Enhancing Scenario-Centric Air Traffic Control Training

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As one of the main focuses of Federal Aviation Administration (FAA) Academy, Air Traffic Control (ATC) training program heavily relies on simulation-based training and is constantly looking into optimizing the use of such technologies. On the other hand, ATC simulation scenarios are not only used for training purposes, but also are key components for conducting human performance experiments. From a recent visit at the FAA Academy, it is well apparent that there is an immediate need for a diverse pool of ATC training scenarios available to trainees off-site. Currently, training scenarios are generated manually from a subject-matter-expert's (i.e. controllers) oral or written briefing. The effort in extracting and verifying operational scenarios and translating them into a machine-understandable language is rather cumbersome and currently conducted completely manual. To address these challenges, here we propose to develop a scenario exploration technology that provides a platform for FAA Academy trainees and instructors to exercise variety of scenarios in the ATC domain. The proposed technology provides a platform for instructors and trainees to explore various training exercises. By taking a model-driven approach and extending the recently proposed domain-specific Aviation Scenario Definition Language (ASDL), we provide ATC scenario specification and exploration platform to easily create a variety of ATC scenarios. Similar to ASDL approach, we first define an ontology for ATC extension, then specify scenario logic using a formal specification language such as statechart, and finally, include a metamodel to allow for scenario modeling.

I. Air Traffic Control Scenario Training

Air Traffic Control (ATC) training currently occurs in two phases: Federal Aviation Administration (FAA) Academy training and on-site training. At the Academy, the Air Traffic Division is responsible for technical training for ATC Specialists. The training begins with classroom instruction and has in-depth courses for two tracks: Terminal, which includes both Tower and Terminal Radar Approach Control (TRACON), and En Route. [1]

The FAA Academy training curriculum varies based on experience. In particular, applicants are grouped into three categories: (1) previous controllers with military or civilian ATC experience, (2) developmentals, who have completed

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an aviation-related program of study from a school which is a part of the Air Traffic-Collegiate Training Initiative (AT-CTI) program started by the FAA, and (3) members of the general public with no exposure to the ATC field. [2] Controllers with prior experience are not required to attend the Academy, but can directly proceed to on-site training. Former civilian controllers, however, are required to complete a refresher course. Developmentals and general hires undergo different levels of classes and can take between two to four months to complete training at the Academy. General public hires start with completing an Air Traffic Basics course which introduces the basic concepts of aviation and air traffic control before proceeding to train in a given track, whereas developmentals head straight to courses within a single track. [2]

The Academy uses a combination of training media which includes classroom instruction, part-task training and technology-enhanced training. Classroom instruction is in the form of in-class lectures which may be supplemented by the use of presentations and handouts. Part-task training involves the use of lectures along with basic laboratory activities. [3] Technology-enhanced training forms the majority of the coursework by the use of low-, medium- and high-fidelity simulators for familiarization with standard ATC tools. A list of all courses and their descriptions can be found in the FAA Air Traffic Training catalog online. [4]

Recently, the Federal Aviation Administration (FAA) established a new Center of Excellence (CoE) to support Technical Training and Human Performance (TTHP) initiatives. The FAA Academy, as the main stakeholder of this CoE, is particularly interested in supporting simulation-based and part-task training projects. A large portion of training depends on the use of simulators because there is no better alternative to teach how to react in high-pressure situations than to place students in one. The type of simulations offered range from two-dimensional (2D) tabletop simulators to full-fidelity Tower, TRACON and En Route systems with identical performance as facility tools. In initial training classes, a larger amount of time is spent in lower-fidelity simulators to enable students to get more comfortable with phraseology and expected tasks one at a time until later in the course when several hours are spent on full-fidelity simulators to show all the different tasks that a controller might have to handle simultaneously. In advanced courses, the approach is reversed to spend minimum time on lower-fidelity simulators for practice after which all lab hours are spent in full-fidelity simulation labs with an experienced controller supervising each student's lab performance. All simulation activities are graded based on the response to a given scenario. A scenario is typically a data file describing the flow of aircraft traffic through an airspace over a period of time. [5] This scenario file contains all the details of the simulation run which starts with the number and details of flights, the events that are triggered, the clearances that have to be issued and any conflict alerts or other environmental conditions that need to be managed.

