

# Bridging the Airgap Communication via (ultra-) sound and others

Degree programme: BSc in Informatik | Specialisation: Mobile Computing  
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This Bachelor thesis provides a proof of concept for data transmission via sound waves alternative to conventional wireless communication solutions.

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## Present Situation

These days, the wireless communication between all kind of devices has become integral in various parts of our daily life, such as paying your errands with Twint, or streaming your favorite music. To satisfy the need for wireless communication, many standards like WiFi, Bluetooth or NFC exist. But as much as they may differ in their functionality and use case, they all share a common ground. All of them use electromagnetic waves to transmit information. If two devices are not able to communicate via the conventional way, we tend to say that these unconnected devices are air-gapped.

## The Idea

Almost every device provides access to speaker and microphone, thus it is able to produce and record sound. The idea is to take advantage of these existing resources by using sound waves for data transmission. In comparison to conventional technologies, the hardware requirements are low for this approach. In fact it is only limited by the capabilities of the audio peripherals and therefore it could easily be adapted for cross platform communication.

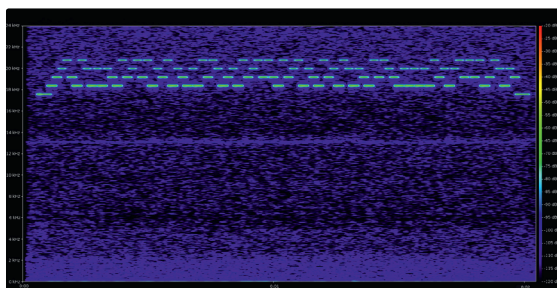
## Scope of the Thesis

The goal of this thesis is the development of an Android API to provide an interface for data transmission via sound waves. Thereby particular emphasis is placed on the inaudible communication in the ultrasonic range. To fulfill this requirement and yet to reach other devices over the airgap as far as possible, a sort of frequency modulation was developed. The approach uses a small set of carrier frequencies to send data in the ultrasonic range like it is shown in the spectrogram on the left side. Besides, the API also provides the possibility of an audible transmission in the lower frequency areas.

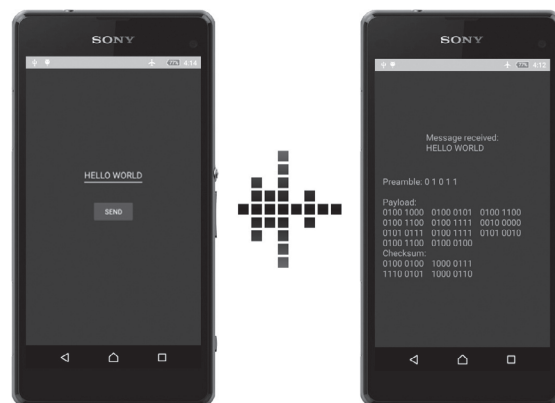
The challenge of data transmission via sound waves is the high degree of noise and the low sound pressure of the speaker. For this reason the receiver interface uses a combination of digital filters and a special form of the Fourier Transform (Goertzel's algorithm) for the interpretation of the audio signal. The implemented proof of concept offers the developer an interface to bridge the air-gap and transmit arbitrary binary data. As an example, this can be used for a message transmission, illustrated in the image below.



Christian Lukas Nydegger



The spectrogram reveals the data modulated in the inaudible ultrasonic range



Message transmission between Android phones with the implemented sound interface