ATCOSIMA DISSEMINATION MEETING,
EUROCONTROL EXPERIMENTAL CENTER, JANUARY 30TH, 2020
BRÉTİGNY-SUR-ORGE, FRANCE

ATCOSIMA

DEVELOPMENT OF COMMON ATC SIMULATION TRAINING ASSESSMENT CRITERIA BASED ON FUTURE PAN EUROPEAN SINGLE-SKY TARGETS (ATCOSIMA): ATC RADAR SIMULATION RESULTS

University of Zagreb
Faculty of Transport and Traffic Sciences

ESKİŞEHİR TEKNİK ÜNİVERSİTESİ
HAVACILIK VE UZAY BİLİMLERİ FAKÜLTESİ

Technische Universität Braunschweig

TÜRKİYE ULUSAL AJANSI
Erasmus+
Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

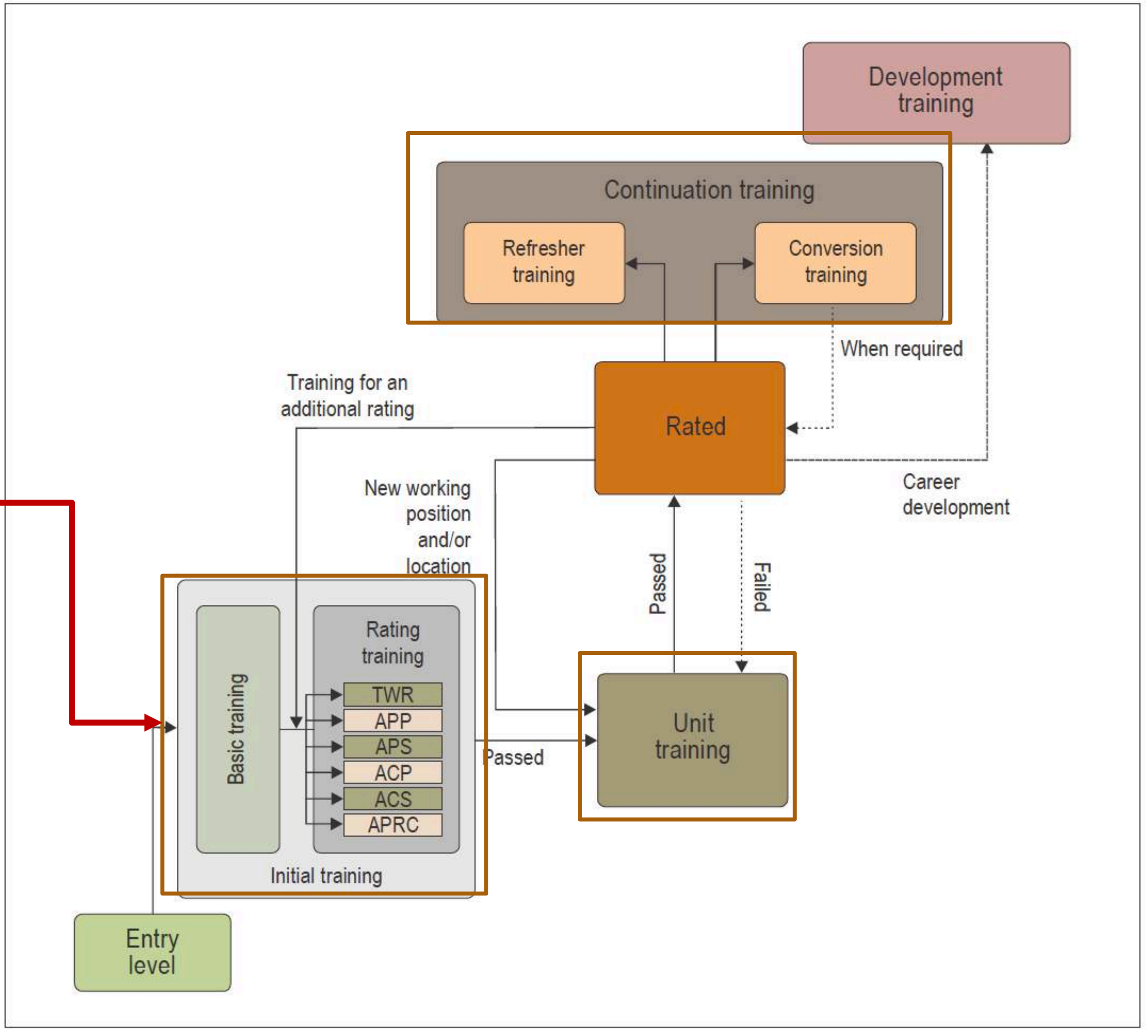
ATCOs:

- ✓ATCOs are responsible for:
  - ✓Maintaining safe, orderly and expeditious air traffic flow within the airspace
  - ✓Planning, monitoring, controlling, coordination, communication, aircraft conflict detection and resolution tasks
- ✓Their role switches dramatically from:
  - ✓ A labor-intensive one to a more technology-intensive one with increasing automation,
  - ✓ But they will remain as the key component of this integrated ATM system

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

ATCO Training*: Organization and Content

- ✓A combination of intensive theoretical and practical training
- ✓Consists of three phases: **Initial training**, **Unit training** and **Continuation training**
- ✓Initial training includes **basic training** and **generic rating training** stages to prepare ATCo candidates for next and more specific training stages at operational ATC facilities.
- ✓**Basic training** stage in the initial phase has a special importance:
  - ✓ Imparts fundamental knowledge through theoretical classes
  - ✓ Develops the required skills through practical classes using **ATC simulators**
  - ✓ The main elements of course, content and methods are defined within EUROCONTROL Common Core Content* and EU REG 2015/340 document**



Funded by the Erasm

*ICAO (2017), EUROCONTROL (2015), EASA (2015)

ATCO Training: Problems

- ✓The basic training practices differ in every country in terms of:
  - ✓ Study mode i.e.: vocational vs academic training
  - ✓ Training hours, frequencies and percent shares, number of exercises, depth and breadth of theoretical and practical parts
  - ✓ No commonly agreed framework for assessment criteria especially for the practical parts of ATCo basic training
- ✓Basic training documents:
  - ✓ No standard metrics and scoring for the assessment process especially for simulation training
  - ✓ Not address how to improve training and assessment to comply with SES targets regarding efficiency and economics of traffic flow.

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

Project Description

Funded by the Erasmus+ Program of the European Union within the KA2 Cooperation Innovation and the Exchange of Good Practices/KA203 Strategic Partnership for Higher Education.

