Department of Informatics Engineering

Towards Energy Efficient Multimedia Streaming in Mobile Devices

Bruno Correia, Marília Curado, Vítor Bernardo

Faculty of Science and Technology
University of Coimbra

Agenda

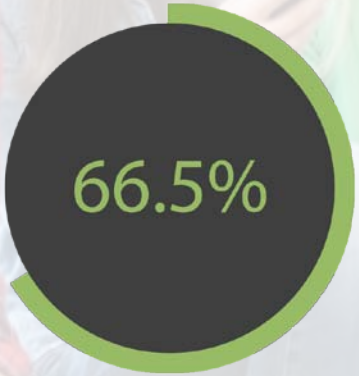
- Motivation
- Objectives
- IEEE 802.11
- Preliminary Results
- Future Work
- Conclusions

Motivation

- The **growth** of **mobile devices**
- **1 million Android** devices activate **every day**
- Android is **Open Source**

24 hours a day

+



Video traffic in 2017 *

=

Fast battery drain

* [Cisco, 2013]
** Images adapted from: http://goo.gl/Y8slmj , http://goo.gl/SIEEr1, http://goo.gl/68gcOu

Objectives

- **Energy assessment** methodologies for IEEE 802.11
- Framework to **control** the IEEE 802.11 **sleep periods** in Android devices
- Mechanism to **reduce the energy**, while watching **video streaming** using IEEE 802.11

IEEE 802.11 - Standard

- A station can operate in **two modes**
- Active Mode (AM)
  - Constantly Awake Mode (CAM)
  - **Radio is always On**
- Power Save Mode (PSM)
  - Static PSM
  - The **station is able to sleep** for certain periods
  - Needs to **wake up** to receive the ***Beacons***

