



MODELLING OF A LANGUAGE TECHNOLOGY SYSTEM TO SUPPORT AIR TRAFFIC CONTROL COMMUNICATION

Mira Zokić, Damir Boras (Phd)

University of Zagreb

Faculty of Transport and Traffic Sciences, Faculty of
Philosophy

Vukeliceva 4, Ivana Lučića 3
10 000 Zagreb, Croatia

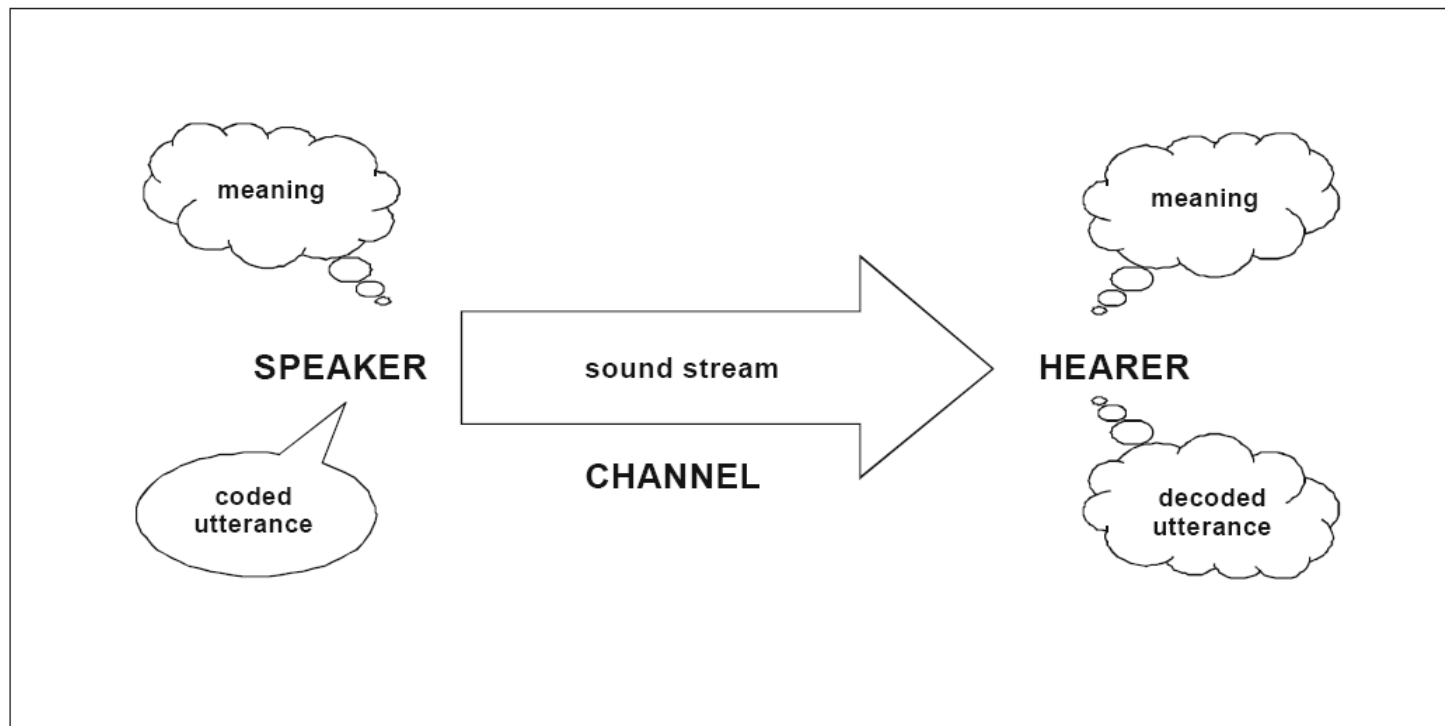


Modelling Of A Language Technology System To Support Air Traffic Control Communication

- The role of the Air Traffic Control is to ensure **safe, orderly** and **expeditious** flow of traffic.
- One of the most crucial tasks that Air Traffic Controllers, pilots and anyone who takes part in aviation perform is **communication**.