This paper will first tackle challenges with ATC training and the need for a formal scenario specification language. We then highlight the needs for a portable ATC scenario training technology that provides trainees with on-demand and easy-to-use training environment with close-to-reality look and feel. We will then include details on ATC training scenario elicitation and formal scenario specification by extending the existing Aviation Scenario Definition Language (ASDL). Furthermore, sample ATC training scenarios will be discussed and formally defined using our proposed approach.

II. Scenario-Oriented Training

Scenario-based training is an amalgamation of knowledge and skills-based training. It is based on the belief that training should always be developed to give trainees the skills to successfully complete a task [6]. In this type of training, a great deal of consideration must be given to the design and development of the scenarios. Clear definition needs to be given to the goals of the scenario: what to evaluate at the completion of the scenario. Scenarios can vary from short and basic to elaborate and detailed. Scenario-based training provides an opportunity to experience the situations that may occur at the trainee's workplace, and teaches systematic risk reduction and critical thinking skills. The purpose of scenario-based training is to subject trainees to real-world situations in a controlled environment. [6]

A. Use of Scenario-Oriented Training

Scenario-oriented training can be applied in many places, but it is most useful in areas of high risk or danger where it is desirable that professionals be extremely skilled before being trusted with their job. This makes the fields of law enforcement training, health care safety, and flight training very suitable for scenario-based training.

In emergency response training for law enforcement, the Federal Bureau of Investigation (FBI) has developed a scenario-based training program to better equip their members with skills required in the field. [6] Their training program focuses on role playing to establish a degree of realism in the scenario, while still being in a controlled environment. [7]

Within the health care domain, simulation has begun to change the ways in which medicine is taught and how trainees and junior doctors acquire the relevant skills. [8] A study performed in 2011 evaluating the training of nurses showed a statistically significant increase in the overall performance of the nurses who trained at a facility where scenario-based simulation training was incorporated into their training curriculum, when compared to a different facility where scenario-based training was used, after the training, as an evaluation tool. [9]

In the field of aviation, flight simulators have been used for initial and advanced training and for proficiency maintenance and evaluation. A major advantage of simulation is that it provides a means for experiencing abnormal conditions in a safe and nonthreatening environment. Simulators allow a trainee to explore the consequences of making particular mistakes, which would be impossible to attempt as a learning exercise in an actual flight. [10] A similar process has been adopted for helicopter training, where a simulation-based syllabus enhances commercial helicopter training experience. [11]

B. Scenario-Based Training in ATC Domain

Within the ATC domain, the FAA Academy makes use of scenario-oriented training modules to teach trainees how to respond to situations they encounter. While it is not possible to make such training exhaustive as scenarios still need to be designed by instructors, it helps them get familiar with different tools and technologies, and with the critical thinking process which is essential in a fast-paced, high-risk environment like that experienced by controllers.

In our analysis of the FAA Academy ATC course curriculum, it was observed that out of 348 courses that were considered, 78 had some form of simulation component as a required part of training. While this is a little short of a quarter of all courses, it is important to note that simulation is a major component of all advanced courses. In the *Initial En Route Qualification Training* course, simulation takes up 188.85 hours out of 324.55 hours of class time, and makes up 58.18% of the total time spent. This course needs to be taken by all trainees in the En Route track, and shows the importance of simulation within the field. In the same vein, the *Initial Tower Cab* course uses simulation for 40.50 hours out of 198.60 hours, or 20.39% of total training time. There are also several classes dedicated to learning the use of particular tools, such as *Ocean 21 Air Traffic Operator Training*, *TRACON Skill Enhancement Workshop*, *Maxsim4 Tower Simulation System (TSS)*, and other similar courses all involve the use of simulation for sharpening skills in a single simulator system.

