STQ Workshop

Auditory and Instrumental Listening Effort – Recent Work in ETSI STQ

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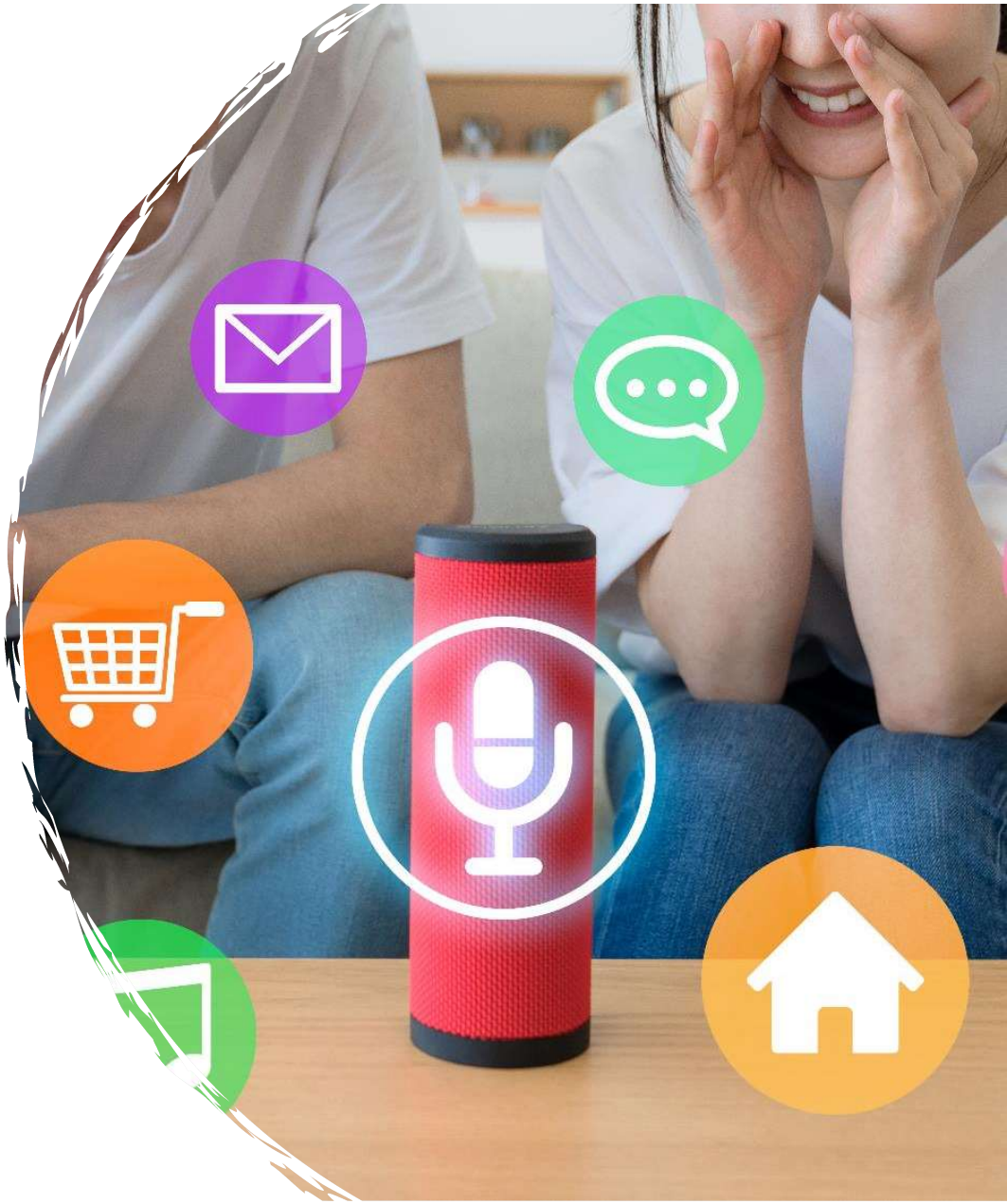


21/11/2022

Motivation

The world is getting louder … which has impacts on our way to communicate:



Modern devices provide (at least a bit) remedy for the listener:

- Improving speech → enhancement algorithms
- Reducing noise → ANC Headsets

… but how to adequately evaluate and qualify such systems?