Modelling Of A Language Technology System To Support Air Traffic Control Communication

The traditional model of communication



Modelling Of A Language Technology System To Support Air Traffic Control Communication

- In Air Traffic Control it is of vital importance that all parties involved in communication understand each other and that the information is delivered and received **timely** and **accurately**.
- the Tenerife airport disaster in 1977, was a collision involving two Boeing 747 passenger aircraft with 583 fatalities.
- Ambiguous terminology and/or the obliteration of key words or phrases, and that the oral transmission of essential information, via single and vulnerable radio contacts, carries with it great potential dangers.



Modelling Of A Language Technology System To Support Air Traffic Control Communication

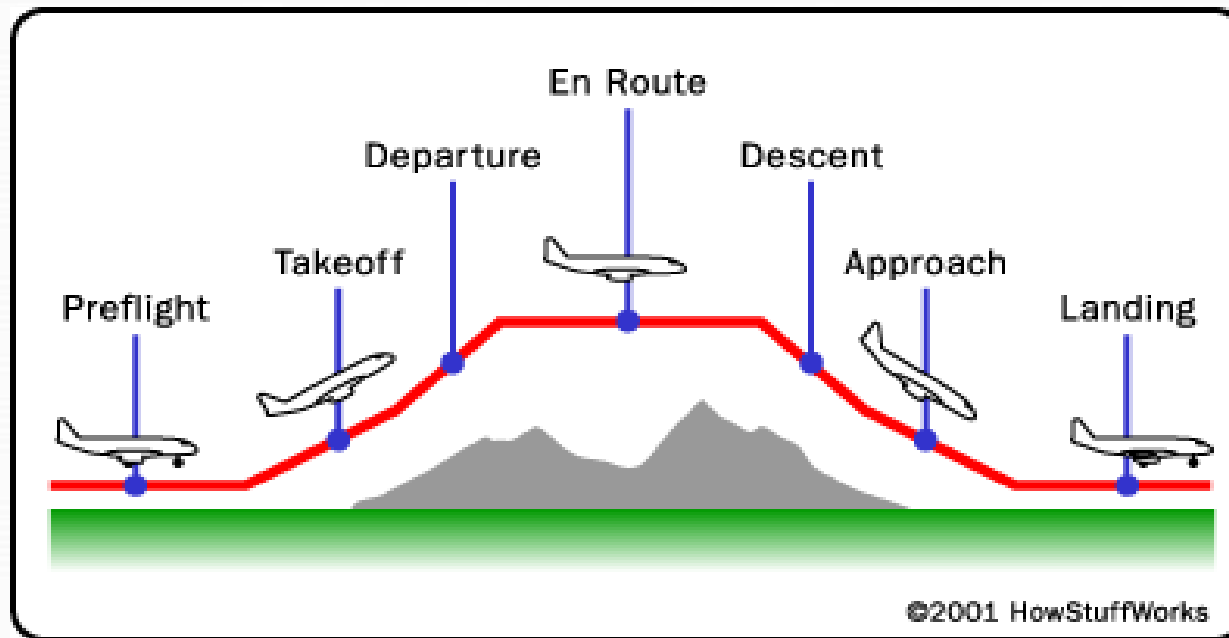
- The major part of communication in Air Traffic Control is voice communication over the radio.
- There are many factors such as homonyms, number problems, readback/hearback error, call sign confusion, ambiguity, expectation, noise, open microphones, etc. That can lead to communication errors.
- This paper proposes that language technology can be used to assist in ATC communication.

Modelling Of A Language Technology System To Support Air Traffic Control Communication

- According to EUROCONTROL, the European Organisation for the Safety of Air Navigation, Air Traffic Controllers have the responsibility to direct aircraft through their airspace **safely and efficiently**.
- Pilots flying the aircraft through the airspace are obliged **to follow the instructions** of the Air Traffic Controllers **precisely**.
- The purpose of the communication is **to synchronize** the Air Traffic Controller's decisions with the pilot and aircraft doings.

