Audio-WiFi: Augmented WiFi Network with Audio Channel for Smart Devices

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1. INTRODUCTION

Wi-Fi is becoming widely popular network interface for data communication in smart phones because of it's high throughput, power efficiency and relatively large range. However, the Wi-Fi network still several inefficiencies in terms of high energy consumption, unfairness between co-located nodes, and bandwidth poor utilization. For example, Wi-Fi transmitter has to transmit the full packet even if the receiver could flags the packet as corrupted one at early stage of the transmission. Another example, Wi-Fi transmits control packets (RTS/CTS/ACK) low rate. Researchers have proposed to use other existing wireless network interface (Bluetooth , ZigBee etc.) as a parallel communication for enhancing the performance of Wi-Fi network by addressing above issues [1, 2]. Although the solution of using bluetooth and ZigBee in parallel with WiFi improves the performance, it creates severe interference with Wi-Fi for communicating in the same frequency band (2.4GHz).

In our project, we like to enhance the performance of data communication over the Wi-Fi network by integrating the mic/speaker of the smart phones as a parallel communication channel. Our idea is to propose a novel framework of communication using mic/speaker in order to develop a more efficient Wi-Fi network communication. The non-interferential nature with Wi-Fi network is the biggest advantage of using audio communication channel for this purpose. For audio communication we like to exploit frequency band beyond normal human ear perception. At our knowledge, most of the smart phones are both capable of generating and discerning audio frequency beyond human ear perception.

2. AUDIO-WIFI NETWORK

CSMA/CA protocol in Wi-Fi network fails to maintain a fair and efficient utilization of wireless channel. For instance, the wireless transmitter cannot detect packet loss, or collision in oder to abort its transmission before transmitting the full packet. As a result the channel remain useless during the corrupted packet transmission. In this scenario we can use the audio communication as a parallel channel to let a transmitter know about the packet loss and abort the packet transmission for better utilization of the channel. The audio channel could be used to coordinate between nodes in Wi-Fi network in order to eliminate the collision. As a consequence, eliminating collision will minimize the contention window and enhance the overall throughput of Wi-Fi network. Assuming the audio interface hardware (speaker/mic) consumes less energy then Wi-Fi receiver, then we can actually turn off the Wi-Fi rather than putting it to sleep during an inactive period. Later, we could turn on the Wi-Fi by sending a control message using the audio channel to make active interaction between Wi-Fi node. In summary, we aim to explore how to utilize the audio communication to enhance the performance of Wi-Fi communication.

Figure 1 depicts the preliminary architecture of our proposed Audio-WiFi network including Wi-Fi interface and Audio interface. The Audio interface has two layers: 1)A-PHY layer: responsible for all signal processing, modulation/demodulation and transmitting/receiving signal using speaker/mic hardware. 2) A-MAC layer: responsible for sending/receiving data frames over acoustic media. The MAC and TCP/IP layers could took the benefit of using acoustic media to

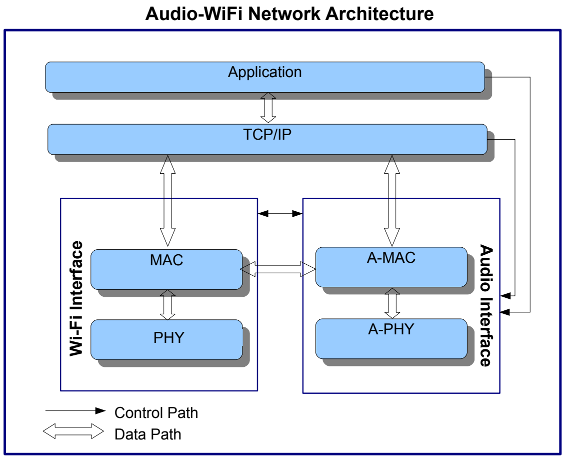

Figure 1: Proposed Audio-WiFi Framework Architecture

send control data frames using the A-MAC layer in Audio interface. In other way, A-MAC could receive control/ acknowledgment data frames over acoustic media and send it to TCP/IP and MAC layer. In order to control these data flows we need to maintain a control informations among the Application, TCP/IP, MAC layers with Audio interface. One of our research focus is to identify the proper control informations flow among them.

3. CHALLENGES AND ONGOING WORK

While radio waves use electromagnetic properties, audio waves use air pressure for propagation. Therfore, audio waves is much slower than radio waves. Moreover, because of the large Doppler effect on audio waves, the reverberation and the background noise affect the audio communication during transmission over air. These fundamental physical properties of audio waves impose some challenges on our objectives of using audio wave in parallel with radio wave(Wi-Fi). In this demo, we will show our implementation of a simple audio interface stack in Nexus S phone with simple FSK modulation/demodulation technique for data communication. Our preliminary study shows the feasibility of transmitting data up to 40 meter indoor space. However, further study needs to be done on the characteristics of bit error rate over different indoor/outdoor ranges. In continuation of our work, we like to understand more and evaluate the limitations audio waves with respect to radio waves. Then, we plan to explore how to utilize the audio communication in enhancing the Wi-Fi communication under different scenarios and network conflagrations.

4. REFERENCES

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