Motivation

- Just measure speech intelligibility (SI)!
  - It's complicated …
  - → Lack of clear definitions/standardization

- Instead, listening effort (LE) became more popular:
  - "opinion test" vs "measuring a subject"
  - Evaluation of wider SNR range (SI saturates at average SNRs)
  - Simultaneous assessment of other attributes (e.g., speech quality, loudness)

Listening Effort – Auditory Testing

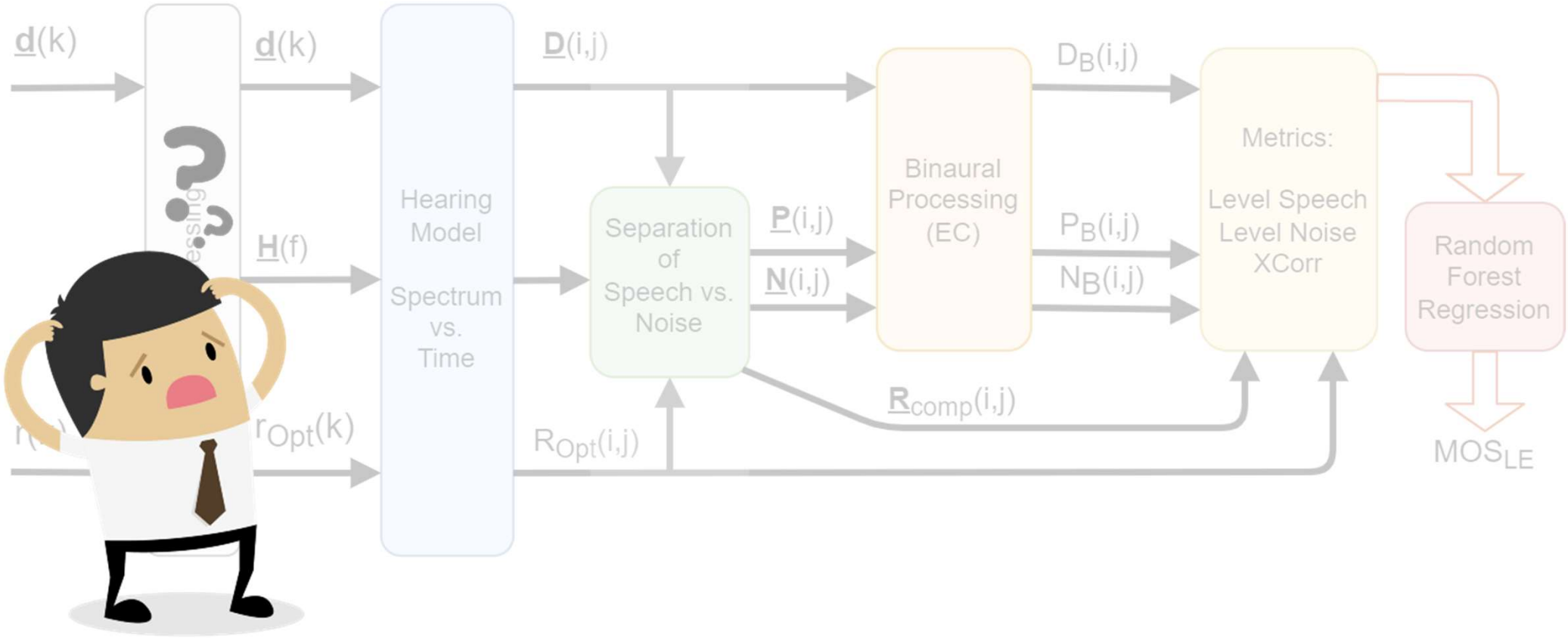
- Repetitions of test stimuli do not (much) impact the test results
- Number of test conditions can be much higher than the number of available speech sequences
- Can be combined with, e.g., "classical" speech quality assessment:

Score	1	2	3	4	5
Listening Effort	No meaning understood with any feasible effort	Considerable effort required	Attention necessary; Moderate effort required	No appreciable effort required	Complete relaxation possible; No effort required
Speech Quality	Bad	Poor	Fair	Good	Excellent

ETSI TS 103 558

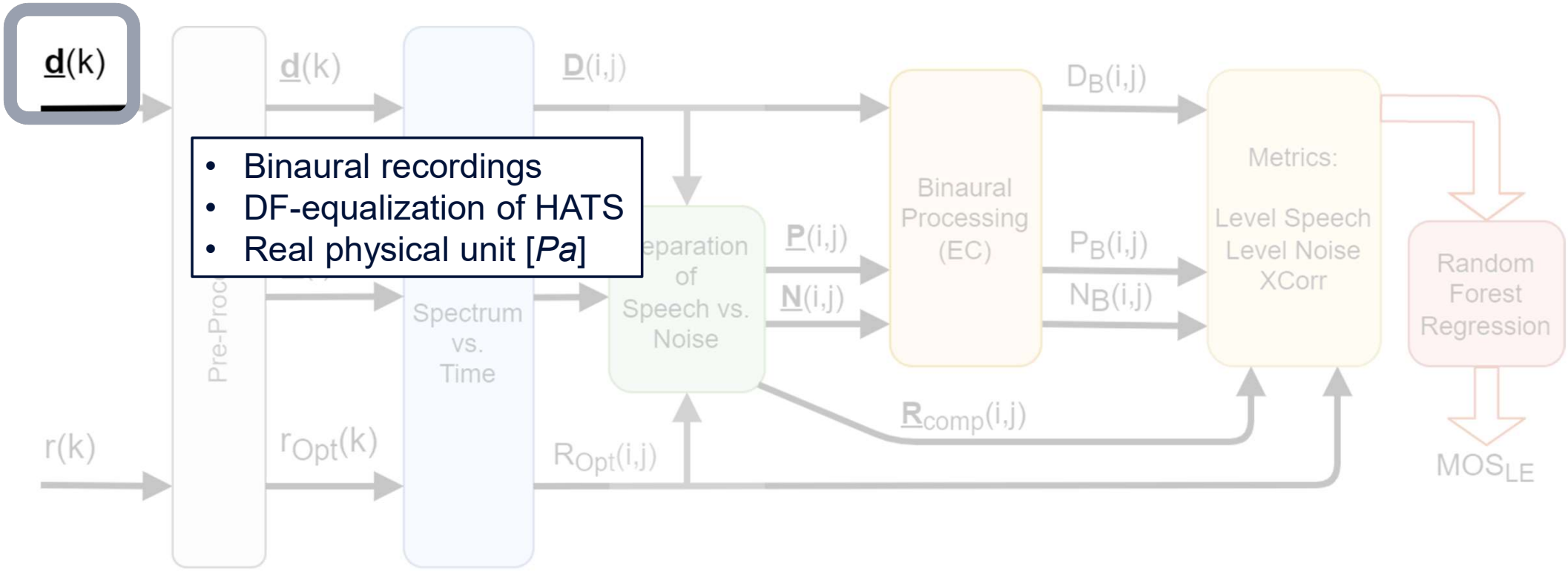
- Includes definition / description of…
  - Prediction model for binaural listening effort
  - Underlying listening test design (based on Rec. ITU-T P.800/P.835, Handbooks, etc.)
  - Underlying listening test databases used for training and validation

