Demo: BYOE: Bring Your Own Earphones

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ABSTRACT

We demonstrate a device that plugs into the audio jack of a TV and broadcasts the audio over Wi-Fi. Nearby mobile devices can capture these Wi-Fi packets and extract the audio for playback on the user's earphones.

1 INTRODUCTION

Public TVs and screens are ubiquitous in modern society. We see them at doctor's offices, at restaurants, at airports, in corridors of office and university buildings, at museums, in buses, and so on. They offer information, entertainment, advertisements, or sometimes are just a means to pass time while waiting for something important. Overall, public TVs provide a variety of conveniences. However, managing the audio from such TVs can be a challenge. In some spaces, such as the doctor's office, the audio could be a nuisance, in others, such as a restaurant, the TV volume will have to be very different for spectators nearby versus those far away. In some places such as the airport, only a small fraction of the people in the vicinity might want to hear the TV while most people in the vicinity are busy in other activities.

In this demo, we present BYOE, short for Bring Your Own Earphones, which is a system to overcome the audio challenges faced by public displays. The idea is quite simple: we have developed a Wi-Fi broadcast device that plugs into the TV's audio port and broadcasts the audio as tagged Wi-Fi packets that any nearby phone could receive, extract the audio from Wi-Fi packets and play the audio. We use Wi-Fi broadcast so there is no limit to how many users can simultaneously listen to the audio, and no user account or Internet access is necessary. We have developed a generic Android App that can be used in any location that has our BYOE hardware at the TVs. When more than one TV is present in the vicinity, say at a restaurant, a simple code can be displayed below the TV that the user types into the phone app. The phone then only captures Wi-Fi broadcast packets with the appropriate application-level tag and discards any other Wi-Fi packets, allowing multiple TVs to each have their own audio feed with users choosing to hear any of them.

Mechanisms such as what BYOE enables are already deployed in silent discos where each participant uses a headphone to hear the disco music [2]. However, special headphones tuned to a particular channel are supplied by the disco. Instead, in BYOE, the user is able to use *their own headphones* which makes BYOE safer from a health perspective even in public settings. Furthermore, since the earphones are connected to the user's phone, the user does not miss important phone calls or notifications. Closest to our system is [1], but without support for infinite number of listeners. It also eliminates the possibility of subscribing to multiple audio sources, which BYOE allows. In addition to mixing related audio streams such as different instruments part of the same orchestra, this can be especially valuable when some of the audio sources are sparse. For example, a user can watch a movie on an Airport TV, while also being subscribed to flight announcements.

2 SYSTEM DESIGN

Our system consists of two main components: a device that plugs into the TV, and an app running on the users' smartphones.

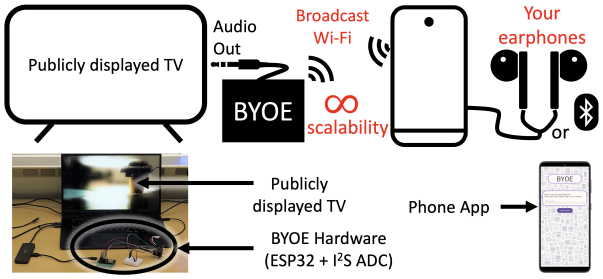

Figure 1: BYOE System Design

The device is based on an ESP32 board, which is a low-cost, low-power microcontroller, that supports Wi-Fi out-of-the-box. The board draws power through a USB port. It is connected to an external ADC, which captures stereo audio via the 3.5mm audio port at 44.1 kHz via the I^2S interface. The device then encodes the signal and broadcasts it over Wi-Fi using UDP packets. On the client side, the app receives the UDP packets, decodes them and plays the audio into the users' earphones. The app also provides the user interface to adjust the volume level and select the audio channel, corresponding to which TV's audio packets are of interest.

We have a fully working prototype where we have overcome several challenges. We transmit around 256 samples per unencrypted UDP packet. To avoid the app missing a UDP packet we broadcast every packet twice, with duplicates handled at the phone app.

3 OUR DEMO

Attendees will be able to download an app on their Android phone to try the system out for themselves. We will demonstrate how easy and quick it is to set up our device, and also the quality, reliability, and latency of the audio stream. Video demo is here: https://b.gatech.edu/3u3xSE9

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