Low Delay Audio Streaming for a 3D Audio Recording System

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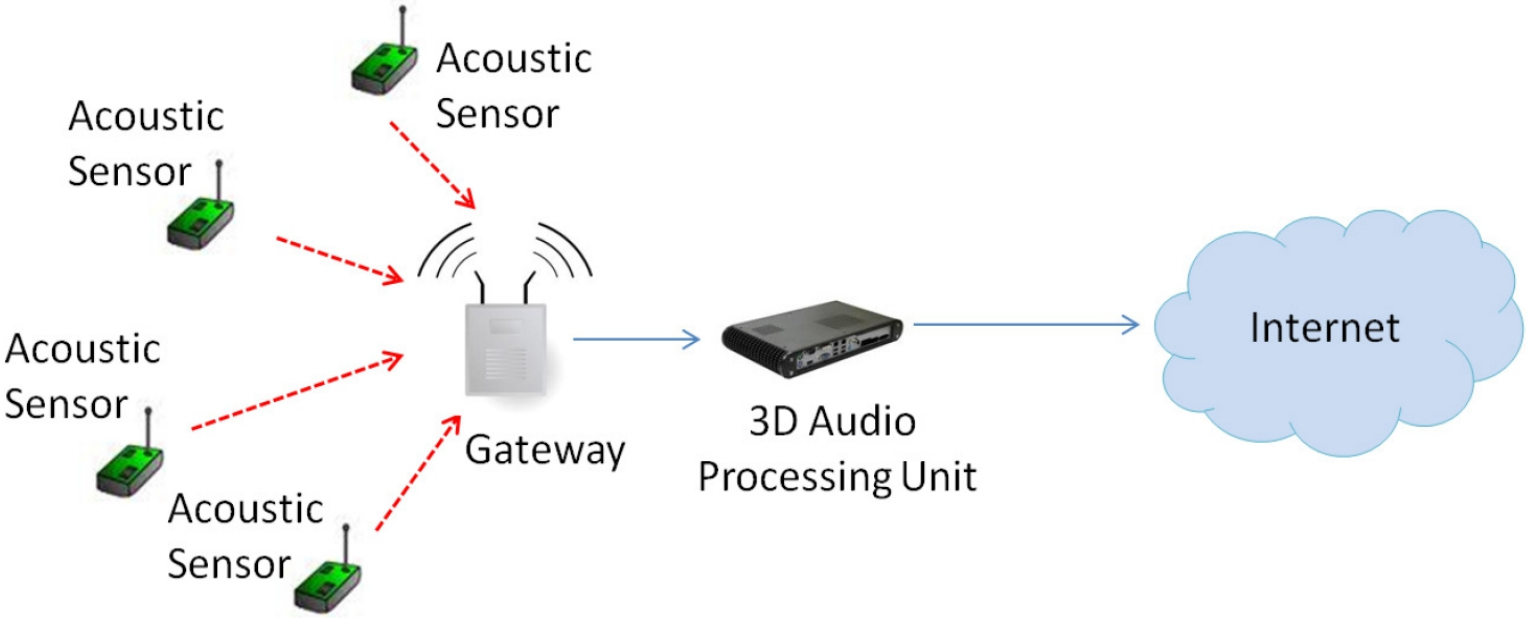
Motivation

How long are the delays?

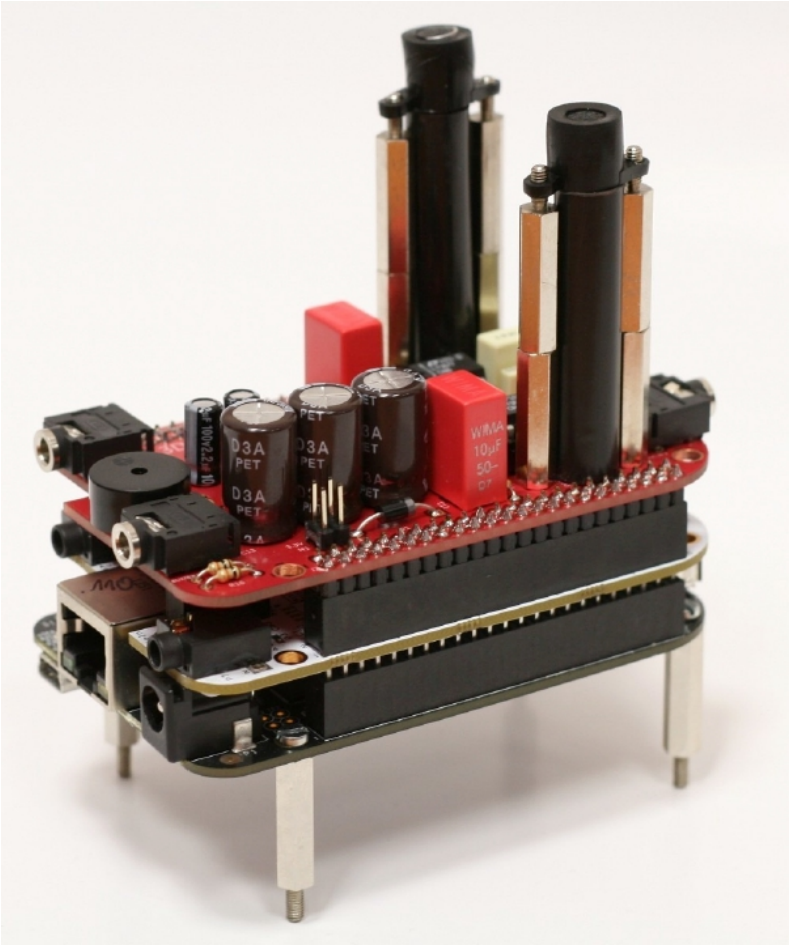
Applications

- Live audio streaming – e. g. teleconference
- Recording animals
- Tracking audio objects
- Virtual/augumented reality
- Recordings for new audio coding standard – MPEG-H 3D Audio

Wireless acoustic sensor network



3D AudioSense



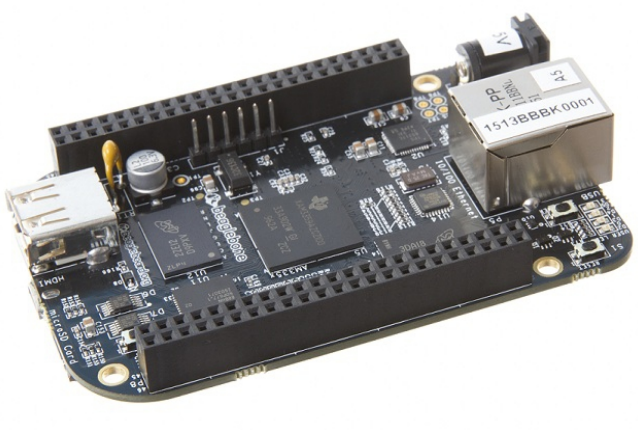
Acoustic Sensor:

- Beaglebone Black + AudioCape

+ mic-board

- Embedded or external microphones
- 802.11n

3D AudioSense



Processing Unit:

- Beaglebone Black

or PC or ...