Listening Effort – Prediction Model



Listening Effort – Prediction Model

- Just a brief overview and key features (details → ETSI TS 103 558) …



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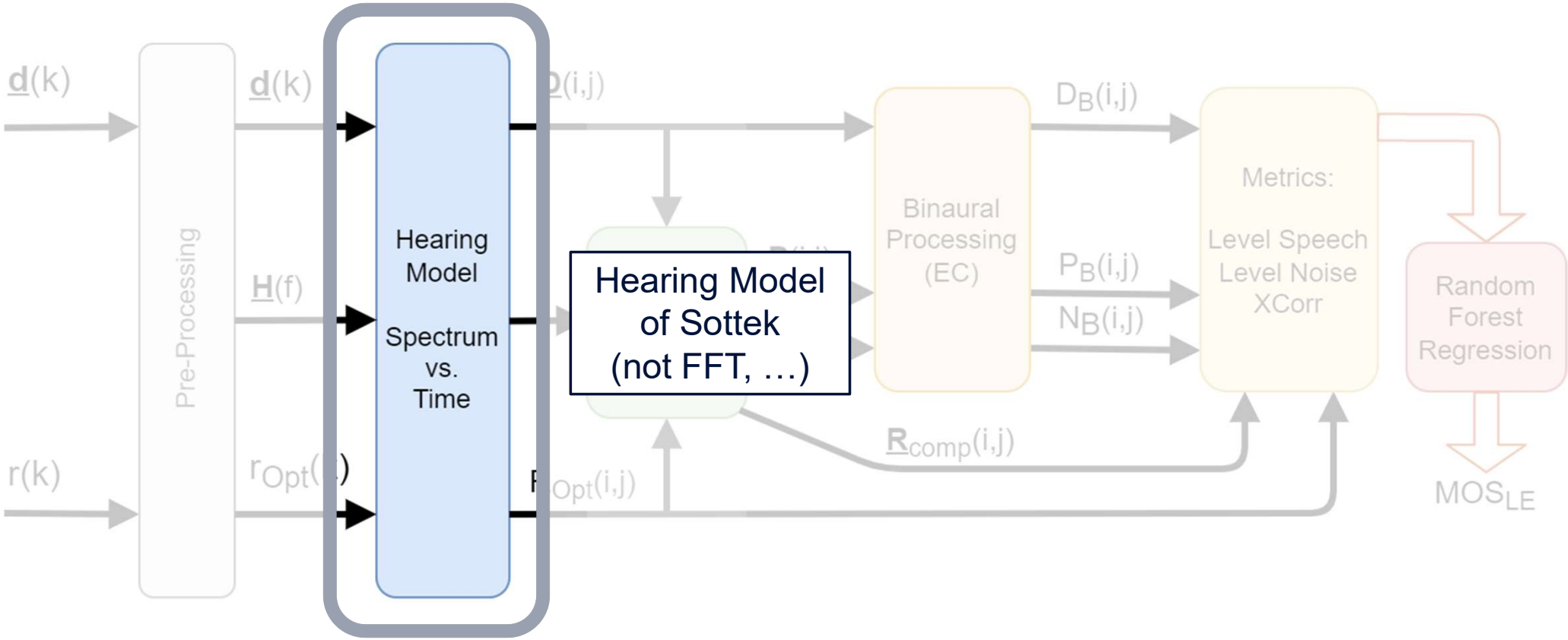

