MALORCA

Machine Learning of Speech Recognition Models for Controller Assistance

MALORCA 2nd Stakeholder Meeting

Cooperation of MALORCA and PJ.16-04

Hon. Prof. Hartmut Helmke

Vienna, 20th to 21st of February 2018

SESAR JOINT UNDERTAKING

Founding Members

EUROPEAN UNION EUROCONTROL

Abstract

Both the MALORCA project and the SESAR solution PJ.16-04 are lead by DLR. The presentation focuses on speech recognition activities of PJ.16-04 and outlines how MALORCA results have already influenced the speech recognition activity in PJ.16-04. This includes the development of an ontology for controller command transcription and also focussing on safety aspect which were neither considered in MALORCA nor in AcListant®.

What is the context of PJ.16-04?

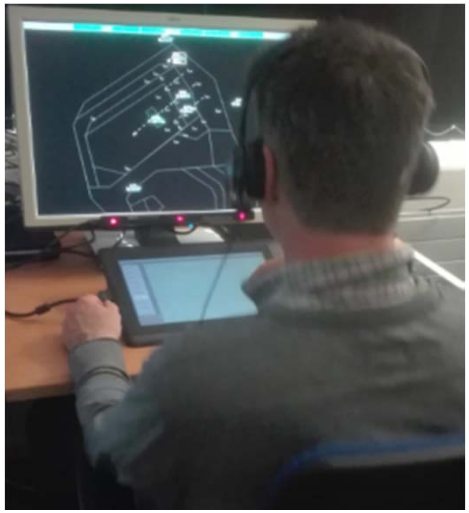
- SESAR 2020 (Single European Sky ATM Research)
  - Budget: €1.5 billion (approx. 50% funding)
    - Exploratory research (e.g. MALORCA)
    - Very large-scale demonstrations
    - **Industrial research and validation (Wave 1 ~2017-2019**)
      - **PJ.16 CWP HMI** (**Controller Working Position Human Machine Interface**) with budget of ~€12 million for 2 main work packages

        →PJ.16-03 Work Station, Service Interface Definition & Virtual Centre Concept

        →**PJ.16-04 Workstation, Controller productivity** (~30% of PJ.16)

What is PJ.16-04's main objective?

"To deliver a set of workstation solutions
following a user centred approach,
to demonstrate an **improvement to productivity**
(based on measurement of human performance)."



Who contributes to PJ.16-04?

