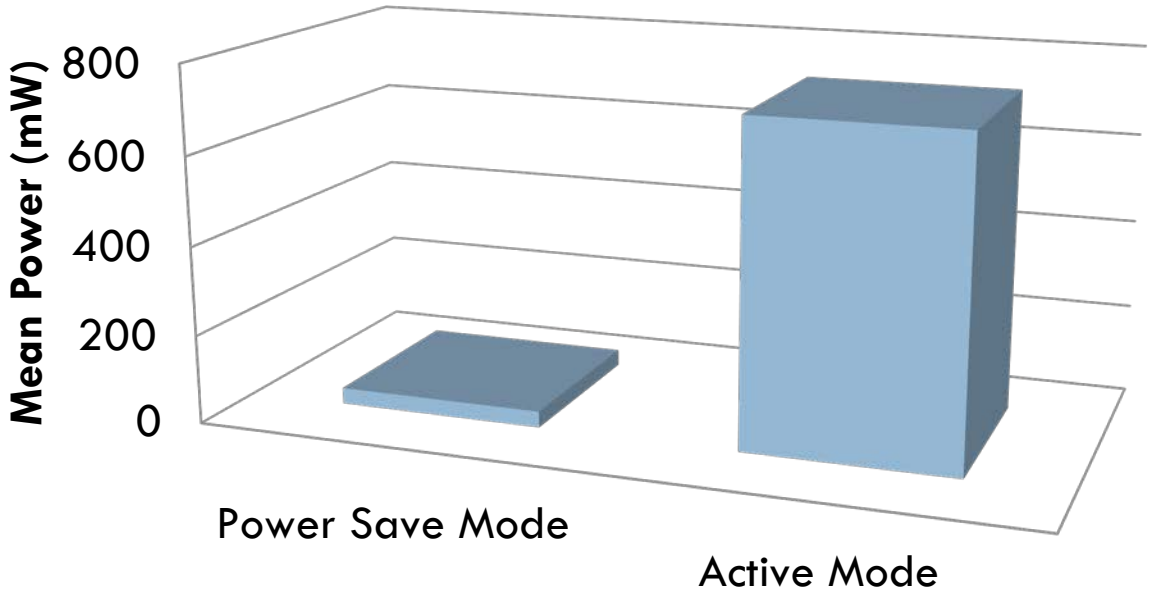
SiFi: EXPLOITING VOIP SILENCE FOR WIFI ENERGY SAVINGS IN SMART PHONES

--- BASED ON SLIDES FROM ANDY PYLES

CSCI780 Sensors and Ubiquitous Computing

Problem Description

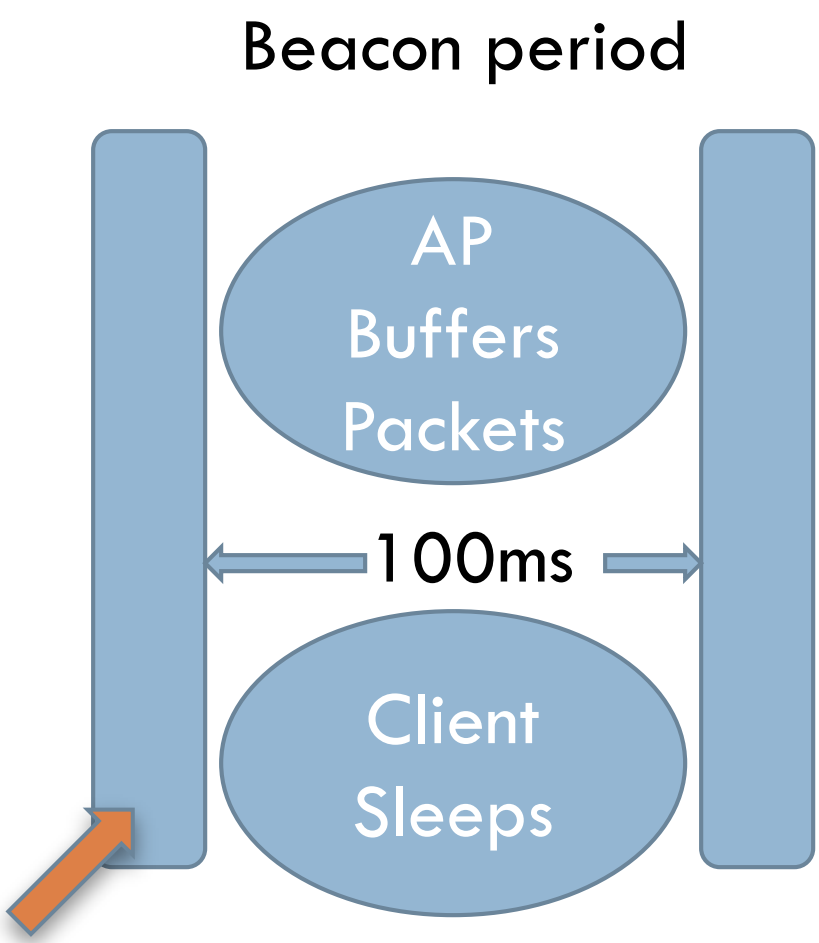
- Minimize energy use during phone calls
- Observation: WiFi consumes 20x more energy when power save disabled.



