From a Sketch to a Real LISTEN Demonstrator

Jozef Ivanecký

www.eml.org

European Media Laboratory GmbH

Who I am …

- Studies:
  - PhD in Speech Recognition, TU Košice, Slovakia
  - MsC in Electrical Engineering at Department of Cybernetics and Artificial Intelligence, TU Košice, Slovakia
- IBM
  - Embedded Via Voice development, Watson Research Group, Czech Republic
  - Acoustic modeling for embedded German and ML ASR systems, IBM R&D, Germany
- EML
  - Language modeling tools
  - Embedded ASR

Outline

- Plans
- Technology
- Integration
- Platforms
- Demo

Plans

- Plans for the demonstrator:
  - Always listening mode
  - Multiple audio sources (strong background noise)
  - High accuracy
  - Bilingual (if possible)
  - Real time recognition
  - No active cooling

Technology

- Key technological enhancements:
  - Stream based segmentation
  - Stream based speaker diarization
  - Improved voice activity detection (VAD)
  - Partial traceback support
  - Dynamic lexicon adaptation
  - Grapheme-to-Phoneme (G2P) service
  - Always-Listening Mode
  - Multiple Search Spaces

Voice Activity Detection

- Efficient filtering non-speech segment before processing the audio signal by the decoder. Load for Intel NUK:
  - Speech segment, KwS: 20-30%
  - Non speech segment: 3-5%
- Improved WER
- ALM trigger

Always Listening Mode

- A prerequisite for any hands-free voice enabled interface
- New extension of EML decoder
  - Utilizes:
    - VAD
    - Partial traceback
- Just Key word spotting

