

Air Base Simulation Technology Focusing on Flow Capacity Solutions

Miloslav BAUER ^a

^a Col. Ing. GS. Miloslav BAUER, Ph.D. Head of Air Force Department; Faculty of Military Technology, University of Defence, Kounicova 65, 662 10 Brno, Czech Republic, miloslav.bauer@unob.cz

Abstract

Air Traffic Flow Management is fundamental subject to be solved within next several years by using a modern approach. The capacity of the airspace as well as workload of Air Traffic Controllers, are fundamental pillars of present Air traffic. To develop the possible solution how to deal with both environment mentioned above the aviation community is focusing more and more on the Information technology. As good results of experimentation, research by means of CASS (Connective Autonomous Surveillance System), inside Air Force department of University of Defence should be mentioned. By using this simulation tool we are able to present new ideas how to solve capacity of any military Air base. The main outcome of this article is proposal of the simulation tool by means of which users are able to check or solve specific area capacity for the traffic flow.

Key words: air traffic capacity, workload, airbase, information technology.

1. Introduction

The Air Traffic flow density is now a day influencing by the development of new sophisticated technologies inside aviation. Among these technologies, simulation environment is used as a training tool quite often. Recent capabilities of simulators and training equipments, their structure and composition allow to create almost real air situations for the flying conditions or operational personnel procedures. Some simulators are even able to prepare conditions, to which the personnel on the specific location will never be exposed [1].

This fact leads us to the consideration, that the same facility, with rich functionality, could be used also for air traffic flow capacities investigation.

2. ATC Simulation Environment

CASS environment should be used for all possible simulation concerning airspace sector capacity, airfield capacity and to simulate acceptable ATC workload. This ATC simulator system is working with generated radar data which are in connection with the system structure. So, airfield and flight plans data are presented as well. The simulator structure consists of:

- Working station
- Simulator airspace map subsystem
- Aircraft characteristic subsystem
- Exercise environment

CASS ATC simulator exercises are mainly oriented to train Air Traffic Controller community. But inside Air Force Department of University of Defence this tool was used as a research environment. By means of several simulation, the maximum workload of ATC in Airbase Čáslav was stated. The simulation scenarios for ground movement of the Air traffic and traffic over the Čáslav Airbase were created realistically.

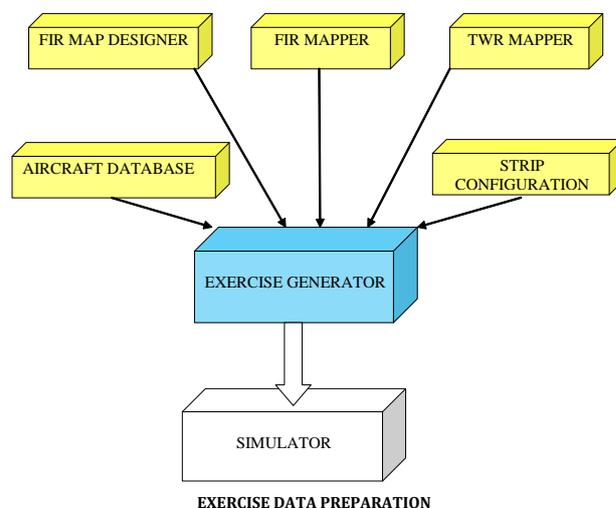


Fig. 1. Scheme of data preparation in CASS environment

Exercises can be focused generally on tasks of Air traffic control routine, or such was in our case, to the concrete conditions of a given ACC, APP and TWR environment.

These conditions were generated in order to overload the ATC positions.

The air traffic capacity environment is defined by five principal factors: Airspace/Sector capacity, Airbase/Airfield capacity, Application of air traffic procedures, Air traffic navigation technology and Air traffic controller workload. All factors are related to each other. So when we prepare simulation tool for air traffic capacity solution, we are obliged to think about all of them. These factors have different approaches from the civil or military point of view due to dissimilar kind of traffic. Moreover, mathematical and theoretical models are not flexible enough to prepare the necessary solution, mostly in the military human factor area [2].

3. Čáslav environment preparation

During the phase of experiment preparation it is necessary to work with the idea, that in many cases a cost-effective capacity testing platform may be found in modification of an existing simulation conditions. The aim of our experiment was to establish, by means of real air traffic conditions simulation, the maximal level of traffic flow around the specific airbase. This should be accomplished by applying all safety, flying and operational procedures of course.

To create simulation as close as possible to real traffic conditions, the meeting with the Čáslav Air traffic controllers was organised. Most of traffic items were then covered during these talks.