Problem Description

- Research by Drago, Molinari and Vagiliani (1978) : **60% of a typical conversation is silence.**
- **Why not enter into WiFi Power Save Mode during silence periods in conversation?**

Background : WiFi Power Save

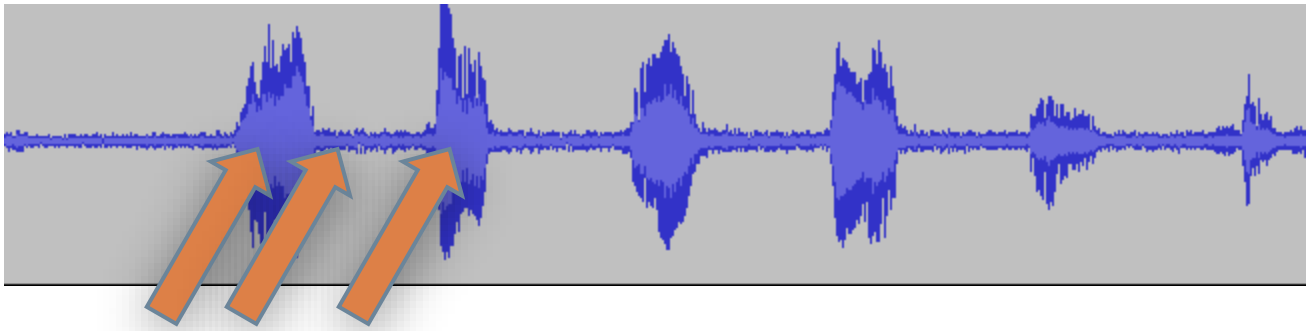


Background: Adaptive PSM

NOTE: AWAKE = CAM mode

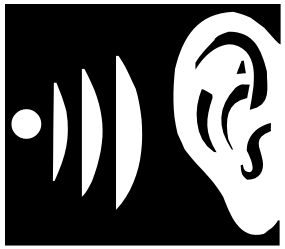
DELAY: depending on driver implementation

Background : RTP



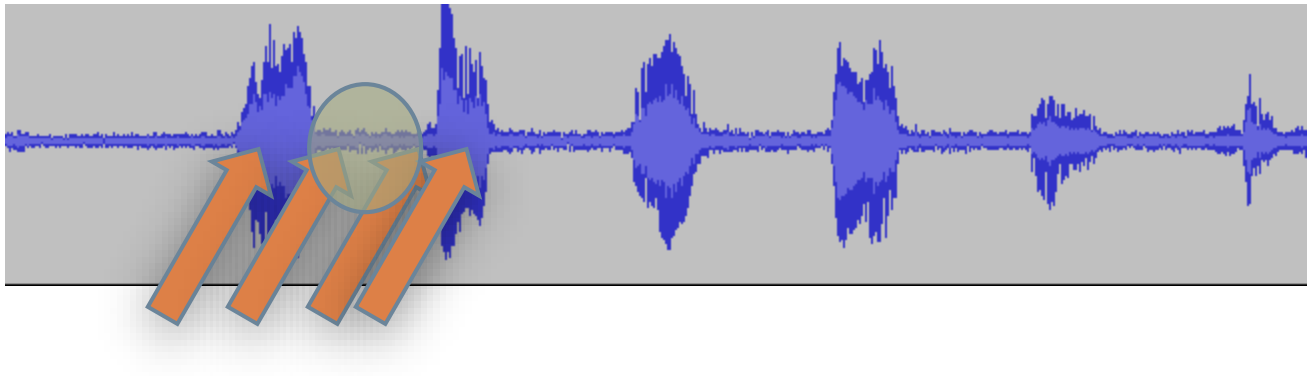
non-VAD :

VAD :



VAD:
Voice
Activity
Detection

Adaptive PSM



Switch to CAM

Could be sleeping!

Delay.. STILL in CAM

NO packets for a while, time to SLEEP!
(POWER SAVE MODE ENABLE)

Related Work

- **802.11 general approaches**
  - Self Tuning Wireless Network Power Management, *Mobicom* (2003)
  - Micro Power Management of Active 802.11 Interfaces, *Mobisys* (2008)
  - Catnap: Exploiting High Bandwith Wireless Interfaces to Save Energy for Mobile Devices, *Mobisys* (2010)
- **VoIP Specific approaches**
  - U-APSD, IEEE *802.11e* (2005)
  - Hybrid Power Saving Mechanism for VoIP Services with Silence Suppression in IEEE 802.16e Systems, *Communications letters (2007)*
  - Towards Energy Efficient VoIP over Wireless LANS, *Mobihoc* (2008)

Contributions

- **Exploit** Silence periods using modeling and prediction
- **Propose** Silence prediction framework called SiFi
- **Implement** SiFi onto Android phone