✓The primary objectives of ATCOSIMA:

- ✓ Develop common assessment criteria for simulation training courses within the ATCo basic training in order to improve students' competencies regarding working effectively and in harmony within the integrated Pan-European air traffic system;
- ✓Improve metrics and scoring tools for the evaluations of students according to SESAR's future targets and provide guidelines and recommended practices for enhanced ATCo training across the Europe.

✓The project proposes an innovative approach to measure the performance of ATCo trainees in radar approach simulations based on integrated **ATC radar and flight cockpit** simulations.

Erasmus+

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

Expected Contributions

The development of the common assessment criteria:

✓shortened adaption times of new ATCos to operational environment,

✓reduced times and costs of advanced ATCo training at operational ATC facilities

✓ improved the overall quality of air traffic services for the airspace users in Europe.

✓increased the transparency and recognition of the skills, qualifications and competencies for learning, employment opportunities and labour mobility across Europe.

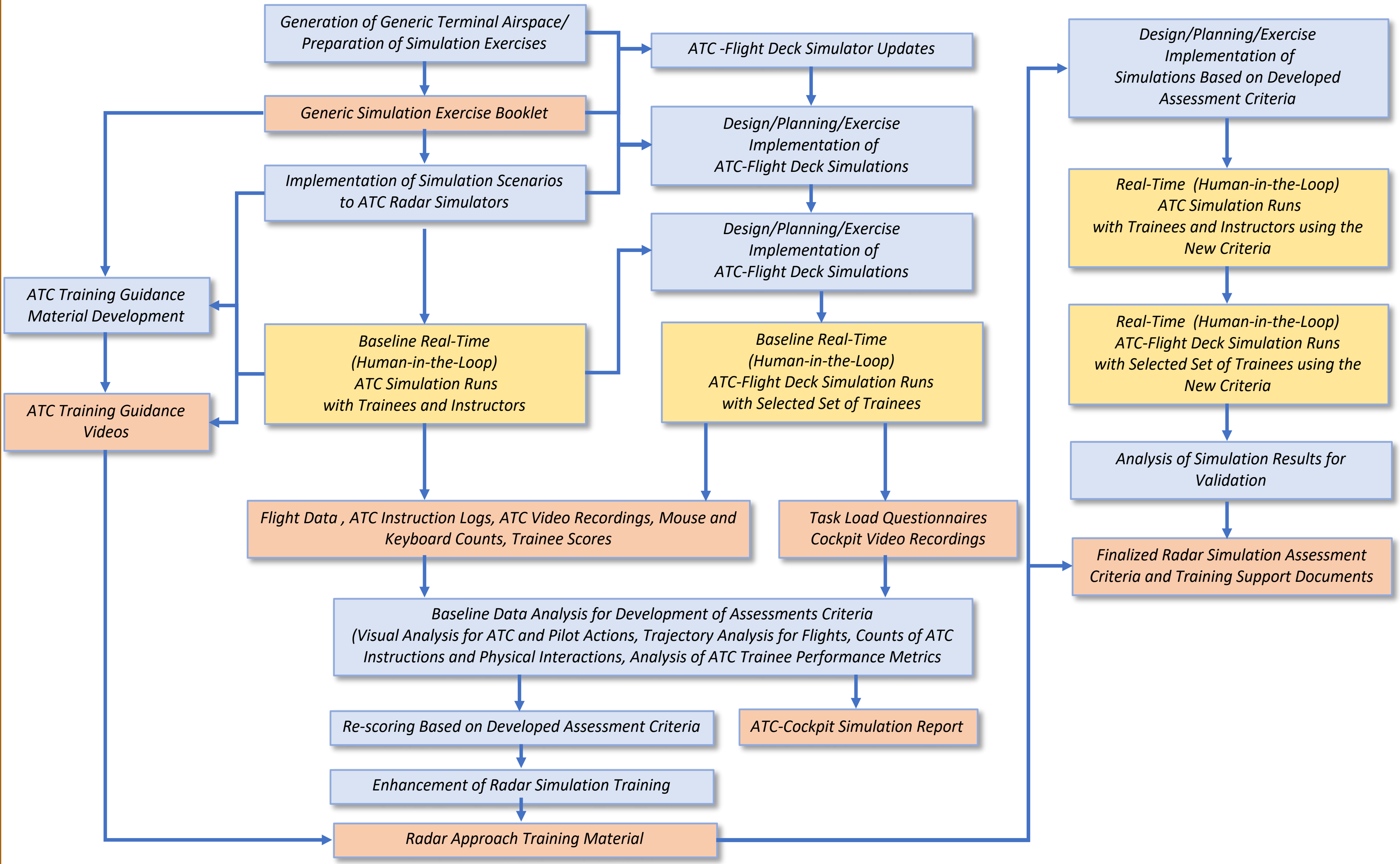
✓improved the level of coordination and harmony between ATCo's trained in different countries.

✓enhanced their skills required by the targeted integrated European ATM such that effective communication with pilots, recognition of pilot intentions, effective use of airspace and flight efficiency.

✓improved overall quality of ATCo training in the higher education across Europe through the promotion of common awareness of aviation safety and efficient and economic air traffic flow management concepts of future operations.

