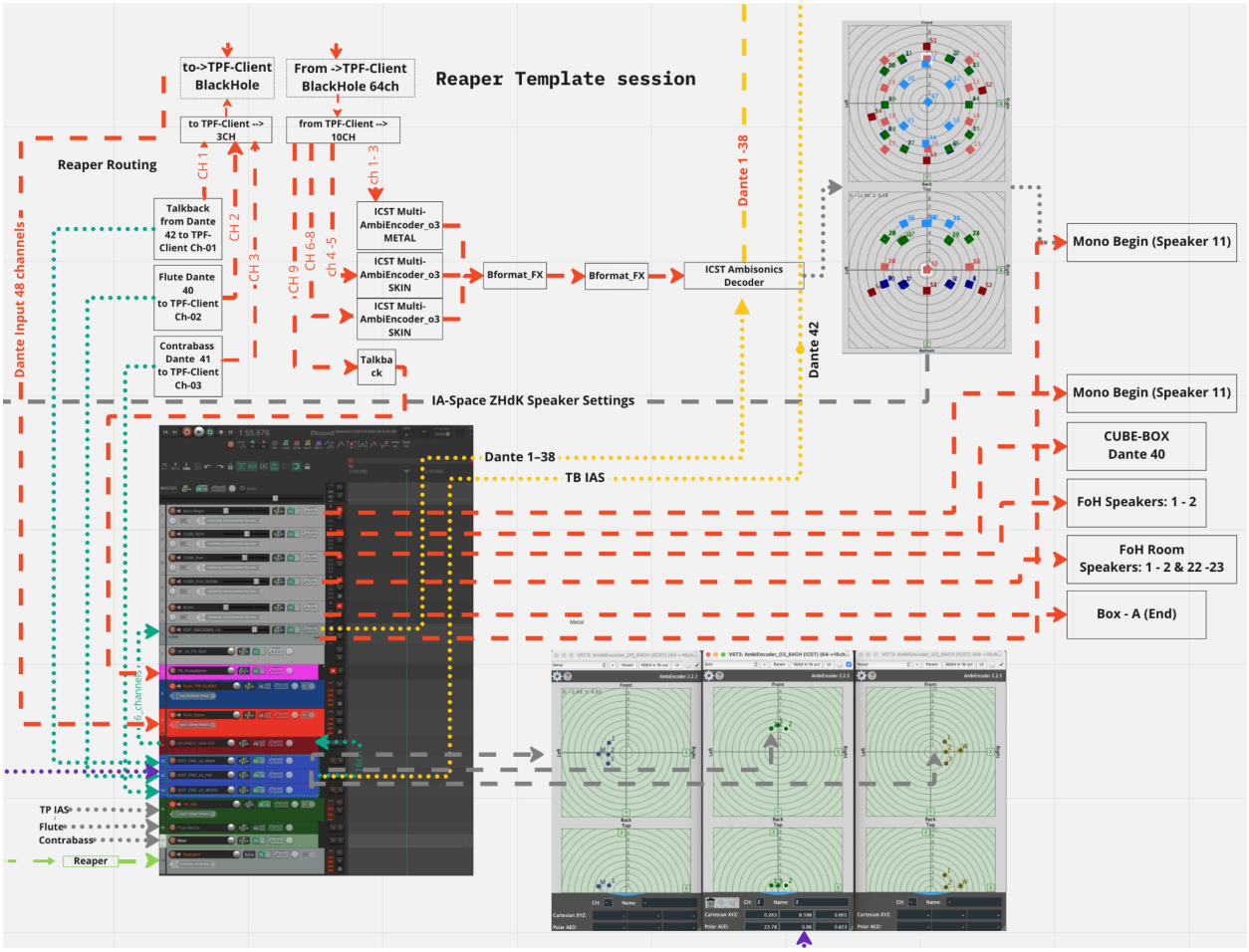

Figure 11: Audio signal routing into Reaper, ICST Ambisonics plugins (Design by Johannes Schütt).

Signal routing: "Aktionsraum"

The "Aktionsraum" was equipped with DAW Reaper, and Blackhole over Jack for the connection to the TPF-Client.[10] TPF-Client is a low-latency multi-channel audio transmission software based on the AoO (Audio-over-OSC) protocol. It was developed in 2020 at ZHdK by Roman Haefeli and Johannes Schütt.