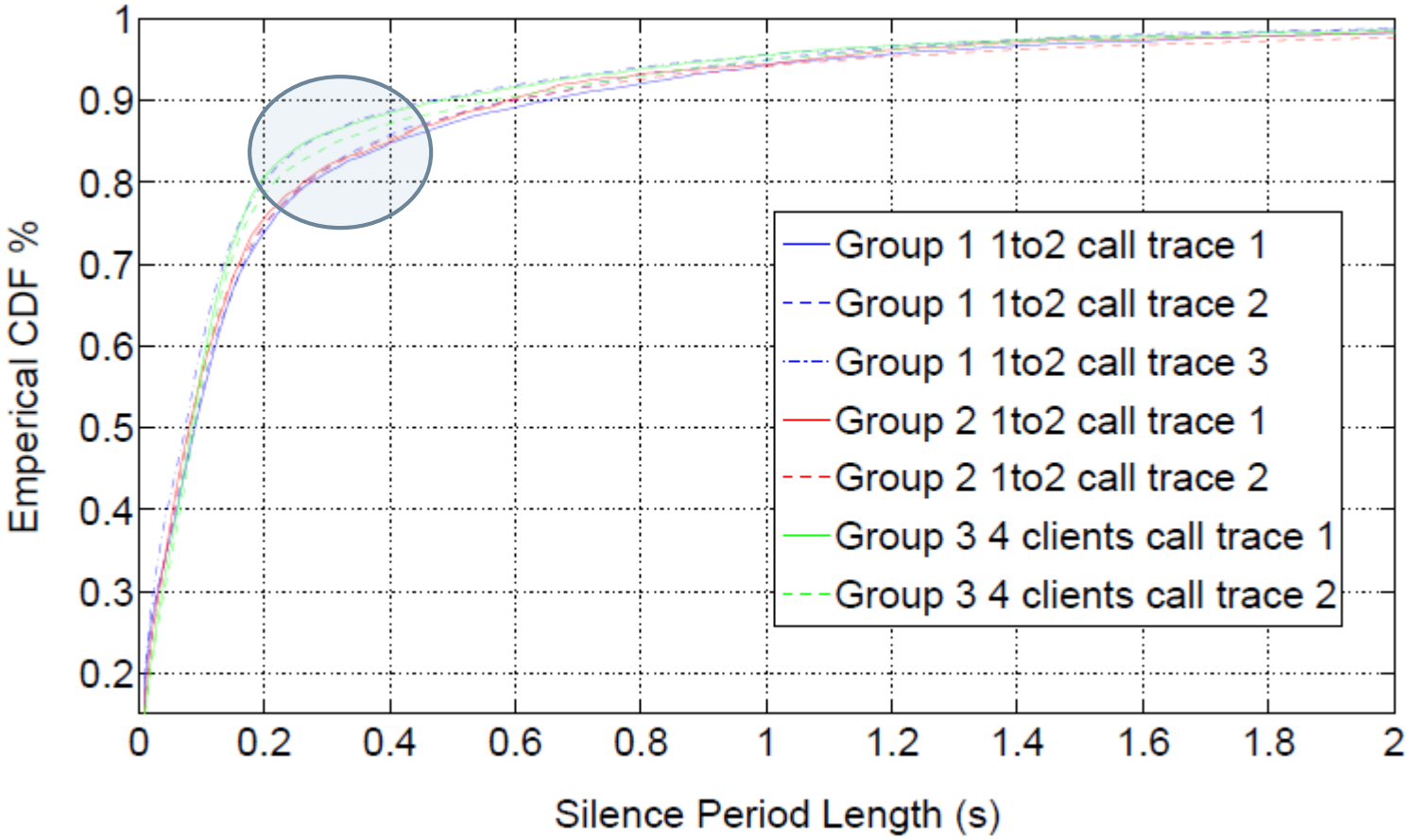
Overview

- **Problem Description**
- **Background**
- **Related work**
- **Contributions**
- Big idea
- SiFi framework
- Implementation
- Evaluation
- Conclusion & Discussion

Big Idea

- Training operation
  - Gather statistics about silence gaps in conversation
- Run time operation
  - Detect start of silence period
  - Predict length of silence period
  - Enable WiFi Power Save Mode during predicted length

Big idea: *Training*



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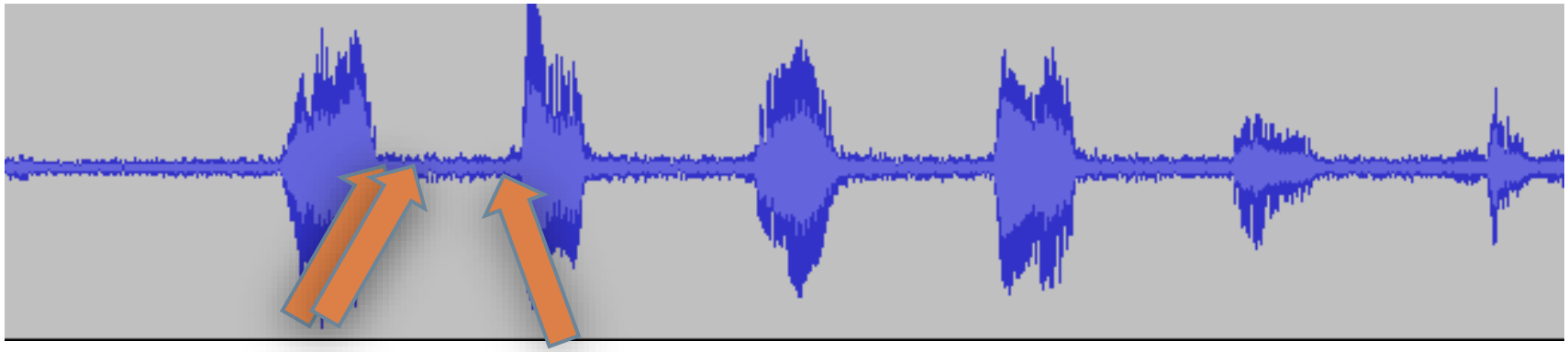
Distribution