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

General Methodology



ATCOSIMA

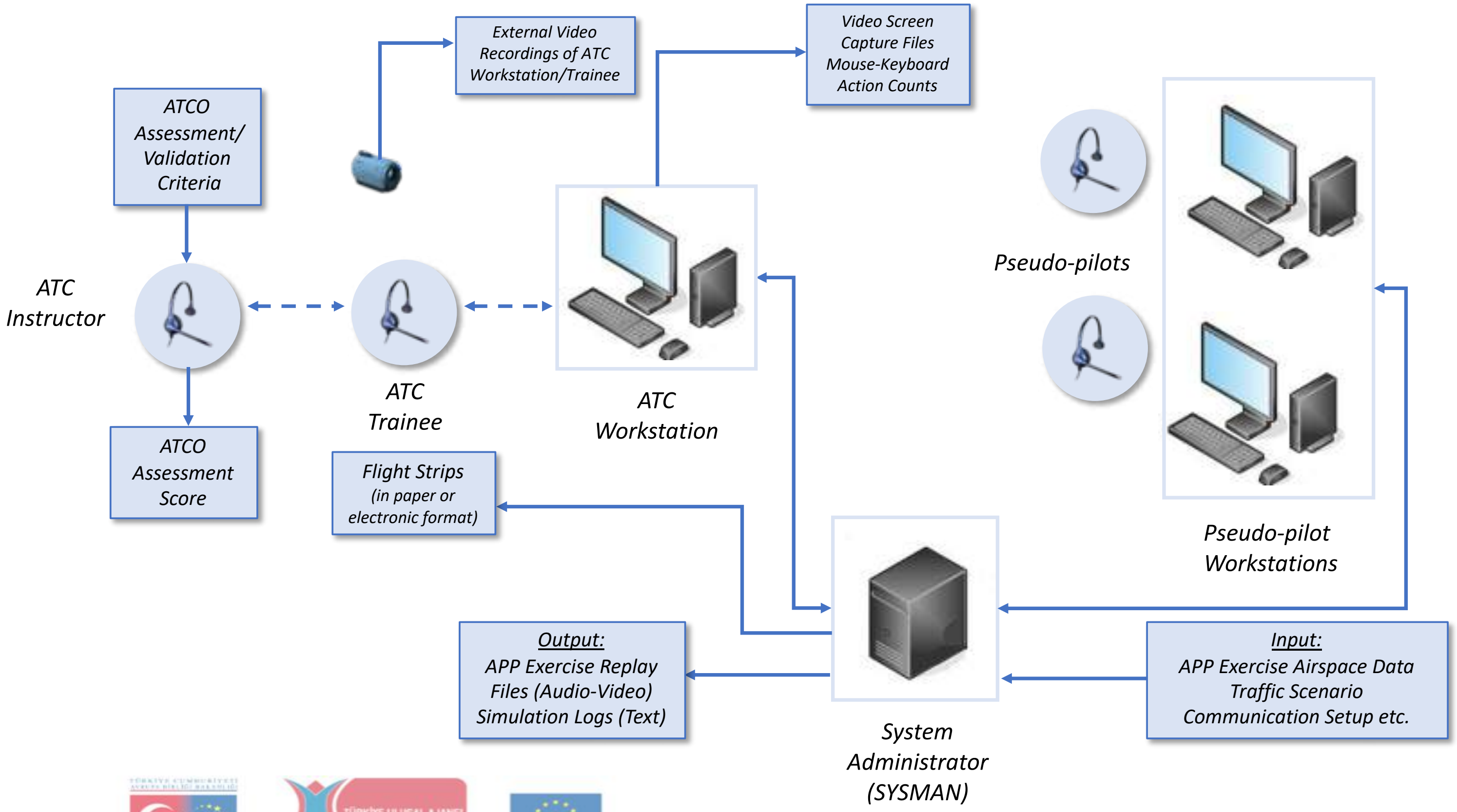
Simulations: So far…

- ✓ Simulation experiments have been done for the baseline analysis:
  - ✓ to evaluate performance of ATC trainees using current assessment criteria for the project's first and second stages
  - ✓ In two stages: ATC Radar Simulations and ATC Radar-Flight Deck Simulations
- ✓The first stage:
  - ✓ Done at ATC radar simulator of ESTU and ZFOT.
  - ✓ 19 ATCo trainees (14 from ZFOT and 5 from ESTU)
  - ✓ Under the supervision of 3 ATC instructors (2 from ZFOT and 1 from ESTU)
  - ✓ The trainees were selected among the enrolled students of ESTU or ZFOT
  - ✓ Required to pass radar approach control course before.
  - ✓ Each student run 10 exercises with increasing level of difficulty based on the traffic complexity.
  - ✓ The experiments were not interrupted
  - ✓ No guidance by the instructors except individual or group briefings and debriefings prior to or after the simulations.
- ✓ The second stage includes the integrated ATC radar and flight cockpit simulations at TUBS
  - ✓ 10 trainees (5 from ZFOT and 5 from ESTU)
  - ✓ A selected exercise (EXE009) were run for each trainee using the simulation setup.