For the visual projections, three Intel RealSense Depth Cameras were used. For the sound setup, two front speakers and two back speakers were used without ambisonics.

[10] *TPF-Client*, GitHub repository, accessed on March 10, 2023, https://github.com/zhdk/tpf-client.

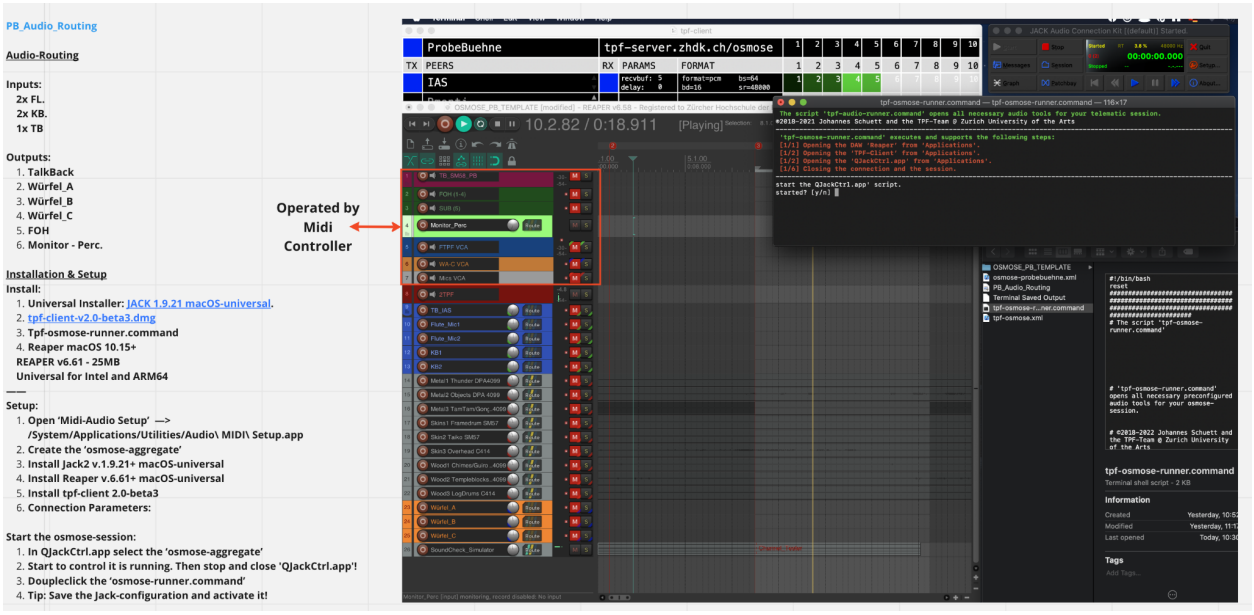

Figure 12: Audio signal routing to TPF-client using Reaper and Blackhole (Design by Johannes Schütt).

