ERICSSON RESEARCH
SERVICES, MULTIMEDIA AND NETWORKS

SYSTEM IDENTIFICATION RELATED PROBLEMS AT SMN

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OUTLINE

- Research Topics @ Ericsson Research
- System Identification related applications at SMN
- Important issues when dealing with real-world problems

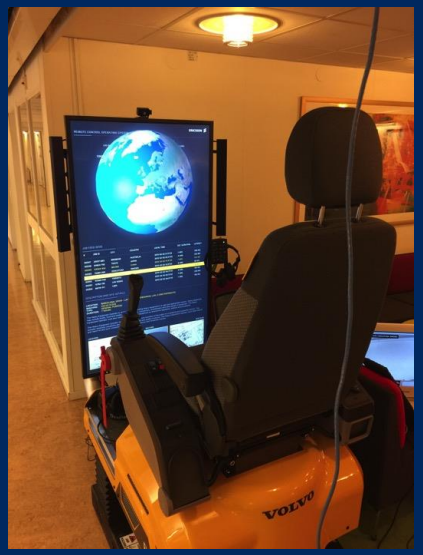
RESEARCH TOPICS @ ERICSSON RESEARCH

- Ericsson Research Blogg
  - http://www.ericsson.com/research-blog

- **5G**
- **Cloud**
- **Context Aware Communication**
- **Data and Knowledge**
- **Internet of Things**
- **LTE**
- **Media Coding**
- **SDN**
- **Security**
- **Sevice Systems**
- **Smart Cities**

CONTEXTUAL COMMUNICTION EXCAVATOR DEMO @ MWC 2015

- Excavator
  - Excavators from Volvo CE
  - Powerful Linux PC
  - Python application with custom signaling built on top of OpenWebRTC