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

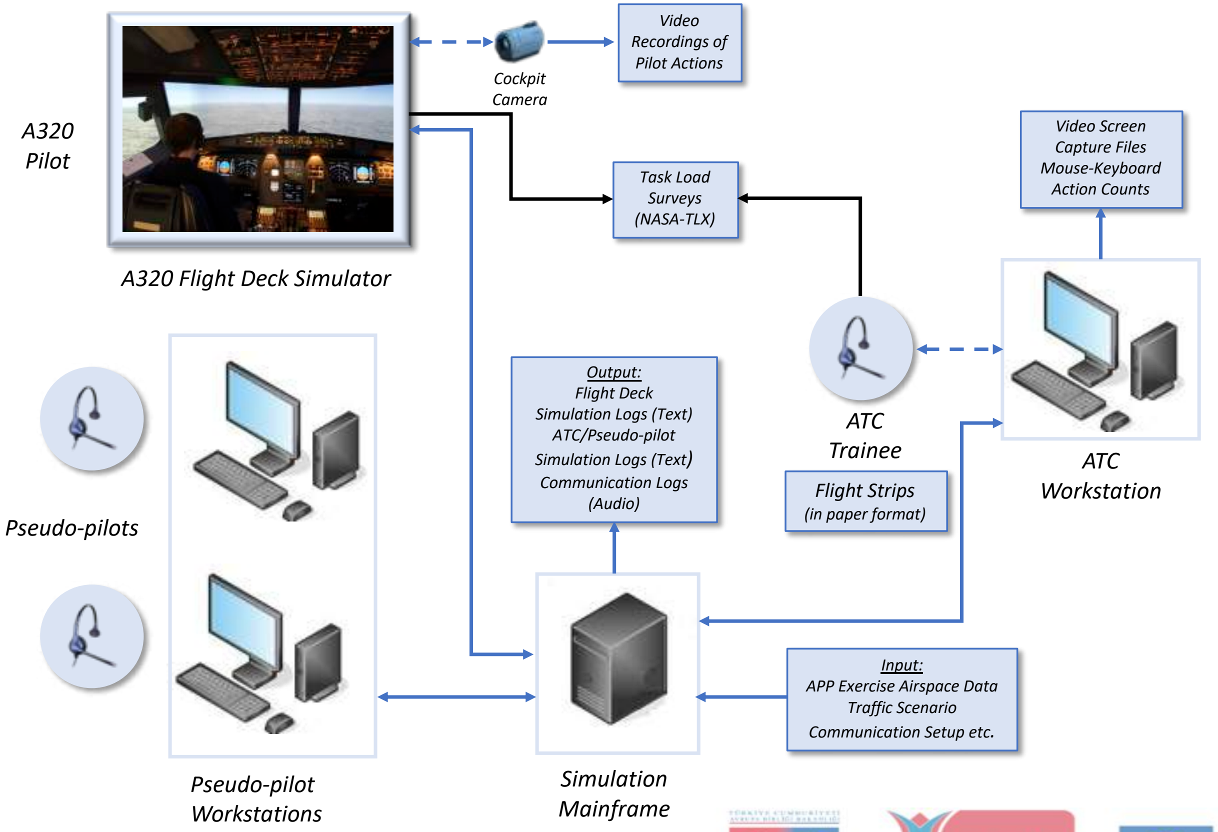
Simulations: 1st Stage-Baseline

ATC Radar Simulation Circuit and Data to be Collected



Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

Simulations: 2nd Stage-Baseline



Integrated ATC Radar-Flight cockpit Simulation Circuit and Data to be Collected

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

Simulations: Airspace

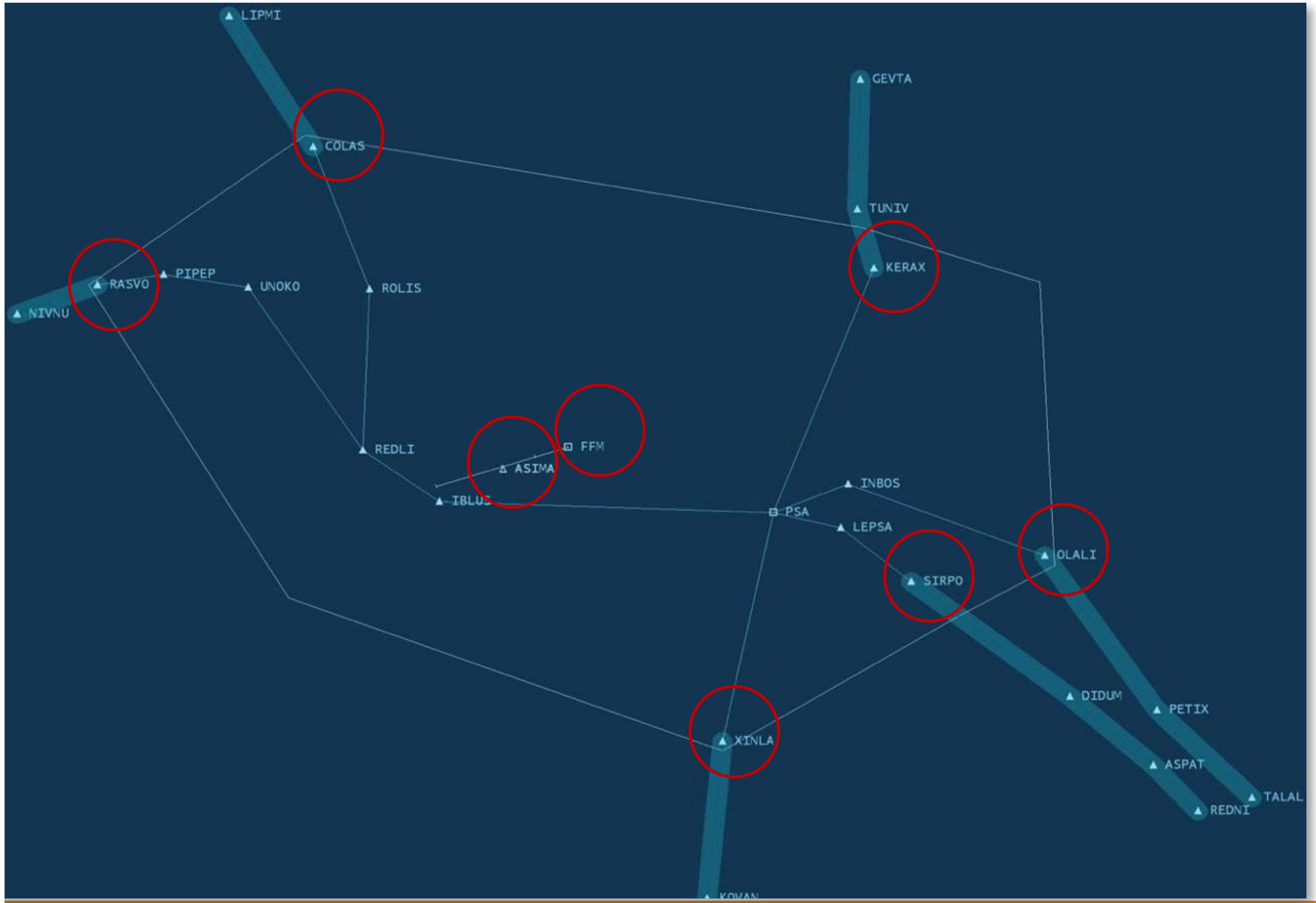
An airspace model was developed to be used in the generic exercises for simulations

- ✓based on Frankfurt TMA different from the airspaces used in ATC simulation courses at ESTU and ZFOT
- ✓ yet easy to adapt for trainees
- ✓large size and convex boundaries (a polygon ~146 NM x 82 NM)
- ✓relatively longer time window for trainees to plan and execute the necessary tasks
- ✓the difficulty of the exercises is due to **the traffic density** and **arrival/departure mixture** rather than **the airspace structure**.
  - ✓No prohibited or restricted areas
  - ✓Low Minimum Vectoring Altitude (MRVA) allowing continuous descent approaches (CDA)

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

Simulations: Airspace Features

- ✓Six STARs passing through six different entry points:
  - ✓ XINLA in the south,
  - ✓ SIPRO and OLALI in the southeast,
  - ✓ KERAX in the northeast,
  - ✓ COLAS in the northwest,
  - ✓ RASVO in the west
- ✓Arrivals should be established on ILS course before they reach to the ASIMA, hand-off point on ILS course and located 10 NM from FFM
- ✓ Transition altitude is selected as 5000 ft for all arriving aircraft within the TMA.
- ✓07C/25C is active only and both arrival and departures operations take place at runway 07 direction.
- ✓The flights are handed off to the relevant en route radar control unit (Langen North or Langen South) when they climb to FL250.
- ✓Separation Minima: 5 NM horizontally and 1000 ft vertically including final approach course.



