

# AN OPEN SOURCE TOOLKIT FOR PRIVACY-PRESERVING REAL-WORLD EMA DATA COLLECTION

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## WHAT IS THIS ABOUT?

Smartphone-based toolkit for **Ecological Momentary Assessment (EMA)**<sup>[1]</sup> that is

- user-friendly
- privacy-preserving
- extensible
- compatible with hearing aids
- open source (Git repository, Apache license)

to capture acoustical as well as situational and subjective parameters of participants in a long-term study<sup>[3]</sup>.

The system

- is highly customisable
- features an open hard- and software design (Java, Matlab)

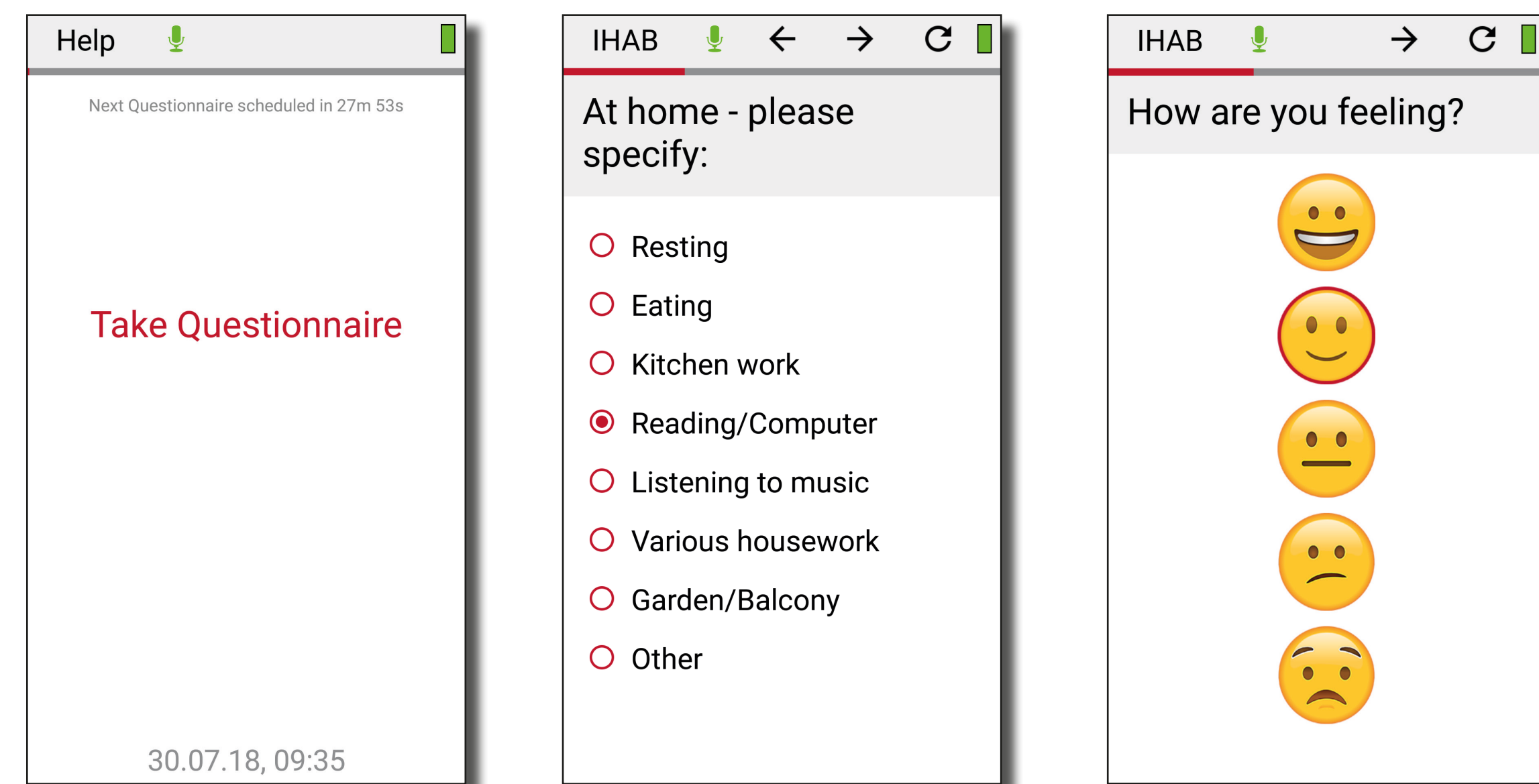
to simplify reproduction. Collaboration is further facilitated by a **shared database**.