The Academy also has courses dedicated to generating scenarios for these systems. Two examples of such courses are: (1*) En Route Automation Modernization (ERAM) Scenario Generation*, and (2) *Ocean 21 for Air Traffic Scenario Developers*. These courses teach users to design scenarios for the given simulators, validate those scenarios and import them into the tool for others to practice on. The fact that there are classes devoted only to generating scenarios to be used in other classes shows the Academy's reliance on scenario-oriented training as a teaching method.

III. Role of Simulation Technologies in ATC

It has been discussed that simulators are essential for training in the ATC domain in order to adequately prepare controllers for their tasks at their facilities. This section will talk about the two ATC tracks: Terminal (Tower and TRACON) and En Route, and the simulation technologies used for training in each one. For reference, the differences between the responsibilities of each track with respect to the airspace and the stages of flight can be seen in Fig. 1.

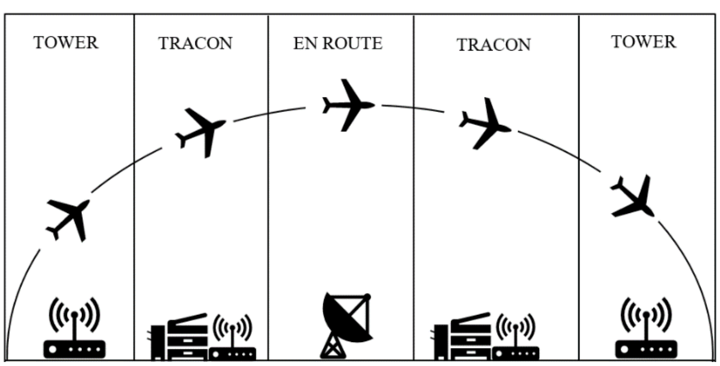

Fig. 1 ATC facilities and responsibilities

A. Tower

The Terminal track instructs students in the functioning of Tower and TRACON facilities. The tower track focuses on activities within a radius of a few miles of the airport. The major responsibilities of tower controllers include providing take-off and taxiing instructions, as well as clearance deliveries. [2] Simulators are used to replicate real

ATC towers and train students. [1] A very important part of the tower simulator is the visual aspect, which makes these simulators large and complex. Relatively simple types of tower simulators consist of 4 big TV-screens with a 3D model of the airport, and a set of computer screens with radar and other equipment. The larger ones are full-size, 360-degree simulators, where the view from the tower windows is created by an array of projectors or large screens. These are full-fidelity simulators and are used for higher levels of training.

Tower scenarios primarily involve the coordination of ground control, airport operations and clearance delivery. Once an aircraft has been cleared for take-off, climb is generally managed by TRACON controllers. In the same vein, aircraft are descended by TRACON and are only taken over by Tower controllers at the last stage of landing. Takeoff and landing clearances are delivered after visual check of the runway status, making the visual display essential in a Tower simulator.

B. TRACON

TRACON training occurs in the Terminal Basic Radar Training Course, which is aimed at developmentals going to a standalone radar facility. This course incorporates classroom training and simulation, and focuses on managing traffic outside the area managed by Towers. TRACON control extends to a 40-mile radius from the primary airport. Major responsibilities of specialists in this track include ascending departing aircraft, descending arriving aircraft, maintaining separation distances, and transferring control to En Route Center controllers or Tower controllers. [2] The airspace managed by TRACON controllers is larger and hence more complicated than Tower space, but not nearly as much as En Route sector airspace. TRACON responsibility is covered in the Academy Terminal track but is primarily performed at the facility. TRACON training is done in radar labs and scenarios usually consist of controlling arriving and departing aircraft in addition to coordination with En Route and Tower controllers. TRACON facilities do not need to be physically co-located with Tower facilities, so there is no need for visual access or equipment.

