Introduction

Three different working groups discussed the usage of context to support automatic transcription.

- Working group 1 consists of 9 people; four of them attended on-site.
- Working group 2 consists of 4 people; two of them attended on-site.
- Working group 3 consists of 10 people. All attendance were in Braunschweig

Motivation

- Automated Processing Pipeline: The SELF-MADE-ATC project relies on the automatic processing of large volumes of air traffic control (ATC) voice transmissions. This significantly reduces the manual effort required from human domain experts to label data.
- Direct Impact of Context Information: In the SELF-MADE-ATC architecture, incoming audio is processed by multiple Automatic Speech Recognition (ASR) models (ASR Model 1, ASR Model 2, ...). The output of the ASR models is dropped into a Transcript Refinement Stage where a Large Language Model creates one ground truth transcript out of the provided pieces of information. The quality of this automatic labelling can be directly influenced and improved by feeding context information into this refinement stage, e.g., callsign or waypoint information.

Questions to the participants

- Which types of contextual information are most relevant for air traffic controller and pilot voice transmissions?
- Is this contextual information already available through a defined interface or format...how could it be provided by the end-user organizations?

Summary

The following pages present the results of the three working groups. They show that many different data sources are in principle availability. Availability in practical applications is an open question and also it needs to be shown what effects using these data elements has on the quality of LLM supported automatic transcription and finally on the performance of the trained ASR model. DLR's research on ASRU applications has show that callsign information has the biggest influence on speech understanding[1]. The used callsign designators and waypoints also improves correction of transcriptions and Speech Understanding.

[1] With callsign information 95% of the extracted commands (which includes at least correct callsign, correct type, correct value, correct condition) are correct and without callsign information available only 75% are correctly extracted.

Results of the Working Groups

Working Group 1

The first working group agreed on the following table as possible input for further discussions:

Information:	Source:	Challenge:
Information: Callsigns	Source: flight plan, MODE-S, ASTERIX CAT62	Challenge: Military Callsigns
Information: Filtered Waypoints, Route DESIGNATORS, Procedures, Taxiways, Transfer Frequencies	Source: AiP, AIXM 5.1	Challenge: Connection among taxiways (laid down in EUROCAE 99)
Airplane Position and Speed	ASTERIX CAT62, Challenge: -	
Information: ICAO Location Indicators	Source: ICAO Doc	Challenges: -
Instruction and Clearance status	Status: EFS/ASMGCS/ATM-System, ASMGCS Standard for Data Exchange	Challenges: Not standardized yet (ED349 published for airports
Information: Assigned Route / airborne trajectory	Source: Flight plan, ED349	Challenge: -
Information: voice transmissions before and after the focused transcribe	Source: Audio resp. ASRU	
Information: Greetings	Source: Dictionary	Challenge: -
PTT-Button	Source: VCS	Challenge:-
Information: Vocabulary from National AIPs, Source: AIP, NfL		
Information: List of Vehicles	Source: AODB interface	
ACDM-Times	Source: AODB-Interface, Flight plan Update Messages	

Working Group 2

The second group agreed on the following enumeration, considering the data elements and its availability.

- **Aircraft Positions and Movements (ADS-B):** publicly available via multiple commercial vendors
- **Aircraft types and performance:** available via proprietary sources (BADA) or flight envelope
- **Airspace-specific information:** military zones, minimum safe altitudes, Standard arrival / departure routes; available via NOTAMs
- **Meteorological data:** available via various sources
- **Flight plan:** available from ANSPs; useful for airline, planned route, callsign
- **Squawk codes**

Further ideas

- Utilization of flight plan and performance data to perform logical checks on the recognition output (i.e. climb rate doesn't match aircraft performance -> utterance less likely)
- Expert LLM finetuned on aviation documents (Manuals, NOTAMs, etc.) instead of "off the shelf"-LLM for ground truth generation

Working Group 3

The second group agreed on the following enumeration, considering the data elements and its availability.

- **Weather Information Standards:** Standardized weather data in ASTERIX CAT 009 and IWXXM formats is already available for Air Navigation Service Providers (ANSPs), provided by the German Meteorological Service (DWD).
- **Available Approach Types:** Information regarding available approach procedures, such as Instrument Landing System (ILS), Required Navigation Performance (RNP) or visual approaches represents valuable contextual input.
- **Aerodrome & Routing Information:** Naming schemes for taxiways, routing information, and related airport surface data are already fully available from the Aeronautical Information Publication (AIP) and official airport layouts.
- **Local Operating Procedures:** Additional context that is only relevant within specific operational environments (for example, in a military ATC context) can likely be extracted from local operational manuals.
- **Use of Negative Prompts:** Providing a negative prompt explicitly excluding certain terms, procedures or invalid options can also be helpful to improve recognition and refinement performance.

- **Optimal Context Balance:** Pipeline must take into account that providing either too much or too little context can confuse the model and degrade the overall refinement process.

Open Challenges

- Standardized digital formats for aerodromes and airports that Large Language Models (LLMs) can directly read already exist, but only a few organizations are actively using them so far. Broad operational adoption is assessed to be primarily a matter of time.