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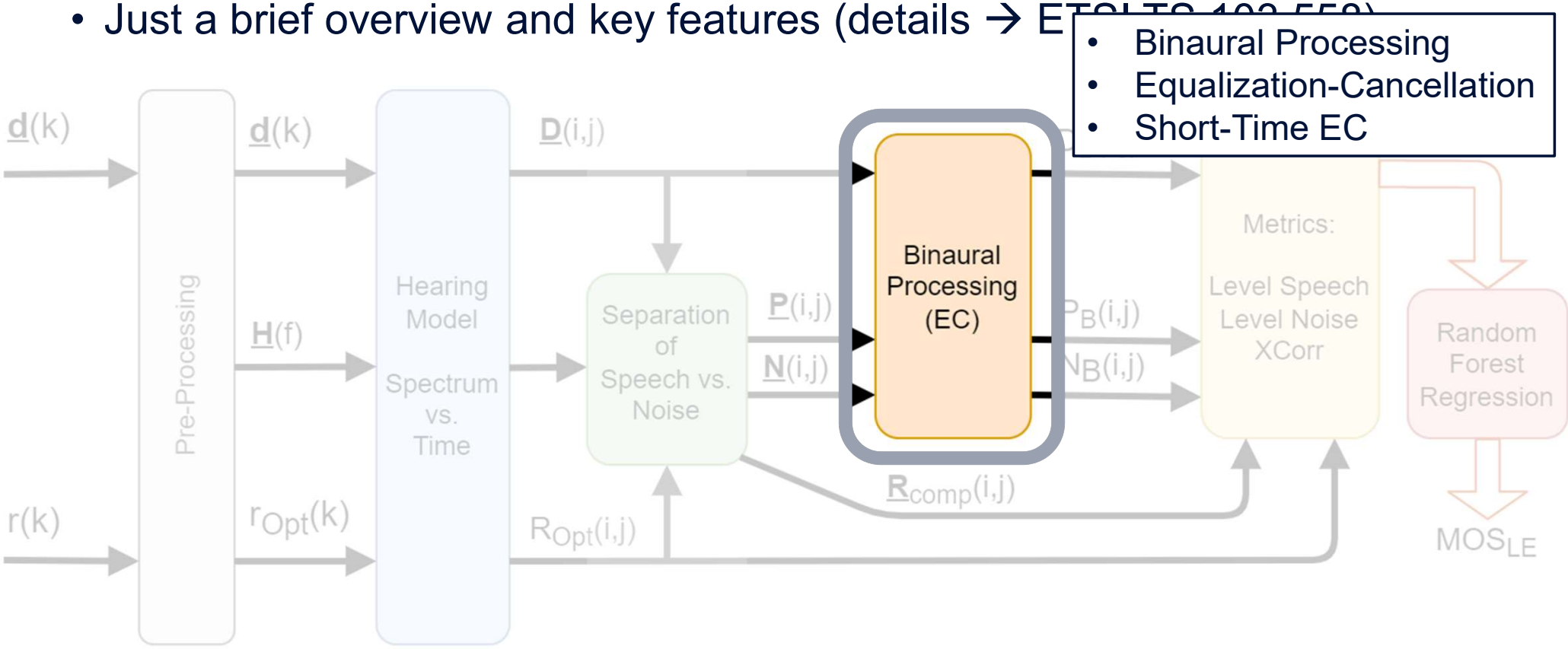

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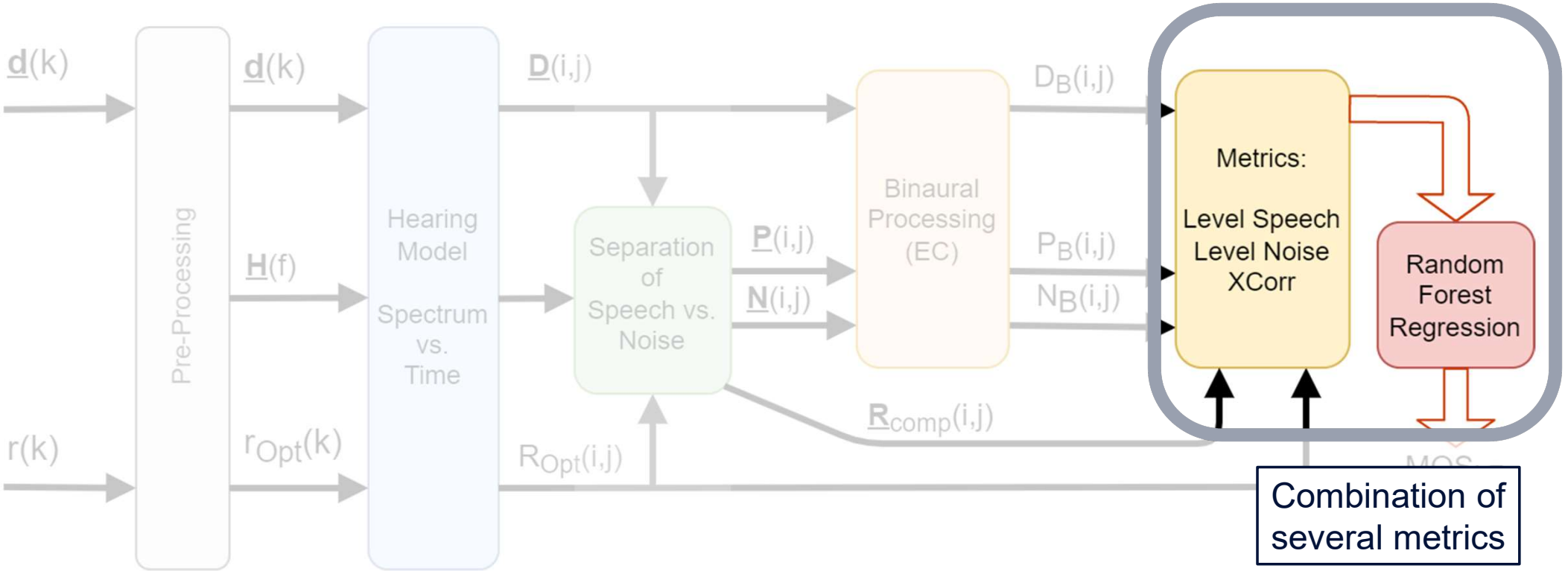
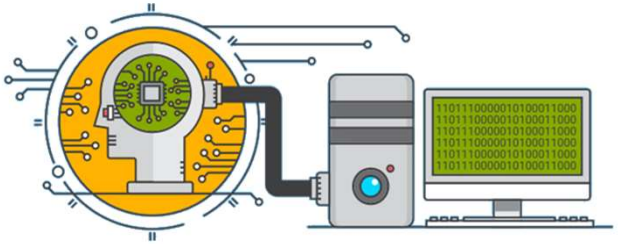
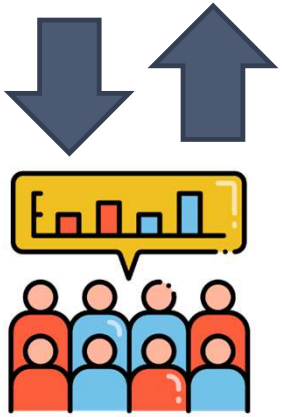