C. En Route

En Route courses are the most detailed and extensive courses as the FAA Academy is the only place developmental ATCs receive this training. The region managed by a single sector of an Air Route Traffic Control Center (ARTCC) is much larger than that managed by a Tower or TRACON controller. This course consists of classroom instruction, medium-fidelity simulation for practice utilizing interactive computer-based instructional systems, and full-fidelity En Route Automation Modernization (ERAM) simulation in an En Route lab. [2]

The ERAM system requires coordination between two controllers managing the same space and looking at two different monitors: (1) the Radar-Position (R-Position) which contains an interface with a radar display, and (2) the Radar Associate-Position (RA-Position) which has an interface to the ERAM Decision Support Tool (EDST). [12]

The R-Position interface shows the data blocks of all flights within the sector airspace and in its immediate surroundings, as well as trailing lines. An image of this interface screen can be seen in Fig. 2. The data blocks can be expanded if needed and show details such as the aircraft ID, speed, sector control and other remarks.

Fig. 2 View of ERAM R-Position interface

The RA-Position lets the radar associate look at several screens, including the radar screen pictured in Fig. 2, along with a list of all flights, altitudes, directions, routes and remarks. EDST warns the associate in the event of potential issues such as an Inappropriate Altitude for Direction of Flight (IAFDOF) or varying levels of conflict alerts. It also gives the controller the option to edit any of the fields or to trial plan a change in altitude or route [13]. An image of this interface screen can be seen in Fig. 3.

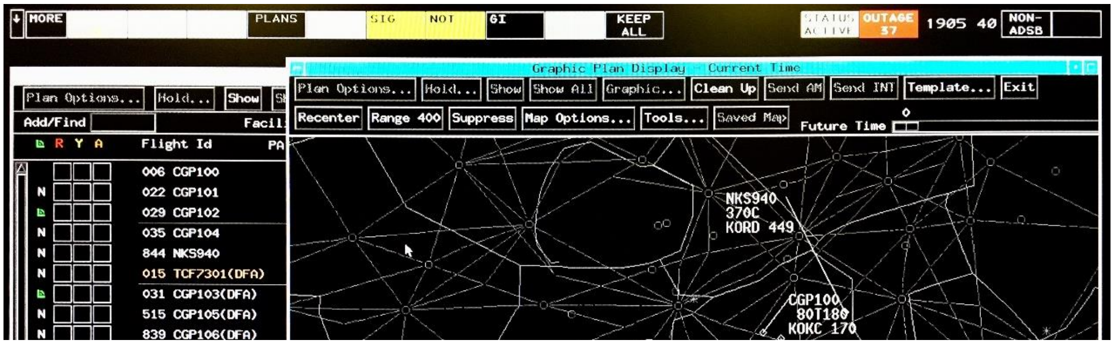

Fig. 3 View of ERAM RA-Position interface

IV. Challenges of Simulation-Based Training

The importance of scenario-oriented training in the ATC domain has been discussed in earlier sections. Given the current mission of the FAA Center of Excellence for Technical Training and Human Performance (TTHP), ATC simulation and training scenarios are the key in conducting human performance studies and delivering simulation part-task training. From a recent visit to the FAA Academy, it is apparent that there is an immediate need for a diverse pool of ATC training scenarios. Currently, training scenarios are generated manually from a subject-matter-expert's (i.e. controllers) oral or written briefing. This is known as the "operational scenario", which is then verified and manually translated into the simulator's language, providing an executable scenario script for the target simulator technology. The effort in extracting and verifying operational scenarios and translating them to a machine-understandable language is rather cumbersome and currently conducted completely manually.

While this process is being implemented currently at the Academy, there are other challenges to providing students sufficient simulator-based training. In addition to the availability of scenarios, a major problem facing this is the cost of the technology. Simulators in place at the Academy cost millions of dollars to obtain and maintain, and are hence used for training as much as possible. This gives students the ability to use them during class time, but they are unable to practice on their own to study at their own pace.

Another big challenge is the amount of coordination required, especially in en route ATC training. Each trainee has two instructors assisting them – one playing the role of the R-Position controller, and the other being the supervisor who observes their interaction and provides advice when needed. There are also ghost controllers and pilots who are required to call in and ask for clearances or make requests as a part of the scenario. It is not possible to have these instructors on hand whenever a student wishes to practice their scenarios, which makes the process difficult.

