

# Audio-WiFi: Audio Channel Assisted WiFi Network for Smart Devices



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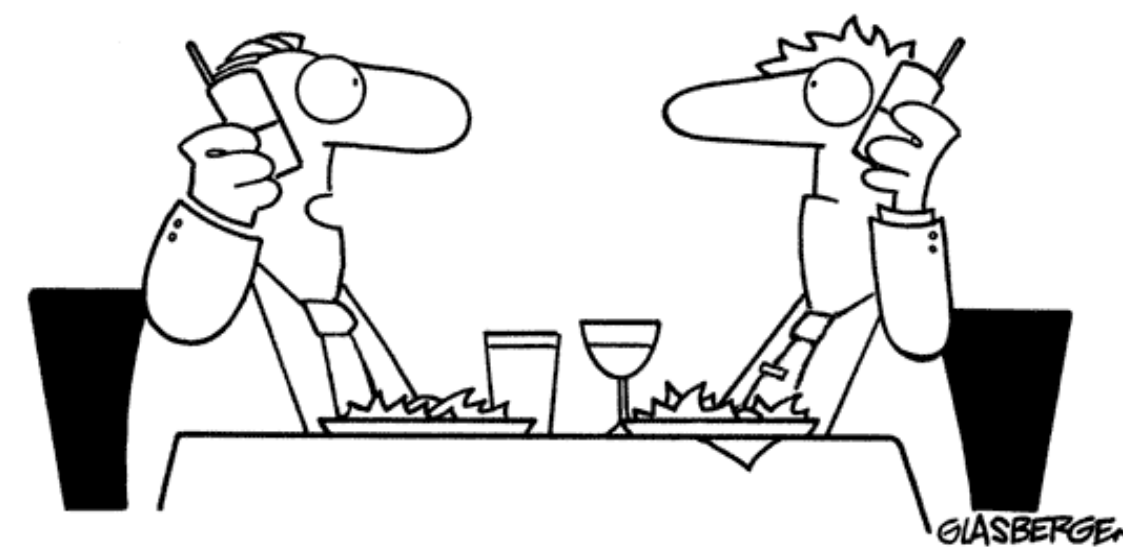
<http://cs.odu.edu/~muddin/audiowifi>

## 1. Motivation

- WiFi is a common communication interface for smart devices.
- WiFi still has some perturbation such as,
  - Poor utilization of wireless channel.
  - Energy consumption during idle state.
  - Unfairness issue due to capture effect.
- Additional channel can be utilize to enhance the performance of Wi-Fi network.
- Smart device can have following interfaces as additional channel:
  - WiFi
  - Bluetooth
  - Zigbee
  - Light/Camera
  - Audio[Can we utilize this interface?]