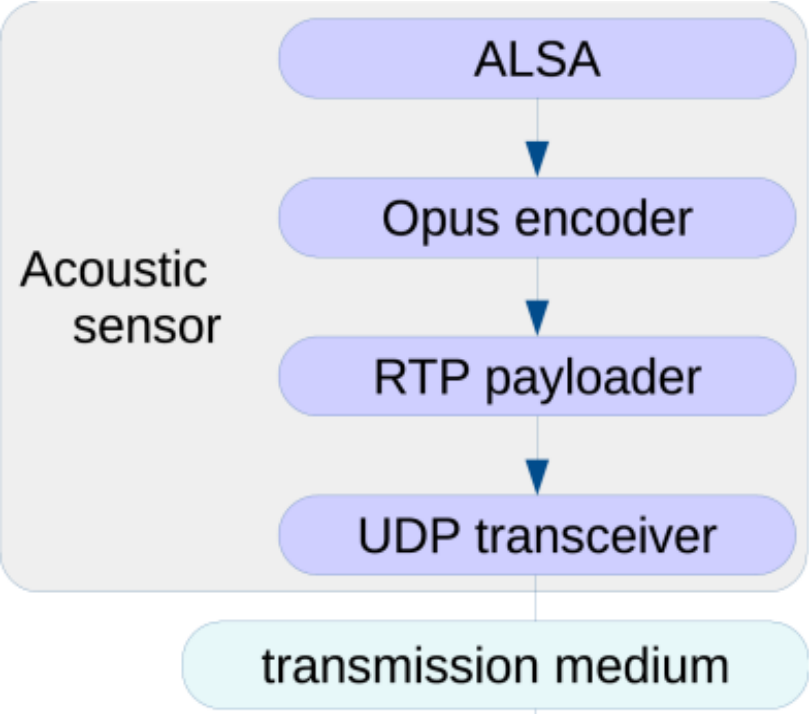
- 802.11n

Gateway

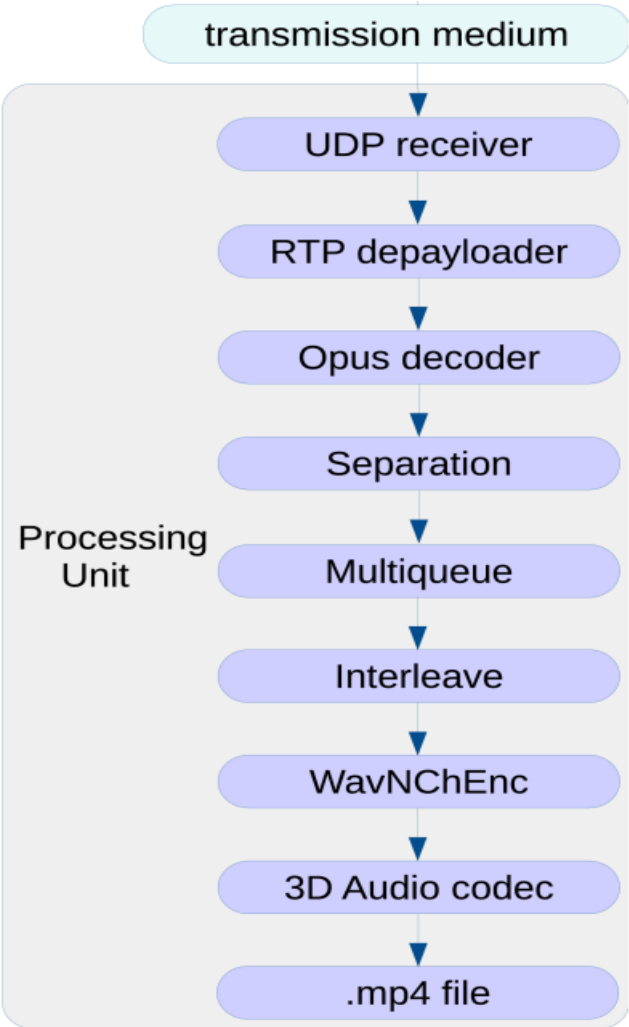
- Router – 802.11n/ac

Software

Gstreamer v1.4

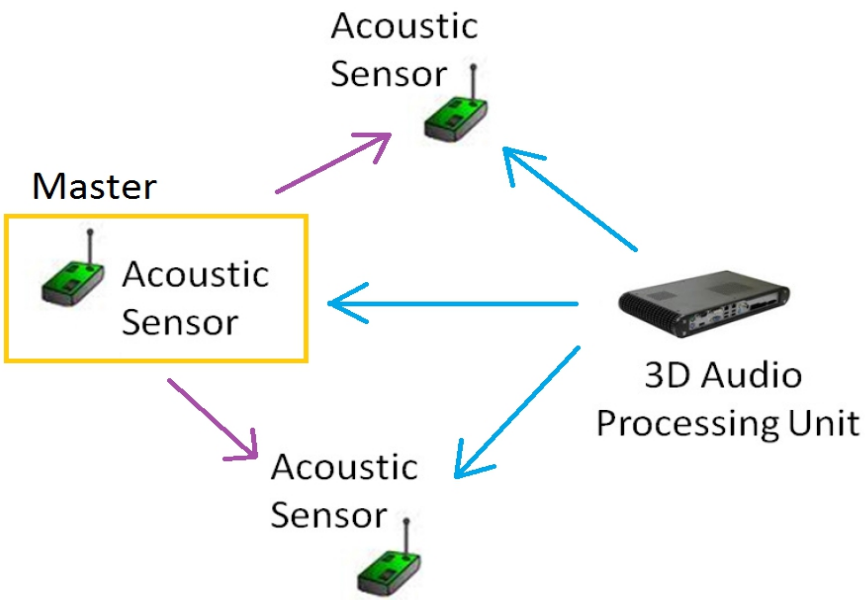


Software


transmission medium
Processing Unit
UDP receiver
RTP depayloader
Opus decoder
Separation
Multiqueue
Interleave
WavNChEnc
3D Audio codec
.mp4 file