Function

Big idea: ***Runtime***



- Detect **start** of silence period
- Wait α (typically 50ms)
- Determine length of sleep period: Δ

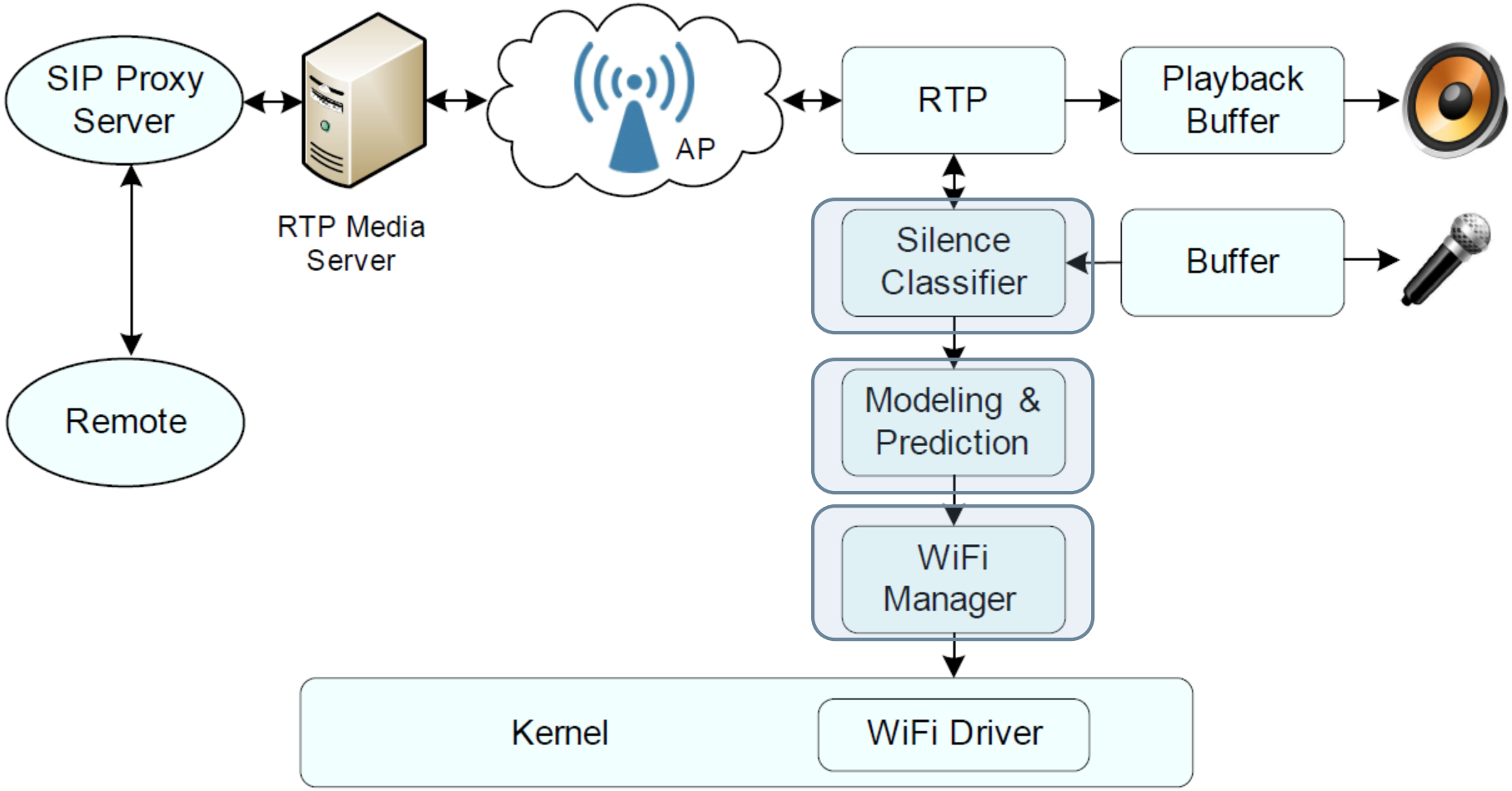
Find MAX Δ where: $P(x>\alpha + \Delta | x > \alpha) \geq \beta)$

