Cloudspeakers – a mobile performance network

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ABSTRACT

In this project we developed a network of cloudspeakers. These are mobile speakers connected to a raspberry pi3 equipped with a low-latency audio card. They are connected to a wifi network and run a SuperCollider-Server (*scsynth*). Our cloudspeaker can be addressed with the SuperCollider (*sclang*) in the network. For this purpose we had to create a stable and scaleable network, and we had to find solutions for problems like latency, jitter, or software management. This network can be used for artistic projects and can be combined with a webserver and the use of mobile devices.

1. INTRODUCTION

With "Die Neukoms" [1] we played some concerts where live music was streamed over mobile phones. In our playful experiments we observed how the use of mobile devices by the audience led to an very specific acoustic situation. By using personal mobile devices, we were able to connect to the intimate space [2] of the listener. The audience began to play with their mobile devices (e.g. the position and direction of sound output). We as musicians responded to the spatial and participatory feedback. A social dimension emerged during the concert. The same or similar phenomenon was observed in the projekt *fields* [3] of Tim Shaw and S'ebastien Piquemal.

We also observed that the spatial distribution and the temporal delays of the different mobile devices resulted in a distinct gesture of spatialization. This acoustic situation reminds us of a natural soundscape of a forest, and we have called it *sonotope.* This gestural space evokes an approach that places in the foreground the space as the primary musical form of expression.

This led us to develop *cloudspeakers*. These are controlled by data (OSC) over a wifi-network in order to have more influence on spatialization.

2. HARDWARE

loudspeaker + raspberry pi + wifi = Cloudspeaker.

The idea behind *Cloudspeakers* is to have a system of free speakers (= without cable), and to enable audience interaction. Cloud-speakers can be controlled and configured by a central computer. By means of sensors or measurements of the Wifi field strength, the position in a room could be determined. All speakers are equipped with a Raspberry Pi3. These microcomputers have a high-quality Cirrus Logic AudioShield, a headless realtime Linux OS installed, and SuperCollider server (scsynth) works as an audio server.

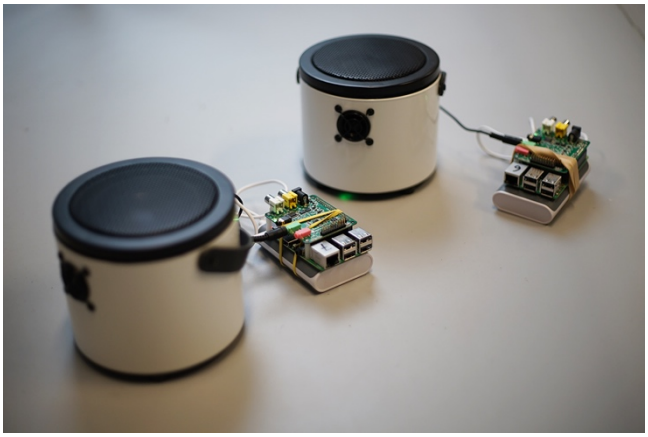

Figure 1. mobile loudspeaker + raspberry pi3

3. NETWORK

3.1 Configuration

These servers can be addressed via Wifi using the OSC protocol. All speakers are integrated into a local Wifi network. To optimally configure and control this network, both a Wifi access point (Unifi AC / AP) and an industrial grade router (Alix-pfSense) are used. A small webserver is also integrated to allow interactions. The figure 2 shows the setup. MBP are Macbooks running *sclang,* also a webserver is integrated. Figure 3 shows the protocols that has been used.

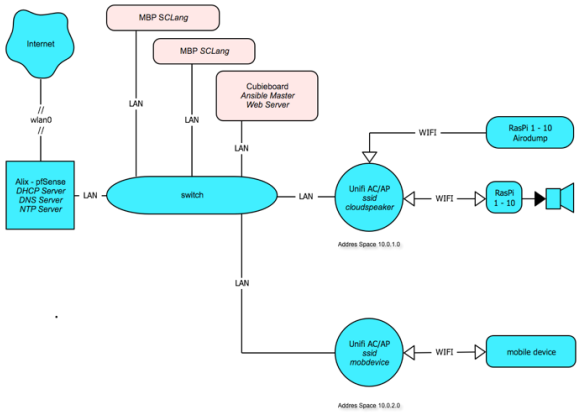

Figure 2. network setup.