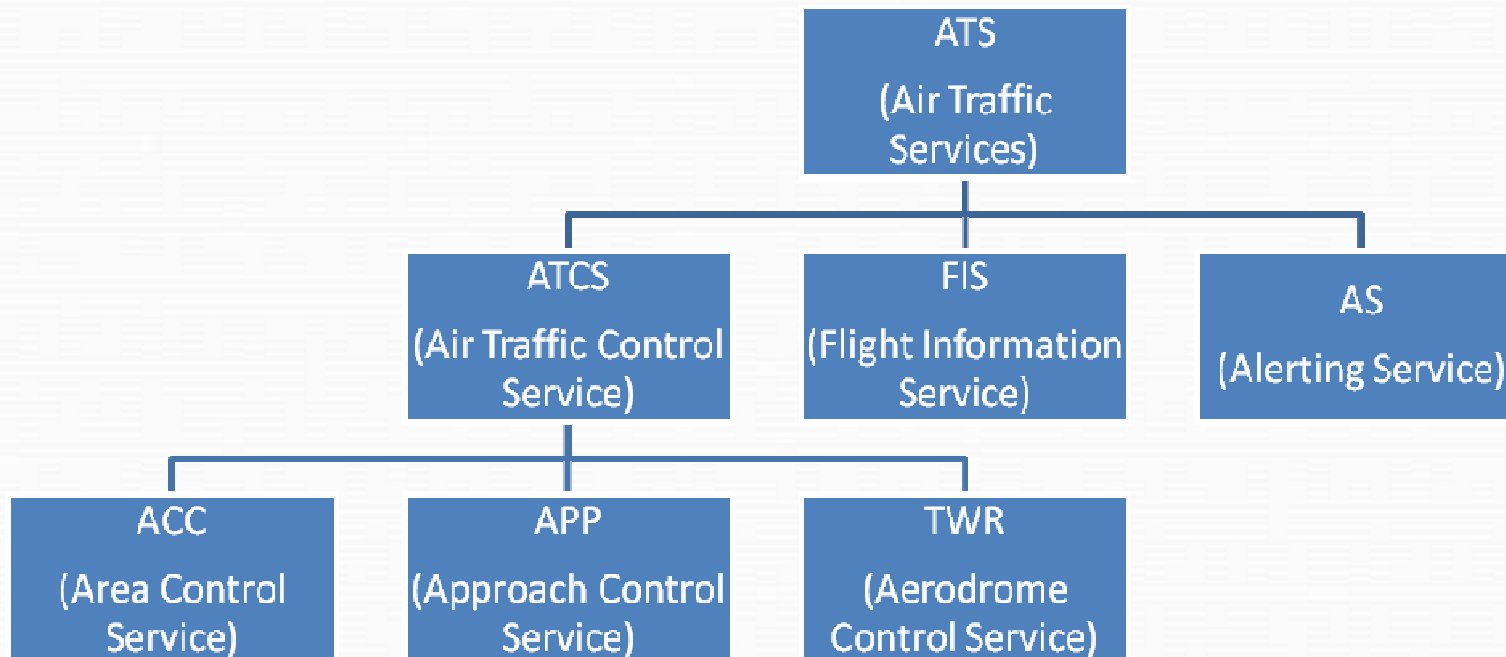
Modelling Of A Language Technology System To Support Air Traffic Control Communication