Auditory Databases

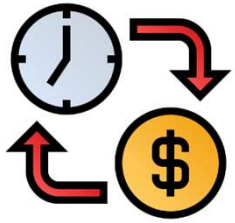
- Prediction model replaces auditory testing …
  - … but needs (a lot!) of data for training.



- As many aspects as possible has to be considered:
  - Speech samples/languages
  - Noise/reverb conditions
  - Applications/device
  - Acoustic paths (send/receive, near/distant, …)
  - Linear/Non-linear distortions, artifacts, …



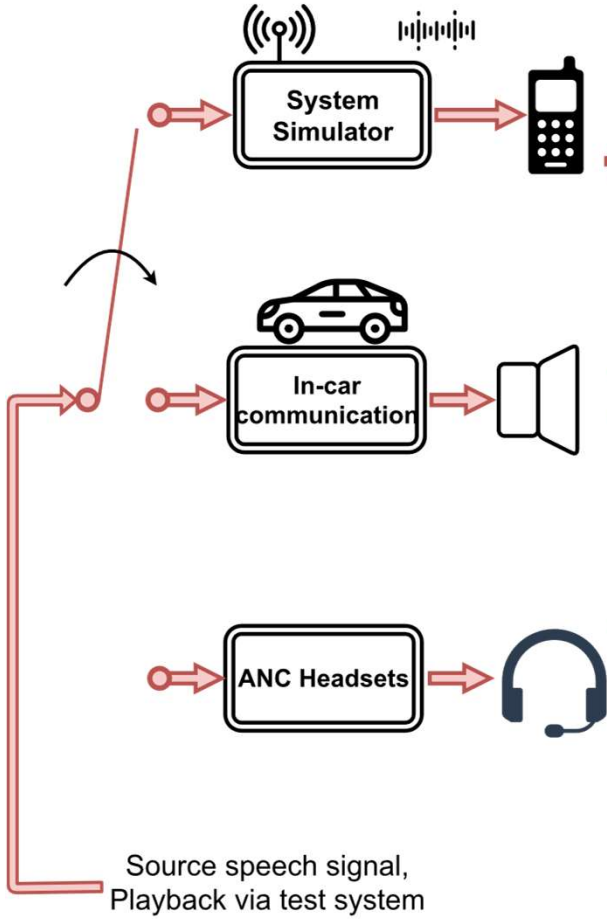
- A long "wish list" … but also expensive/time-consuming!
  ➔ Funding via Specialist Task Forces (STF) in ETSI STQ