23 partners from 16 European countries

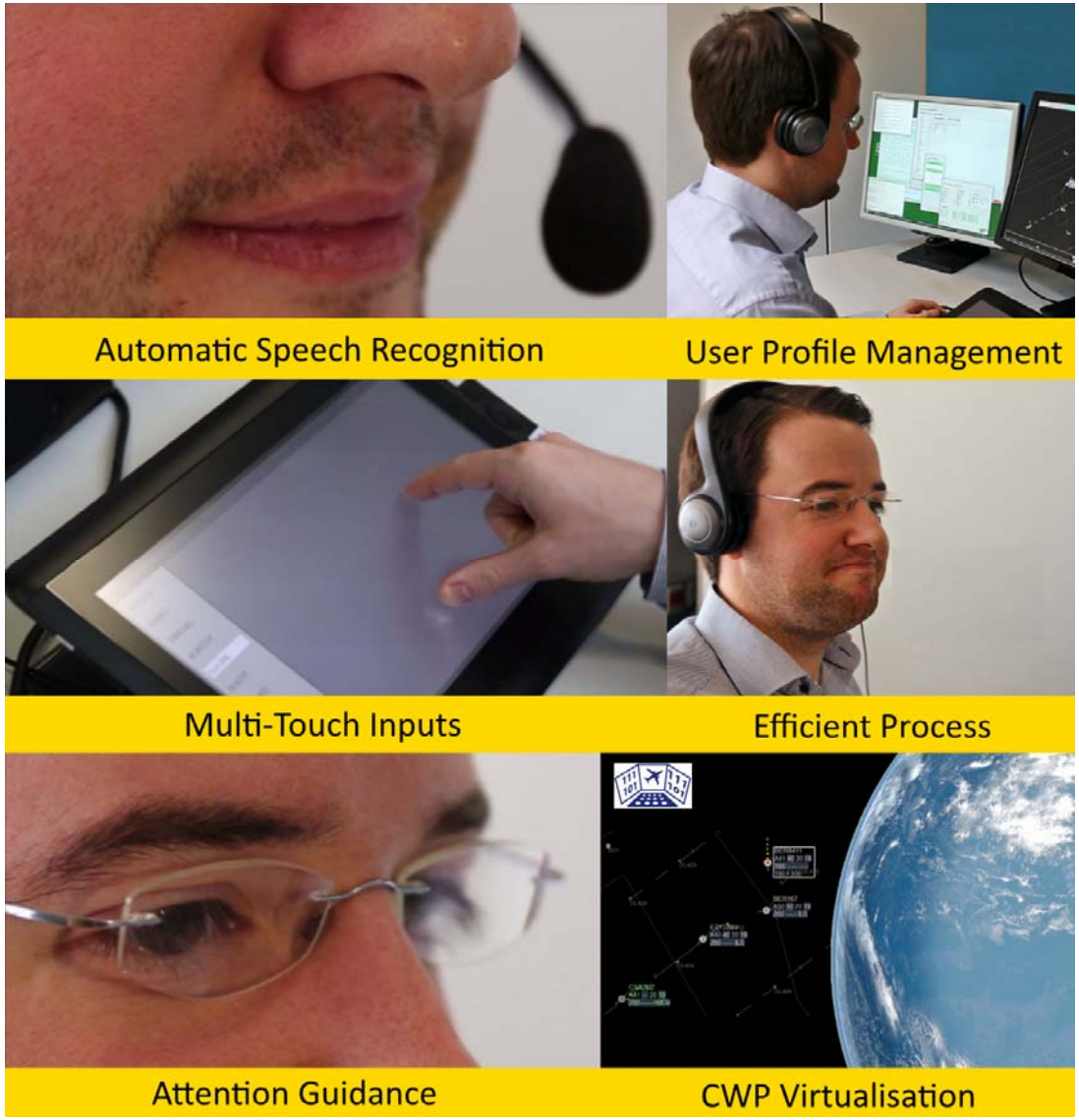
PJ.16-04 Team

THALES AIR SYS
ANS CR (B4)
Integra
LPS SR (B4)
ACG/COOPANS
CCL/COOPANS
LFV/COOPANS
Naviair/COOPANS
DFS
ENAIRE
CRIDA
NATS
Avinor ANS
SKYGUIDE
SKYSOFTATM
EUROCONTROL
DLR (AT-One)
FRQ (FSP)
HC (FSP)
SINTEF (NATMIG)
INDRA
ROMATSA
LEONARDO