Phases of flight



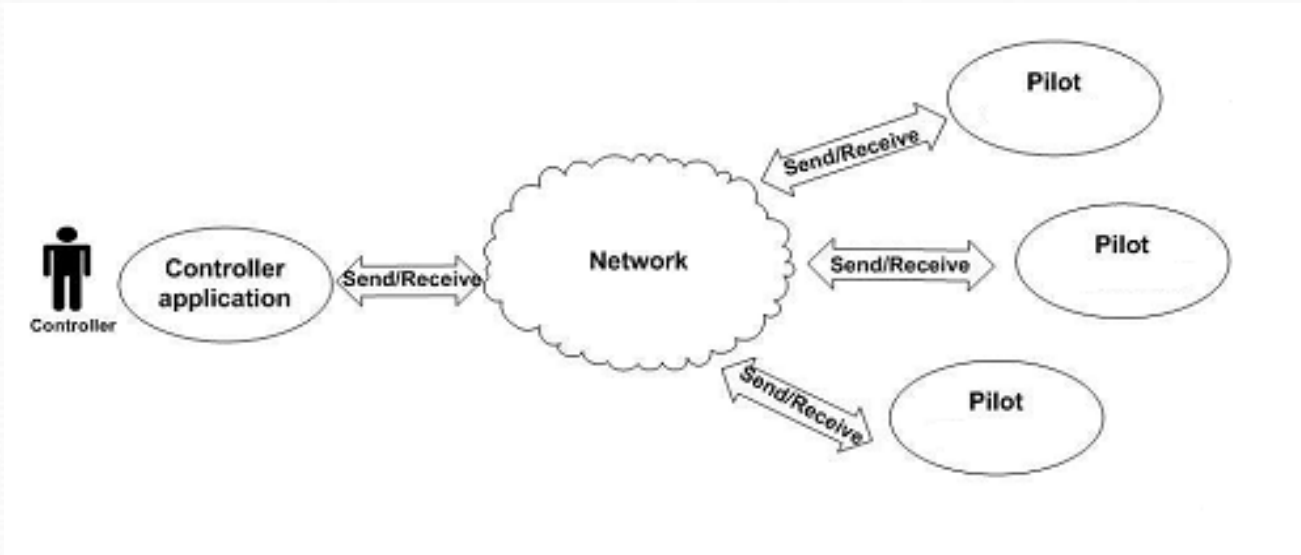
Modelling Of A Language Technology System To Support Air Traffic Control Communication

Division of Air Traffic Control Services.



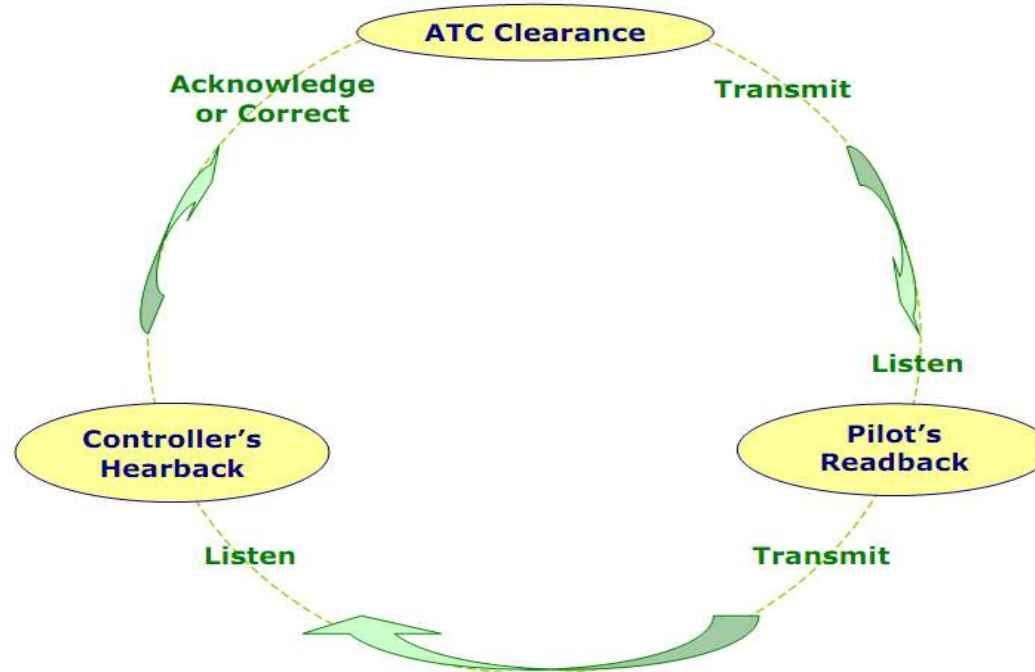
Modelling Of A Language Technology System To Support Air Traffic Control Communication