Preparation activities inside simulation were aiming on procedures dealing with knowledge systems. This platform is relating to infrastructure data and characteristics as well as to information about airspace and procedures inside specific areas to be flown.

CASS software is able to provide creation of: Airbase infrastructure, Airspace environment, Database of aircraft performances, Flying procedures in a specific part of airspace[3].

3.1. Airbase infrastructure

This simulation environment is working on basics of real Air Traffic conditions. It means real aviation procedures have to be applied. The creation of airbase infrastructure is for CASS tool provided by TWR Mapper system either for 2D or 3D picture. A map generated by the TWR Mapper can be considered as a grouping of junctions (points) and lines and corresponding relationships. The Airbase infrastructure is formed in accordance with data from Aeronautical Information Publication (AIP) for this specific airport and area. Example of the necessary airport features to create Airbase infrastructure is listed below:

Aerodrome reference point - Designated geographical location of an aerodrome given to the nearest second of lati-

tude and longitude. The ARP is located as near as is practical to the geometric centre of the landing area.

Runway and axis – long strip of land used by aircraft for taking off or landing and extended centreline.

Thresholds – the beginning and the end of the runway part which is suitable for aircraft landing and take off.

Taxiway – a paved strip on the airfield which aircraft use to move from the parking area to the end of runway.

Standpoints – parking area, shelters or apron- area where aircraft can be parked and tied down

Each of these characteristics has the precise geographical coordinate location which must be putting down to the TWR Mapper (Fig. 2).

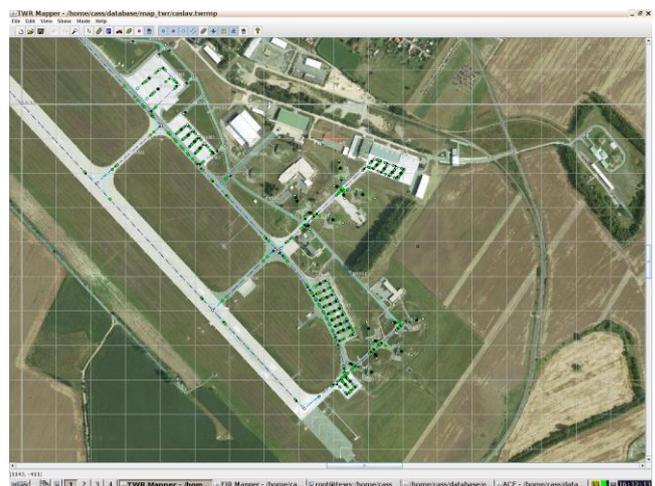


Fig. 2. Creation of Čáslav Airbase Infrastructure in CASS environment

3.2. Airspace environment

CASS simulator by means of FIR Mapper is able to provide necessary map characteristics for description of the airspace structure and procedures which have to be flown over the airfield area. Among these are for example geographical and radio navigation points, airports, runways, navigation routes, airspace areas (Fig.:3). Basic pillar for the production of the Airspace simulation are details about flying procedures following the real flying rules. These are mentioned in Aeronautical Navigation Service publications for specific areas. Example of them is listed below:

Standard Instrument Departures (SID) – a preplanned instrument flight rule, providing for the flight transition from terminal to the appropriate enroute airspace structure.

Standard Terminal Arrival Route (STAR) - a preplanned instrument flight rule, providing for the flight transition from the enroute structure to the specific approach area or waypoints close to airport of the flight destination.

Special use of Airspace – airspace of defined dimensions, wherein activities must be separate from other regular traffic. (CTR; TMA; TRA; Holding areas; etc.).

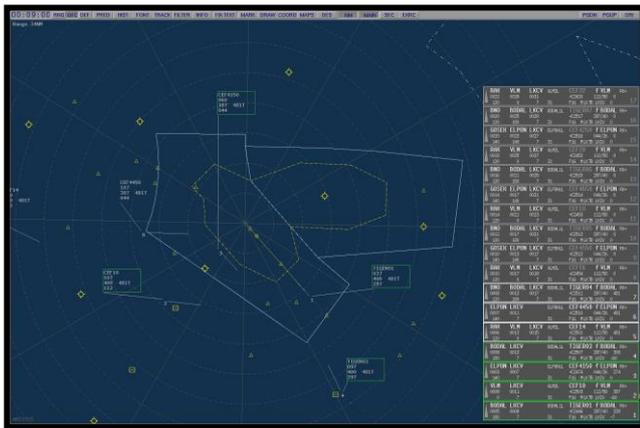


Fig. 3. Creation of Čáslav Airspace environment in CASS environment

3.3. Database of aircraft performances

This part of the ATC CASS Simulator is dealing with aircraft characteristics needed to be insert into Aircraft Database module. System has its own „Aircraft Library“ and is selected for the specific simulation scenario. For Čáslav, the aircraft already flew onto this environment were selected. Once when Aircraft flying data are inside “Library” with all requested performances, the simulator is able to modify flying characteristics in accordance with type of flight requested (Fig.:4). It means for example to change bank of turns and flight profile conditions for the specific area or flight of airliner military transport or multirole aircraft.