Web Audio Conference WAC-2017, August 21–23, 2017, London, UK.

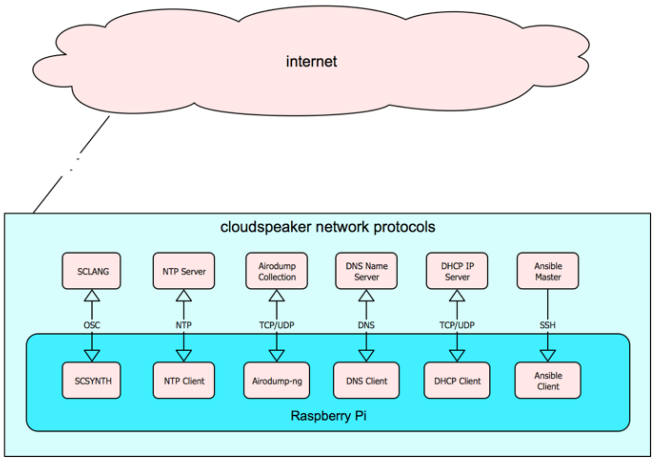

Figure 2. network protocols

3.2 Problem areas and possible solutions

- Network stability:
  We used a DHPC / DNS router based on the open-source program pfSense. This bundle simplifies the configuration, it is open source and runs on any intel-hardware with a few network interfaces.
- Network latencies:
  First we used pfSense also as an NTP server. It is necessary for starting the sound on individual cloudspeakers at the same moment and to provide synchronicity. The latencies between the individual nodes is around 4-8ms in our test environment.
- Synchronization of time:
  Although the individual devices get the same time with a difference of less than 10mS, the difference can grow quite big in a few hours. Also, NTP will re-align itself after a difference of about 1000mS, which is, of course, too much for our purposes. PTP would provide a much more accurate solution. Because of the greater hardware expenditure we could not yet pursue this. In a new setup we configurate the cubieboard with a gps-modul as NTP-server. It is very accurate now.
- Network jitter:
  The latency is not very stable in a Wifi network. It changes constantly. The latencies differ on every node. In our test environment it was between 0.5ms and 9ms on average. In SuperCollider we have used Timestamped OSC, to be able to place events in the future. We set this above the latency plus the jitter time.
- Software management and administration:
  Soon, we came upon the Question how we can manage scalable multiple RaspberryPis. With Ansible [4] we have found a lightweight software which not only manages software but can also start applications from a single location. It is scalable, and is very easy to configure. [5]
- Location of mobile devices / listeners:
  The application *airodump* is used here. The package can have a WIFI dongle in monitor mode, and thus enables a measurement of the Wifi strength. This software is also available in existing networks, and we are using this inventory.
- OSC communication mobile devices:
  The communication of the web application should be fast. Also there should be a bidirectional connection between web server, a web client and a music application on a server. As a framework we used rhizome [6]. It provides a complete implementation with Nodejs and OSC communication. For the communication with mobile devices it uses websocket. Other projects already examined the possibilities of syncronisation with mobile devices and webaudio. [7]

4. CONCLUSION

We were able to create a mobile network with cloudspeakers which can be used for artistic projects. The project is in an early stage. We indentified technical problems and possible solutions. However, we need further development to make a reliable and stable system, which can be used easily for various artistic projects. It is a unusual but also interesting approach to generate the sound directly on the *cloudspeakers* or mobile devices themselves. Additionally we used the mobile devices as interactive controllers. These approaches may lead to interesting artistic solutions. We realized first projects, e. g. *Play Descartes* which was shown during the conference of the Project *Sound Colour Space [8]*. We like to realize further artistic performances to explore the possibilities of *Cloudspeakers*.

5. ACKNOWLEDGMENTS

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