## USER INTERFACE

Answer formats include:

- Radio buttons
- Checkboxes
- Emojis
- Sliders
- Free text
- ...

creating an **intuitive framework** for the assessment of subjective parameters.



## TRANSMISSION VIA BLUETOOTH

Clip mounted transmitter box contains:

- **Stereo** Bluetooth transmitter
- A/D audio converters
- LiPo battery
- >14h runtime



- Multiple charging options: USB, induction coil, power supply
- Voltage safeguard circuit
- Status LEDs
- Protocol: **A2DP**
- Next Generation: **RFCOMM**



## ACOUSTICAL FEATURES

Objective features include<sup>[2]</sup>:

- Stereo RMS Level
- Power Spectral Densities (PSDs)
- Zero Crossing Rate (ZCR)

Real-time online calculation of above parameters allows for further metrics. → Standardised **plug-in framework** simplifies implementation of external estimators.

## PRIVACY-PRESERVING

Current features in accordance with German regulations:

- **No audio** data is stored
- Information **cannot be reconstructed** from extracted data<sup>[2]</sup>

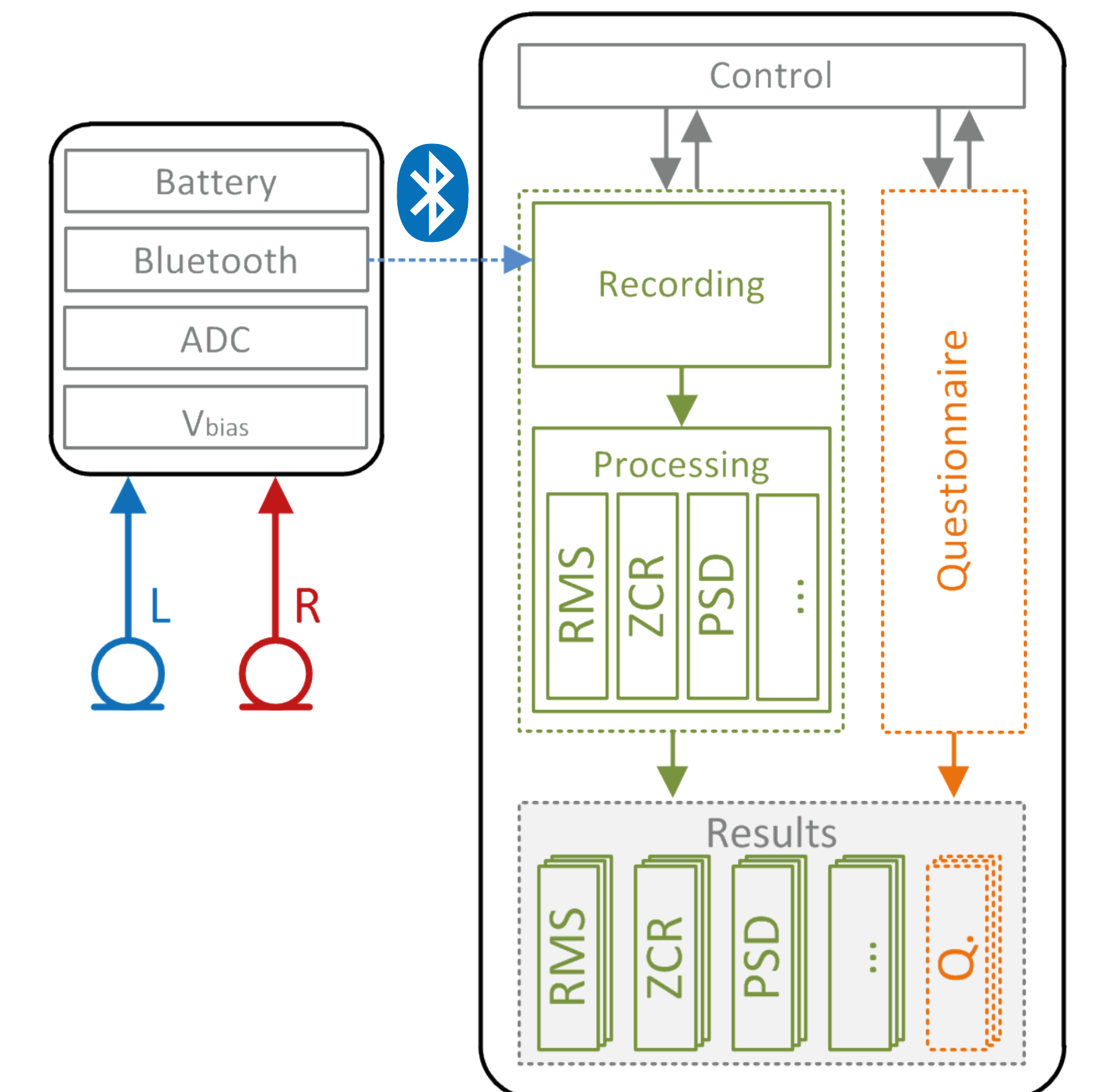
## HOW DOES IT WORK?