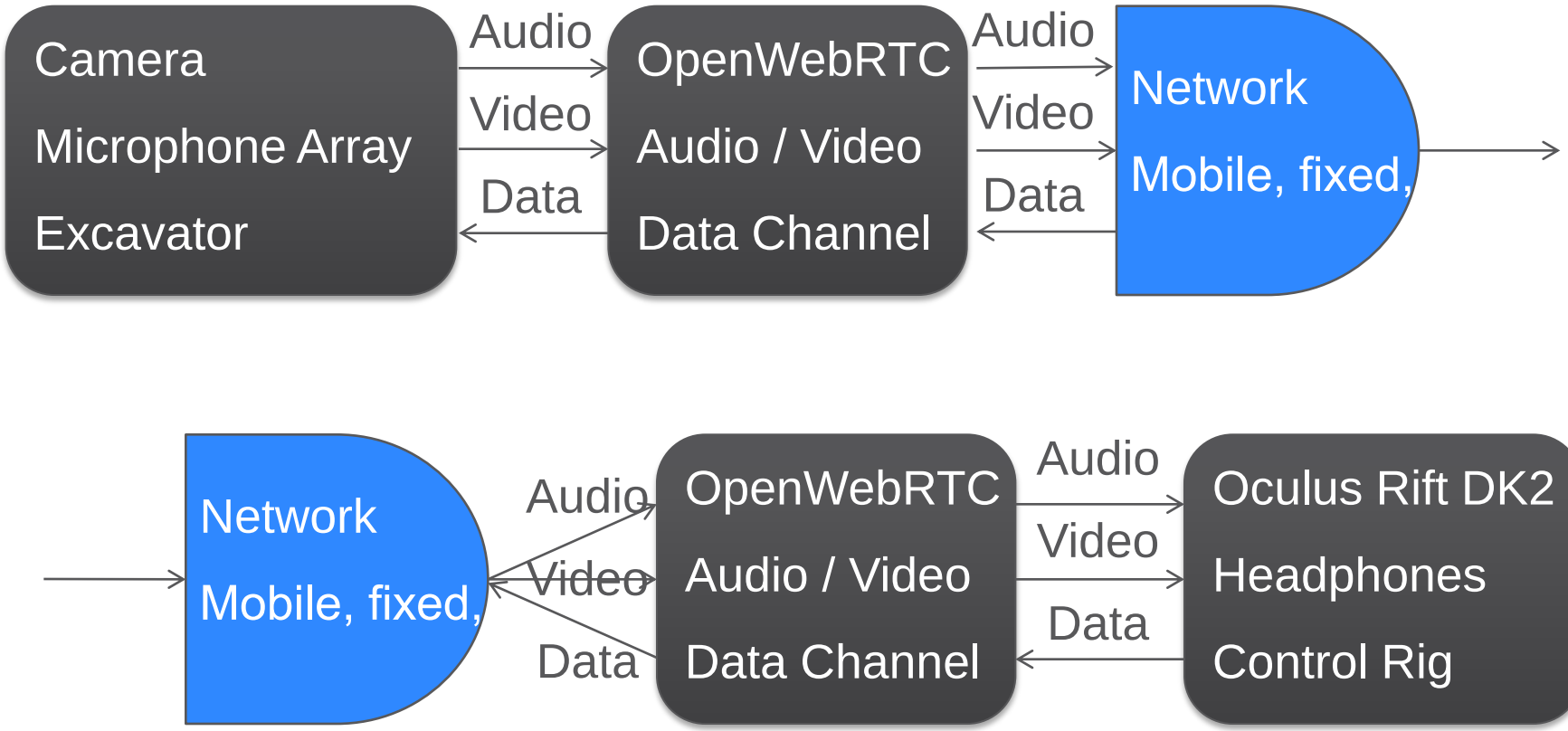


- Control Rig
  - Simulator from Oryx and Volvo CE
  - Mac OS X computer
  - OS X Cocoa application with custom signaling built on top of OpenWebRTC
- Signaling Server

REMOTE EXCAVATION

- Technologies
  - Spatial scene capture, both video and audio
  - Spatial scene rendering, both video and audio
  - Low latency real time communication
  - Low latency remote control