Logos of PJ.16 Members

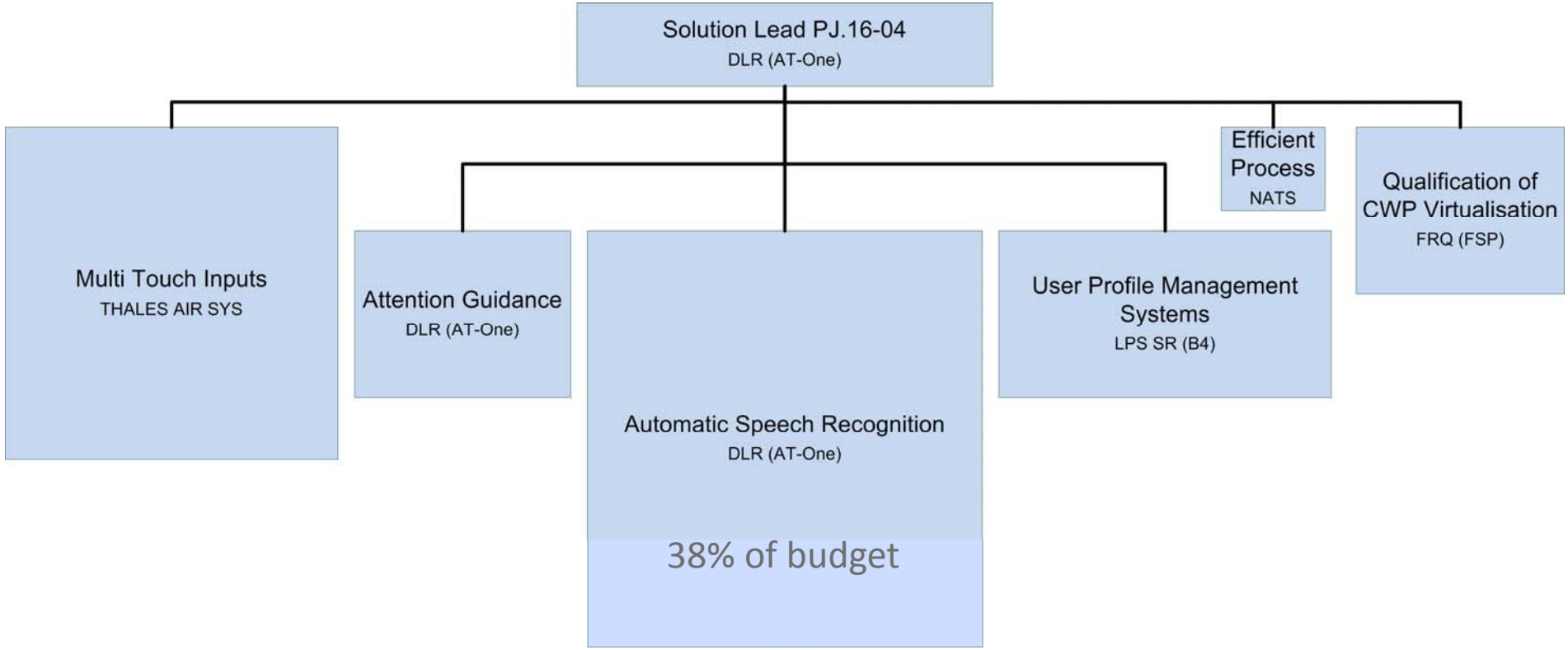
ATM System provider
ANSPs
Research and Consulting Institutes

What is the concrete PJ.16-04 content?



How is PJ.16-04 Solution organized?

- Innovative HMI (Human Machine Interface) technologies

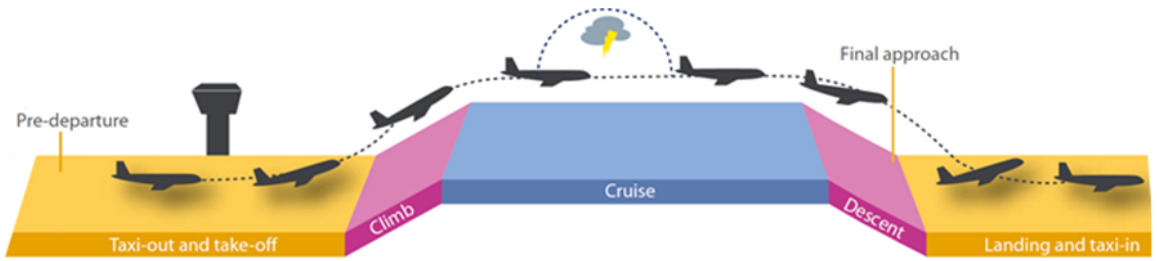


- In many cases multiple Exercises per Activity

What are the PJ.16-04 Exercises about?