## 2. Proposed Idea

*Utilize audio channel as an augmented channel to enhance WiFi performance*

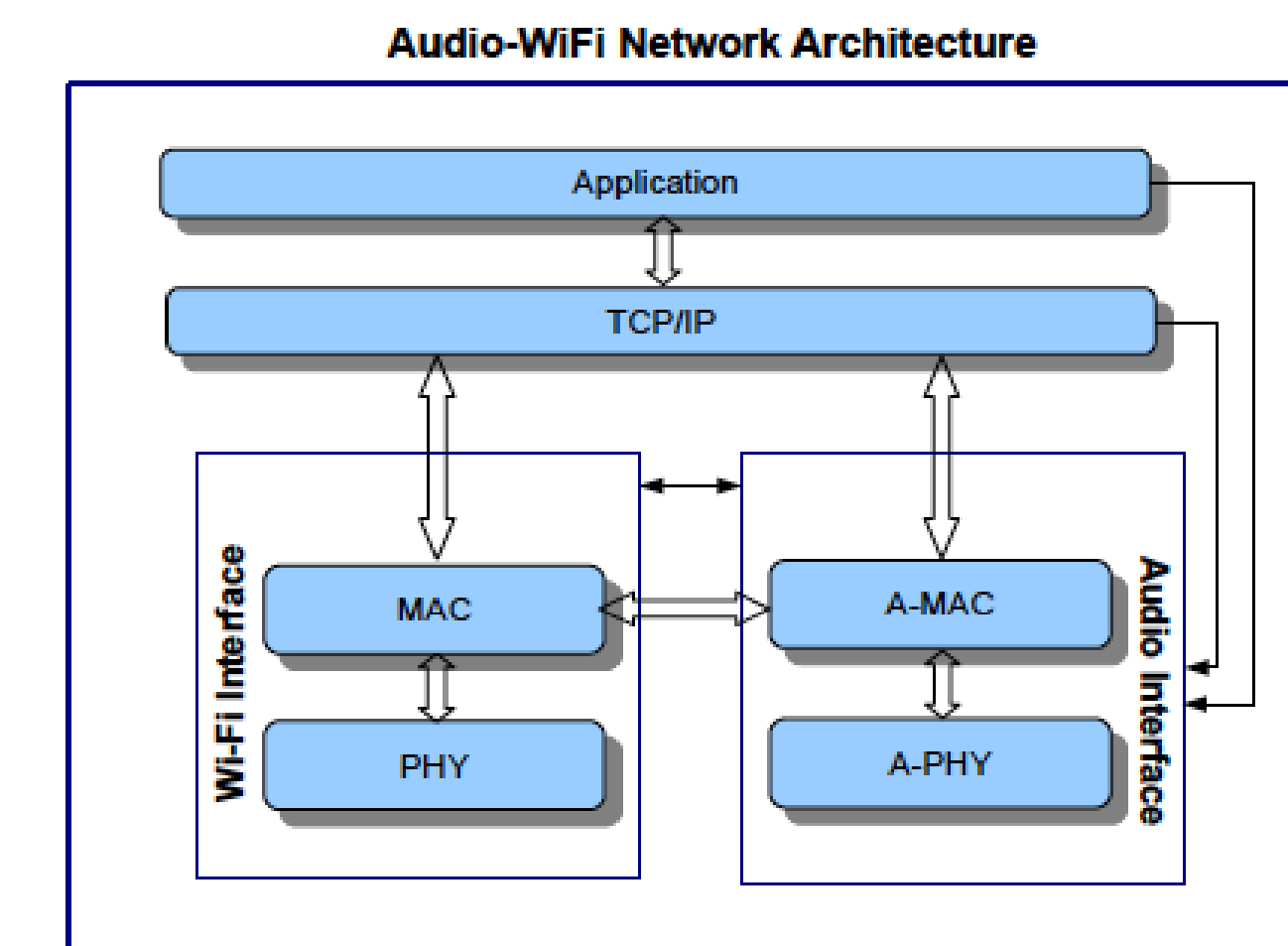


We like to exploit audio frequency beyond human ear perception as a parallel communication channel with WiFi.

- Why Audio communication?
- Non-interferential with radio network.
  - No additional bandwidth required from WiFi.
  - Speaker/Microphone are very common hardware component in smart device.
  - Smart devices are capable of generating and discerning audio frequency beyond human ear

## 3. Audio-WiFi Network

Preliminary Architecture of proposed Audio-WiFi network



*A-PHY: responsible for signal processing and sending/receiving signal using ,mic/speaker*