MEDIA PROCESSING ARCHITECTURE



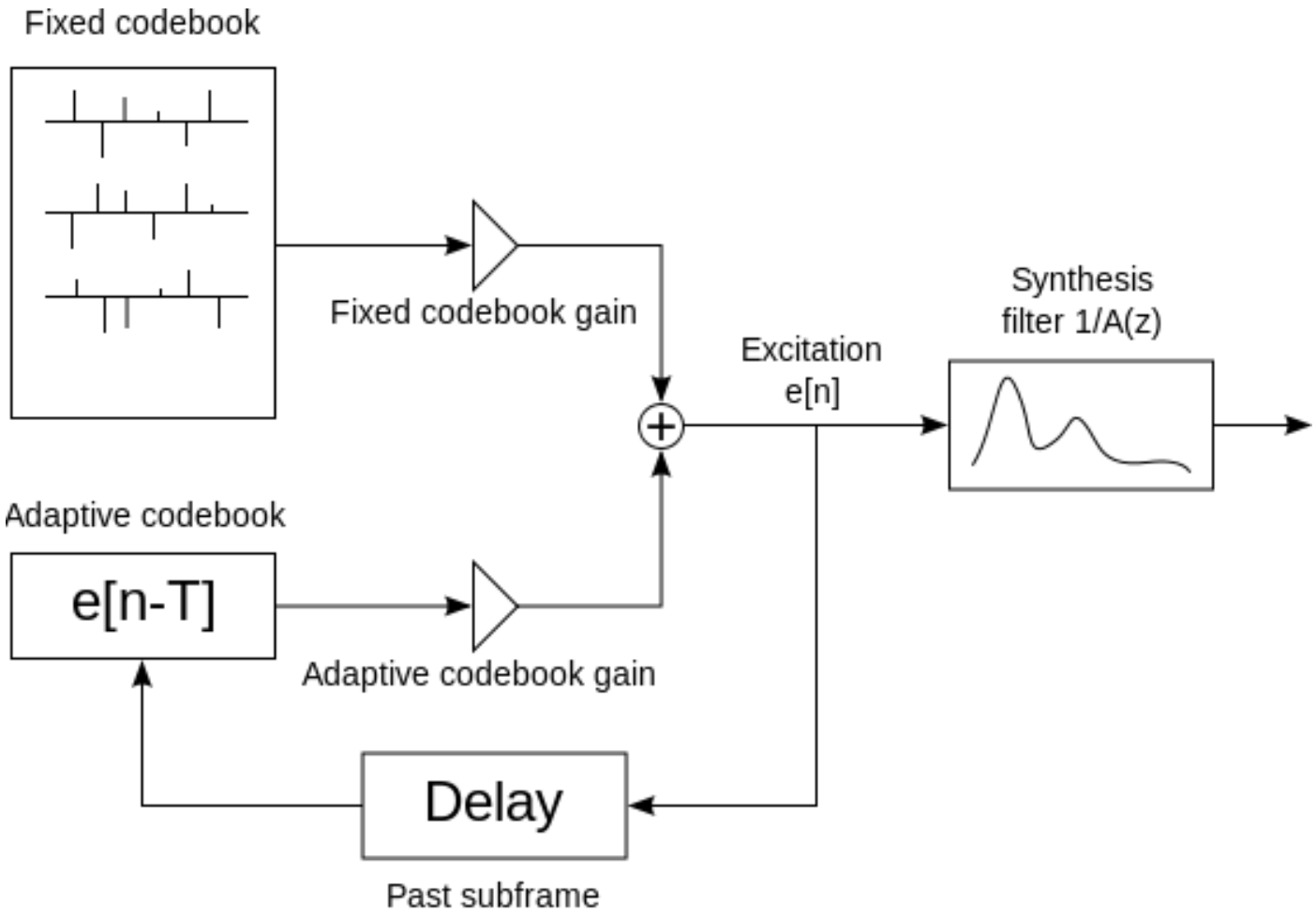
SYSTEM IDENTIFICATION RELATED APPLICATIONS AT MMT

- Audio and Speech Coding
- Audio Mining (ASR)
- Audio Media Processing
  - Acoustic Echo Cancellation
  - Noise Suppression
  - Voice Activity Detection
  - Spatial Audio Capture
  - Spatial Audio Rendering
- Video Coding (2D and 3D)
- Objective Quality Estimation of Encoded Audio and Video
- Congestion Control in IP Networks

AUDIO AND SPEECH CODING

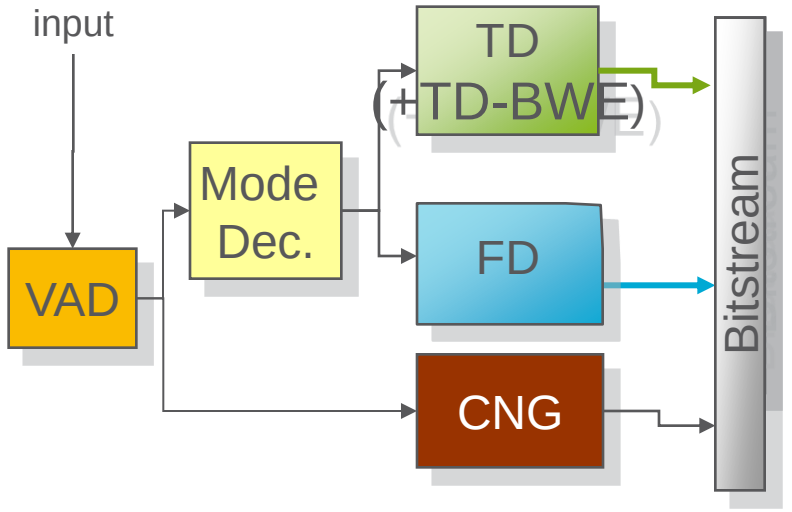
- Clean speech signals can be modeled very efficiently with Code-Excited Linear Prediction (CELP) encoders (Based on ARX model of the speech signal)
- Music signals are better encoded with transform encoding methods (Subband filter banks, MDCT)
- Signal classification and hybrid encoding used to obtain efficient encoding of audio signals of varying content
- EVS (Enhanced Voice System) just standardized in 3GPP standardization
- Special EVS session at ICASSP 2015 in Australia