- Pilot /controller communication



- the controller utters an instruction through the headset system, the instruction is transmitted via a satellite network to the pilot, the pilot then receives the instruction using his/her headset and replies back.

Modelling Of A Language Technology System To Support Air Traffic Control Communication



- The pilot/controller **confirmation/correction** process is a “loop” that ensures effective communication and serves as a defence against communication errors.

Modelling Of A Language Technology System To Support Air Traffic Control Communication

- Radiotelephony Phraseology is a set of prescribed rules and language to be used by anyone involved in aeronautical communication.
- The rules for this language are located in Annex 10, Volume II, and Chapter 12 of Doc 4444 and are further illustrated in Doc 9432.
- These are the basis of a “restricted” sub-language for routine situations. They contain rules for when to say something, what to say (words and sentence patterns), what to understand and how to pronounce and utter messages/instructions.

Modelling Of A Language Technology System To Support Air Traffic Control Communication

Word/Phrase Riječ/Fraza	Meaning Značenje
ACKNOWLEDGE POTVRDITE	"Let me know that you have received and understood this message" "Potvrdite da ste primili i razumjeli poruku"
ADVISE RECITE	"Tell us/Inform us of the following ..." "Recite nam o ..."
AFFIRM DA	"Yes" "Da"
AIRBORNE POLETIO	"The time the flight has started after the take-off phase" "Vrijeme početka leta nakon faze polijetanja"
APPROVED ODOBRENO	"Permission for proposed action granted" "Dozvola za traženi postupak odobrena"
BREAK PREKID	"I hereby indicate the separation between the portions of the message" "Ovime označavam razdvajanje dijelova poruke"
BREAK BREAK PREKID PREKID	"I hereby indicate the separation between messages transmitted to different aircraft in a very busy environment" "Ovim naglašavam odvajanje poruka proslijeđenih različitim zrakoplovima u vrlo gustom prometu"
CANCEL PONIŠTITE	"Annul the previously transmitted clearance" "Poništite prethodno dodijeljeno odobrenje"
CAUTION OPREZ	"Beware of the following conditions or situations" "Pripazite na"
CHECK PROVJERITE	"Examine a system or a procedure" "Provjerite sustav ili postupak"
CLEARED SLOBODNO/ODOBRENO/DOZVOLJENO	"Authorized to proceed under the conditions specified" "Odobreno nastaviti prema utvrđenim uvjetima"

Modelling Of A Language Technology System To Support Air Traffic Control Communication

- The principal linguistic characteristics of standardized Phraseology (Philps, 1991) is a reduced vocabulary (around 400 words) in which each word has a precise meaning, often exclusive to the aviation domain.
- Sentences are short resulting from the deletion of “function words” such as determiners (the, your, etc.), auxiliary and link verbs (is/are), subject pronouns (I, you, we) and many prepositions.
- Sentences also frequently contain nominalizations (verbs transformed into nouns).

Modelling Of A Language Technology System To Support Air Traffic Control Communication

- A high proportion of sentences (around 50 per cent) are imperative or passive. Examples of such sentences are:

Cleared to take off.

Ready for push back.

Confirm brakes released.

Requesting low pass.

Modelling Of A Language Technology System To Support Air Traffic Control Communication

- Pilots should always read back the ATS messages/instructions detailed in AIC.
- Controllers should always ensure that they receive these readbacks. The ATS items listed below are to be read back in full by the pilot.
- If a readback is not received, the pilot will be asked to do so. Similarly, the pilot is expected to request that messages/instructions are repeated or clarified if they are not fully understood.

Modelling Of A Language Technology System To Support Air Traffic Control Communication

The mandatory items are:

- Taxi/Towing Instructions
- Level Instructions
- Heading Instructions
- Speed Instructions
- Airways or Route Clearances
- Approach Clearances
- Runway-in-Use
- Clearance to Enter, Land On, Take-Off On, Backtrack, Cross, or Hold Short of
- any Active Runway
- Secondary Surveillance Radar Operating Instructions
- Altimeter Settings
- VHF Information
- Frequency Changes
- Type of ATS Service
- Transition Levels

Modelling Of A Language Technology System To Support Air Traffic Control Communication

- According to a survey carried out by the NASA Aviation Safety Reporting System (ASRS), incorrect or incomplete pilot / controller communications is a causal or circumstantial factor in 80 % of incidents or accidents. The following factors affecting pilot/controller communication have been identified:

Factor	% of Reports
Incorrect Communication	80 %
Absence of Communication	33 %
Correct but late Communication	12 %

Modelling Of A Language Technology System To Support Air Traffic Control Communication

- Absent-mindedness and Slips
- Ambiguity
- Callsign Confusion
- Code Switching
- Different Voices
- Emergencies
- Enunciation
- Expectation
- Headsets
- Homonyms and Homophony
- Noise
- Not Hearing
- Number Problems
- Open microphones
- Readback Error
- Similarity of SIDs (Standard Instrument Departures), STARs (Standard Recommendations and Practices) and Waypoints
- Speech Acts
- Speed of Delivery and Pauses
- Vigilance.

Modelling Of A Language Technology System To Support Air Traffic Control Communication

- Here, in this paper, it is also suggested that the usage of a language technology system could support the pilot/controller communication and assist with training.
- The system should assist in:
- detecting language-based communication problems such as unfamiliar RT terminology, full and partial readback/hearback errors;
- communication problems not based on language such as problems with numbers, discrepancies between position reports and clearances (altitude, heading, etc.);
- general problems such as message not sent, message sent but not replied, etc.