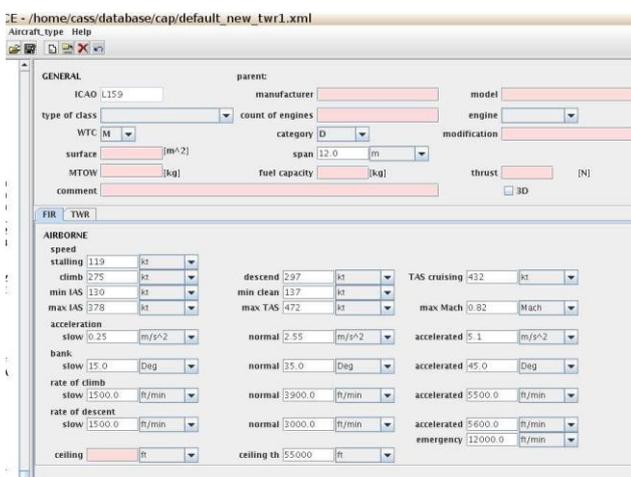


Fig. 4. Creation of Aircraft performances in CASS environment

3.4. Flying procedures in a specific part of airspace

Characteristics inserts into CASS ATC simulator sub-systems already mentioned are fundamental to prepare a flying scenario. During the exercise CASS generates the surveillance radar screen situation in specifically defined area of interest. Events are performed according to the prepared scenario and related to the airspace topology.

A unique flight system number is automatically assigned to each aircraft during the exercise and is displayed on the right edge of the pilot electronic strip. This system number simplify the Controller orientation on his working position. For the altitude of flights, aircraft can only achieve th altitude given by the ceiling in the aircraft performance database. All flying objects are allocated with specific SSR code. For the specific part of airspace aircraft are automatically (IAW flight plan) departed from selected airports. Each Aircraft can be pre-programmed as having different route and trajectory. Route is the planned route used for flight planning and FDP processing, trajectory is used for simulation and can be identical or deviate totally from route.

Simulator is able to prepare, as far as the traffic density concerns, some “overcrowded airspace” which leads to “Holding Patterns”(HP) creation. In that case pattern parameters are taken from the airspace topology. Procedures are referring to all holding aspects, like for real airspace conditions. That means the real procedures to enter or to leave HP has to be simulated.

As was already mentioned, even for taking off and landing situation the simulator follows real airspace structure, points and procedures. That is why Exercise generator is collecting relevant characteristics, data and procedure to propose for the simulator conditions which are as close as practicable to the real Air traffic conditions.

4. Capacity experimentation with Airbase environment

During the phase of experimentation works were done with the idea, that in many cases a cost-effective capacity testing platform may be found in modification of an existing simulation environment (Fig.:5). The aim of our experiment was to establish, by means of real air traffic conditions simulation, the maximal level of traffic flow inside the airbase environment.

The whole execution of the experiments confirmed, that the CASS ATC system is designed in a very user friendly way, allowing fast, intuitive and convenient work even in the most demanding requirements and operational tasks. The experiment preparation, execution and evaluation was easy, allowing to focus on the experiment target and not on handling the system, and having all tools required to meet the experiment target.



Fig. 5. Experimentation with Airbase Čáslav environment

5. Conclusion

Research activities inside Air Force Department of University of Defence proved that CASS ATC Simulator system operations were very realistic and close to the everyday ATC experience. The Airspace Flow Capacity solutions could be solving not only with mathematic formula and statistic calculation but by using ATC Simulator in the specific manner too [4]. In accordance with the opinion of Air Traffic Control agencies, theoretical and mathematical solutions are not good enough to prepare a relevant data close to reality. Beyond the real air traffic activities, only an experiment with the air traffic control simulation environment will give the most valuable data about procedures, human factor and technology. Another benefit from usage of the ATC CASS Simulator and its derivation is support of the theoretical education by the Air Traffic simulation in the field of aviation subjects, presented by Air Force Department personnel.

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