V. Enroute ATC Scenario Elicitation

En route scenarios contain several aircraft, usually a combination of active flights and departure flights, the latter of which are activated in the middle of the scenario. The en route controller trainee's job is to handle all traffic within their sector. This includes maintaining separation, coordinating point-outs and handoffs with neighboring sectors, issuing clearances and responding to any issues, conflict alerts and other emergencies.

For the purposes of training, several tasks are selected for the student to be tested on, and a record of their response to each situation is used for grading their proficiency. This section describes the actions and events within one such sample scenario to illustrate the workings of an ERAM controller's tasks.

A. Sample Scenario

The scenario has a total of 26 aircraft, and tests users on events including point outs, arrivals, departures and conflict alerts. The scenario lasts for 45 minutes, and has events occurring at random intervals in that timeframe, thus requiring the controllers to be alert and focused throughout the period.

At the 5-minute mark, an aircraft that is currently in a high sector right above the trainee's sector of control calls in, requesting a lower altitude. The controller must verify that there would be no conflict with traffic under their control and appropriately accept or reject the request. A minute later, there are two events that need to be coordinated simultaneously – a departure from one airport and an arrival into another. The trainee is required to assess which one to respond to first and ensure that clearances are issued after the traffic situation has been assessed. Three minutes after this event, there is a red alert between two aircraft. A red alert occurs when there is an aircraft to aircraft conflict, with a separation of less than five miles or one thousand feet. This is considered an emergency, and the trainee must change the altitude or heading of one or both flights to increase separation, without letting the aircraft come into conflict with any other flights in the area. A minute after this, there is a yellow alert between two other aircraft, which occurs when separation is greater than five miles, but still within the detection range (five to twelve miles). This requires similar rerouting action on the controller's part so that no red alert is triggered. The scenario continues with another arrival three minutes after the yellow alert, then another request for a lower altitude from a high sector, two more arrivals, two departures and a red alert and a yellow alert. Twenty-six minutes into the scenario, an aircraft is identified as coming into the sector with an IAFDOF. The general rule is that all aircraft flying east must do so at odd levels of altitude, and those heading west should fly at even altitudes. The IAFDOF requires the controller to update the altitude or give clearance to continue on the inappropriate altitude in case of possible conflicting traffic before the aircraft can be accepted into their sector. The scenario ends with two more departures, two arrivals, two alerts and another IAFDOF over the rest of the allotted time.

Point outs are key elements of this scenario that need to be taken when an aircraft is entering the sector (Take Pointout), and made when an aircraft is leaving the sector and entering another one (Make Pointout). The issuance of clearances and ability to recognize an IAFDOF is also tested several times in the scenario. The trainee must be able to handle conflict alerts and resolve them to maintain separation within their sector at all times.

VI. ATC Scenario Exploration with ASDL

A Domain-Specific Language (DSL) is generally a programming language with limited expressions which aims to model a particular domain. An aviation-specific DSL called the Aviation Scenario Definition Language (ASDL) has been proposed to model scenarios within the aviation domain. [14] ASDL has been designed using a scenario-based development process from a Model-Driven Engineering (MDE) perspective. [15] ASDL's conceptual metamodel (expressing syntax and entities relationships) allows users to define three different kinds of scenarios: departure, en route and landing. ASDL also models entities such as pilots, airports, runways, control towers, flight properties, weather patterns and aircraft. This metamodel has been integrated with the Base Object Model (BOM) entities of interplays, state machines and events to describe a flight scenario. [16]

This original design of ASDL was able to model a flight from departure to landing with respect to major flight events as well as clearance deliveries. However, not much coordination or communication with ARTCCs was included within the first iteration. The model had to be extended in order to explore scenarios from an ATC perspective. The extension included: (1) addition of en route terms to the ASDL ontology [17], and (2) addition of model entities corresponding to newer concepts to the ASDL metamodel.