ATCOSIMA

Simulations: Traffic Scenarios (Exercises)

	Number of Aircraft		Exercise Characteristics	
Exercise Number (EXE)	Arrival	Departure	Estimated Duration (min: sec)	Difficulty Level
001	5	0	23:30	1
002	6	2	25:30	2
003	6	3	24:30	3
004	6	4	26:00	4
005	7	3	27:00	4
006	7	4	27:30	6
007	8	3	28:00	8
008	8	4	30:00	9
009	9	3	31:00	9
010	9	4	30:00	8

- ✓10 exercises prepared for radar approach control simulations with increasing difficulty
- ✓The first exercises are designed to familiarize trainees with the TMA and hot spots as well as allow them to practice basic radar vectoring techniques
- ✓The last exercises require advanced decision-making skills regarding effective and timely use of vectoring, airspeed adjustments and flight level change for conflict resolution and arrival sequencing.
- ✓The difficulty level depends on:
  - ✓ Number of aircraft in the exercise
  - ✓ Mix of departures and arrivals
  - ✓ Initial separation (or interarrival time) between successive departures
  - ✓ Initial distances of arrivals from the ILS course

Erasmus+
Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

ATC Radar Simulations: 1st Stage-Baseline

- ✓Simulation experiments have been conducted in two parallel groups at ESTU and ZFOT between February-April 2018.
- ✓Both partners use MicroNav BEST ATC Radar Simulators
- ✓The systems consist of ATCo and pseudo-pilot controller workstations.
- ✓Trainees used printed flight strips to note all clearances and instructions given to aircraft during the simulations.
- ✓The following data sets have been collected during the exercises:
  - ✓ Exercise replay files and exercises logs
  - ✓ Video screen capture files from ATCo workstation
  - ✓ Replay files were used by instructors to assess the trainees' performance based on ATCO assessment validation criteria
  - ✓ Flight trajectory metrics (i.e. arrival sequence, distance flown by each aircraft, exercise duration and aircraft spacing on the ILS course
- ✓the number of instructions (i.e. flight level, heading and speed) given by trainees in each exercise and the number of tasks (i.e. distance and heading measurements and relocating aircraft labels) were detected.

ZFOT

ESTU

Funded by the Erasmus+ Program of the European Union. However, European Commi
responsible for any use which may be made of the informa

ATC Radar Simulations (1st Stage-Baseline): *Descriptive Statistics of Trainees*

ATCOSIMA

Category	**Variables**	**N**	**Min.**	**Max.**	**Mean**	**Std. Dev.**
Flight and Traffic Performance	Average aircraft spacing on the ILS course	10	7.1	8.3	7.8	.38
	Average exercise duration	10	33.5	38.4	36.1	1.49
	Average of total distance flown	10	78.3	96.5	86.7	6.48
ATCo Instructions	Total flight level instructions	10	32	52	40.4	5.91
	Total heading instructions	10	24	52	34	9.10
	Total speed instructions	10	5	35	20.3	11.36
ATCo Actions	Distance measurement between aircraft	10	5	38	14.6	9.05
	Distance measurement between aircraft and ILS course	10	0	22	11.6	6.38
	Heading measurement	10	4	52	22.3	18.76
	Relocating aircraft labels	10	33	99	60.6	24.68
	Assessment score	10	70.00	100.00	92.00	8.35

Türkiye Ulusal Ajansı
Turkish National Agency
Erasmus+
Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

ATCOSIMA

ATC Radar Simulations (1st Stage-Baseline): *Correlation Analysis*

Variable Pairs	Sig.	Pearson correlation (r) /Spearman's rho
Average exercise duration * Total speed instructions	.038	.660*
Average exercise duration * Heading measurement	.007	-.790**
Average of total distance flown * Total flight level instructions	.029	.685*
Total flight level instructions * Total speed instructions	.002	-.853**
Average of total distance flown * Heading measurement	.001	.852**
Total flight level instructions * Total heading instructions	.004	820**
Total flight level instructions * Total speed instructions	.036	-.665*
Total flight level instructions * Heading measurement	.004	.811**
Total heading instructions * Heading measurement	.003	.826**
Total speed instructions * Heading measurement	.001	-868**

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
All other comparisons were non-significant.

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

ATC Radar Simulations (1st Stage-Baseline): *Average Fuel Consumption vs Instructions per flight*

- *The averages of the 10 trainees were analyzed first to find the general performance of the main trainee group for all exercises.*
- *The total of 71 arriving flight are investigated in terms of average number of instructions received and average fuel consumed for all exercises done by all trainees.*
- *Based on the results of analysis, a linear regression model is constructed between fuel consumption of each flight and number of the instructions given by trainees.*

$$FUEL\ (kg) = 109.9 \cdot HDG + 108.0 \cdot FL + 93.2 \cdot SPD - 373.5$$

(R^2=63.9%)

$$FLIGHT\ DISTANCE\ (nm) = 10.1 \cdot HDG + 11.7 \cdot FL - .69 \cdot SPD - 1.12$$

(R^2=62.7%)

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

ATCOSIMA

ATC Radar Simulations (1st Stage-Baseline):

Correlation Analysis: Fuel Consumption and other variables

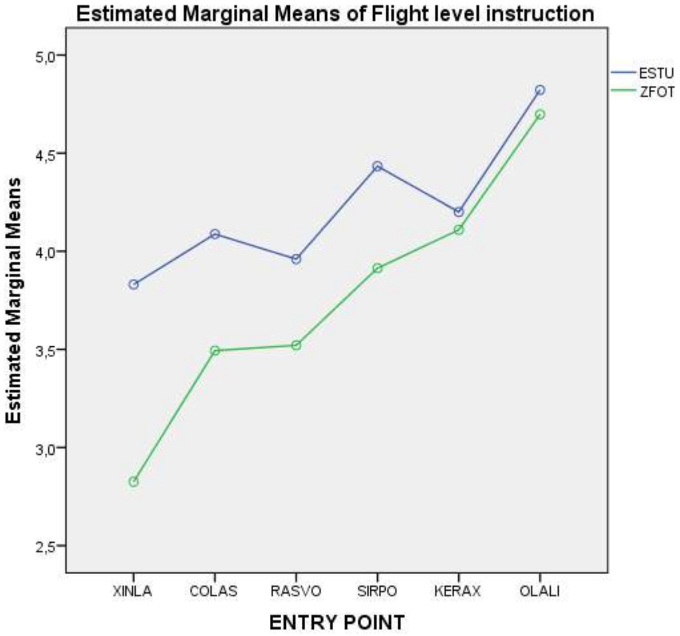
	FUEL	FL	HDG	SPD	Position Shifting	Spacing in ILS Course	Flight Distance
FUEL		.657**	.686**	.170	.128	.482**	.786**
FL	.657**		.577**	-.033	-.125	.520**	.686**
HDG	.686**	.577**		-.152	-.059	.283*	.718**
SPD	.170	-.033	-.152		.139	-.016	-.106
Position Shifting	.128	-.125	-0.59	.139		.344**	-.149
Spacing in ILS Course	.482**	.520**	-.283*	-.016	.344**		.356**
Flight Distance	.786**	.686**	.718**	-.106	-.149	.356**	