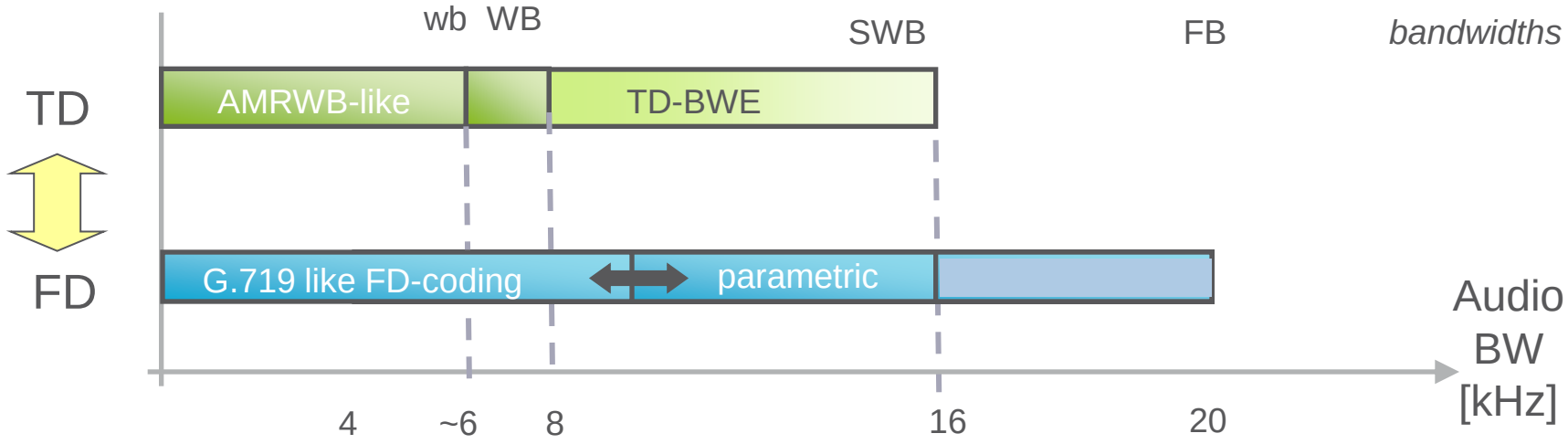
CELP SPEECH MODEL



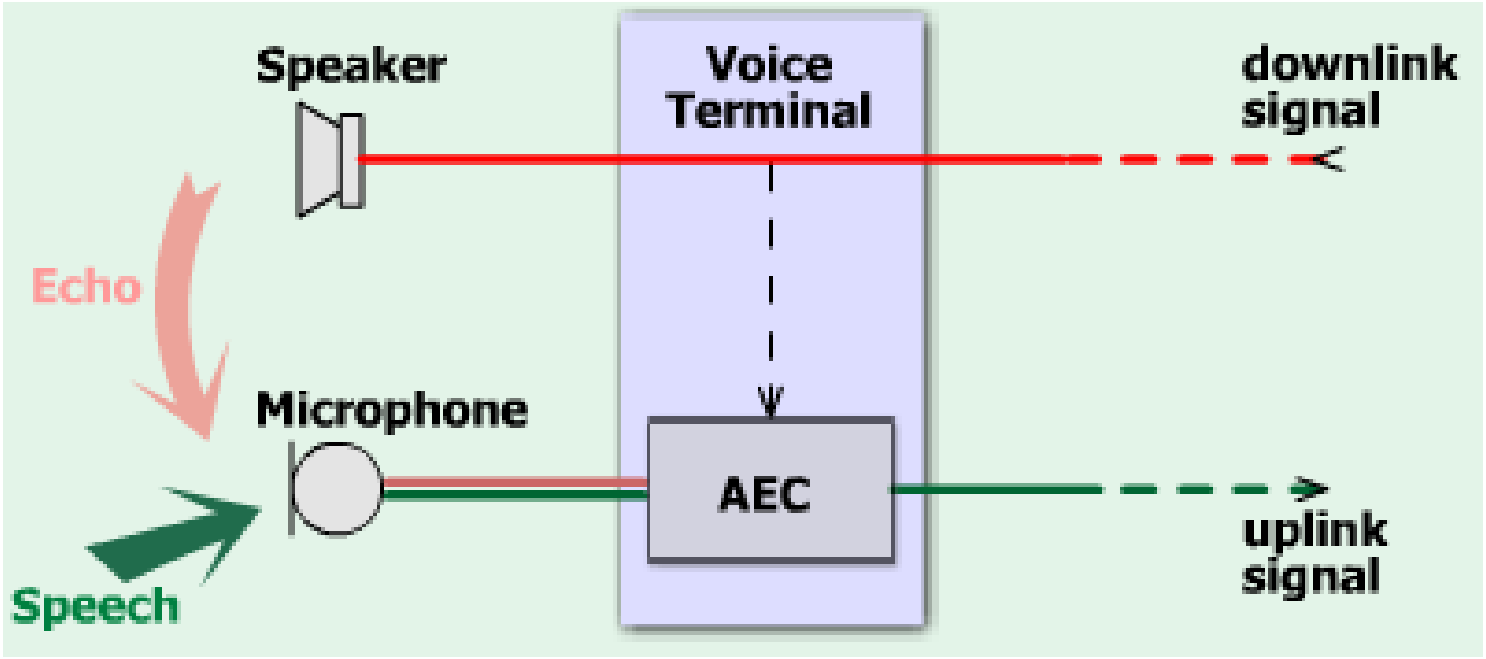
EVS SPEECH/AUDIO CODEC PROTOTYPE HL STRUCTURE

Mode	***Technology***	
TD	Improved AMR-WB technology	Linear Pred. + ACELP FCB *variable sf.*
TD-BWE	Parametric high band	Linear prediction, energy/gain
FD	G.719-like	Transform (*LD*-MDCT), block switching





ACOUSTIC ECHO CANCELLATION



- Long echo impulse reponses: 300-500 msec
- At 48 kHz sampling : 14,400 – 24,000 samples