β = confidence interval

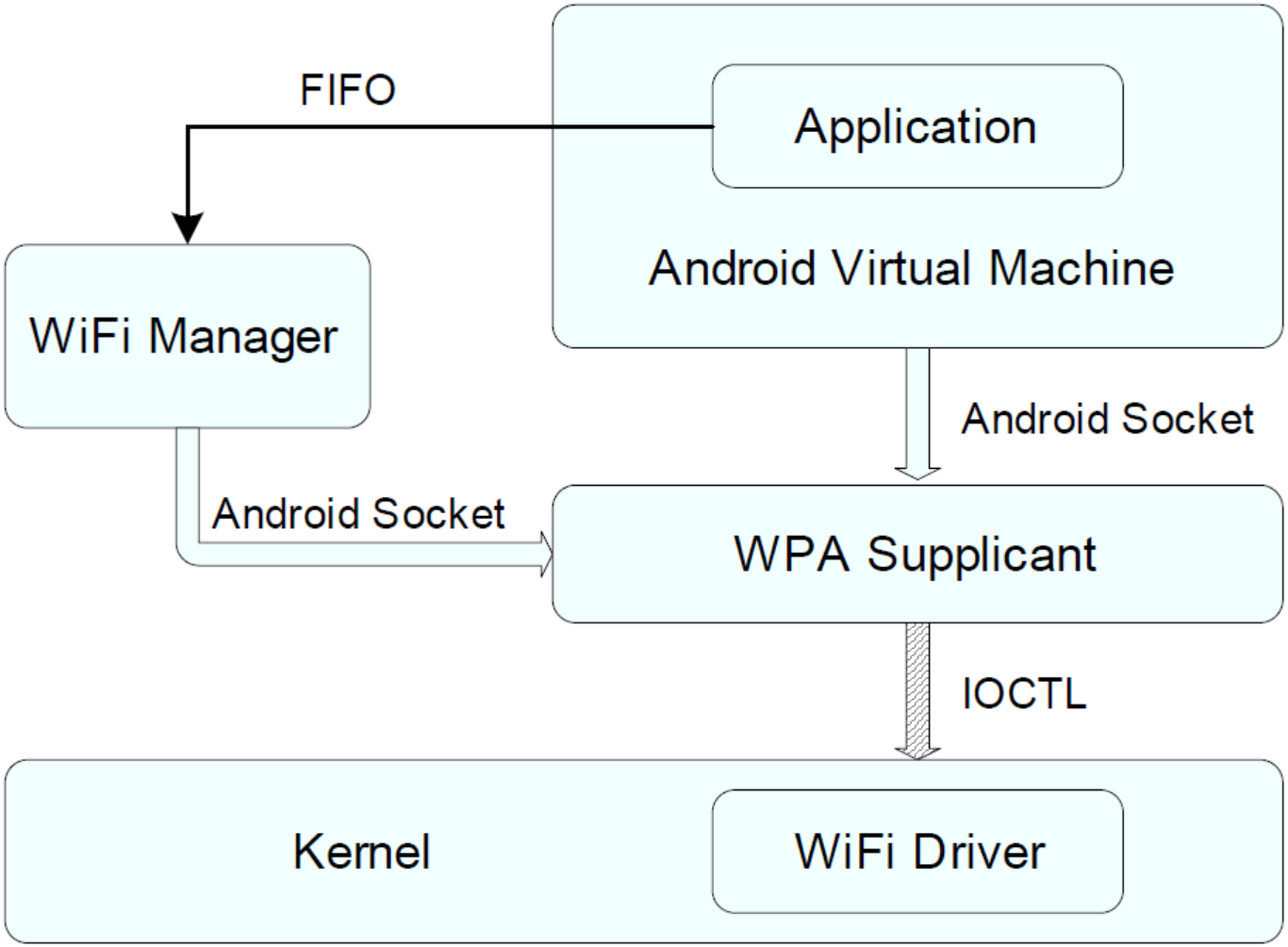
Introducing SiFi

- Silence Prediction based WiFi Energy Adaptation

SiFi Framework



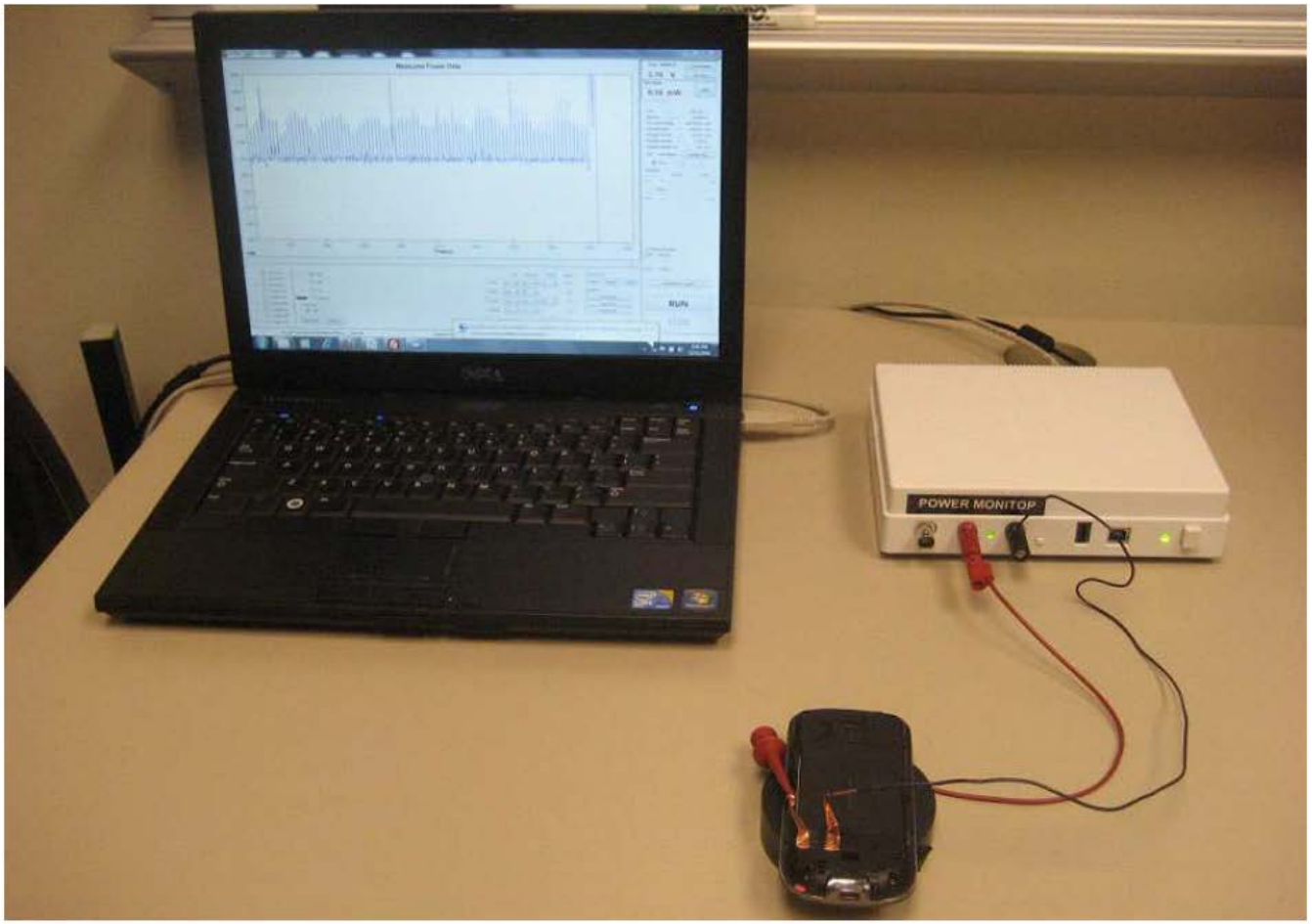
Implementation: WiFi Manager



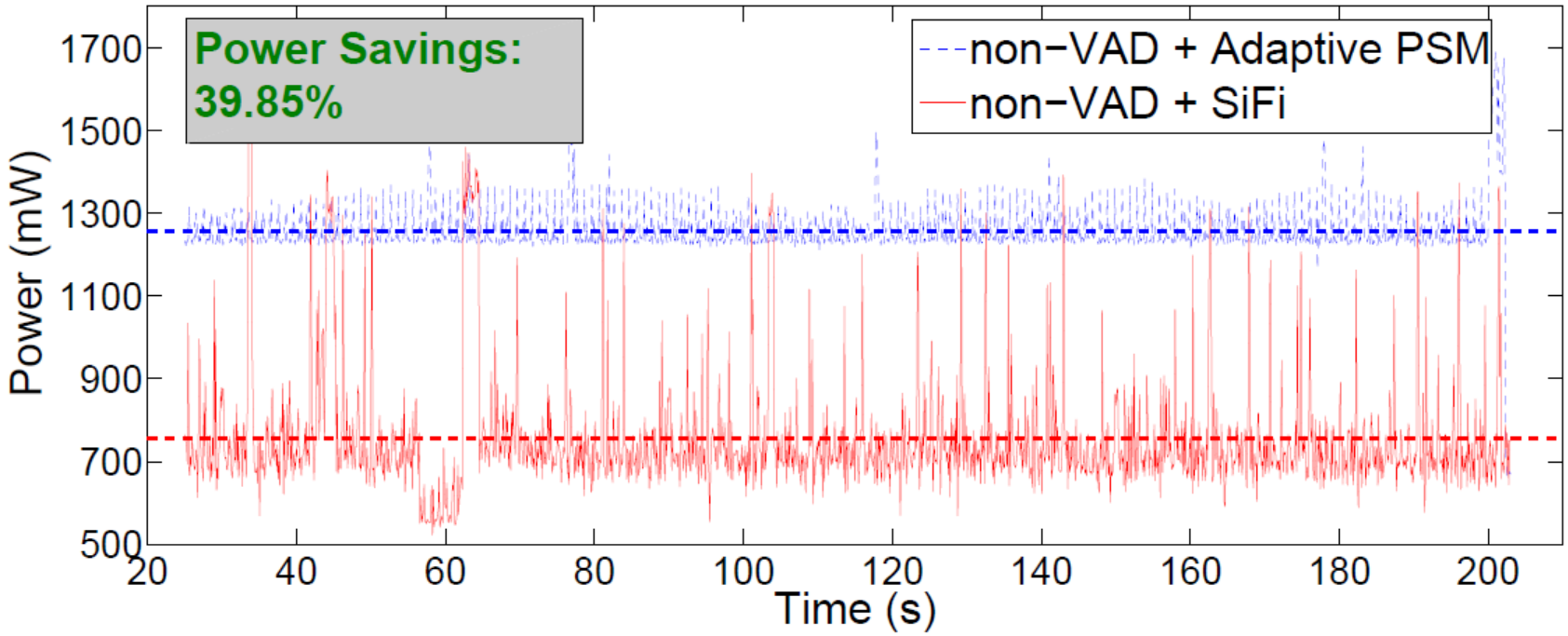
Evaluation

- Energy Consumption
- Application Fidelity

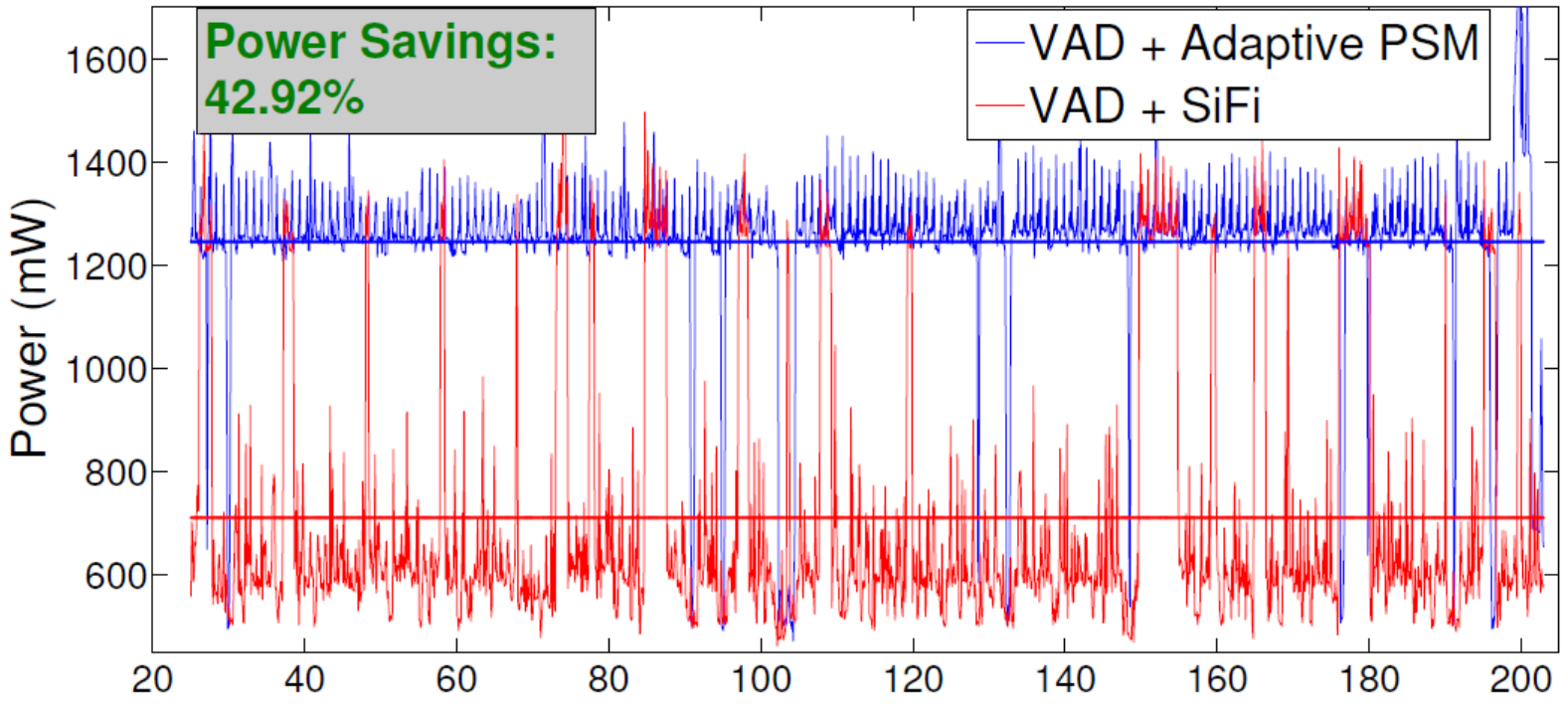
Evaluation: Energy Consumption



Energy Consumption: non-VAD