### Hardware:

- Microphones (flat response) attached to glasses
- Pocket-sized Bluetooth device
- Wireless stereo transmission of data directly to phone via A2DP

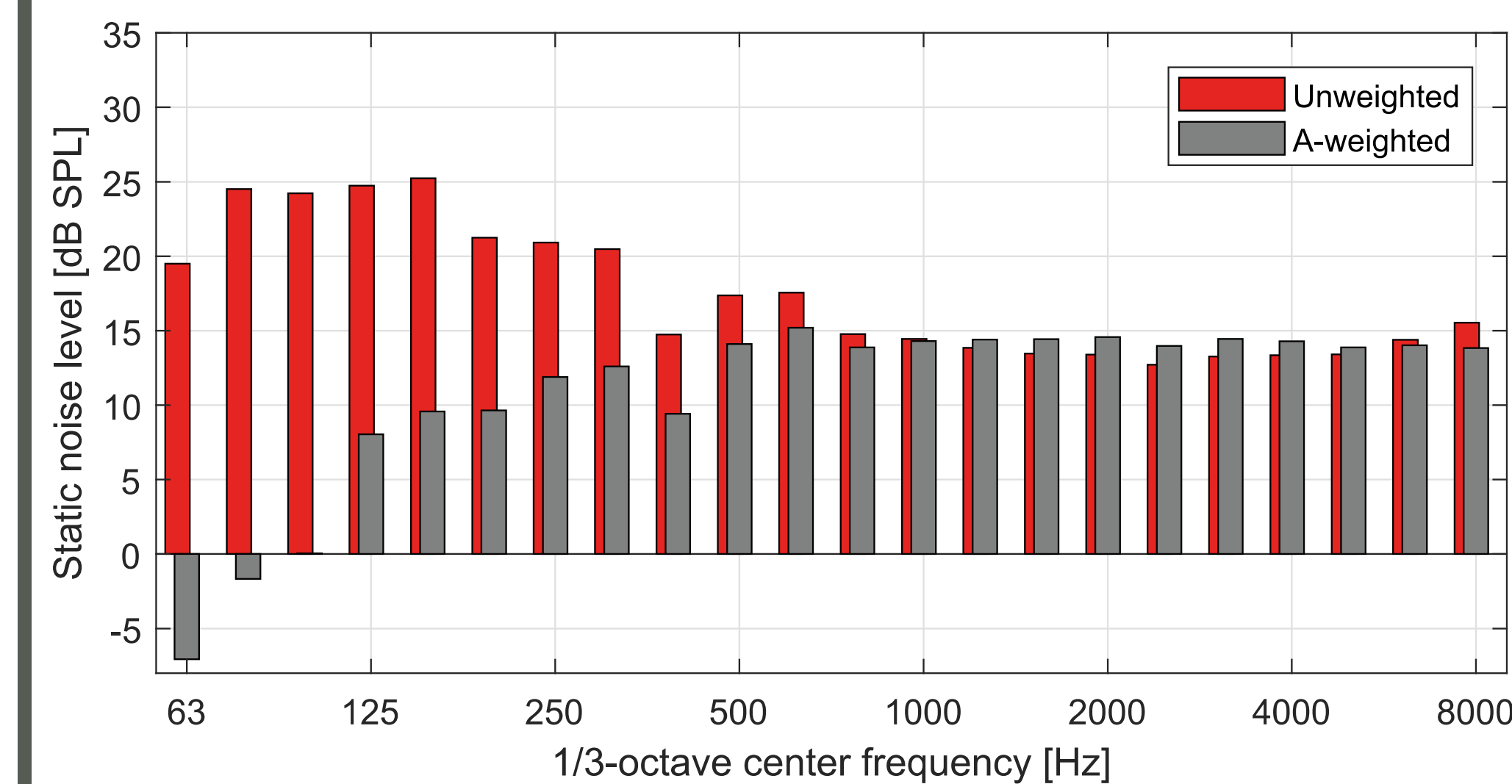
### Software:

- Based on Android **Automotive** OS enabling smartphone to act as Bluetooth stereo audio receiver
- Background **service** for data handling and extraction of acoustical features, foreground **application** for status display and questionnaire
- Flexible questionnaire design in **human-readable** format with functionality, constraints, schedule, ramifications

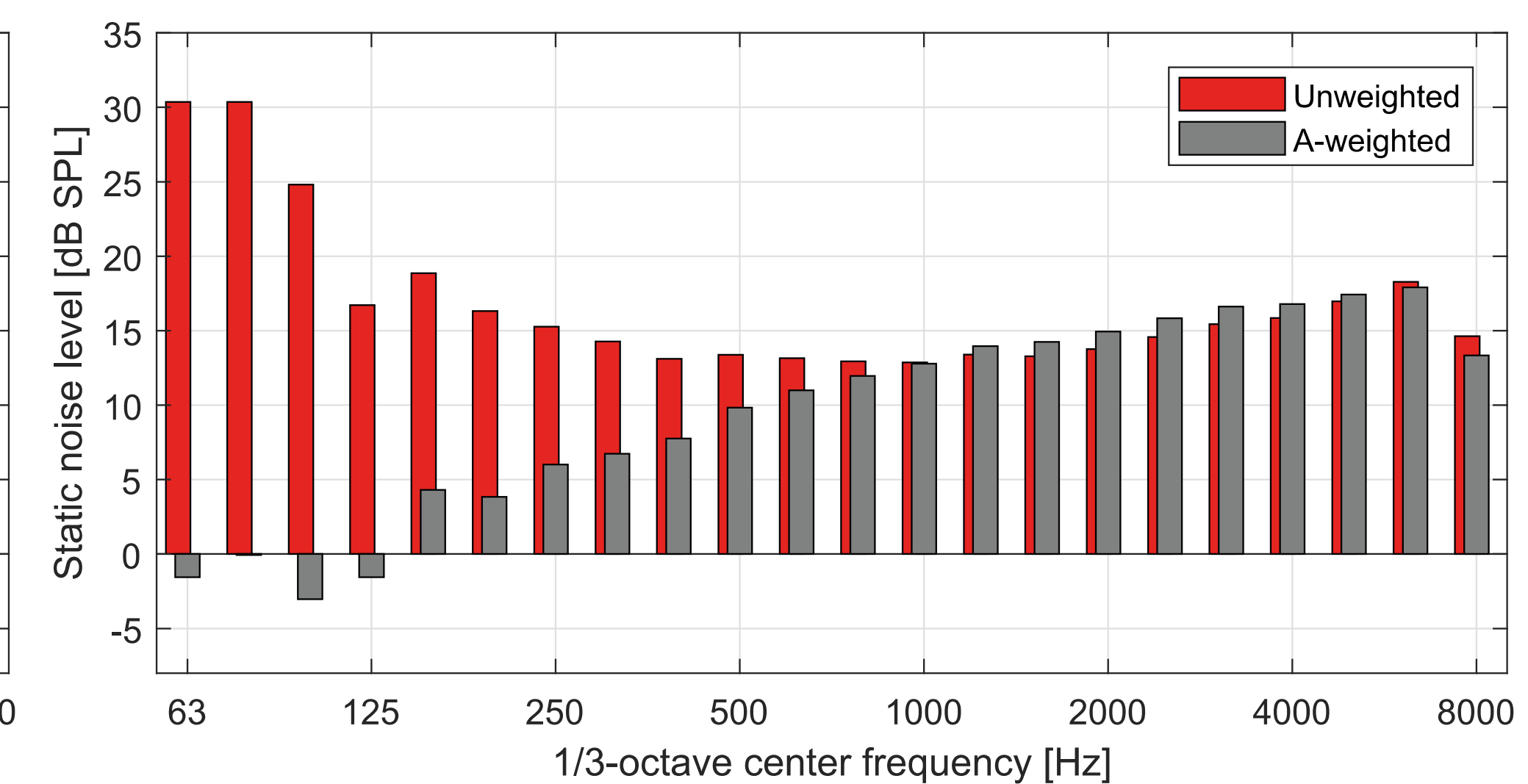


## LOW INHERENT NOISE

Current System (A2DP):