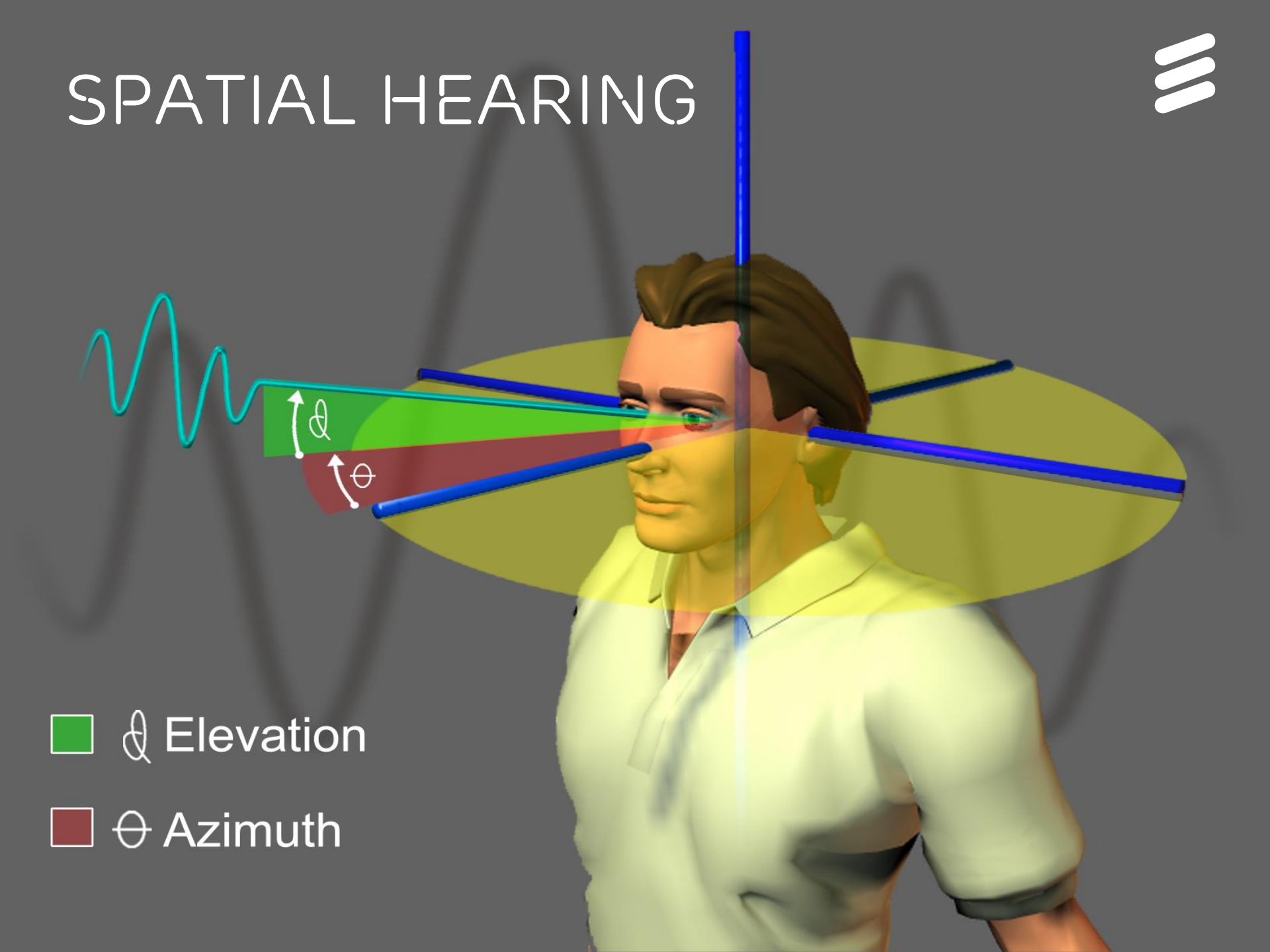
SPATIAL AUDIO CAPTURE

- Microphone arrays
- Filter design in the spatial and frequency domains
- Beamforming techniques
- Adaptive tracking of the most active speakers in a room

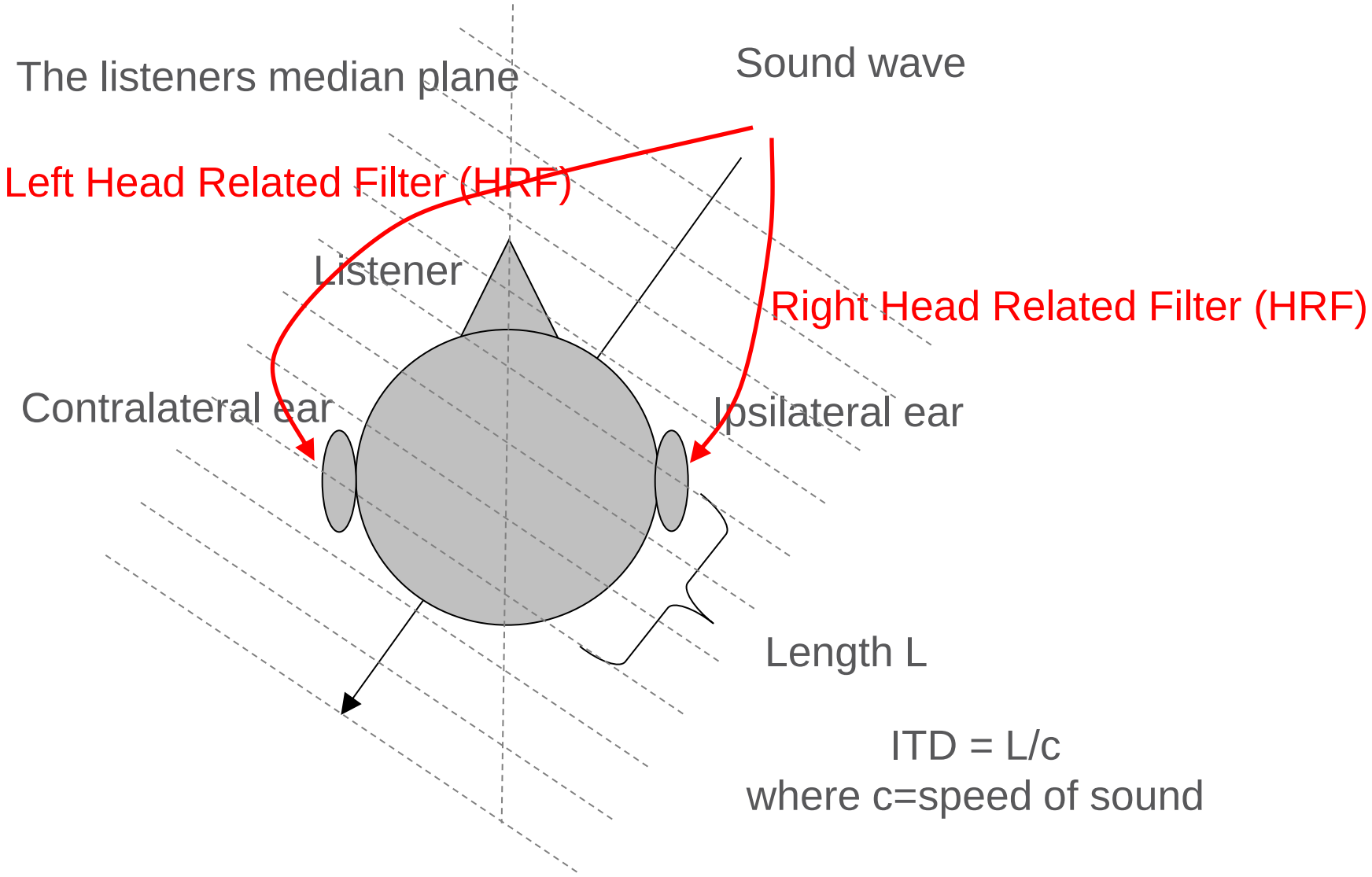
SPATIAL AUDIO RENDERING

- Spatial hearing
- 3D binaural rendering through Head Related Filtering (HRF)
- Very useful in 3D gaming and evolved communication solutions
- Spatial audio rendering onto any loudspeaker configuration