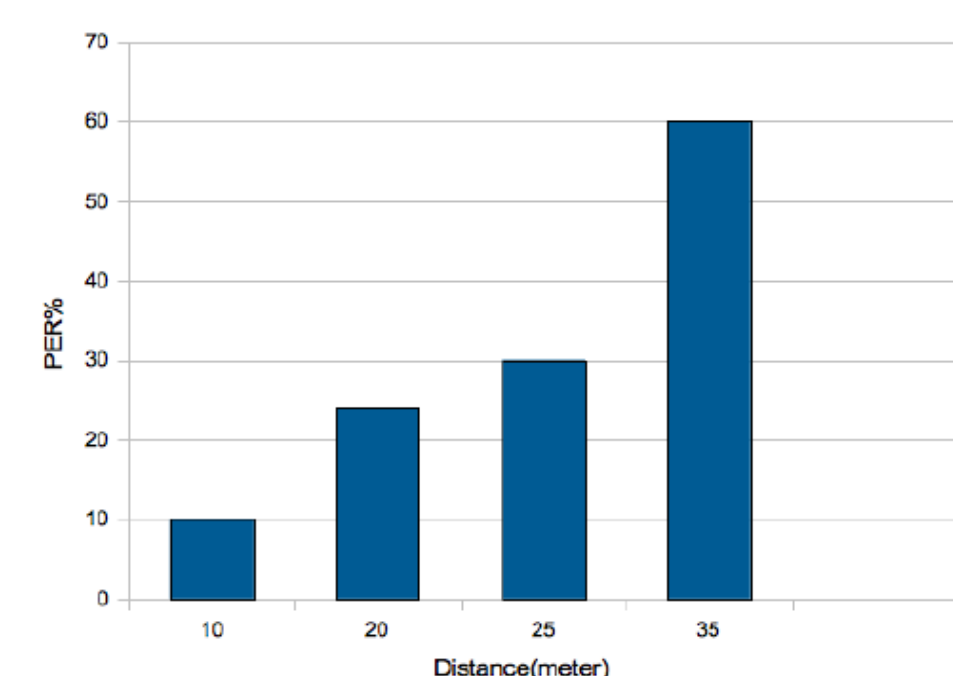
*A-MAC: Can be utilized by MAC and TCP/IP layer to send small size data packet over audio channel.*

TCP/IP and MAC has control path with A-MAC.

## 4. Preliminary Evaluation work

*Sending/Receiving data frames over audio channel*

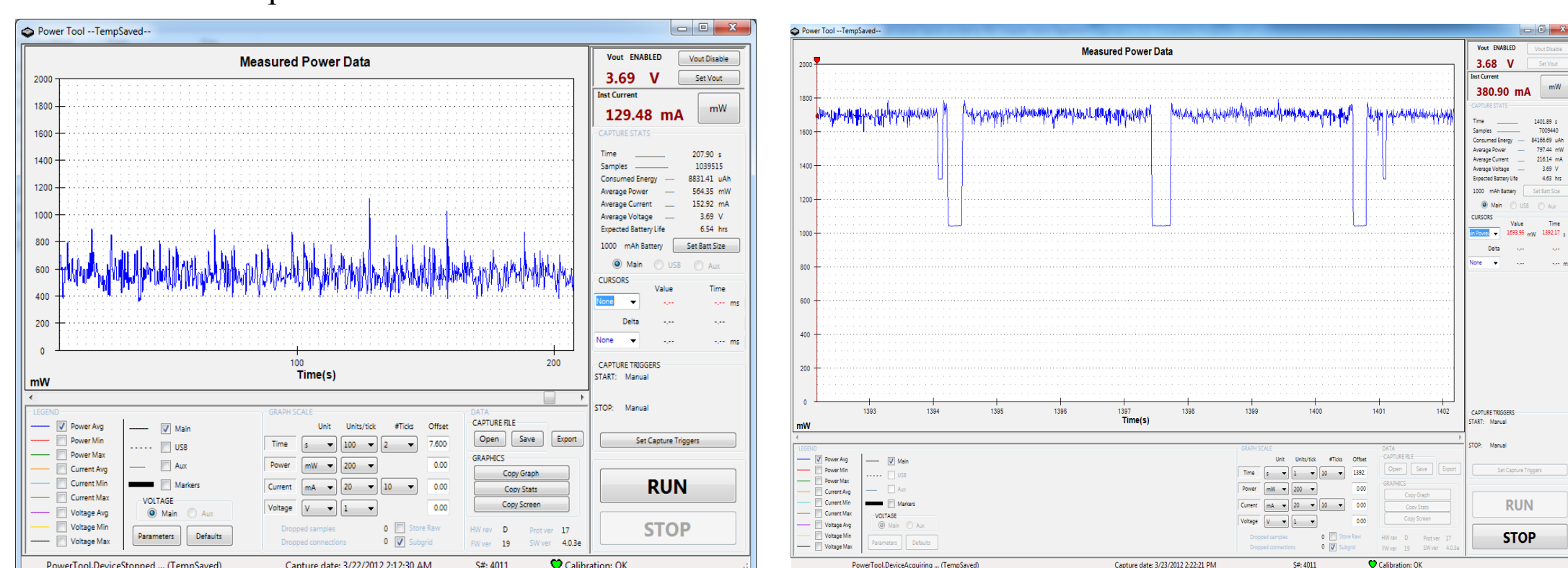
- M-array FSK modulation/demodulation.
- We use 16 frequencies for our modulation/demodulation.
- Each frequency represents a symbol of 4 bit.
- Frequency range from 18000-21200Hz.
- Equal frequency spacing.
- 30bps as data transmission rate.
- Frame size is 25byte.