The ATC terms added to the ontology were divided into three categories: Actions, Entities and Events. Actions are responses to the Events, and are performed by or through the use of one or more entities. Entities are objects or beings present in the physical world that interact with each other and are modeled within the scenario. Events are triggered proceedings that occur either with time – for instance, departures or arrivals, or when favorable conditions exist – for instance, yellow alert when separation between any two aircraft is between five to twelve miles.

The entities, events and actions described in the sample scenario can be seen in the ASDL Ontology, written in Web Ontology Language (OWL). All these elements can be found in Fig. 4. Entities are on the left and include the ARTCC (Center), Aircraft, Airport, Airspace, Controller and Weather. Some of these are broken down further, and an explanation of each term can be found in Table 1. Only those terms that relate directly to en route control have been defined, as entities such as an aircraft and airport have already been defined in other works on ASDL. [14] [18] Events can be seen in the middle of the figure and include arrivals, departures, holding, IAFDOF and the various alerts. A description of each of these terms is also available in the table. Actions are shown on the right side of the figure and are performed by the controller entity. Some examples of actions are: making point outs, handoff, route changes and responding to requests. A description of these can also be found in Table 1.

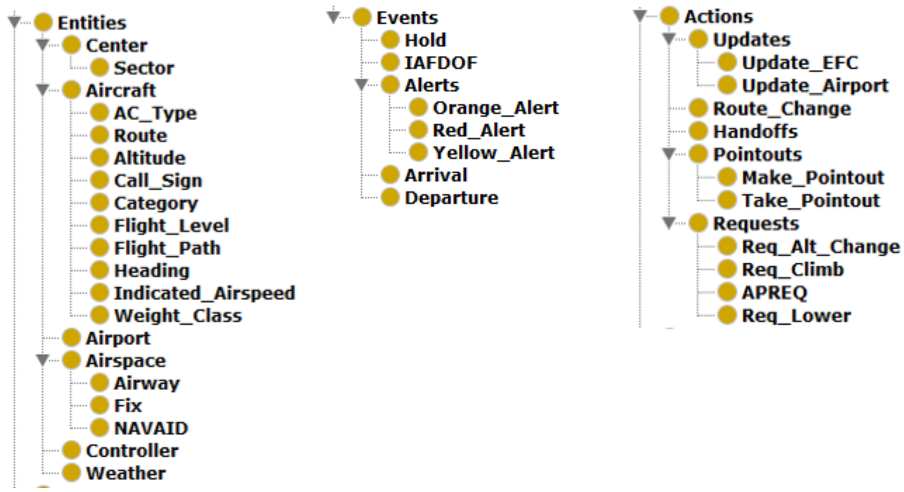

Fig. 4 Elements added to En Route Ontology

Table 1 Definition of elements added to the En Route Ontology

Type	Element	Definition
Entities	Center	Air Route Traffic Control Center, or ARTCC
	Sector	A sector within the ARTCC
	Airspace	The collection of all space available for aircraft to fly within.
	Airway	A Class E airspace area established in the form of a corridor, the centerline of which is defined by radio navigational aids.
	Fix	The geographical position determined by visual reference to the surface, by reference to one or more radio NAVAIDs, by celestial plotting, or by another navigational device.
	NAVAID	Any visual or electronic device airborne or on the surface which provides point-to-point guidance information or position data to aircraft in flight.
	Controller	A person authorized to provide air traffic control services.
Events	Hold	A predetermined maneuver which keeps aircraft within a specified airspace while awaiting further clearance from air traffic control.
	IAFDOF	Inappropriate Altitude for Direction of Flight.
	Alerts	A notification that the controller must pay attention to an event, usually relating to separation of aircraft.
	Orange_Alert	Aircraft to airspace conflict.
	Red_Alert	Aircraft to aircraft conflict. Occurs when separation is less than standard separation (5 miles/1000 feet).
	Yellow_Alert	Aircraft to aircraft conflict. Occurs when separation is greater than standard separation (5 miles), but within detection range (5-12 miles).
	Arrival	The act of an aircraft touching down.
	Departure	The act of an aircraft becoming airborne.
Actions	Updates	Any changes made by the controller to an aircraft's flight characteristics.
	Update_EFC	An update to a prior "Expect Further Clearance" message.
	Update_Airport	An update to an airport (usually arrival) due to unfavorable circumstances.
	Route_Change	A change to the route, either by request or prompted by the controller due to weather, separation or other circumstances.
	Handoffs	The act of transferring radar and radio control of an aircraft to another sector.
	Pointouts	An action taken by a controller to transfer the radar identification of an aircraft to another controller if the aircraft will or may enter the airspace or of another controller and radio communications will not be transferred.
	Make_Pointout	The act of making a point out to another controller.