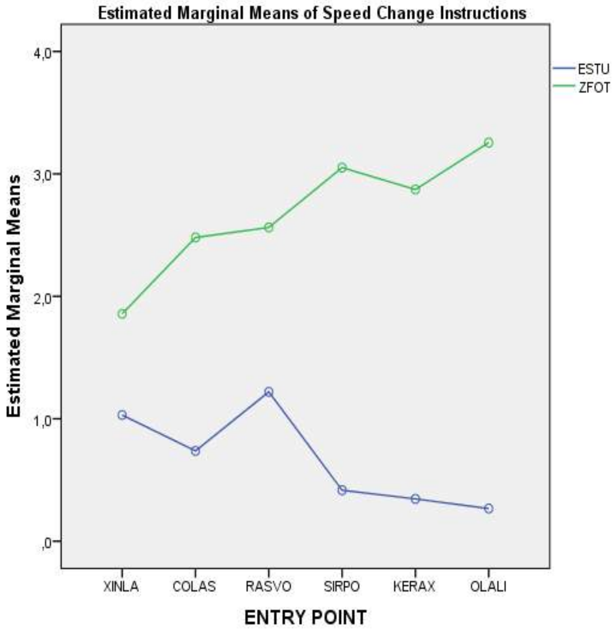
**Correlation is significant at the 0.01 level (2-tailed)

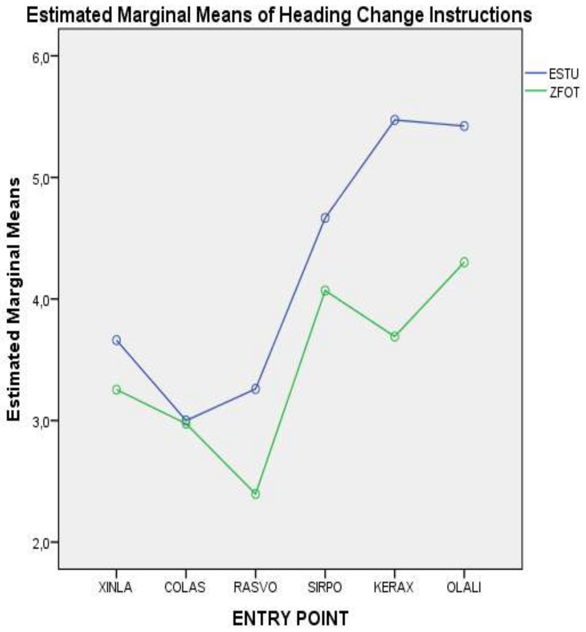
* Correlation is significant at the 0.05 level (2-tailed)

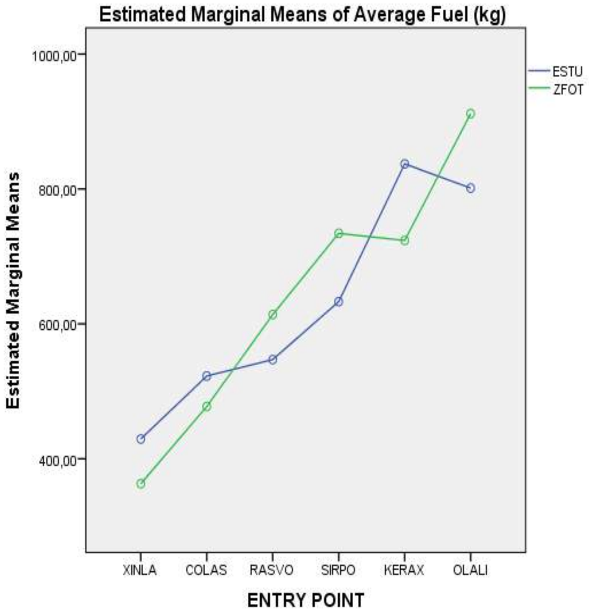
ATC Radar Simulations (1st Stage-Baseline):

Effect of Airspace Structure and Comparison of Groups









Distance to ILS Course

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

Conclusions for 1st Stage-Baseline

✓Preliminary results of ATC radar simulation show a **significant difference among the trainees' approaches** to handle arriving traffic in terms of the number of instructions.

✓Observed moderate **positive relationship** between **exercise duration and average aircraft spacing** on the ILS course indicates that effective use of radar vectoring techniques can increase service throughput.

✓ Therefore, **arrival separation management on the ILS course** can be one of the possible developments in the new assessment criteria.

✓Trainees can be encouraged to use alternative techniques depending on the traffic complexity but still more extensive analyses are required over the larger set of data to determine efficient combination of different instructions.

✓ Similar analyses will be done for all ATC radar exercises and traffic complexity metrics such as number of aircraft, arrival-departure mix, conflict encounter geometries and time separation between departing aircraft will be considered

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

Project Progress and Outcomes: So Far

- ✓The baseline analysis tasks of ATCOSIMA have been completed and Generic Simulation Exercise Booklet including scenario details as well as simulation files and setups for ATC and integrated ATC-Flight cockpit Simulations were prepared.
- ✓In addition to these intellectual outcomes, baseline assessment validation criteria were adopted and instructive ATC training guidance videos were produced in order to be used as the inputs of the next steps of the projects.
- ✓A vast amount of data set was also collected for the further analysis regarding ATCo performance, flight efficiency and pilot task load and acceptance.
- ✓These outcomes will not only support the development of new ATC radar simulation assessment criteria but also provide a framework and database of other studies to be done in the future..