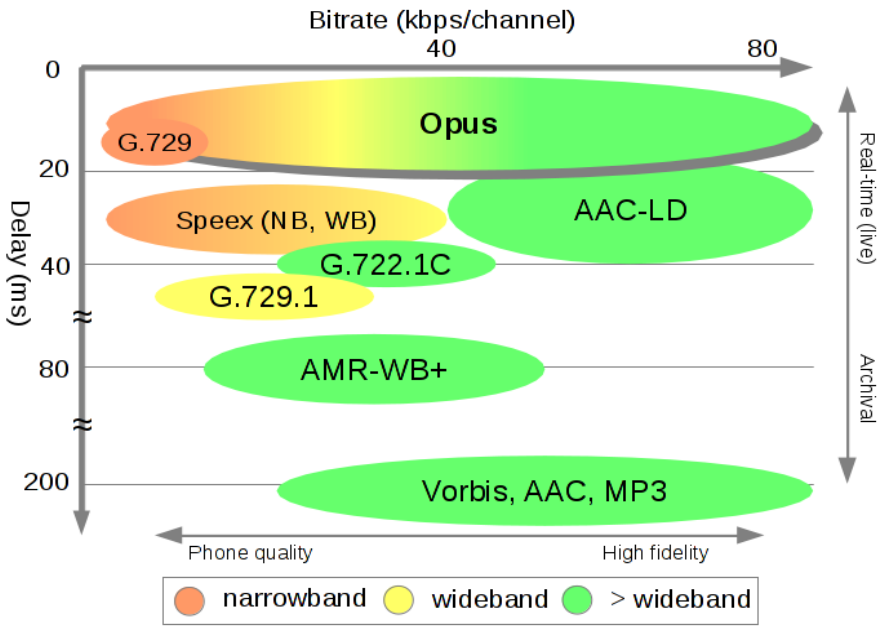
Synchronization

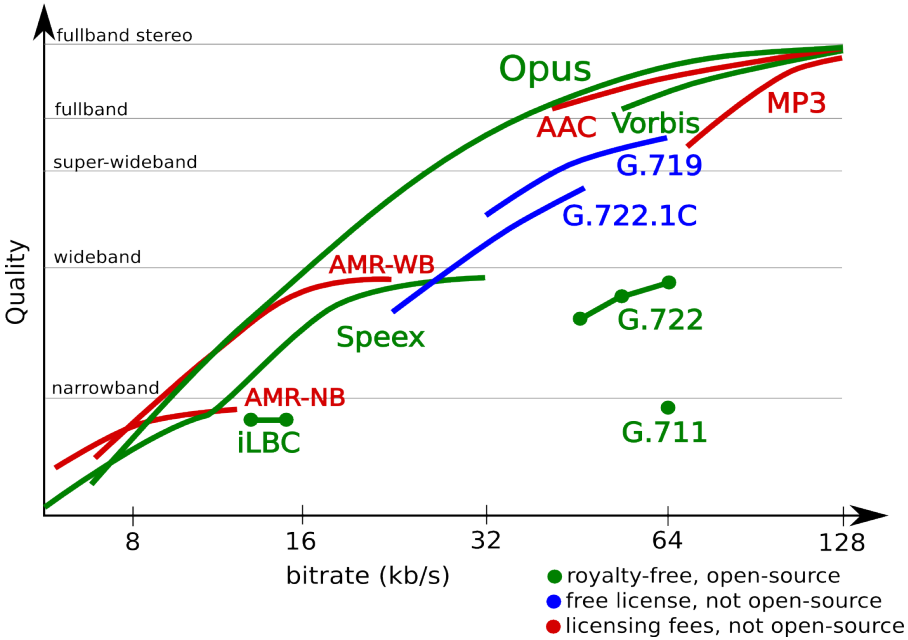
- Reference broadcast
- Linear regression
- Synchronization error: 200 us



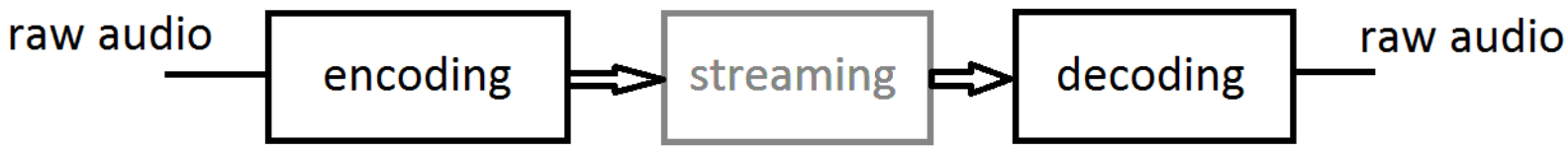
Opus

- SILK – for speech, CELT – for music and hybrid mode
- Wide range of bitrate
- Configurable parameters like duration of a encoded frame
- Allows control on complexity of the encoder





Measurements

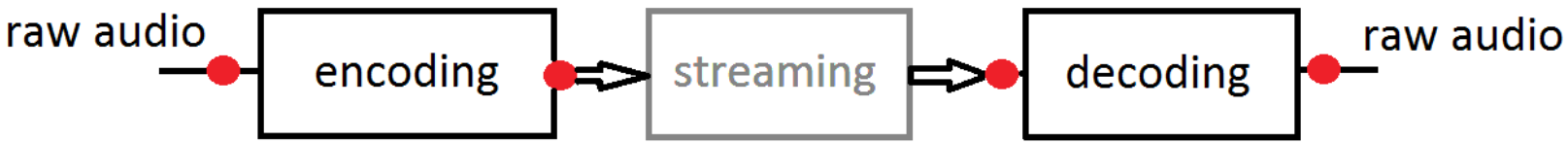


Test cases:

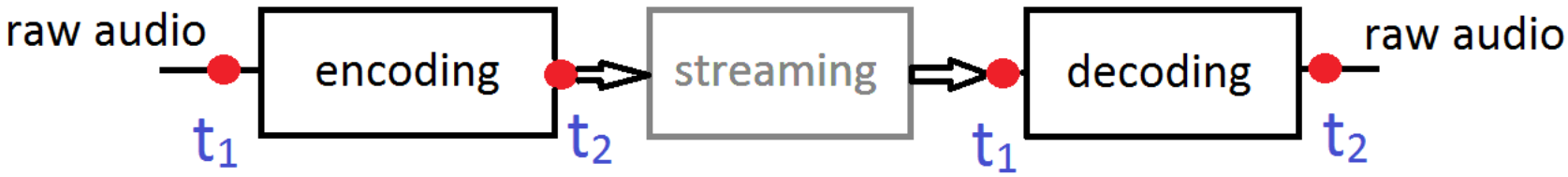
- Encoding time
- Decoding time
- Streaming time

*** No sound quality tests ***

Measurement of coding and decoding time

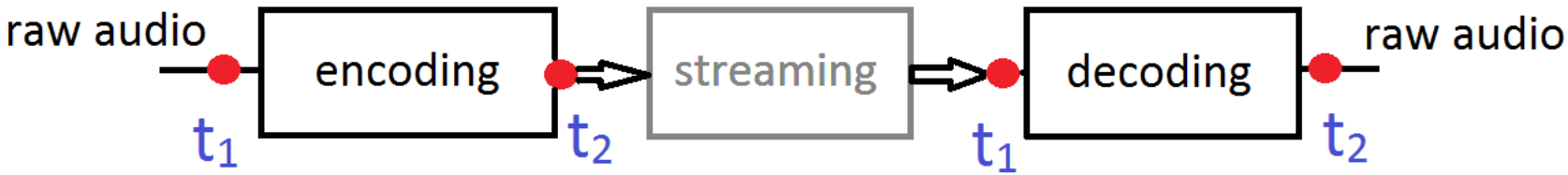


Measurement of coding and decoding time



- t1 – a timestamp from moment when one whole buffer of data is passed on to the encoder/decoder
- t2 – a timestamp from moment when encoded packet leaves the encoder/decoder
- Delay: $\Delta t = t2 - t1$