Exercise	Partners involved	Short Description
Multi Touch Inputs 1	INDRA, ENAIRE, ROMATSA	Madrid Approach
Multi Touch Inputs 2	THALES AIR SYS, ANS-CR, INTEGRA	Prague En-Route
Multi Touch Inputs 3	SINTEF (NATMIG)	Milan Approach, Combination with ASR, (PJ.08)
Automatic Speech Recognition 1	DFS	Munich Approach (PJ.10-02b)
Automatic Speech Recognition 2	THALES AIR SYS, DLR (AT-One), ANS CR (B4), Integra	Prague Approach
Automatic Speech Recognition 3	CRIDA, ENAIRE	Madrid FIR (Route/TMA) (PJ.10-01b)
Automatic Speech Recognition 4	DLR, HC (FSP)	Hungary Remote Tower Environment (PJ.05-02)
Automatic Speech Recognition 5	FRQ (FSP), DFS	Germany Remote Tower Environment (PJ.05-03)
Attention Guidance 1	DLR, HC (FSP)	Flight-Centric ATC Hungary (PJ.10-01b)
Attention Guidance 2	SKYSOFTATM, SKYGUIDE	Machine Learning MTCA Forecast
User Profile Management Systems	LPS SR (B4)	UPMS mock-up demonstration (Technical Validation exercise)
Efficient Process	NATS	Process Review and Comparison Exercise (not a classical « exercise », demonstration of process)
Qualification of CWP Virtualisation	FRQ (FSP), EUROCONTROL, HC (FSP)	CWP Virtualisation Qualification (Technical Validation exercise)

ASR Exercise of PJ.16-04



Pre-departure	Taxi-out and take-off	Climb	Cruise	Descent	Landing and taxi-in
Tower	APP	En-Route	APP	Tower	
Munich Approach (DFS / PJ.10-02b / DFS Simulator)					
Prague Approach – (Vienna Approach) (THALES / DLR / ANS-CR / INTEGRA / Coopans / PJ.16-04 internal / SHAPE Sim					
	Madrid FIR (Route/TMA) (CRIDA / ENAIRE / PJ.10-01b / CRIDA Lab)				
Hungary Remote Tower Environment (DLR / HUNGAROCONTROL / PJ.05-02 / DLR TowerLab)					
Germany Remote Tower Environment (FREQUENTIS / DFS / PJ.05-03 / DFS Premises)					

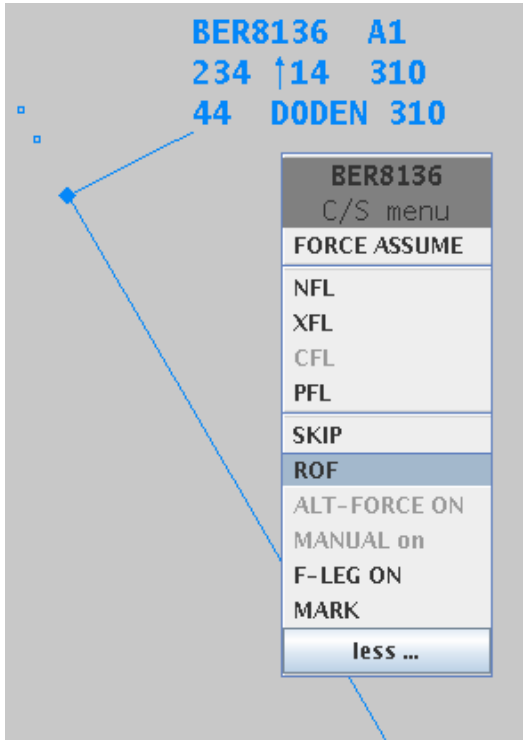
Munich Approach Exercise (DFS)

Target Location Assistance (TLA):

- Recognize callsign and highlight so that controller can easily identify which aircraft is spoken to.