ETSI STF Project 575 – Databases for receive path (RCV)

Recordings & auditory tests for:

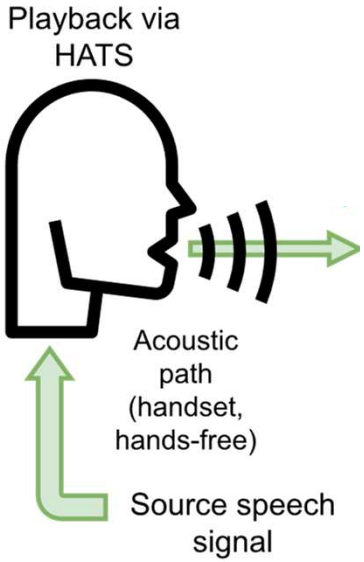
- Handset (HS) & Hands-free (HF) telephony scenarios
- ANC headsets (internal/external speech source)
- In-car communication (ICC)



ETSI STF Project 590 – Databases for send path (SND)

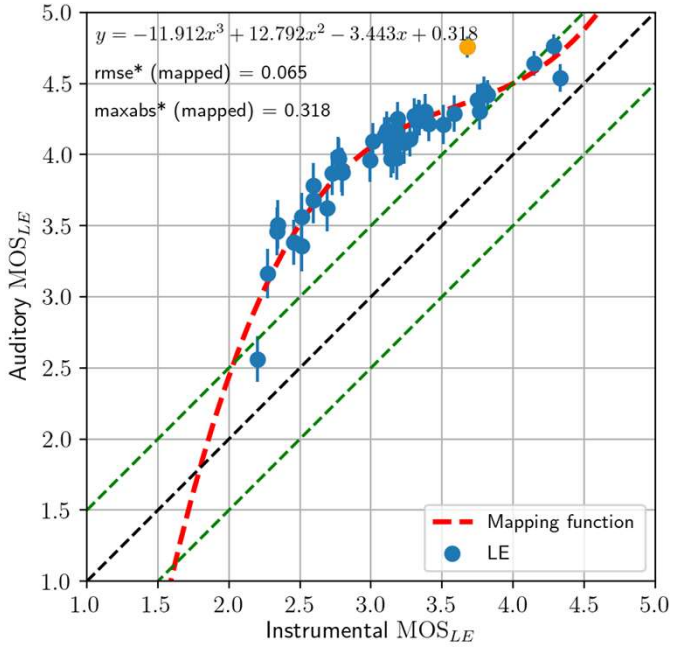
Recordings & auditory tests for:

- DB01: Acoustic impairments (noise, reverberation…)
- DB02: linear & non-linear processing in terminals
- DB03: network-related processing like transcoding, packet loss, packet loss concealment, etc.



Prediction performance – Validation results

- Languages considered:
  - Mandarin/Chinese (MAN)
  - American English (ENG)
  - German (GER)



Prediction performance metrics

RCV

Application	Language	RMSE*	MAXABS*
ANC	ENG	0.19	0.71
HF	MAN	0.07	0.22
HS	GER	0.09	0.17
ICC	MAN	0.07	0.32

SND

Application	Language	RMSE*	MAXABS*
DB01	MAN	0.20	0.84
DB02	GER	0.20	0.87
DB03	ENG	0.09	0.25

Summary & Conclusion

- Comprehensive work on perceived listening effort!
  ➔ 14 databases, ~570 test conditions, ~5000/~2700 for training/validation

- ETSI TS 103 558 bundles:
  - Prediction model
  - Underlying listening test design
  - Description of databases used for training/validation
  - ➔ Clear scope

- Validation proved high prediction accuracy
- Your application is not included?
  → Join STQ and collaborate on further extensions! ☺

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