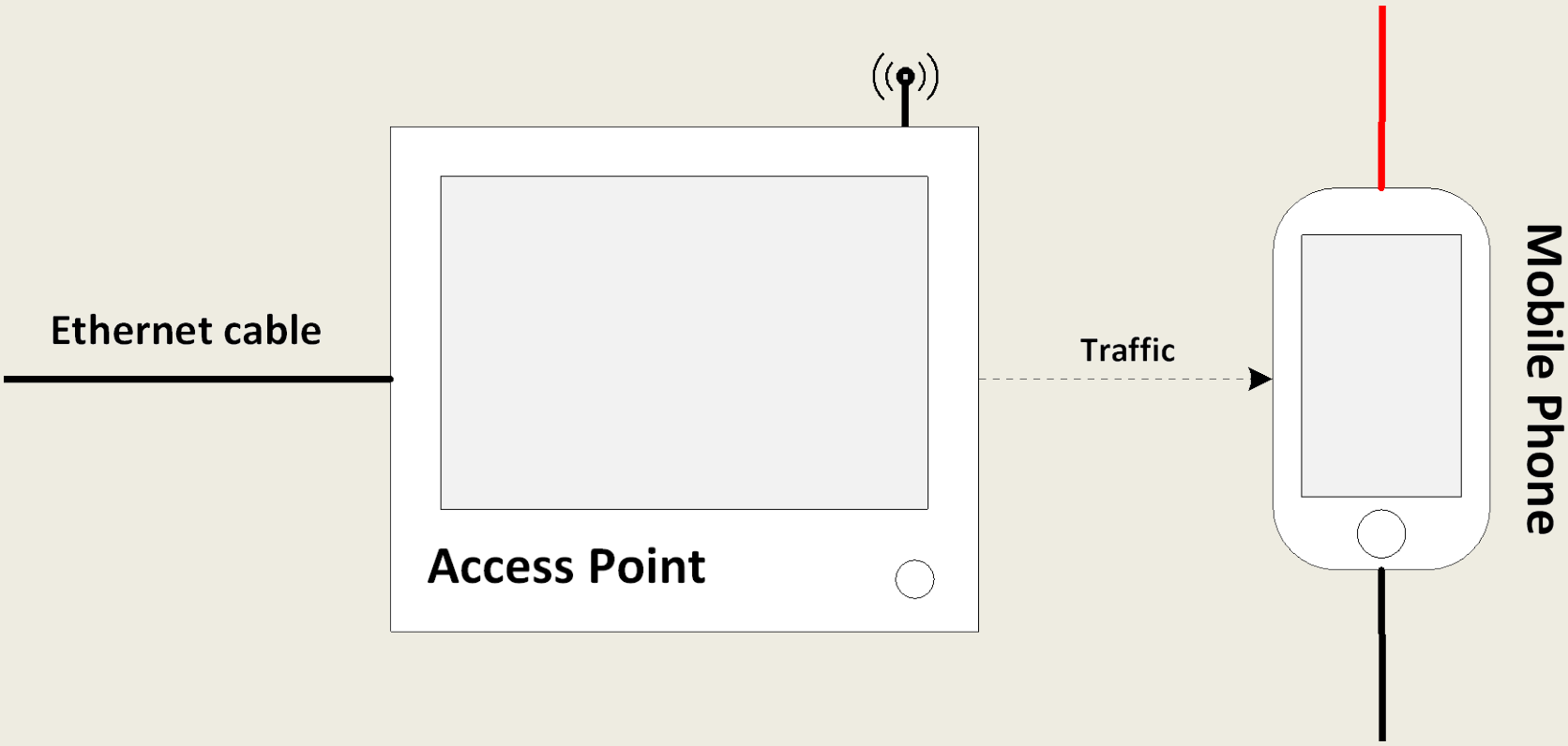
IEEE 802.11 - Adaptive PSM

- Recently implemented in smartphones
- Achieves the **best of CAM and PSM**
- Switches between CAM and PSM depending on the network traffic

Results - Experimental Evaluation

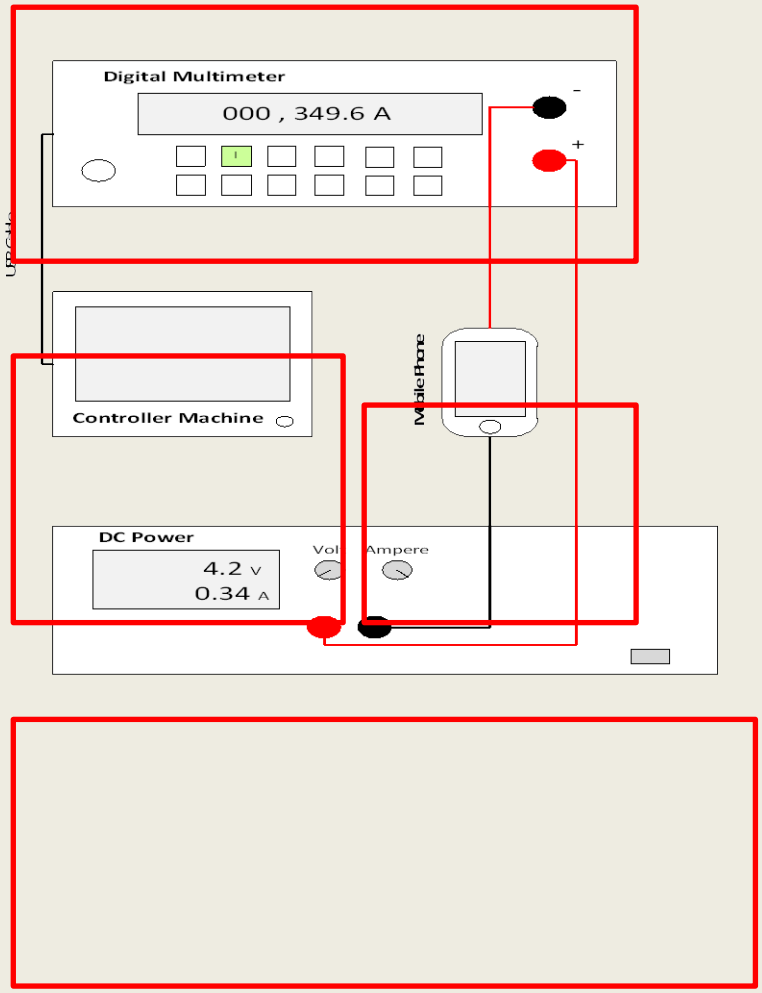
- Goal:
  - Understand the impact of IEEE 802.11 power management modes in energy consumption
- Scenarios:
  - Display brightness
  - IEEE 802.11 Power Management Modes
  - Continuous UDP traffic
  - On/Off UDP traffic