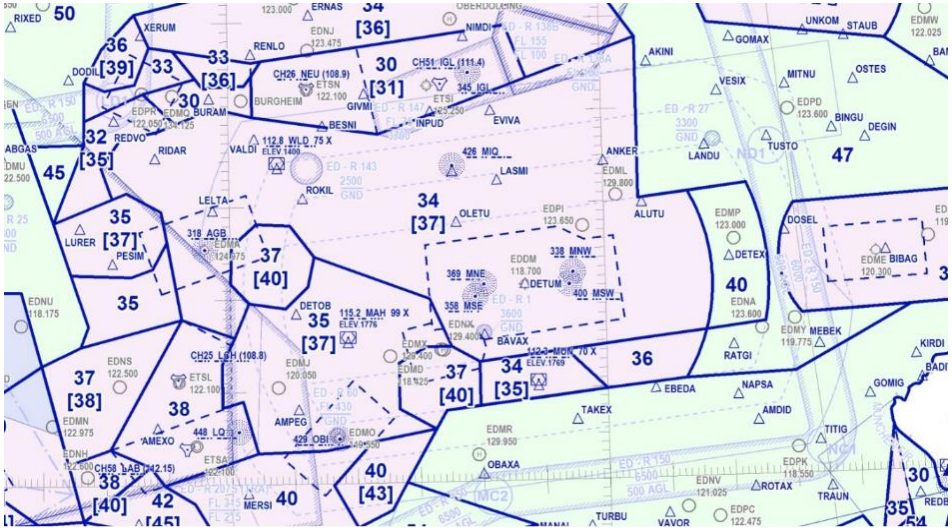
Controller Clearance Verification (CCV):

- Each spoken controller clearance shall be verified with the related controller system input (into electronic flight strips).
- Deficiency shall be shown to the controller
- Executive controller needs to correct the deficiency
    - either by changing the system input or
    - by giving a new clearance.



Munich Approach Exercise (2)

- DFS simulator environment NEWSIM
- ATVoice® based on the AVOKE engine
- Grammar based system
- Assistant Based Speech Recognition NOT applied
- Machine Learning NOT considered yet



Prague/Vienna Approach Exercise

- Partners are: Thales, DLR, ANS CR, Integra and Coopans
- Thales premises in Rungis, France
- Shape platform (more flexible than TOPSKY)

- ASR used to maintain radar labels (baseline maintenance by mouse)

Objectives:

- Enhance requirements engineering of MALORCA
- validate that the ASR supports controller
- resulting in increased controller's productivity.
- Determining ASR influence of safety
- Performing CBA