	Take_Pointout	The act of receiving a pointout from another controller.
	Requests	Any request made by a pilot or a controller which requires the approval of a Controller.
	Req_Alt_Change	A request for an altitude change that needs to be approved or rejected based on traffic conditions.
	Req_Climb	A request for a change to higher altitude that needs to be approved or rejected based on traffic conditions.
	APREQ	An approval request, usually between two controllers, that asks for something unusual or unnatural to be allowed, such as an aircraft travelling in an IAFDOF.
	Req_Lower	A request for a change to lower altitude that needs to be approved or rejected based on traffic conditions.

Once these additional elements were added to the ASDL Ontology, ATC training scenarios could be described using the tool. This process has been described for the sample scenario in the following section.

VII. Formal Scenario Specification and Verification with ASDL

ASDL can be used to define all entities, attributes, and relationships needed to specify a complete flight scenario. [14] The ASDL tool suite has been created in three stages, as can be seen in Fig. 5. First, the conceptual scenario metamodel is built using Ecore in Eclipse to be used as a baseline for all scenarios. This metamodel has been built using the ATC ontology, which has been discussed in Section VI, and includes all the keywords and concepts that define an ATC scenario. In the second step, the metamodel is used to create an Ecore model of a specific scenario. This model does not need to be designed and implemented in Ecore directly, but is rather created using the ASDL Graphical User Interface (GUI), which gives users the option to select specific scenario elements from a menu. This allows the user to work directly with the tool, without needing to understand the background code involved. At the deployment stage, the information entered within the scenario model is automatically converted into a standard scenario script, in eXtensible Markup Language (XML) format. This XML script can then be utilized by end users to execute the scenario in their target simulator.

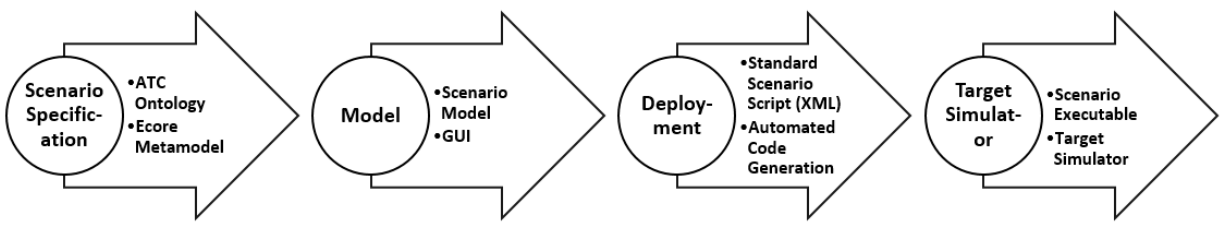

Fig. 5 Development process for ASDL scenario generator

In order to ensure that a generated scenario can be executed, it needs to be verified for correctness. Formal verification is the application of formal or mathematical methods to perform the verification of a system. This can be done in several ways by using, 1) exhaustive exploration (model checking), 2) experiments with a restrictive set of scenarios in the model (simulation), or 3) experiments with a restrictive set of scenarios in the real world (testing). [19] ASDL handles verification by using formal methods to describe allowed events within a scenario.