Results - Network



Network setup

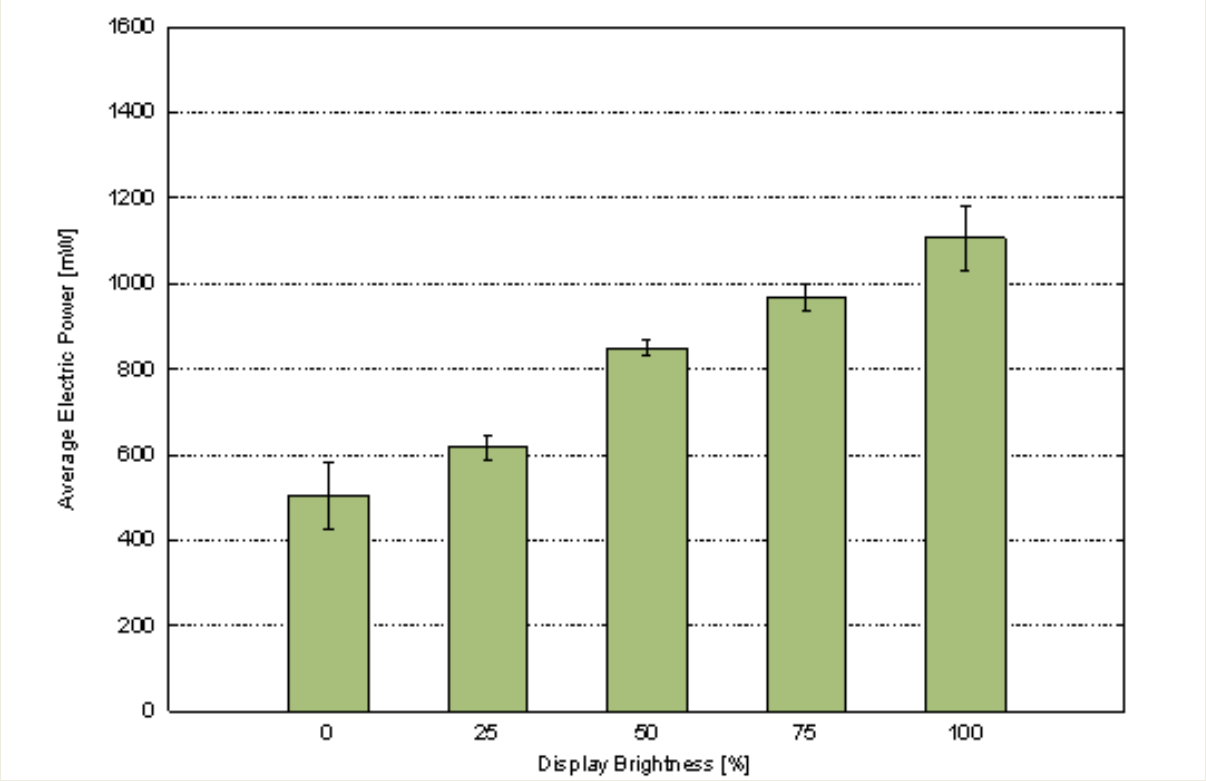
Results - Energy Measurement



Energy measurement setup *

* Methodology already validated in [Bernardo et al., 2011]