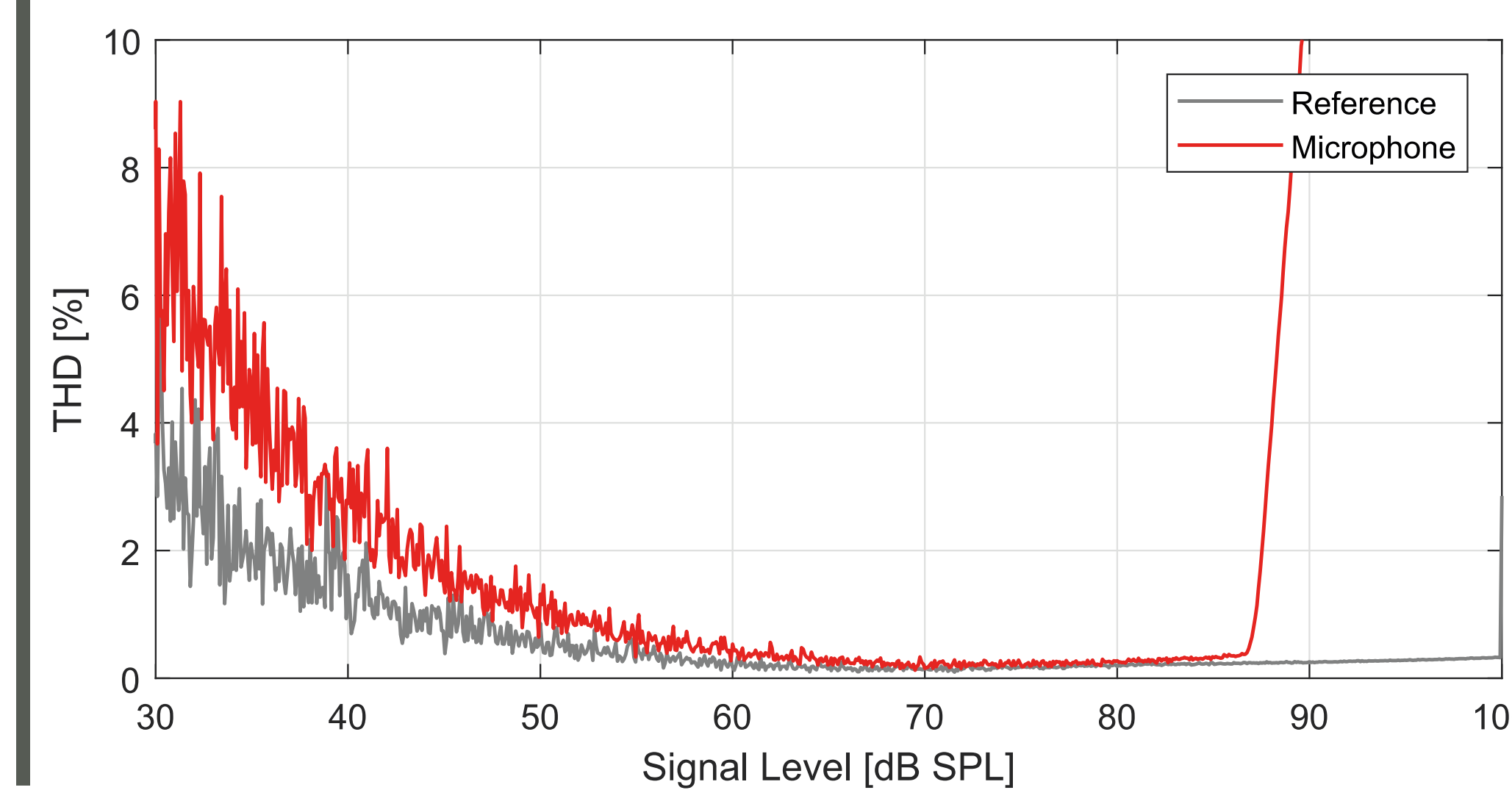


Next Generation (RFCOMM):

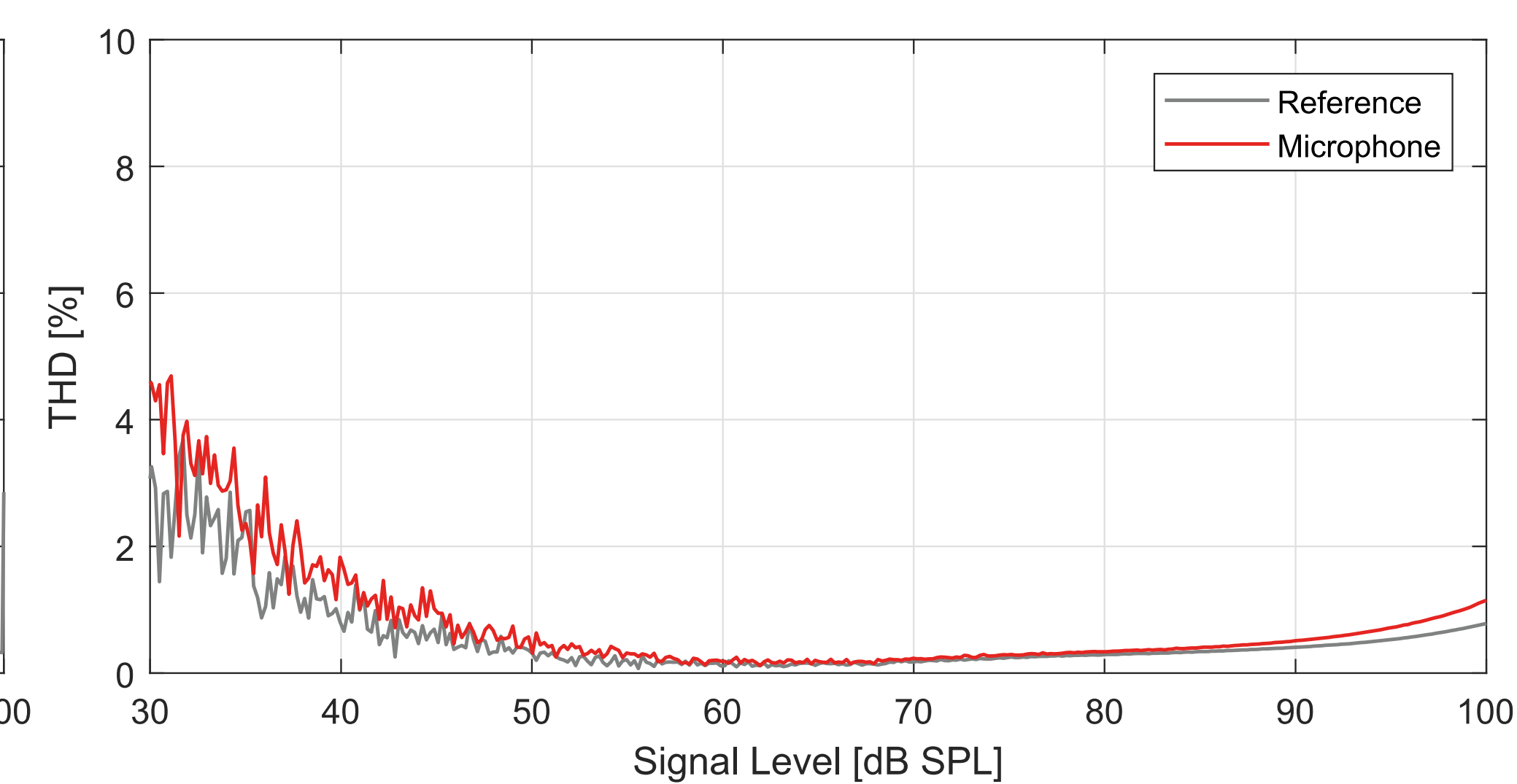


## EXTENDED DYNAMIC RANGE

Current System (A2DP):



Next Generation (RFCOMM):



## REFERENCES

- [1] Shiffman et al. *Ecological Momentary Assessment*. Annual Review of Clinical Psychology, **2008**, 4.
- [2] Bitzer et al. *Privacy-aware Acoustic Assessments of Everyday Life*. JAES, **2016**, 6, Vol. 64
- [3] Gablenz et al. *Data analysis from real-world hearing assessment*, IHCON **2018**, please refer to poster **D8-P-13**

## ACKNOWLEDGEMENTS

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SOURCECODE: <https://github.com/IHAB-RL/MobileSoftware>