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

PLEASE FOLLOW US ON:

www.atcosima.org

atcosima_erasmusplus

ATCOSIMA ERASMUSPLUS

ATCOSIMA_ERASMUS+ @ATCOSIMA_Eplus

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

Recently Completed Research Projects (ESTU)

A Multi-objective Mixed Nonlinear Integer Programming Model for Arrival Sequencing

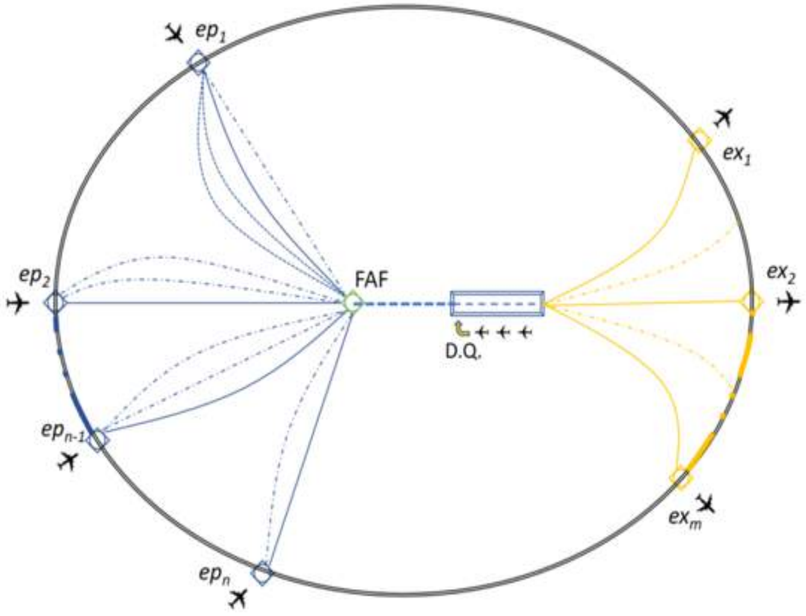


Figure 1. TMA configuration with a single runway

Objectives:
Total Minimum Fuel Consumption and Total Minimum Delay in the air and on the ground

Different queue disciplines were implemented for Istanbul Sabiha Gokcen Airport (LTFJ)

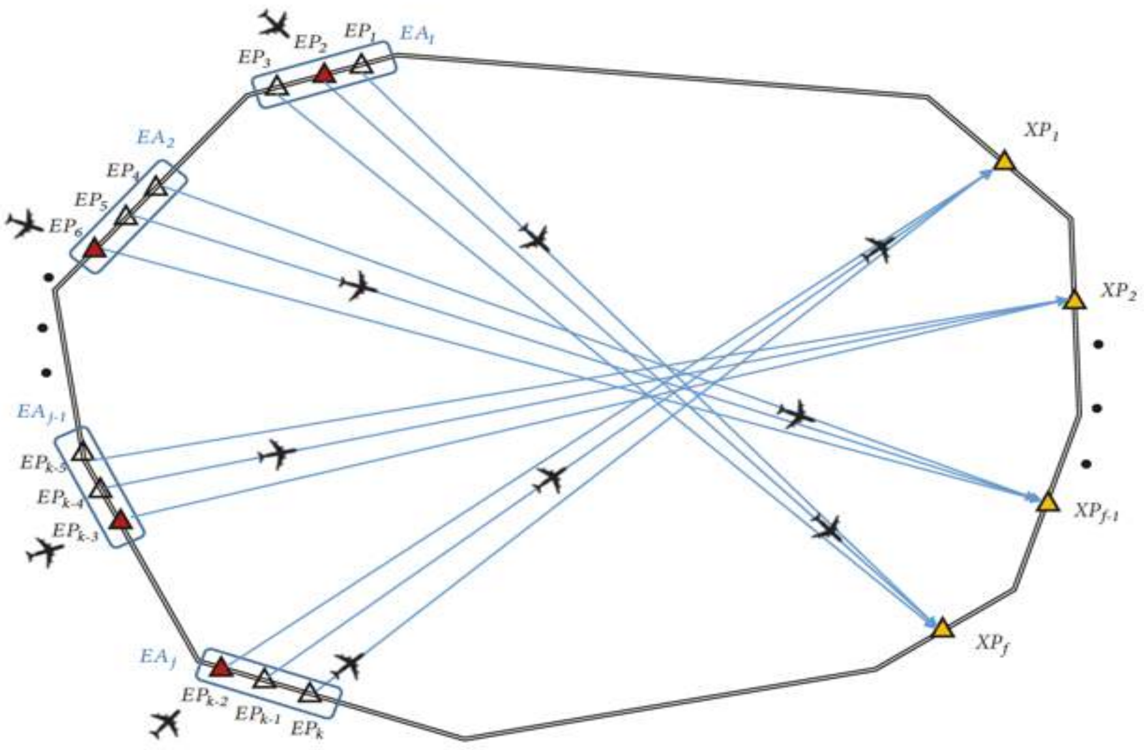
Ɛ-constraint method is implemented to handle nonlinear vectoring manuevers

Erasmus+

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

Recently Completed Research Projects (ESTU)

A Two-Step Model for Air Traffic Flow Delay Minimization using Pre-tactical Conflict Resolution in Free-Route Airspace