Packet Error Rate (PER) over different distance

We monitor the power consumption of Audio Interface and WiFi Interface under the following configuration in Nexus S phone:

1. Phone is in Airplane mode.
2. Either audio or wifi interface in active (receiving data)
3. Screen of the phone is turned off.



Audio Interface is receiving data

WiFi Interface is receiving data

## 5. Challenges

Technical Challenges

**Challenge1:** Audio channels suffer from low data rate.

Possible Solution:

- Use audio channel to transmit only small control frames.
- Use different audio tones instead of actual bits for control frames.

**Challenge2:** Frame-level synchronization between WiFi and audio.

Possible Solution:

- Use single audio frame for aggregated WiFi frames.

## 6. Ongoing Work

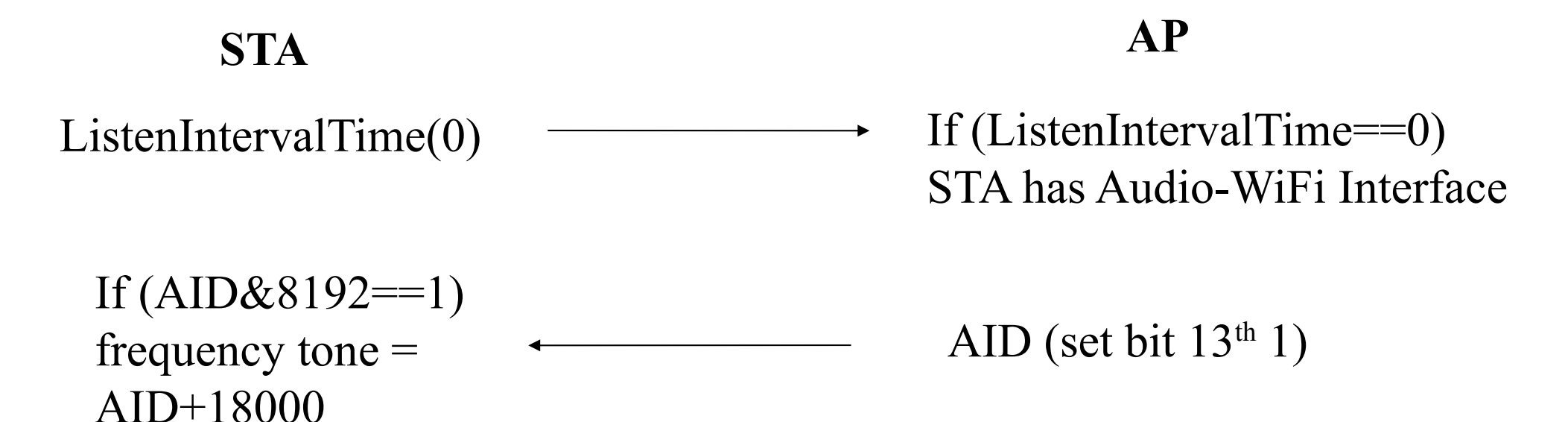
- Utilizing audio channel to enhance the performance of Power Save (PS) mechanism for 802.11.

- Using audio channel as an control channel for sending ACK frames while WiFi is sending data frames.

- Utilizing audio channel for coordinating between node to reduce the collision.

## 7. Audio-WiFi PS Mode

**Association mechanism**



**Power Management**

- STA turn on the audio interface instead of the wifi interface in each beacon time when it moves to Audio-WiFi PS mode.
- AP will send an audio frequency tone while it has packet for Audio-WiFi STA.

Challenge: Need to determine and minimize the length of the frequency tone.

- STA turn on the wifi interface when it receives certain frequency tone from the AP.

**PS-Poll mechanism**