SPATIAL HEARING

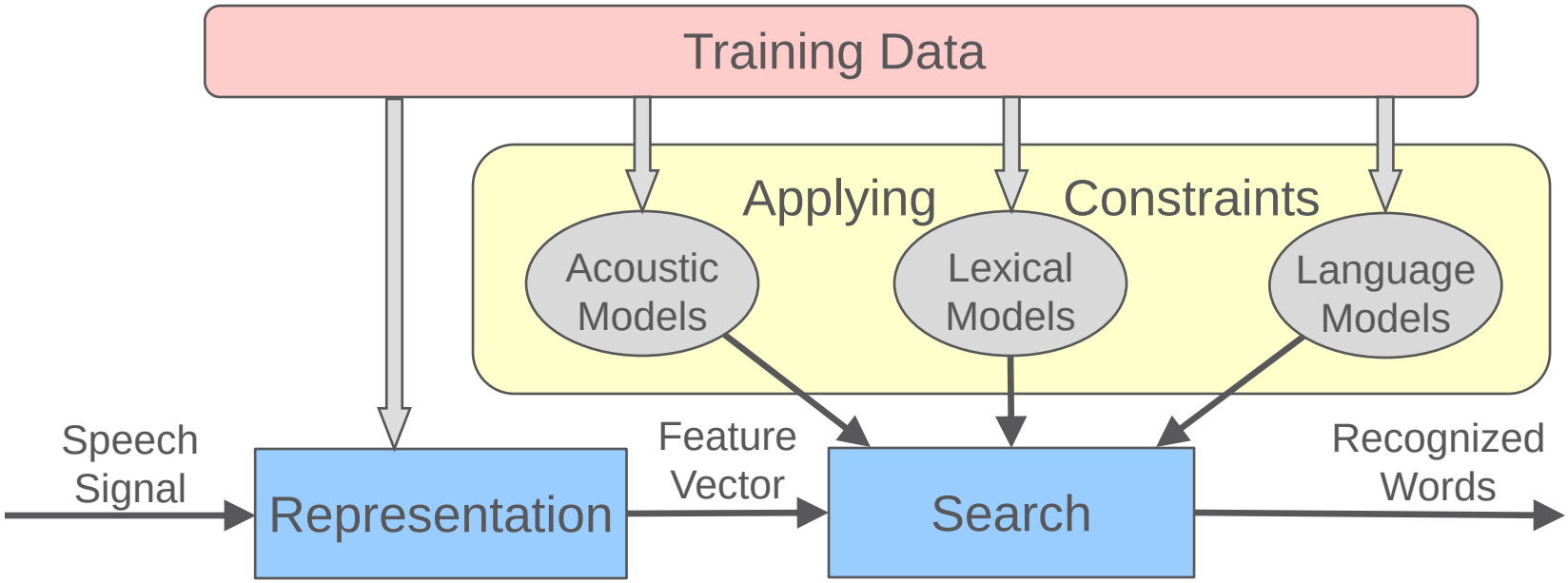


ACOUSTIC WAVE RECEPTION



ITD = L/c
where c=speed of sound

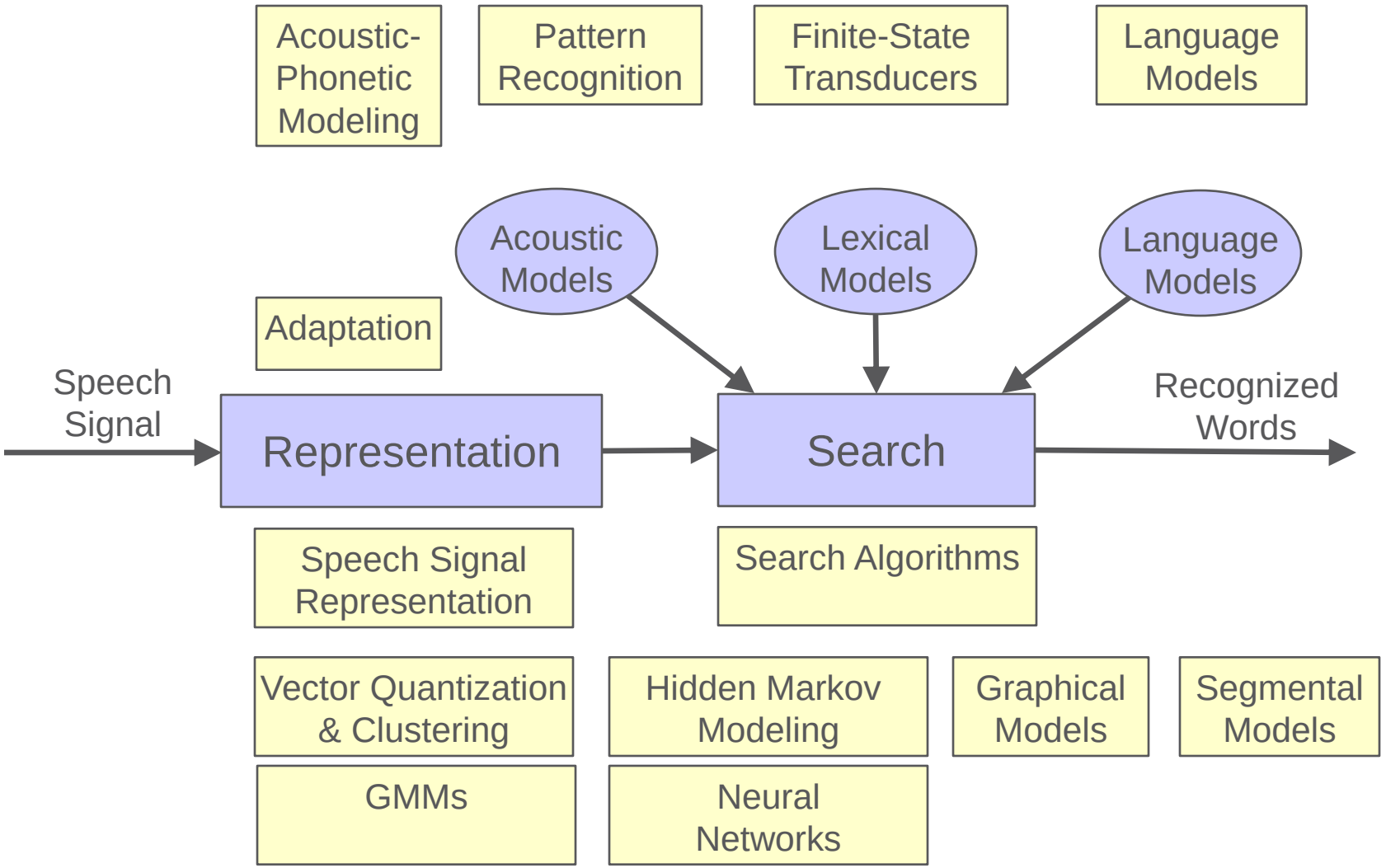
ASR SYSTEM – MAIN COMPONENTS



Speech recognition is the problem of deciding on

- **How to *represent* the signal**
- **How to *model* the constraints**
- **How to *search* for the most optimal answer**

ASR SYSTEM – SOLUTION COMPONENTS



IMPORTANT ISSUES
WHEN DEALING WITH REAL-WORLD PROBLEMS

- Understand the strengths and weaknesses of the different identification methods
- Preprocessing the data before the optimization can be crucial
- Choose the minimization criterion with care and adapt it to the problem at hand
  - Different type of regularization components in the criterion can make the difference between success and failure
  - Some times a criterion having components in both the time and frequency domains will work, when single domain criterions fail.

IMPORTANT ISSUES
WHEN DEALING WITH REAL-WORLD PROBLEMS

- Some applications require classification based modelling, where the current model used depends on signal classification of some signals
- Many systems have to deal with spurious events
  - This will require the detection of such events and special model updates when they are detected
  - Monitoring of system model
  - Hypothesis testing and estimation

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