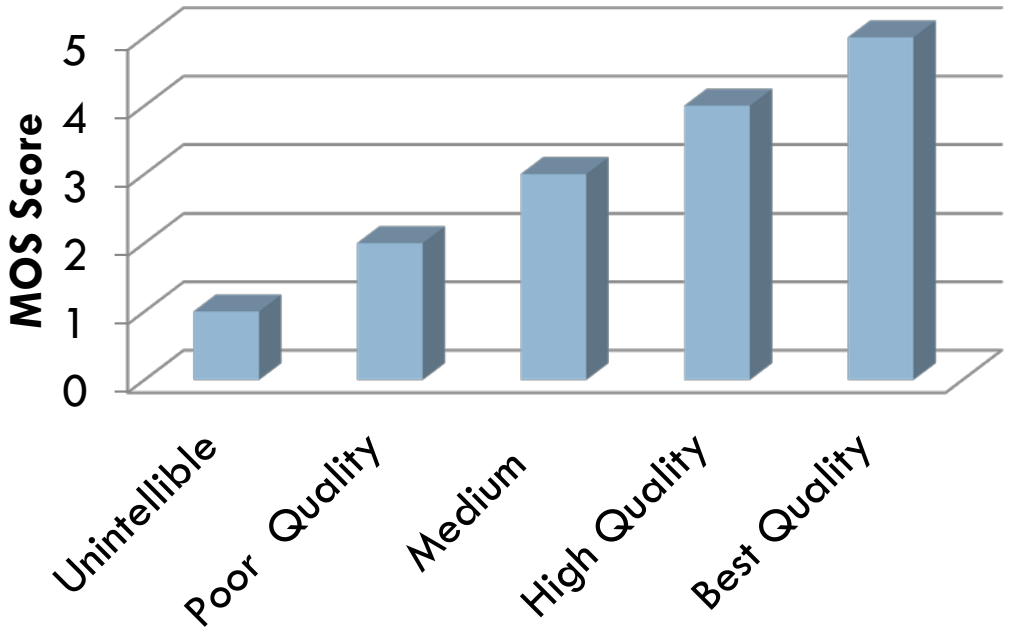


Energy Consumption: VAD



Evaluation: Application Fidelity

- We use Mean Opinion Score (MOS) for evaluation



Evaluation: Application Fidelity

- MOS is a subjective measurement
- Factors that impact MOS score:
  - ONE-Way delay (mouth to ear delay)
  - Jitter
- How do we put this together?
- E-MODEL:
  - $1 + 0.035R + 7 * 10^{-6} R(R - 60)(100 - R)$