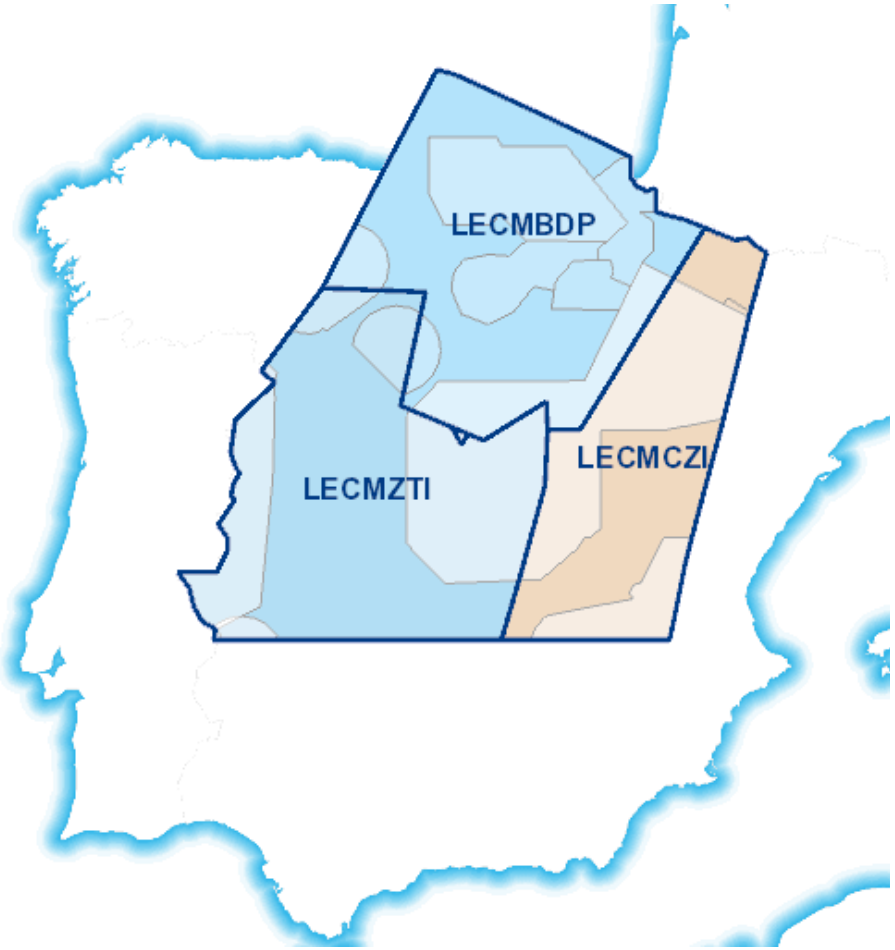
Prague/Vienne Approach Exercise

- Nuance speech recognizer
- Grammar based system
- Command Prediction Input provided by DLR, i.e. ABSR applied
- Checker provided by DLR
- HMI provided by Thales
- Safety Assessment done by Integra
- Controllers from ANS CR and Coopans
- Machine Learning NOT considered yet

Spanish En-Route Exercise

- Partners are: CRIDA and Enaire
- VOICE developed by CRIDA used
- Usage of recorded audio files from Madrid airspace
- NN are trained for recognition models
- No direct involvement of ATCos

- ASR output is used to transform recognized commands into events;
  events are used to quantify controllers' workload



Hungarian (+Lithuanian) Remote Tower Exercise

Hungarian Tower Traffic is simulated at DLR's TowerLab in Braunschweig:

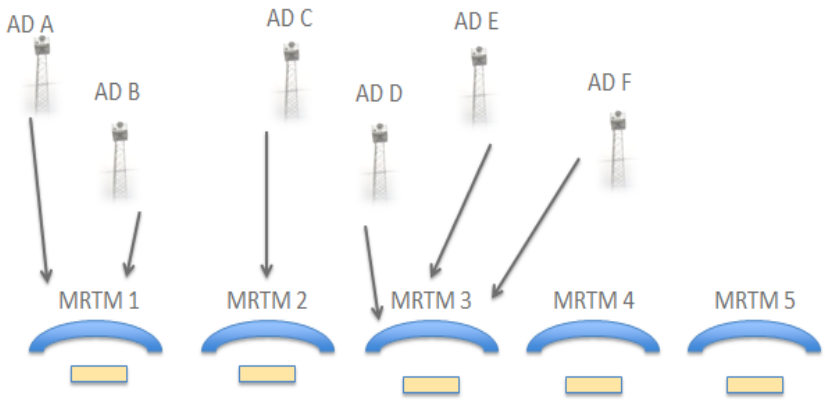
- Budapest Tower (LHBP),
- Debrecen Tower (LHDC),
- Papá Tower (LHPA)

- No Speech Recognition
- Focus is on Command Prediction for Tower Environment
- Completely different set of Commands (Vacate, Taxi …)
- Transcription for Tower Environment

- Nov 17, 2 w. with Hungarian ATCos
- March 18: Lithuanian ATCos
- Nov 18: Hungarian ATCos
- Dec 18/Jan 19: Shadow mode trials in Budapest

German Multiple Remote Tower Exercise

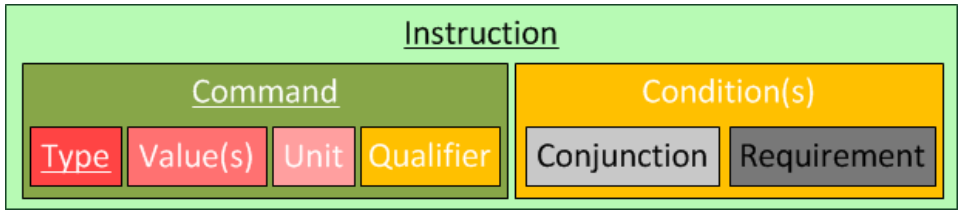
- DFS and FREQUENTIS are developing a multi remote tower validated for
  - Saarbrucken
  - Dresden
  - Erfurt

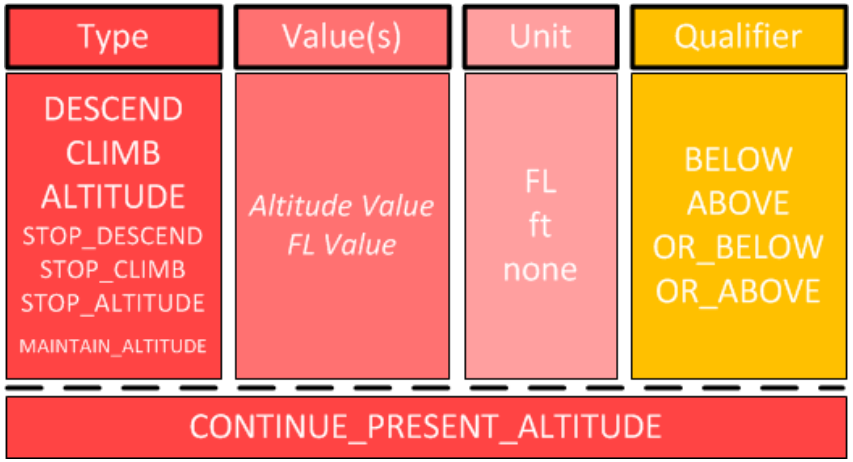


- ASR used as history of flight conversation: overview about conversation of pilot and controller of history and relevant information
- This will improve situational awareness due to visualising conversation history for different locations
- Assistant Based Speech Recognition NOT applied
- Machine Learning NOT considered yet
- COTS speech recognizer

What did PJ.16-04 do in the first year? Nov 2016 to Feb. 2018

- Intense Document Work (necessary to pass SJU's Maturity Gate)
- Literature Analysis
- Operational Concepts
- Requirements
  - Example from ASR: Ontology for transcription of controller commands



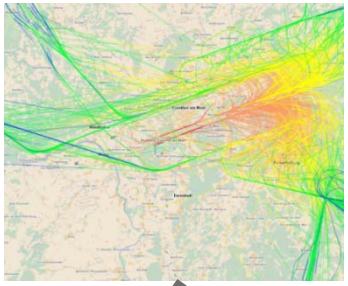


Ontology enables exchange of transcriptions between different partners

MALORCA's command transcription versus PJ.16-04 Ontology

MALORCA/AcListant®	PJ.16-04 ontology
TURN_RIGHT_HEADING 10	HEADING 010 RIGHT
HANDOVER_FREQUENCY 118.1	CONTACT_FREQUENCY 118.100
DESCEND_OR_BELOW 3000 ALT	DESCEND 3000 ft OR_BELOW