The logic of scenarios is captured in the form of statecharts, where a state is used to describe the behavior of a system at a given time, and a transition shows the action that enables the change in state of the system. For flight scenarios, this formal verification of ASDL has been explored in other works. [14] The same principle can be used to verify ATC scenarios, where all events and actions needed to be taken for the event are captured in statecharts. This allows room for scenario exploration, as various elements can be added to test different skills of trainees, and can be used to generate scenarios easily as long as the rules are followed. Implementation of ASDL involves a model-checker being invoked before the XML script is generated, so that any errors in definition can be handled before the script has been obtained or is attempted to be executed. ASDL has a GUI which allows elements to be added to a scenario as required, without needing the model to be coded using Ecore or Eclipse. This GUI thus functions as an assistant in creating new executable scenarios, as these do not need to be checked before being defined but can be verified before the executable scenario is created. This gives course instructors the ability to expand the scenarios they provide to students for training, as they can modify small aspects of existing scenarios, or create new ones completely without having to manually run the scenario through and then sitting down with a developer to code it.

A snippet of an XML scenario script can be seen in Fig. 6. This script corresponds to the scenario described in Section VI, and the snippet shows the number of aircraft in the scenario, the airspace it is involved in, and the start and end times. Weather conditions are listed as entered, followed by any prompts and then aircraft information.


```xml
<?xml version="1.0" encoding="UTF-8"?>
<scenario>
    <syntax_version>5</syntax_version>
    <isim_version>2.2.0.2316</isim_version>
    <name>ERAM 3</name>
    <description>26 AIRCRAFT, CBM COLD, R931 COLD, R357 COLD, VFR</description>
    <start_time>01:00:00</start_time>
    <stop_time>02:30:00</stop_time>
    <external_airspace>MasterZAE_NewBJ.xml</external_airspace>
    <wind>
    <wind_position>
        <id>CENTER</id>
        <position>400000N/0850000W</position>
        <wind_level>
        <altitude>0</altitude>
        <from>360</from>
        <temperature>0</temperature>
        <speed>0</speed>
        </wind_level>
    </wind_position>
    </wind>
    <prompt>
    <time>01:06:05</time>
    <acid>N5334D</acid>
    <active>1</active>
    <pending>0</pending>
    <action>General Text</action>
    <text>REQUEST VISUAL APPROACH GWO</text>
    </prompt>
```


Fig. 6 Snippet of XML script for sample scenario

Once the scenario begins, the aircraft are simulated as flying based on their flight data, and interact with the airspace and controller whenever an event is triggered, either based on time and pre-recorded data, or based on live environment scanning. Examples of the latter include yellow and red alerts, as well as hand-offs and point-outs when they have to be received from other sectors.

VIII. Conclusion

The new Center of Excellence for Technical Training and Human Performance initiatives established by the FAA has invested in simulation-based and part-task training projects. A survey of current FAA Academy courses showed that a lot of simulation-based training is done with the help of scenarios that are used to train and test one set of skills at a time. These scenarios are generated by technical experts after consultation with subject-matter-experts. This scenario-based training occurs in simulators owned and used by the Academy, and for en route training, requires the presence of four other people to play the role of the radar controller, supervisor, ghost controllers of other sectors and pilots.

A short overview of the importance of scenario-based training and their relevance to the ATC domain have been discussed in this paper. In order to allow for a more reasonable means of practice for trainees, a portable technology was proposed, which aims to make a lightweight tool that mimics the properties of an ERAM simulator, but is web-based and accessible on any device connected to the internet. Built on top of a domain-specific language called ASDL, such technology will allow users with administrative privileges to build and validate their own scenarios in order to increase the pool of scenarios that can be attempted. This project has just been launched and is still under development. The use of ASDL to create scenarios for ATC training has been discussed and an addition to the ontology and domain model to include such scenarios have been described here. The use of ASDL GUI to generate new scenarios has been explored, so that there is no need for both technical and subject-matter experts, but rather those familiar with the domain can create the scenarios themselves with the use of drag-and-drop options for scenario elements. Automatic generation of XML script of scenarios is supported by ASDL. As a future work, an XML schema will be developed and used to automatically grade these practice scenarios and provide feedback to trainees.

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