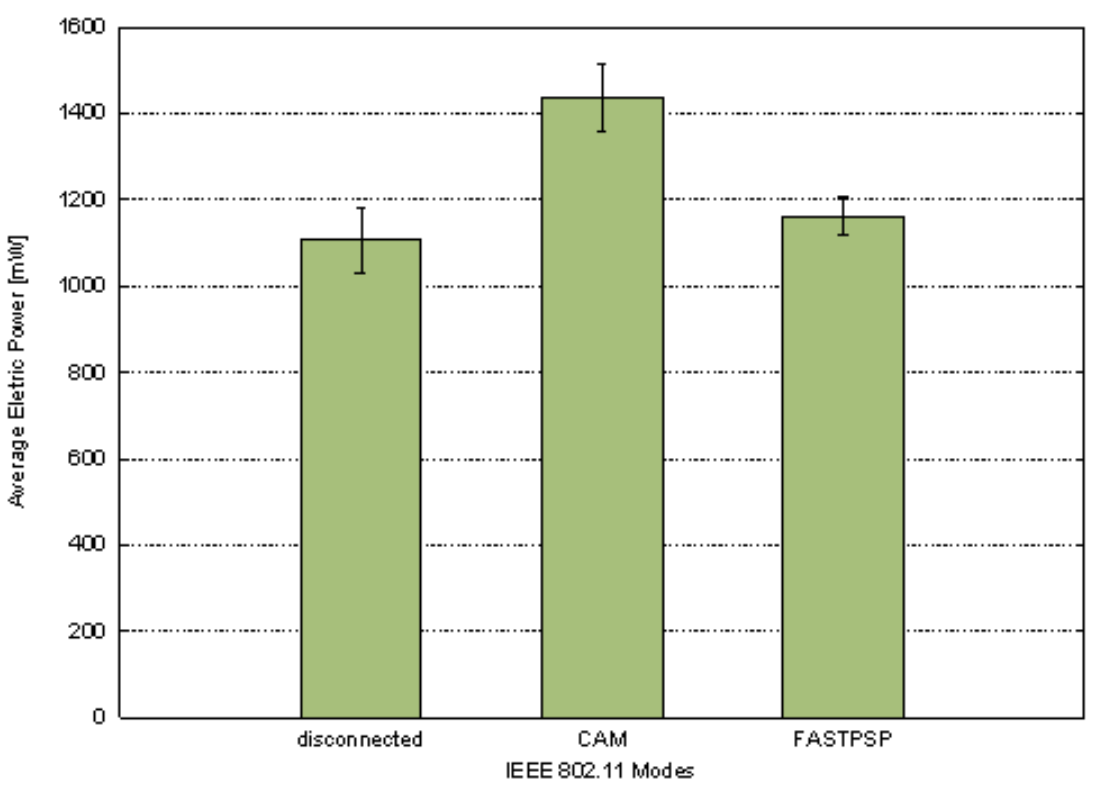
Results - Display Brightness



Average power consumed with different display brightness

- Energy consumption proportional to the display brightness
- The device with the brightness at 100% consumes **more than 50%**, compared with the brightness at 0%