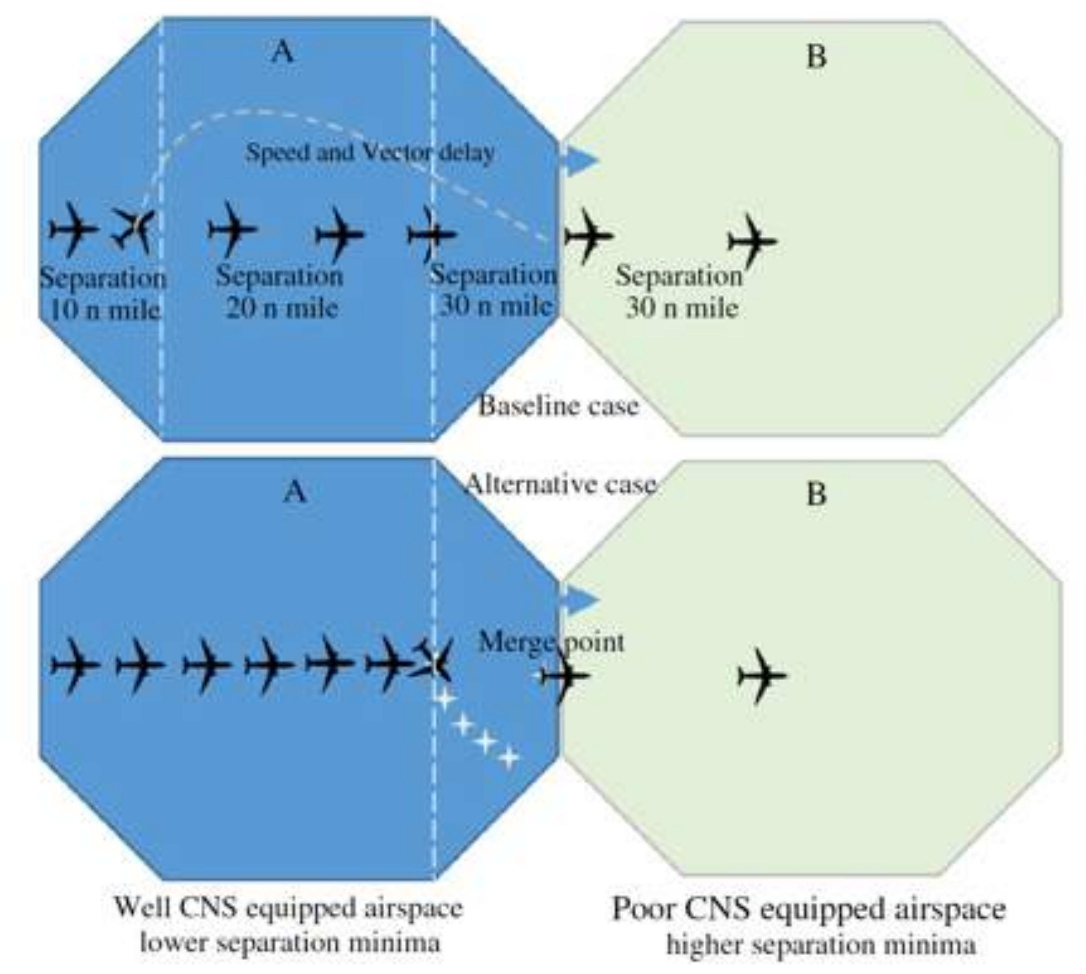
First Step:
A MILP model with GA and TS metaheuristics aims to minimize total airborne delays due to CR using MEP assignment and heading change resolution

Second Step:
A NLP model to minimize fuel consumption for the required heading change resolutions

Erasmus+
Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

Recently Completed Research Projects (ESTU)

Point-Merge Concept for En Route Air Traffic Flow Management

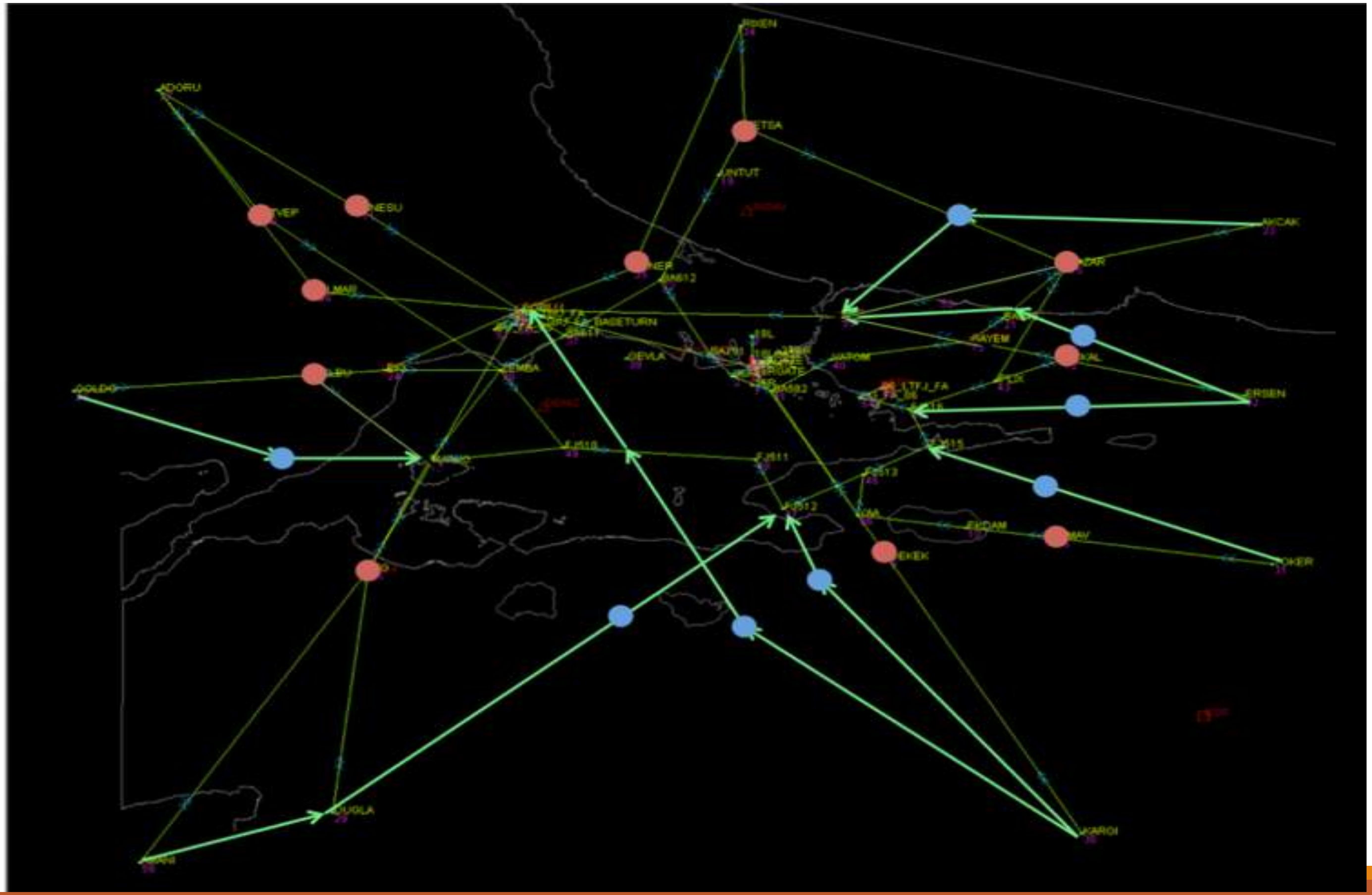


The study develops and analyzes a separation algorithm using point merge method at area traffic control as an airborne delay strategy

:rasmus+
ɪn and Turkish National Agency cannot be held
ɪ contained therein

Recently Completed Research Projects (ESTU)

A simulation model for Dynamic Entry Point Assignment in TMAs



On-going Projects

1. A Machine Learning based Decision Support System for Enhanced Air Traffic Flow

2. Determination of Aircraft Cruise Performance Parameters using QAR Flight Data

3. Conflict Resolution with Dynamic Intermediate Points Assignment in Free Route Airspace

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein