



ICE 1.6

Intelligent Communications

Environment

Functional Specifications

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Revision Control

Document History

The revision number indicates the software release version. The number in parenthesis indicates the revision number of the document for a given software release.

Revision	Date	Superseded Documents
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1. Document Scope

This document describes the functional specifications to be delivered to a prospective client wishing to acquire Adacel's Intelligent Communications Environment (ICE). This innovative solution trains student pilots and air traffic controllers in the art of aviation communications procedures and terminology. An additional benefit of Adacel's ICE is to help train users in the vocabulary and comprehension necessary to meet the International Civil Aviation Organization's (ICAO's) aviation English language requirements.

2. Introduction

ICE, the Intelligent Communications Environment, is a software system designed to be a single and portable device capable of assisting in the teaching of a student proper phraseology and procedures related to aviation plus additional fields. This learning event is accomplished while immersing the student in a "scripted environment". Two distinct modes of training optimize student learning potential, student throughput and minimizes overall training time.

ICE utilizes speech recognition as its primary student interface. The speech system allows course administrators the capability of measuring the accuracy, quality and timeliness of the student responses and the correct phraseology of radio communications.

The ICE Assessment Tool provides feedback to the student and instructor. The assessment identifies and quantifies areas in need of further development.

The system is both portable and flexible. It can be configured either on a laptop or desktop. The native (.ICE / .PRF) files can be networked via a user accessible common server. Networking allows the instructor to provide classroom teaching/coaching to a large body of students, as well as the flexibility of interfacing with an LMS (Learning Management System) which are SCORM compliant with AICC CMI001 – CMI Guidelines for Interoperability.

3. Abbreviations and Acronyms

The following abbreviations and acronyms are used in this document:

ATIS – Automatic Terminal Information Service

ATC – Air Traffic Control

CMI – Computer Management Instruction

ICE – Intelligent Communications Environment

ICAO – International Civil Aviation Organization

LBUI – Lesson Builder User Interface

LMS – Learning Management System

PC – Personal Computer

PTT – Push-To-Talk

SR – Speech Recognition

SUI – Student User Interface

TTS – Text-To-Speech

4. Objectives

The main objective of the ICE software system is to permit the training and practice English communications of all types as well as procedures. This includes Aviation English phraseology and procedures for pilots, air traffic controllers, airport drivers, and others. This is done within ICE's emulated radio communications training environment which:

- Implements English speech recognition (SR)
- Text-To-Speech (TTS) technologies
- Provides performance metrics and a recorded transcript
- Provides portability and flexibility by use of laptops, desktops, and/or networks
- Delivers performance feedback and assessment to the student and/or instructor
- Customizable lesson plans
- Requires *no* certification or proficiency to engage ICE training

In addition to the above, the system can be used for other types of training thanks to features like Questions and Answers, Teaching Points, multi-lingual "Text-To-Speech", and Assessments. Here are some examples:

- Meteorology
- Airspace familiarization
- Airport layout familiarization
- Procedures (Holding, navigation, identification, etc.)
- Aircraft performance
- Flight planning and flight plan format
- Radar identification, sequencing, and guidance

5. Functional Overview

ICE offers the means for a student to progressively learn the basic English language based aviation phraseology and allows them to practice voicing the learned phraseology within a customizable and dynamically changing Air Traffic Control (ATC) environment situation. Once the student has acquired knowledge of the phraseology and their pronunciation is adequate, the next level of training allows the student to be immersed in an environment where the new learned knowledge can be practiced.

ICE is installed on a compatible Microsoft Windows based PC. Speech recognition is the primary student interface.

The system has two training modes: Practice and Assessment (i.e. Test). Each mode contains a lesson which may have pre-recorded aircraft tracks. These tracks contain all the communication exchanges between the pilot and ATC. At the conclusion of the lesson ICE provides a Performance Report.

6. System Requirements

The ICE software can run under various versions of Microsoft Windows which include 7, 8, and 10.

6.1 Recommended Hardware Requirements

- 2 GHz 64-bit (x64) Microsoft Windows compatible processor
- 16 GB of RAM
- 100 GB hard drive with at least 15GB of available space

- 1024 MB of graphics memory
- Computer screen size which provides 1080 lines of vertical resolution
- Standard Windows compatible Audio Input/Output interface
- Compatible network interface
- Standard Microsoft Windows PC headset (with or without noise cancelling) or Plantronics air traffic control USB headset¹

7. ICE Training Concepts

ICE offers progressive learning of basic aviation phraseology in a dynamic Air Traffic Control setting. This dynamic and interactive learning process includes: read and repeat, system prompt and response, scripted training scenarios and real time simulated air traffic conditions. The ICE training system reinforces aviation procedural training and the understanding of the English language as it is applied in real traffic situations. The SR software automatically recognizes correct and incorrect responses and pronunciation. When the student has successfully acquired knowledge of phraseology and correct pronunciation, the next level of training is to be immersed in an environment where the new learned knowledge can be practiced.

In the training modes, where the student is required to interact, ICE provides an end of lesson Performance Report. The report evaluates the student's performance based on criteria such as: accuracy and validity of response, time to respond, radio discipline and quality of word pronunciation. The instructor has the capability, using the Lesson Builder, to define the minimum acceptable score for each assessment parameter.

ICE also offers an instructor input capability, which allows the instructor to challenge the student during a lesson by inserting pre-scripted questions, comments or suggestions. The questions can be either multiple choice or oral. The multiple-choice questions are evaluated automatically (student assessment) by the ICE, whereas the oral questions must be evaluated by an instructor.

7.1 Lesson Briefing and Training Objectives

The student selects a specific lesson, and will be presented with the following information via a lesson briefing:

- Name of Lesson
- Lesson Objective(s)
- Lesson Context (airport name, runway in use, ownership location and details, traffic mix, environmental conditions)
- Instructor Notes (evaluated criteria, success thresholds, number of questions...)
- Lesson Execution Modes
- Cues and Hints

The content of the lesson briefing is prepared by the instructor and can be viewed by the student at any time during the lesson via an electronic kneeboard tab.

¹ Standard headset used in the air traffic control industry.

7.2 Modes of Training

The two distinctive training modes are each designed to provide the instructor with the tools to train by using various degrees of difficulties. There is “Practice Mode” and “Assessment Mode”. At lesson preparation time, the instructor can choose the mode of training to be made available to the student. The instructor can also select the student’s role, as pilot or air traffic controller.

A lesson, which is created by the instructor, is an aggregation of tracks. A track can be viewed as a timeline where certain events will occur. ICE has several sets of tracks available to the instructor: interactive content, broadcast, student, pilot, ATC. The interactive track contains teaching elements to the student, such as teaching point and questions.

Broadcast tracks are reserved exclusively to virtual ATC entities to transmit a message to everyone. ATIS message is good example of a broadcast message.

Virtual entity tracks (broadcast, pilot and ATC) are temporal descriptions of the behavior of a given virtual entity. A speech dialog is a communication transmitted by a virtual entity using synthetic speech. If the entity is an air traffic controller, the track will only include the speech. If the entity is an aircraft, the track will contain both the aircraft route and its associated speech dialog. The aircraft route is shown on a 2D map display.

The student is presented with a graphic display of the situation with a timeline at the bottom which contains all the speech interactions.

7.2.1 Practice Mode of Training

The practice mode of training is designed for an individual who wishes to attempt performing a given lesson with various degrees of cues or when an instructor wishes to increase the level of challenges offered to the student; i.e. ask questions or evaluate more aspects of their performance. The student reads the phraseology presented on the timeline at the appropriate point in the lesson. instructor can use ICE to evaluate pronunciation and evaluate validity and accuracy, timeliness of response of each transmission and radio discipline. This mode of training is designed to expose the student to procedural elements of flying or controlling aircraft and prepare them for the ensuing assessment.

Students may be required to answer questions during the lesson. There are two question categories that are available, multiple choice and oral response. Correct answers to questions are always provided in this training mode since there is no assessment of the lesson.

7.2.2 Assessment/Test Mode of Training

The assessment/test mode of training is designed to allow a student to be assessed on a given lesson. While in this mode, the phraseology is not visible to the student, thus he/she must remember the necessary response. Cues cannot be manipulated by the student in the assessment mode. The student is provided with a start capability and the lesson ends automatically.

At the end of the lesson, the student will be provided with a report of their performance and where they can review each phraseology exchange and the score.

7.3 Using Cues/Hints

Cues and Hints are designed to vary the degree of assistance that ICE provides to the student, thus helping prepare for the assessment where limited cues/hints are provided. These cues/hints are:

- Teaching Point
- Phraseology hints
- Dialog Events
- Transmission History
- Questions (multiple or oral)

A cue selection window is provided in the Student User Interface (SUI). This allows the student to select or deselect desired cues.

A teaching point provides general information to the student (i.e. how to flight a VFR pattern). The teaching point and question text can be written in any language supported by the computer. It can be possible to add synthetic voice to a teaching point, which will read the teaching point text to the user. The instructor must select a compatible voice of the same language of the text written. Compatible voices must be pre-installed. However, Questions do not have the capability to have a synthetic voice that reads the text. The instructor may limit available cues to the student in any lesson.

7.4 Interfaces

The Student interface, Lesson Builder interface are Windows based GUIs.

7.4.1 Student User Interface (SUI)

One of the cornerstones of the ICE is that it provides the student with the capability to view, in real-time, the air situation unfolds as communications are made. From the moment the lesson is started, the student can view, in 2D, an airport display or a radar display. The map displays allow the student to develop situational awareness and create instant visual reinforcement following any communication exchange. The SUI allows the student to activate the microphone either via a mouse by clicking the PTT button on the interface or via the use of the “spacebar” keyboard key. PTT can also be activated by the headset when using air traffic control headset.

The student interface presents, as an option, a weather panel. The panel has the following information: METAR message, wind and direction and runway in use. Those elements of information are defined in the lesson.

Lesson Controls

The SUI supports the following lesson control features:

- Start/Open lesson
- Pause/Play/Restart lesson
- Stop/Close lesson
- Exit ICE

When the lesson ends, ICE generates a Performance Report.

7.4.1.1 Lesson Builder Interface (LB)

The LB software component allows the instructor to edit an existing lesson or to create a new lesson using a graphical interface. It is through the LB that the instructor can progressively increase the complexity of situations the student will be facing.

The LB software tool may reside on a separate PC which may also act as the server from which student would download the newly created lessons.

The LB contains tools to assist the instructor with creating a lesson. Some of the items created by these tools can be reused in other lessons. Information regarding the synthetic speech and the speech recognition are described in section 7.5.

Background Designer Tool

The background designer is used to import a 2D image as the background of the lesson. Radar map and airport maps are good examples of background images. The system supports Adacel “GXF” and bitmap bmp file formats. The tool also allows the user to rotate the image.

Route Designer Tool

Since there is no simulation engine inside ICE, a pre-scripted path emulates the aircraft movement. The route designer allows the creation of an aircraft/vehicle path or trajectory, which can be used later in a pilot track. A trajectory is essentially a spline curve, where the instructor defines the spline’s control points. The mouse (clicks on the 2D map) is used to determine control points position. Also, speed and altitude are assigned to every control points. The aircraft path and speech dialog are independent so they may be reused in other lessons.

Phraseology edition

Each lesson includes the phraseology that will be use by the virtual entities and by the student in each lesson. The Lesson Builder allows the instructor to define the required student phraseology as well as acceptable phraseology deviation. It also allows the instructor to define the level of correctness of the phraseology to be use (ex: first sentence is grade A, the second one is grade B, and so on).

7.5 Synthetic Speech and Speech Recognition

ICE’s strength is that it provides the student with the ability see a 2D image and to voice interact with virtual controllers or virtual pilots using English speech recognition and text-to-speech technologies.

7.5.1.1 Synthetic Speech (TTS)

The TTS system provides synthetic speech voices to simulate the virtual pilots and virtual air traffic controllers, as well as other human entities. Every entity, defined in the lesson, will be assigned a voice using the TTS voice panel. A voice panel displays, in the Lesson Builder, the voice characteristics (gender, rate, accent) and allows listening to each one of them. The system uses commercial of the shelf (COTS) synthetic voices that are compliant with the SAPI standard. This allows the addition of many non-English voices such as French, Spanish, German, Chinese, and others to the included five English voices

7.5.1.2 Speech Recognition (SR)

The SR system is the key element to allow the student to learn how to communicate properly in the aviation environment.

The SR engine recognizes the words being said when the PTT is depressed. Depending on the quality of the transmission, each word that the student had to say will appear in green, yellow or red. Green denotes a good transmission; yellow is an average transmission and red is an unacceptable transmission. The instructor has the capability to adjust the sensitivity of the color assignment threshold. The color grading is based on the SR engine's level of confidence in the recognition of the words spoken.

ICE uses a constraint-based speech recognition engine, which doesn't require to be trained.

7.5.2 Supported Languages

The SR system supports operation only in the English language. ICE has been designed with the objective of having users learn proper English phraseology.

7.6 Assessment Tools

The assessment tools provide immediate feedback to the student and the instructor. The tools identify the specific areas which require further work.

7.6.1 Student Evaluation and Reporting

A Student's Performance Report is produced at the end of a lesson.

The system supports the recording and scoring of the following performance criteria:

- Grammar Validity and Accuracy of the spoken phrase compared to what should have been said.
- Timeliness of Response between when the controller should start talking and when he depresses the PTT.
- Pronunciation based on the confidence level of the voice recognizer.
- Radio Discipline, to make sure the controller doesn't step on a transmission.
- Questions (multiple choices and voice).
- Language Proficiency (requires an instructor).

Scoring is provided at the end of each lesson and is based upon performance criterion that has been benchmarked by the instructor. Assessment parameters are evaluated automatically, except for the language proficiency which must be evaluated by the instructor. It is also possible to select which of the parameters will be assessed.

The performance report contains the recordings of all the transmission that occurred during the lesson (student and the virtual entities). It is possible for a student or an instructor to listen to any transmissions.

The performance report contains all the student answer to the questions asked and the associated score.

The report results are contained in a single file (.prf) which can be transmitted via network methods (ex. Compatible email). It can also be saved as part of the student's electronic record.

7.6.2 Language Proficiency Evaluation

Instructor may evaluate any voice response against the ICAO Language Proficiency Matrix. The ICAO Language Proficiency Matrix is available to the instructor within a

parallel scoring matrix. It tabulates the instructor issued score for each question, and for each language component, then generating an overall assessment for each recorded voiced question. The assessment allows the instructor to determine if a student is or is not at the desired ICAO English Proficiency Level.

Note: This feature is not to be construed as a formal ICAO language evaluation, but only as an aide.

8. LMS Requirements

ICE is SCORM and AICC compliant, making it capable of connecting to Learning Management Systems (LMS) and sharing information. The ICE LMS interface allows a student to connect to an LMS using a web browser and view a list of available ICE lessons. The lessons can be selected from the LMS webpage to be executed locally.

Once ICE is connected to the LMS, a lesson record is automatically saved in the LMS with the associated lesson information and scoring data.

This exchange of data allows the student to review their course progress and lesson scores via the LMS webpage. The LMS also allows an instructor to review course progress and lesson scores of his students via the LMS webpage. When necessary, the instructor may modify the scoring data in the LMS for any given lesson attempt by a student.