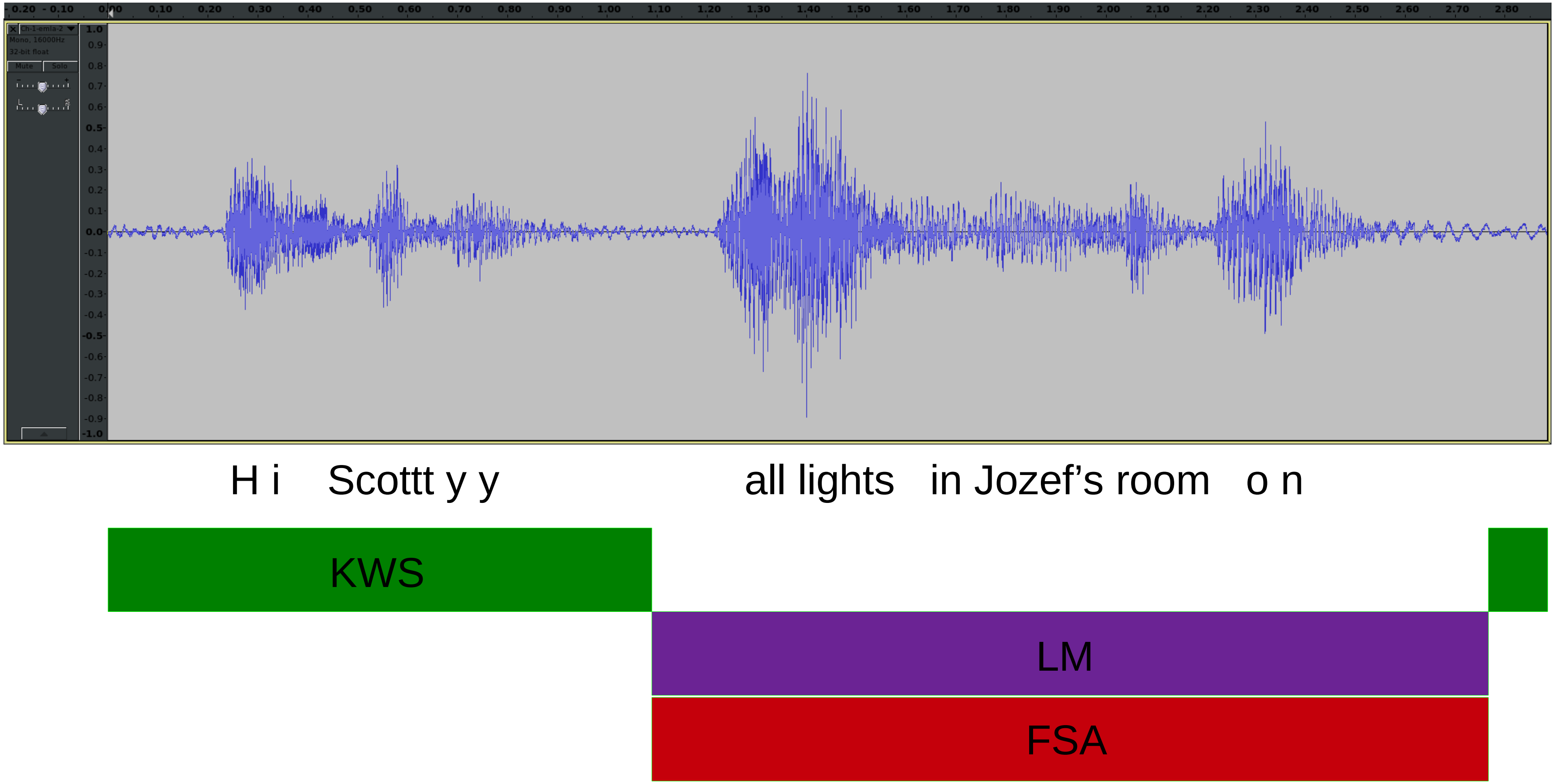
Multiple Search Spaces

- The demonstrator uses 3 search spaces (SS):
  - SS #1: Key word spotting – with dynamic lexicon update
  - SS #2: Large vocabulary language model
  - SS #3: Small vocabulary grammar (FST)
- After initialization:
  - SS #1 – ON
  - SS #2 & SS #3 - OFF

Multiple Search Spaces

- Why not just 1 SS?
  - Resources saving: Large vocabulary LM vs. simple KwS system
    - KwS load for Intel NUK: 20-30%
    - LV LM load for Intel NUK: 100%
  - Privacy issue
- Why not just 2 SSs?
  - Small grammar - better accuracy for noisy environment:
    - In a quiet environment SS #2 and SS #3 produce usually identical result
    - In a noisy environment are SS #3 results better
    - SS #3 is faster