Interfaces



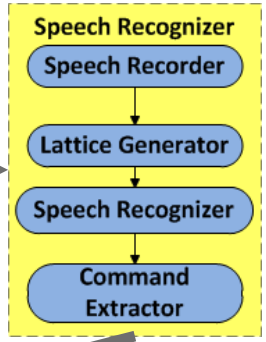
Radar

Flight Plan

Asterix CAT62

Hypotheses Generator

Based on ontology



Based on ontology

Plausibility Checker

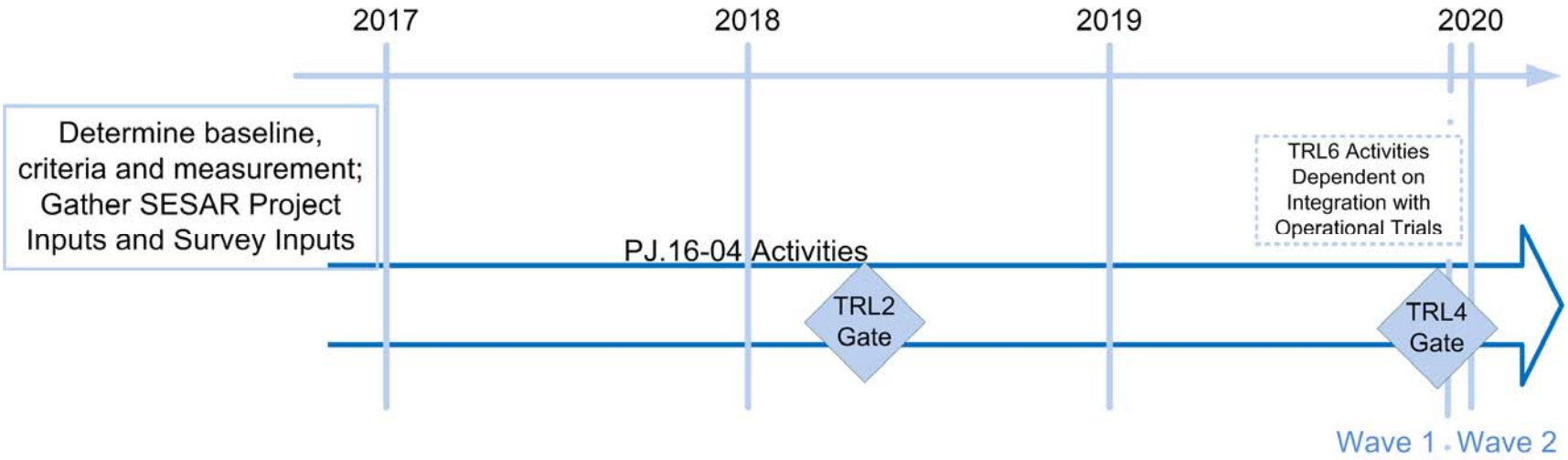
Based on ontology

HMI

- Ontology enables common interfaces and exchange of technology
- DLR/Thales/Coopans/ANS CR/Integra exercise first test case

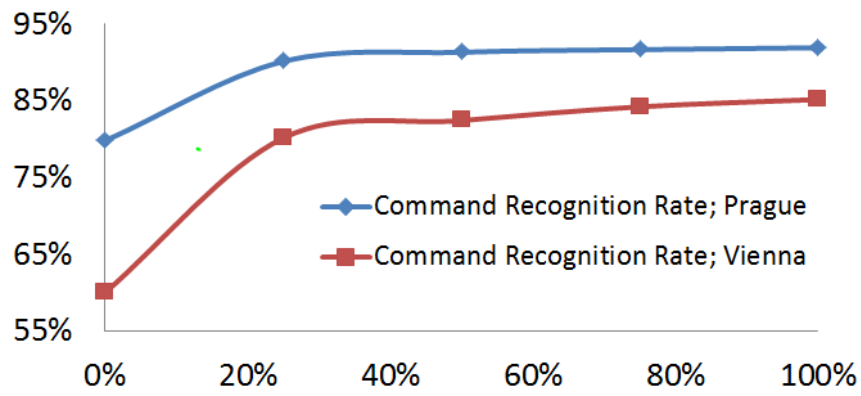
What is PJ.16-04's plan for the future?

- Bring innovative and controller productivity increasing HMI solutions closer to the ops rooms
- Preconditions for the project
  - Pass TRL2 Maturity Gate
  - Pass TRL4 Maturity Gate

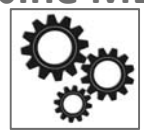


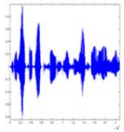
Conclusions

- Work of MALORCA (and AcListant®) influenced PJ.16-04 of SESAR 2020
- MALORCA's early problems with command transcription encourages development of ontology
  - Currently only MALORCA's ASR results are used
  - Machine Learning achievement still not commonly known
  - Our results are brand new (created in January 2018)



  - Today's workshop might support promotion
  - SJU wants to combine ML and ABSR in wave 2





MALORCA

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DLR

UNIVERSITÄT DES SAARLANDES

idiap RESEARCH INSTITUTE

austro CONTROL

Air Navigation Services of the Czech Republic

Covering the sky...

Thank you very much for your attention!

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