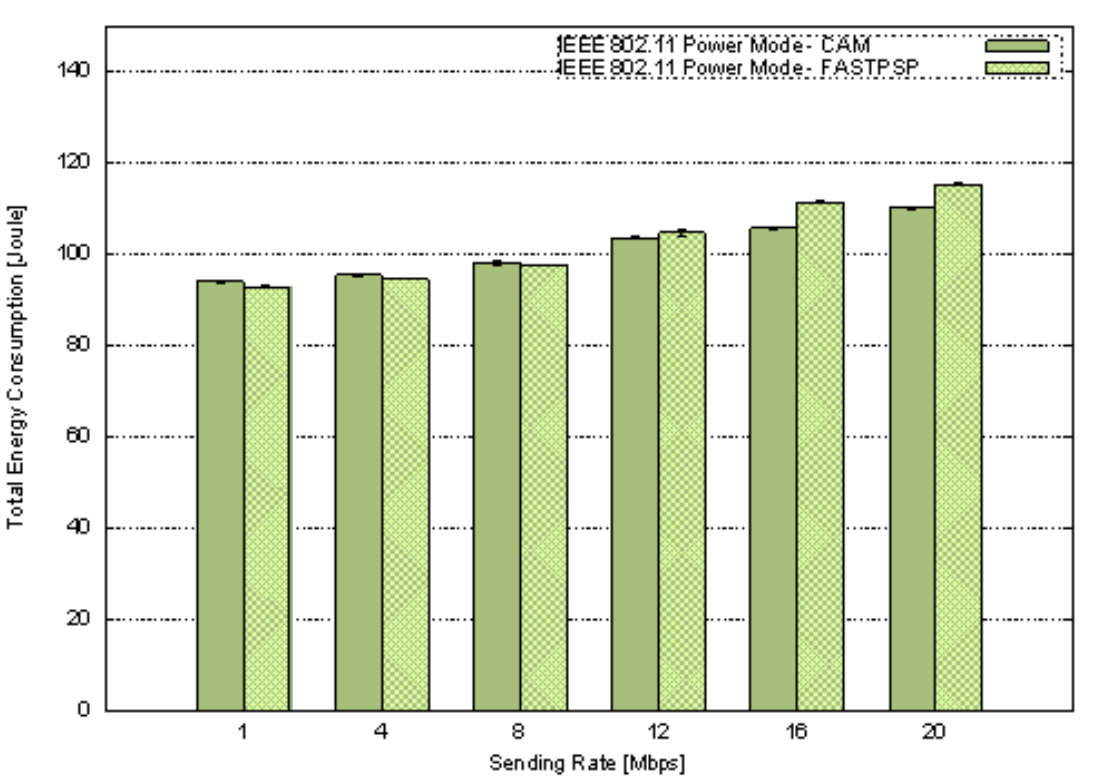
Results - IEEE 802.11 modes



Average consumption in different IEEE 802.11 power management modes

- CAM consumes **approximately 30% more** than when the interface is disconnected
- FASTPSP power is **similar** to the interface disconnected

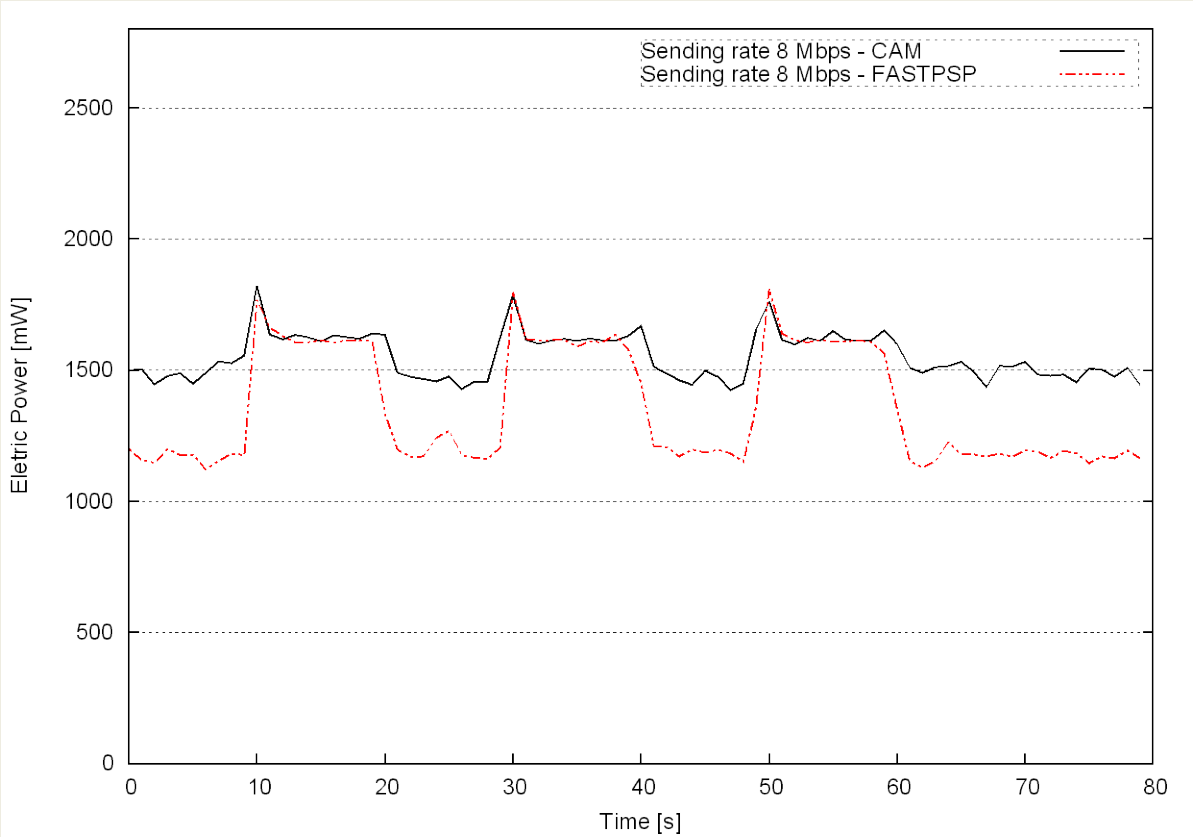
Results - Continuous traffic



Total energy consumed in IEEE 802.11 power management modes with continuous UDP traffic