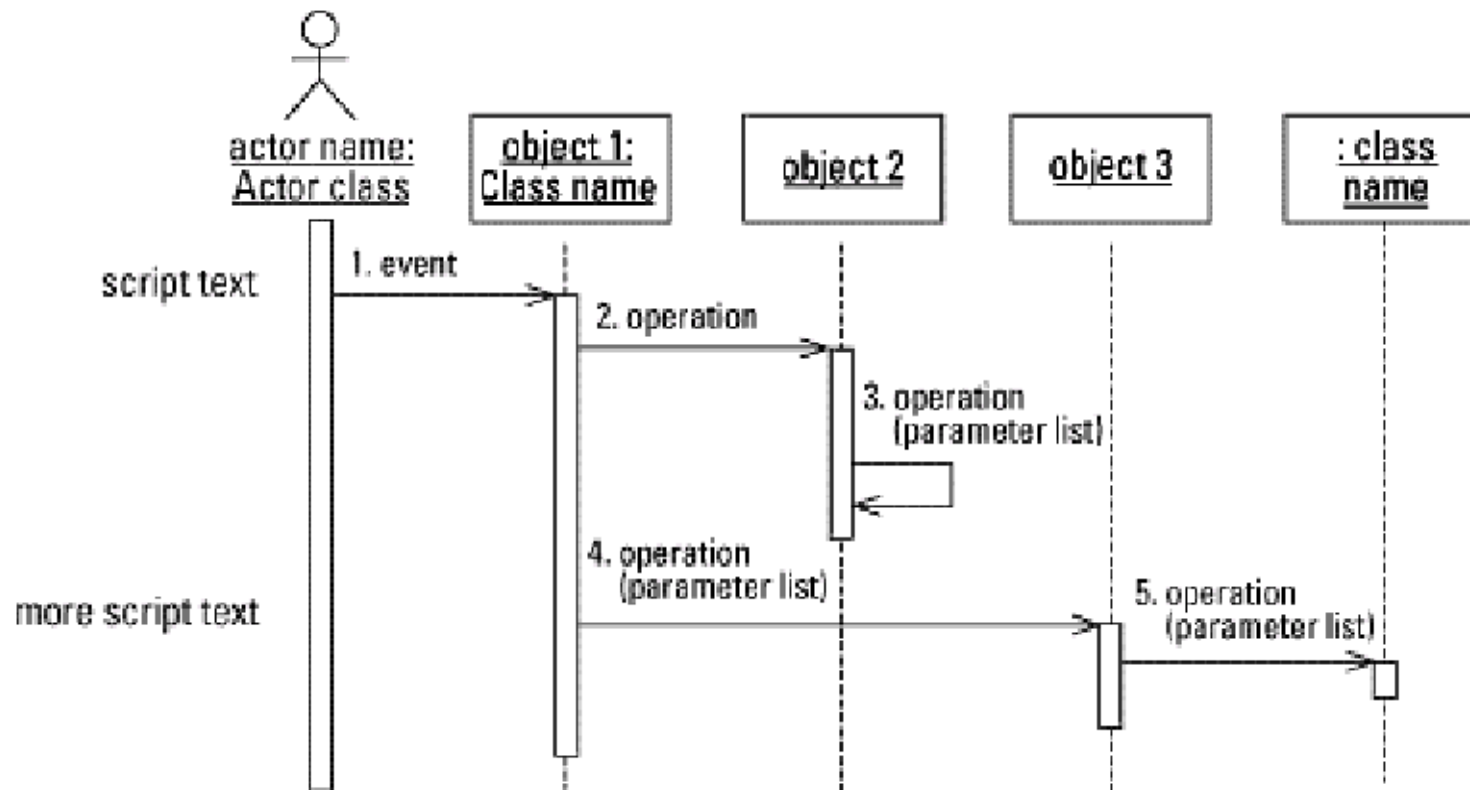
Modelling Of A Language Technology System To Support Air Traffic Control Communication

- The system should be applied in the Approach Control Unit, as the majority of prescribed standard RT communication is used in that phase of flight.
- The functionality of this language system will be described using scenarios and sequence diagrams, using Approach Control as an example, and will be demonstrated using the Wizard of Oz usability test.

Modelling Of A Language Technology System To Support Air Traffic Control Communication

- Scenarios are a software definition method. They are stories that provide a common ground for understanding the functionality of a system and give a context of a plot with participants and events that lead towards a certain goal or objective.
- Sequence diagrams will be used to depict which parts of the system are interacting to carry out functionalities and to remove all ambiguity and clearly define the behaviour of the system.

Modelling Of A Language Technology System To Support Air Traffic Control Communication



Modelling Of A Language Technology System To Support Air Traffic Control Communication

- The Wizard of Oz usability test will provide the same scenarios in that the images of the software prototype will be presented to the users by a “wizard” (the experimenter) behind the scenes.
- The user believes that a fully functional application system is used.
- The objective of such usability testing is to get information on how the user reacts to the system and how accurately and reliably the system reacts to the user.

Modelling Of A Language Technology System To Support Air Traffic Control Communication

- The fully functional language technology system should consist of an Automatic Speech Recognition tool that should identify the words that a user utters into a microphone or telephone.
- A Speech-to-Text software should convert the utterances into a text. The uttered/written text will be compared with the database consisting of RT Phraseology, prescribed RT instructions and related numbers.

Modelling Of A Language Technology System To Support Air Traffic Control Communication

- The system should report on discrepancies or errors.
- The proposed system would only be designed as a support tool by giving warnings when discrepancy or error is found and is not meant to make decisions how the air traffic controllers should control the airspace.
- This paper proposes the idea that with the usage of language technology the communication between air traffic controllers and pilots could be made more reliable and efficient, and in that way would contribute to the improvement of aviation safety.