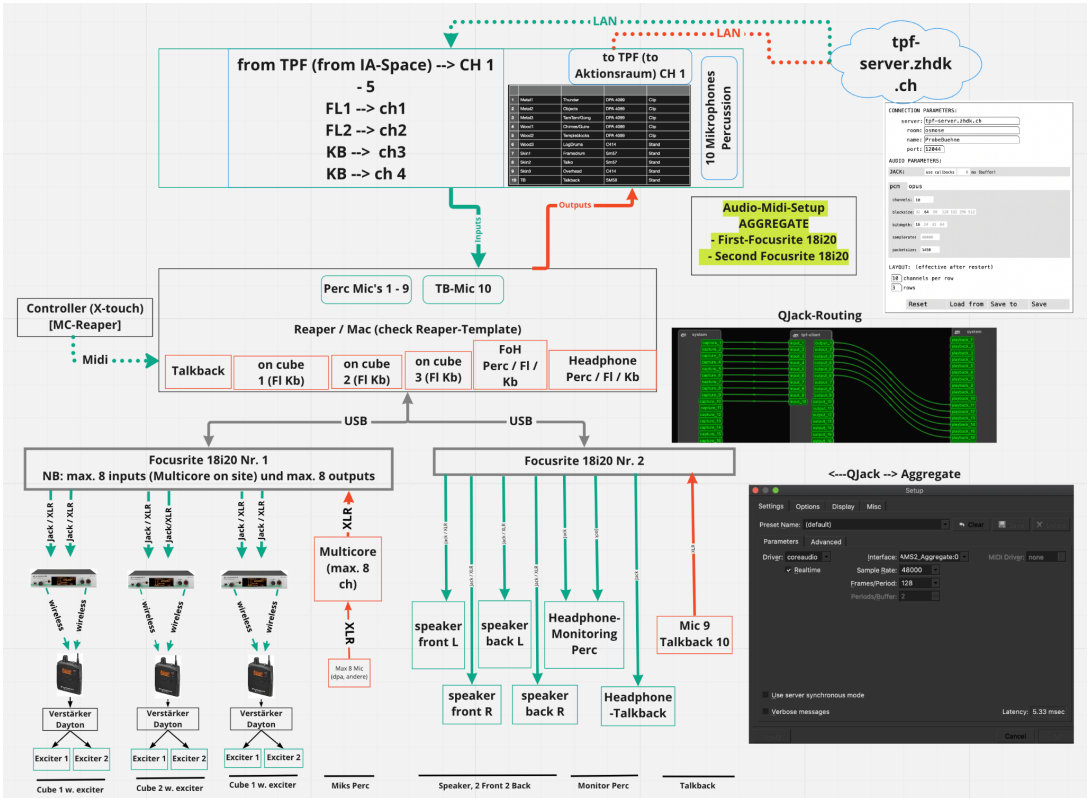

Figure 13: Signal routing "Aktionsraum" microphones through Reaper to the mobile sound cubes (Design by Johannes Schütt).

Streaming the Apparatus: The Third Space

The basic layout of "Osmosis" assumes that two spaces are telematically connected. Both places have a live audience and a stage setup. In the context of the NowNet Arts Conference 2022, the question arose of how to convey this setting online as the conference was hybrid. This was accomplished in two ways. One solution was to present it with a split screen for online participants. This was done over OBS and then live streamed to Vimeo. However, the permeability of the concert setting was only shown to a limited extent. On the visual level there was only a limited immersivity, whereas the sound was transmitted as a binaural mix.

Figure 14: Screenshot of video feed streaming “Osmosis” over OBS to Vimeo.

Streaming over the Metaverse

To make the streaming format more attractive, a third space was designed by Oliver Sahli[11] (Immersive Arts Space) for the Metaverse. It was a virtual platform containing elements of both physical spaces. Visitors who accessed the platform by clicking a URL could rotate the percussionist's cube element using the keyboard of their device. The percussionist's cube was captured with Intel RealSense Depth Cameras. The movement of the cube in the third space looked correct in perspective.

11 Oliver Sahli, accessed on April 23, 2022, https://oliversah.li/.

This format is not yet fully developed and, based on its success in the performance of "Osmosis," holds great potential for further performances.

Figure 15: Screenshot of Osmosis over the Metaverse.

Conclusion

The "Osmosis" project has shown that numerous new approaches to performances can be obtained from analyzing the asymmetry of telematic connections. The software used in the project is freely available and the work of the Telematic Research Project at ZHdK can be followed at its website.[12] The challenge of hybrid performances, including virtual platforms will be a major focus for future projects. The three years research project *Spatial Dis/Continuities in Telematic Performances* will continue until October 2024.

[12] "Telematic Research Project," accessed March 10, 2023, www.networkperformance.space.

Acknowledgements

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Team

Patrick Müller (overall direction research project, concept)
Matthias Ziegler (overall concept, music, flute)
Joel De Giovanni (image, sound cubes, staging)
Benjamin Burger (staging, direction),
Johannes Schütt (audio engineering, streaming)
Martin Fröhlich (motion capture, projection mapping, streaming)
Hannah Walter (sound cubes)
Roman Haefeli (IT, streaming)
Patrycja Pakiela (live mix)
Oliver Sahli (virtual platform)
Dominique Girod (contrabass)
Sylwia Zytynska (percussion)

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