- The energy consumption is **similar in both modes**
- The energy consumption increases if the sending rate increases

Results - On/Off traffic



Power consumed in IEEE 802.11 power management modes with on/off UDP traffic sent in 10 seconds intervals, along the time

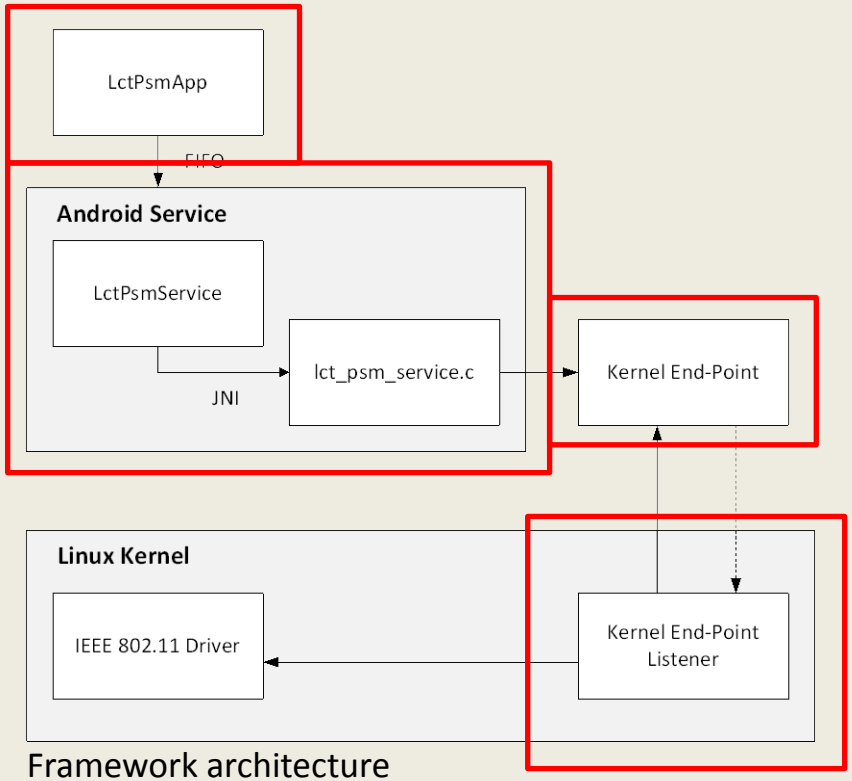
- The FASTPSP mode switches the interface into CAM and FASTPSP respectively when the traffic starts and stops

Results - Conclusions

- **Lower energy** consumption when the IEEE 802.11 interface is **in sleep**
- **Similar energy** consumption by different IEEE 802.11 modes **with continuous traffic**
- It is **important to control** the network interface **sleep periods**

Future Work (1/2)

- **Framework to control** the IEEE 802.11 interface **sleep periods**, in Android devices



Framework architecture

Future Work (2/2)

- OPAMA lite
  - **Maximum allowed delay** by user
  - **Delay packet delivery**
- Enhanced OPAMA
  - **Standard** Power Save Mode **extension**
  - Tradeoff between **energy and QoE** perceived by end users, while watching **video streaming**
  - Android devices needs

Conclusions

- **Reduced battery lifetime** in the Android devices
- **High energy** consumption of **IEEE 802.11 interface**
- **No energy reduction** in the presence of **video streaming**
- Develop **mechanisms to reduce the energy** consumption of **IEEE 802.11 interface**, while watching **video streaming**

Thanks for your attention.

Questions?

* Image from http://goo.gl/UxQDoD