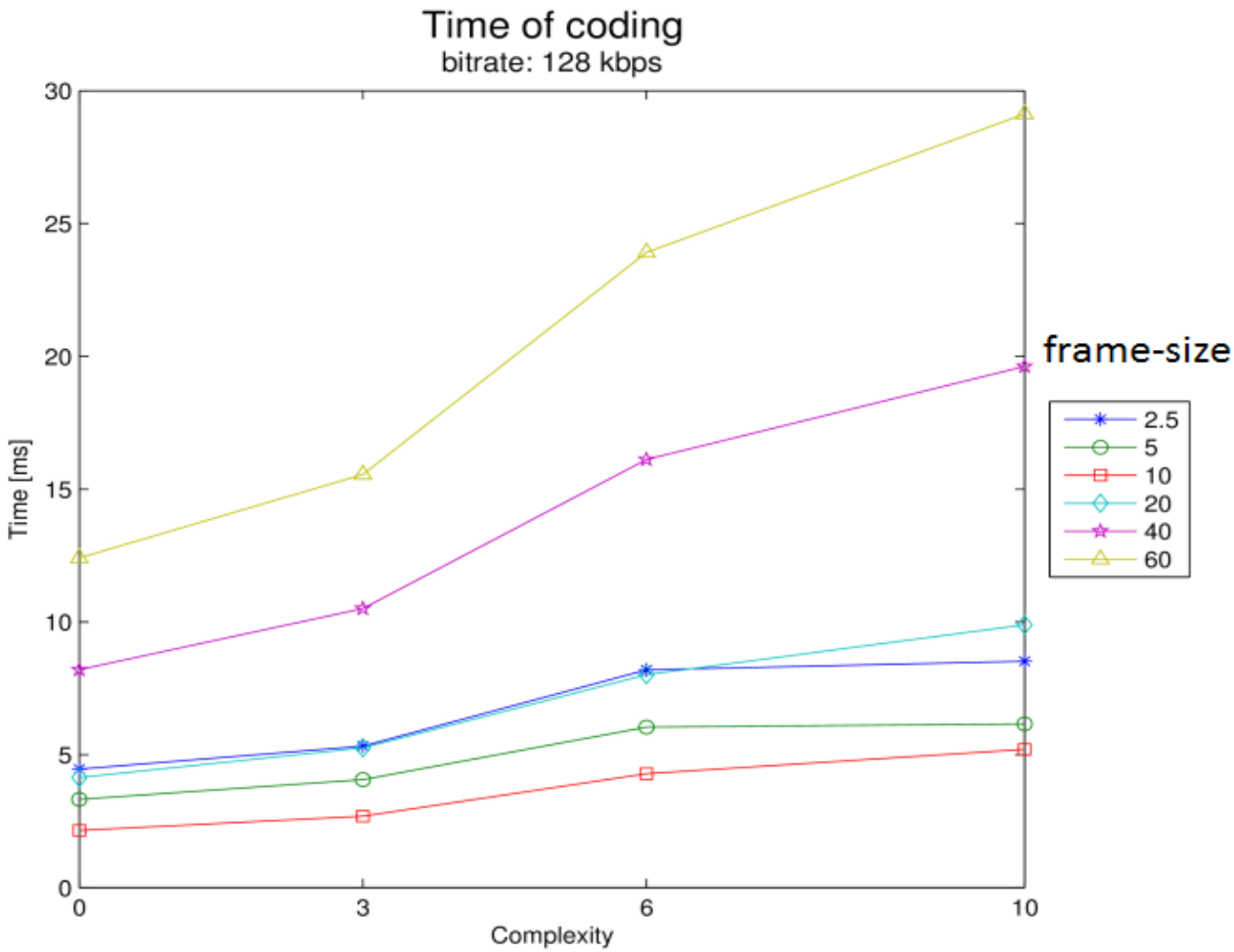
Measurement of coding and decoding time



The most significant parameters:

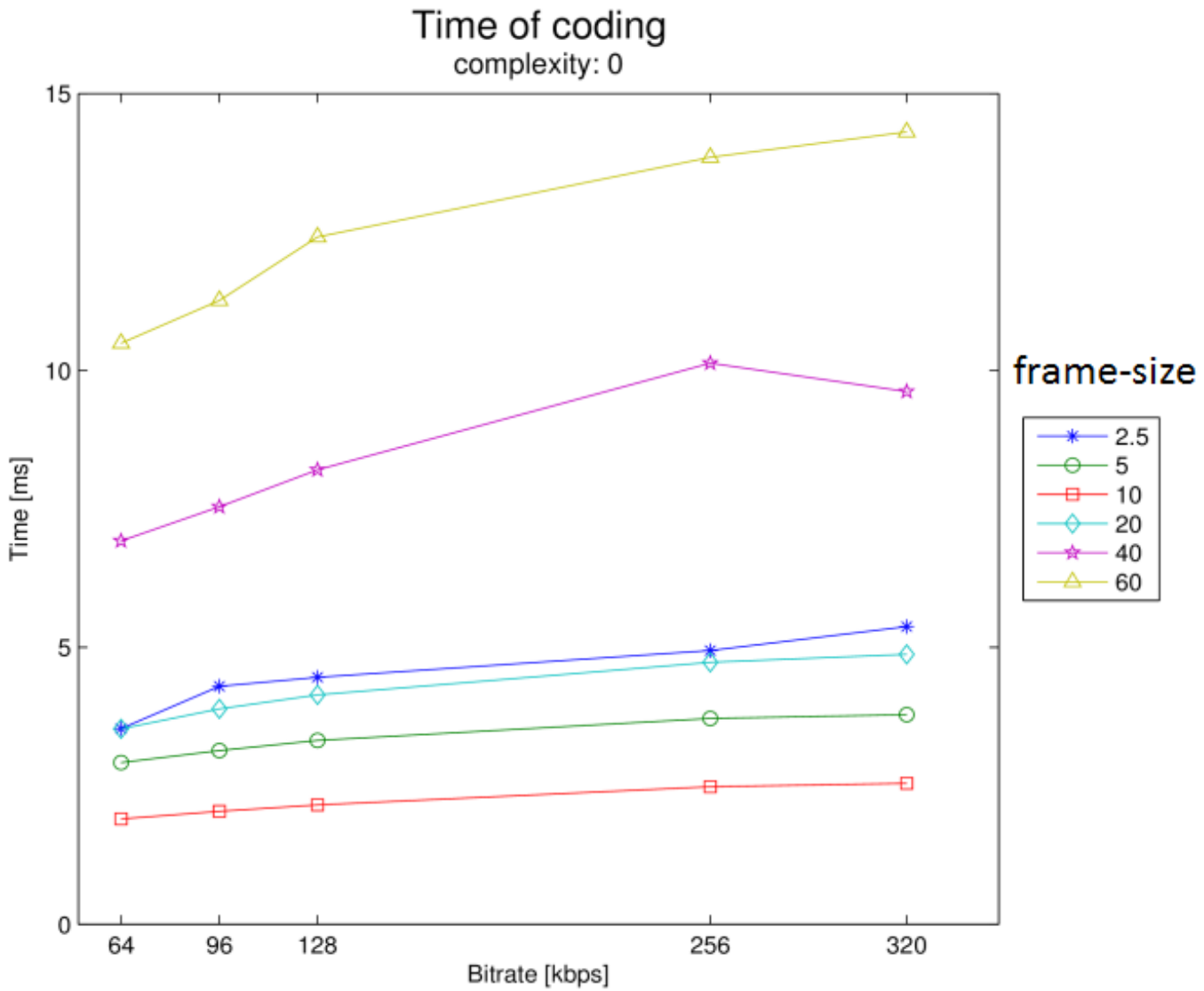
- Bitrate
  - 64, 96, 128, 256, 320 [kbps]
- Complexity
  - 0, 3, 6, 10
- Frame-size
  - 2.5, 5, 10, 20, 40, 60 [ms]

Encoding time

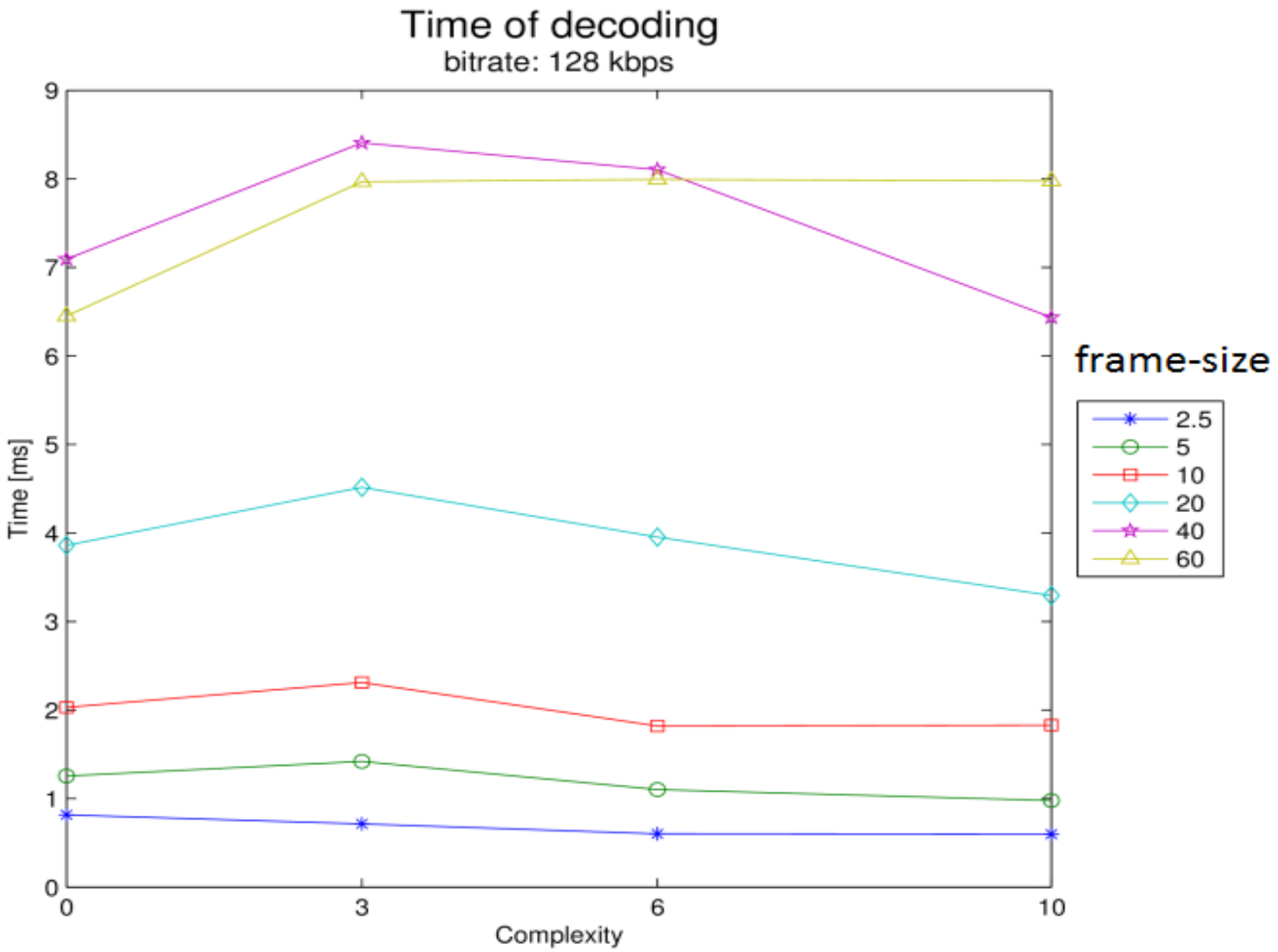


- 1 point => several hundreads of measurements

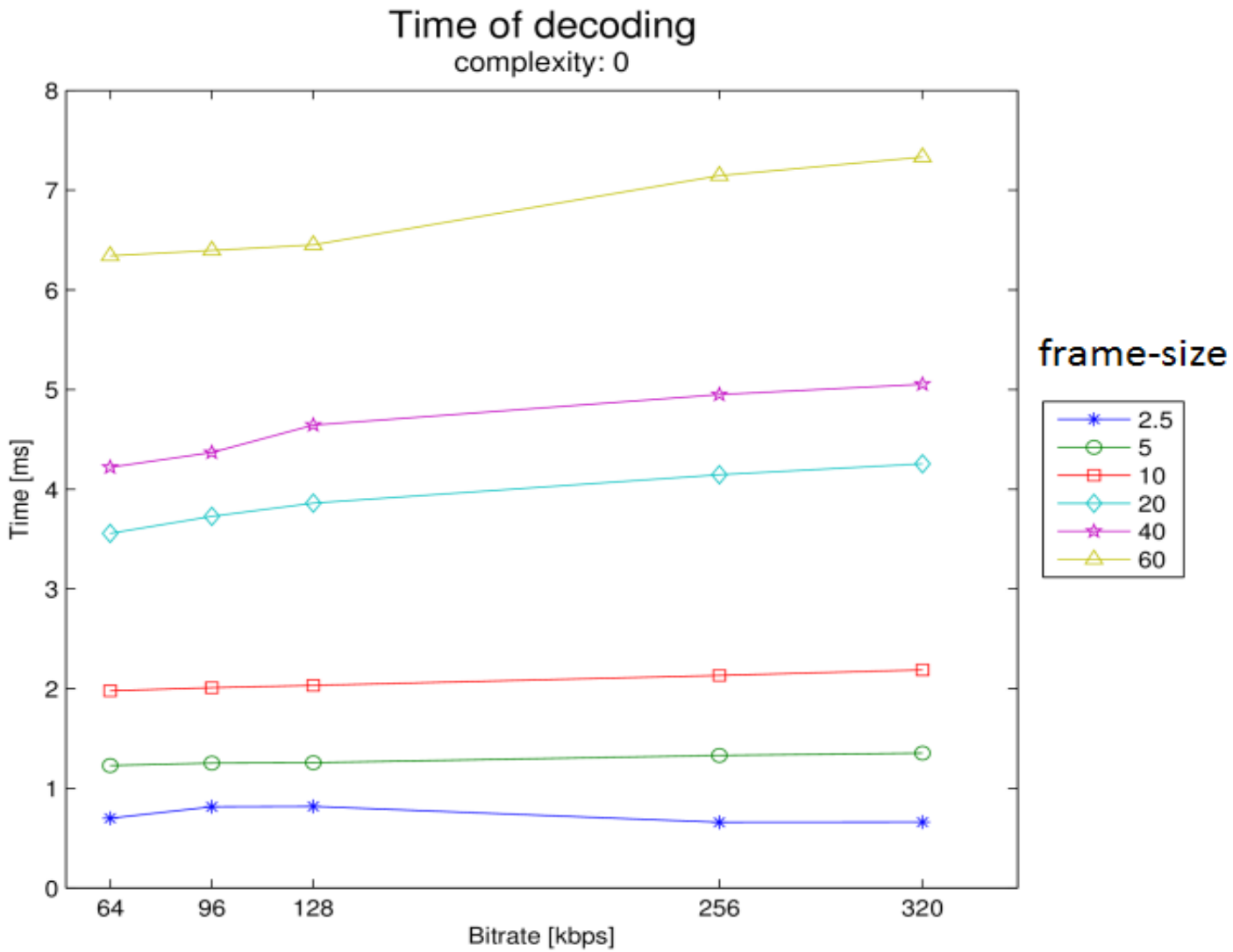
Encoding time



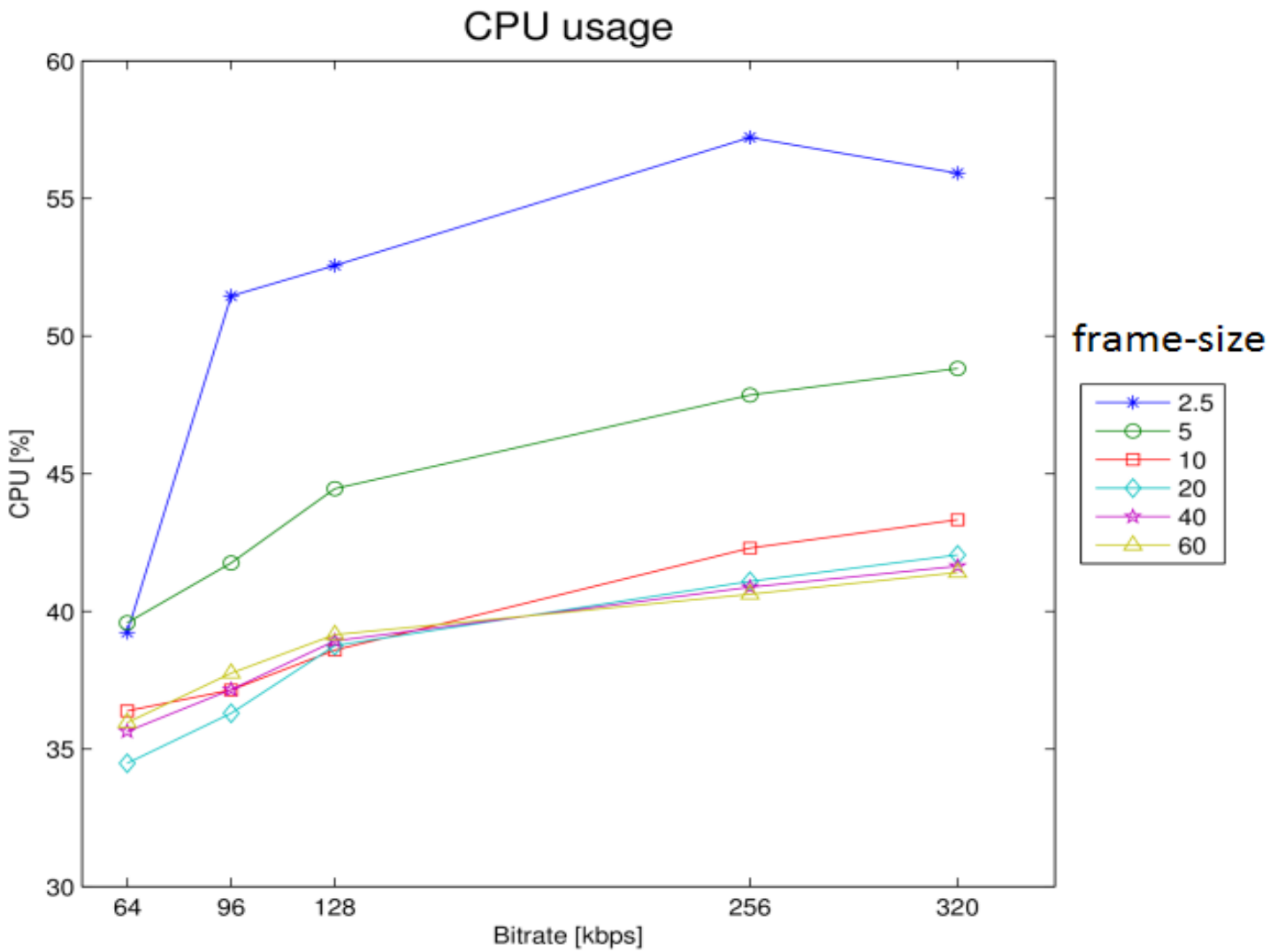
Decoding time



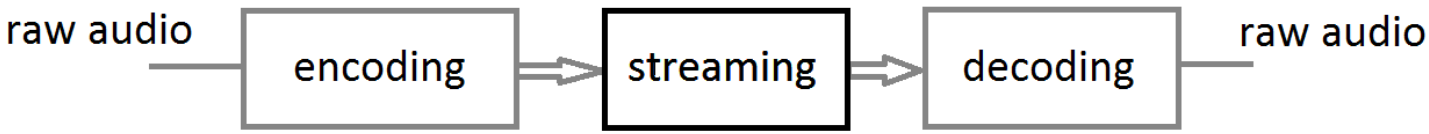
Decoding time



CPU – ARM Cortex A8



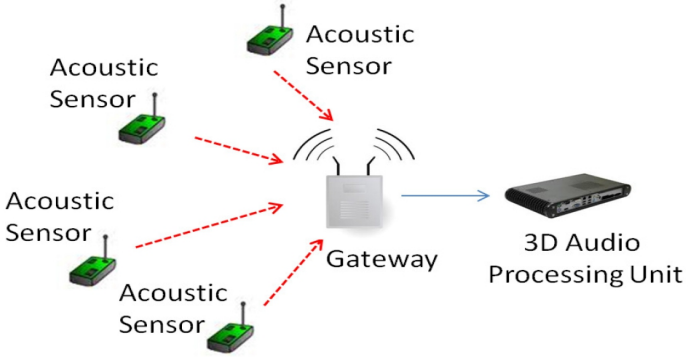
Measurement of streaming time



Conditions:

- Line of Sight
- Non Line of Sight

Network topology:



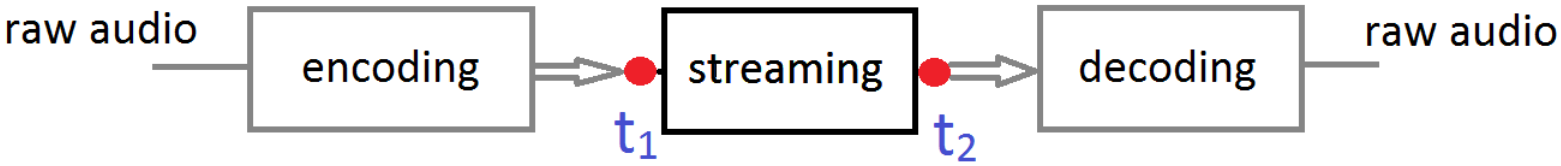
Number of sensors:

- 1, 2 and 3

Distance

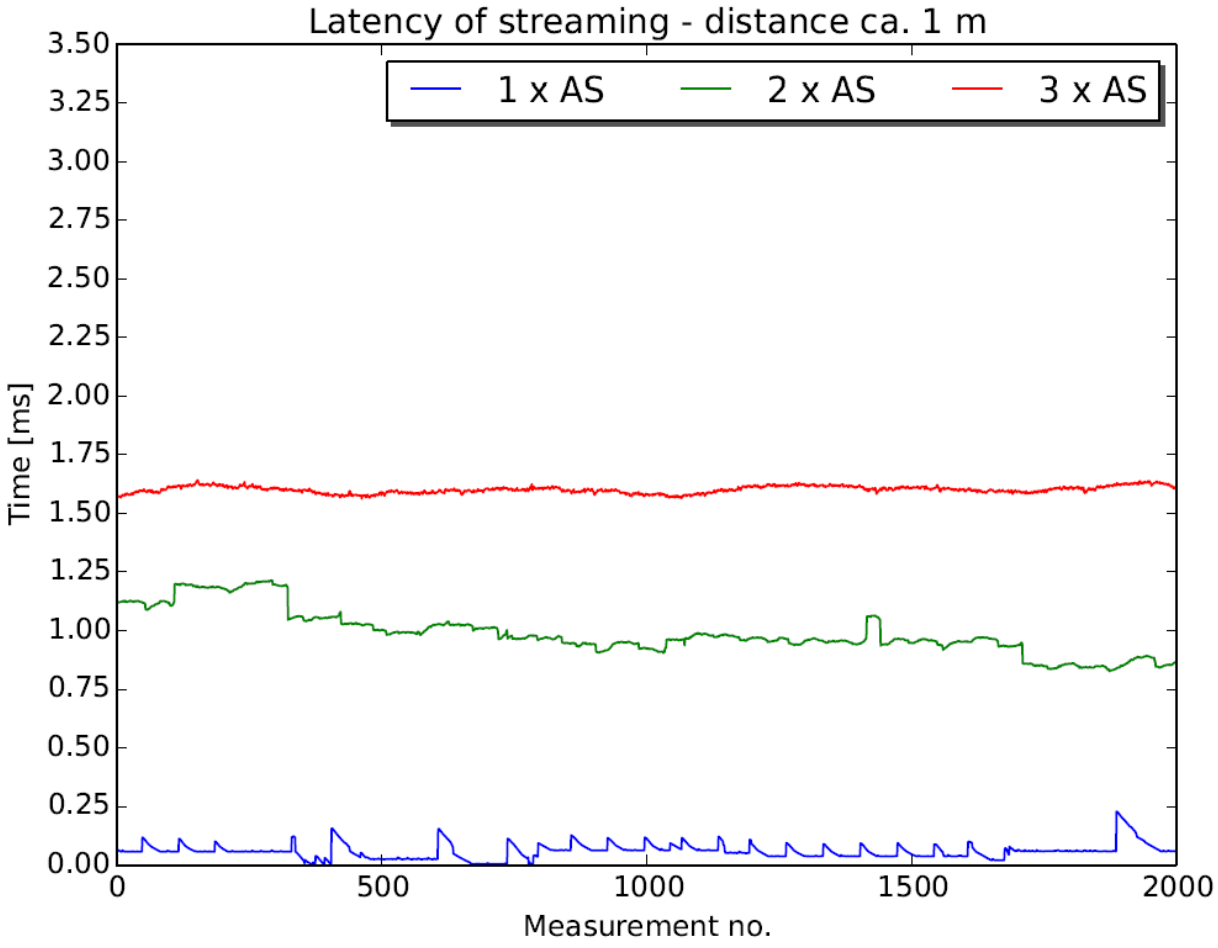
- 1, 6 and 10 m

Measurement of streaming time

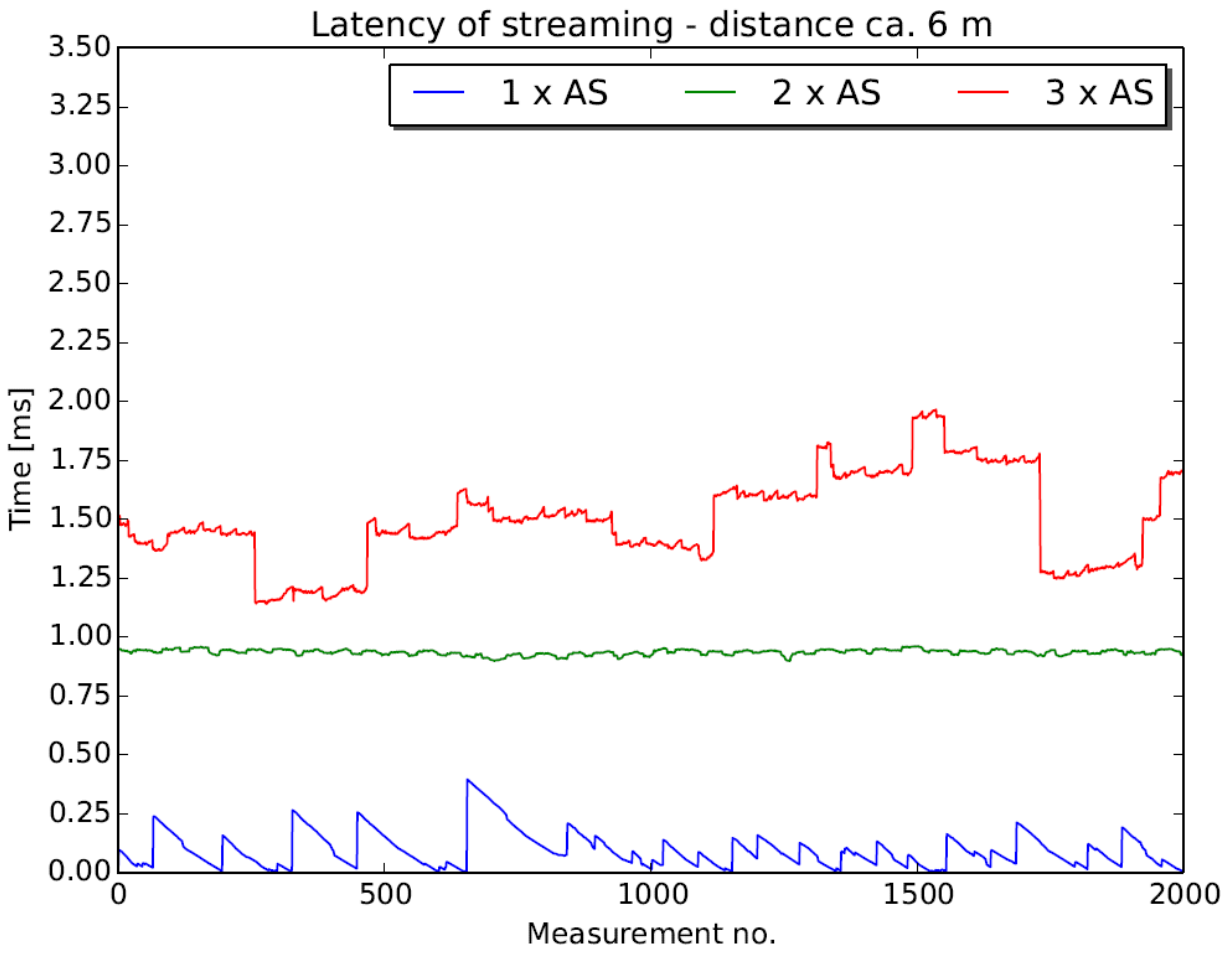


- t1 – a timestamp from moment when one encoded packet is sent
- t2 – a timestamp from moment when a packet arrives to the receiver
- Delay: $\Delta t = t2 - t1$

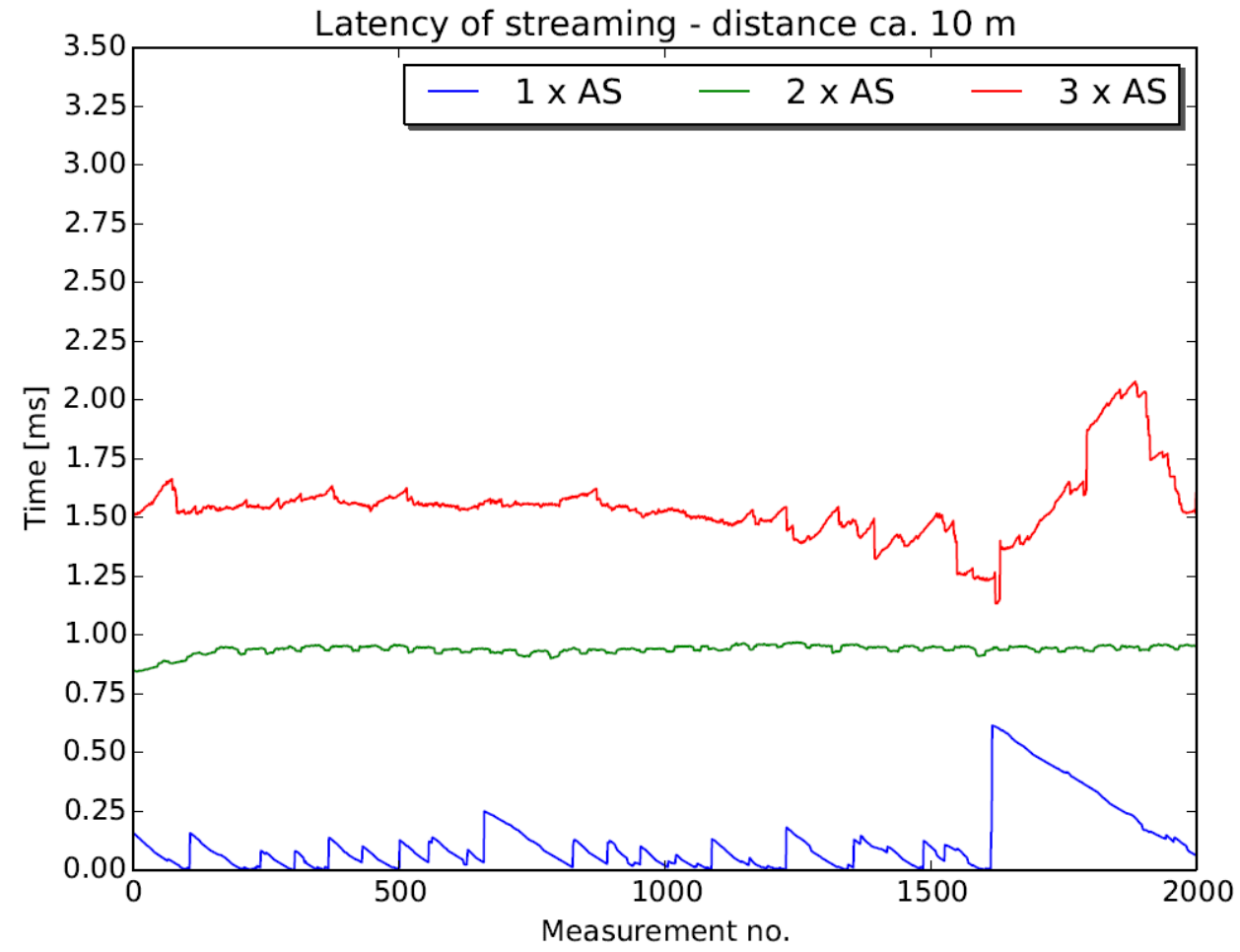
Streaming time - LOS



Streaming time - NLOS



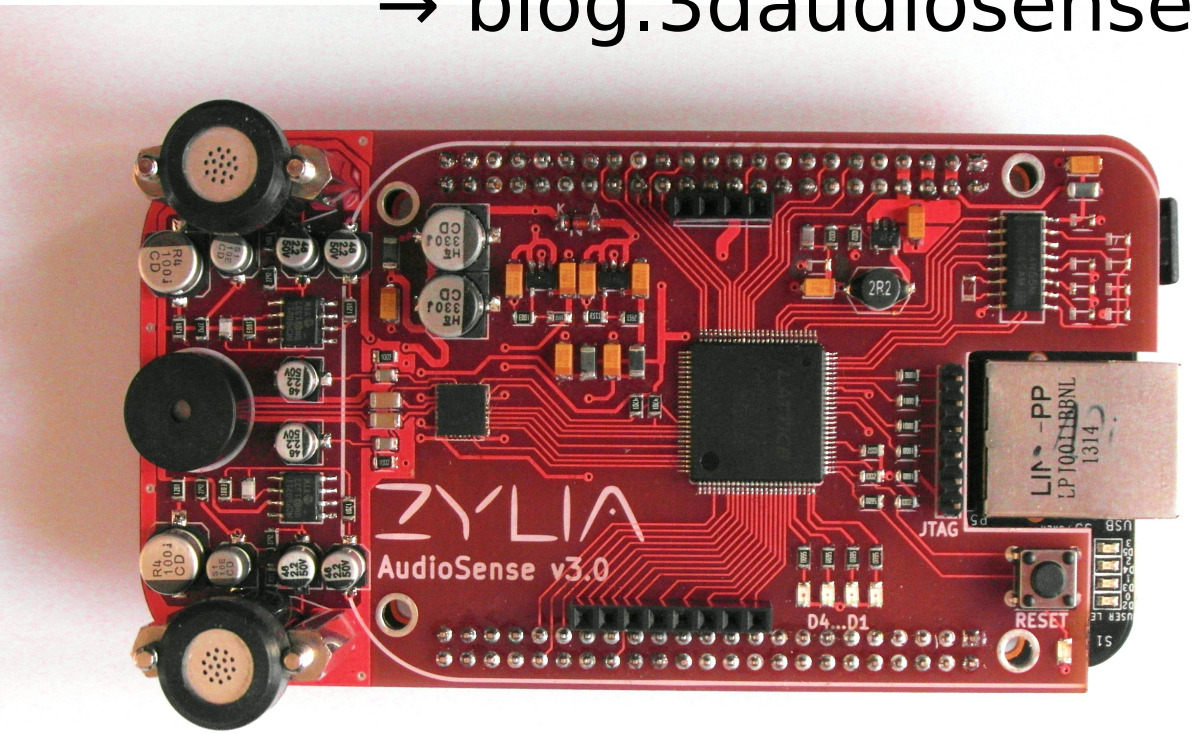
Streaming time - NLOS



Future work

- 802.11ac
- New acoustic sensor

→ blog.3daudiosense.com



Acknowledgements

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