  - "**R**" can be approximated using one-way delay, and inferred codec information

Application Fidelity: **Delay**

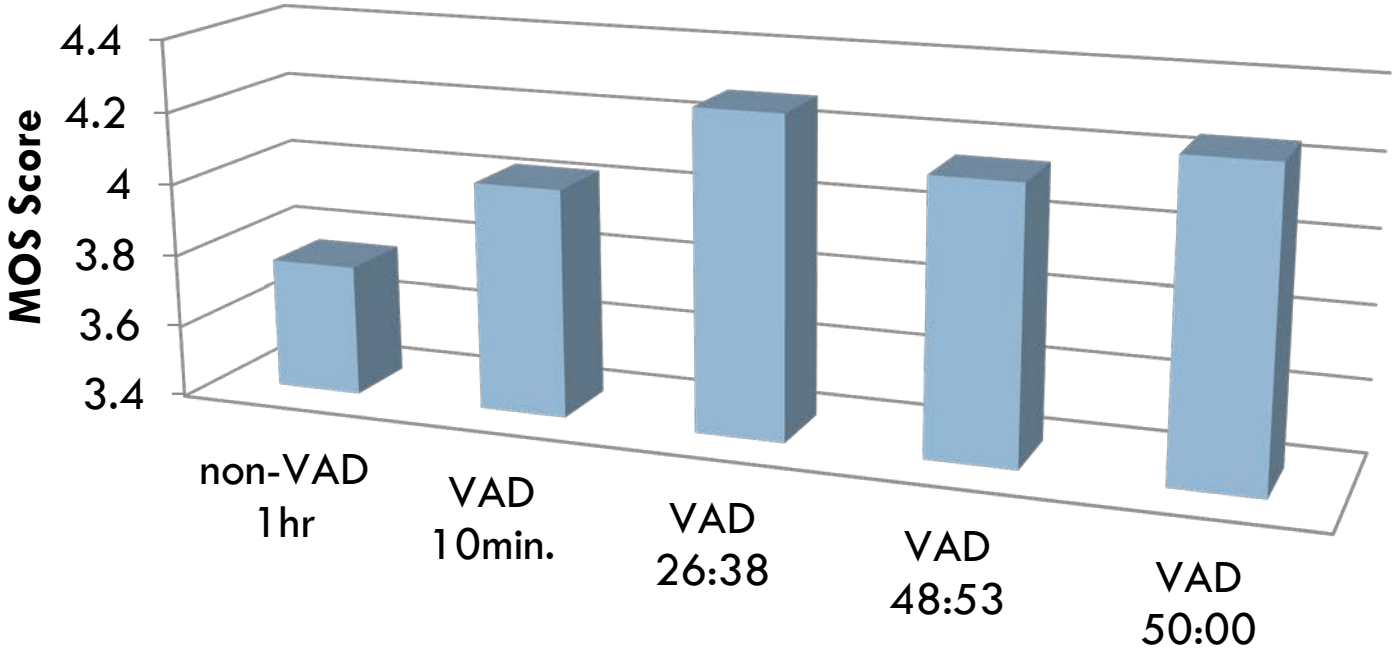
- One Way delay can be calculated if clocks are synced. (Can't assume that!)

ASSUME: OWD = RTT/ 2

RTT= (Ta2 - Ta1) - (Tb2 - Tb1)

Evaluation: Application Fidelity

- E-Model : Estimate MOS rating of a call



Conclusion

- Feedback from application layer to WiFi driver leads to energy savings!
- **Exploit** silence periods using modeling and prediction
- **Propose** silence prediction/exploitation framework called SiFi
- **Implement** SiFi in Android phone

Discussion

- How to reduce modeling efforts:
  - for the same group of persons but at different times and contexts?
  - for different group of persons?
- Can we replace “voice silence” with something else?
  - Video?
  - What is “silence” in video?