Search Space Usage



H i Scottt y y

all lights in Jozef’s room o n

KWS

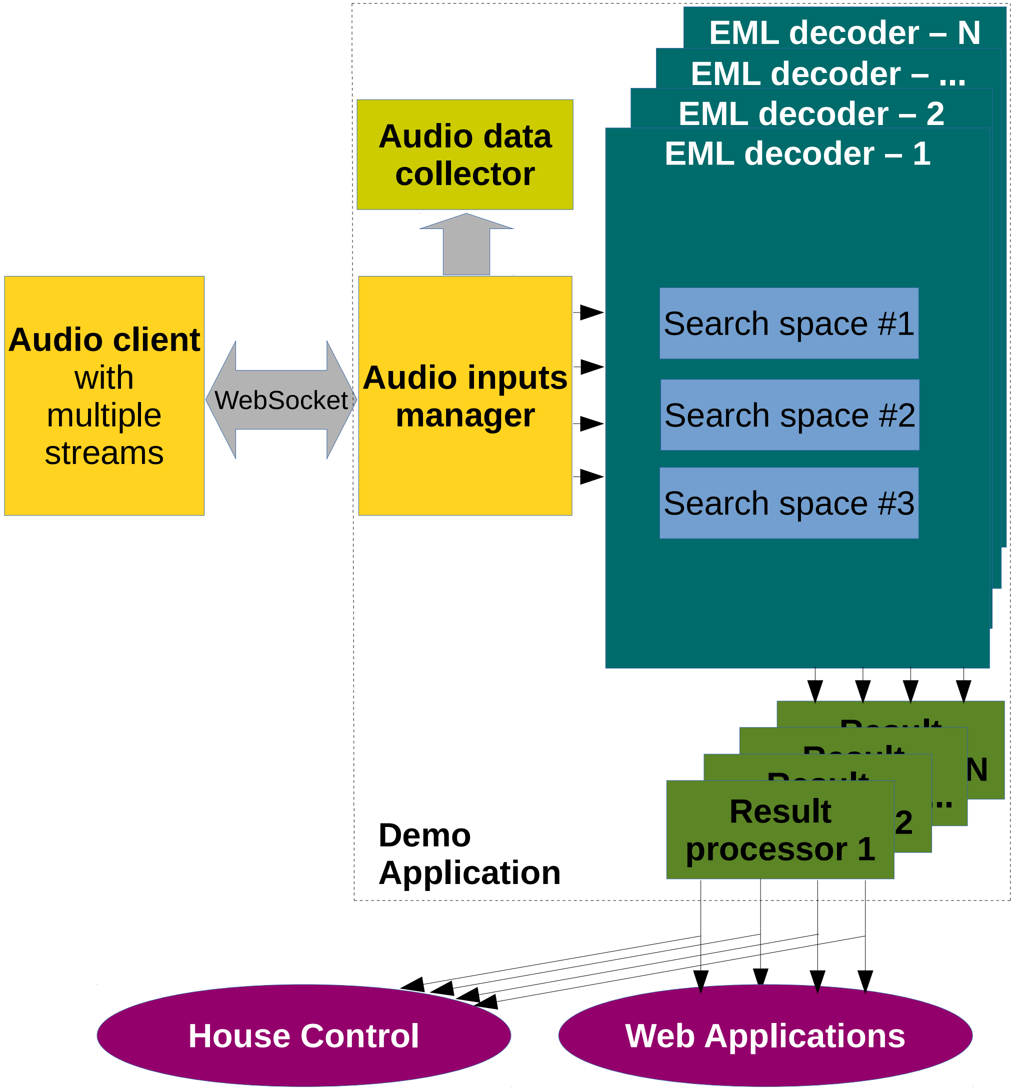
LM

FSA

Demonstrator v1

- The first version of the demonstrator was using two recognition engines:
  - Engine #1: SS #1 - KwS + small PCM buffer
    - ALM mode
  - Engine #2: SS #2 + SS #3
    - P2T mode – controlled by Engine #1
    - VAD included
  - Different AM for Engine #1 and Engine #2

Demonstrator Architecture v2+



Audio client with multiple streams

WebSocket

Audio inputs manager

Audio data collector

EML decoder – N

EML decoder – ...

EML decoder – 2

EML decoder – 1

Search space #1

Search space #2

Search space #3

N

..

2

Result processor 1

Demo Application

House Control

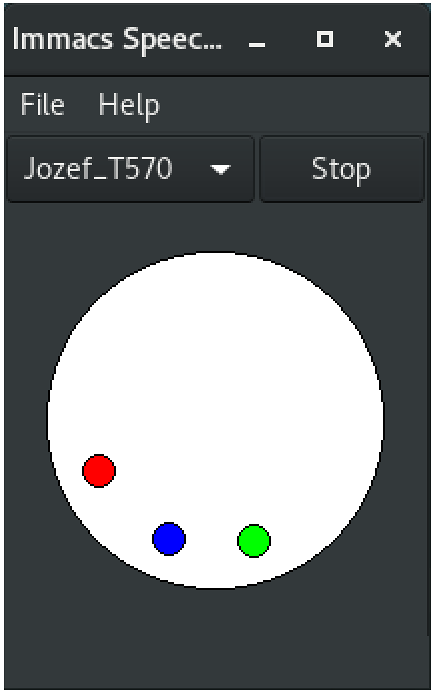
Web Applications

Platforms

- Several options
  - EML Transcription platform
  - Intel based NUK 3 – current demo choice
  - Cortex A-9 based Odroid U-3 – for a limited version

Audio Clients

- Simple directional microphone
- Microphone array
  - Sources tracking
  - Sources separation



Demo Time

- Microphone array with multiple audio sources
- Bilingual system: German-English
  - Key word: [Hi/Hallo] Scotty
  - LM vocabulary size: 680314+438061
  - Grammar vocabulary size: 109+96
- Platform: Intel NUK 3
  - 32G RAM
  - 4 cores i7-7567U CPU @ 3.50GHz

Thank you for your attention!