KTE Légiközlekedési Tagozat

A mesterséges intelligencia bevezetésének lehetőségei a légiközlekedésben – Elemzés az AISA és AWARE projekteken keresztül

DR. GURÁLY ROLAND

SLOT CONSULTING

2025. JANUÁR 30.

Tartalom

AI és Irányítás

AISA projekt

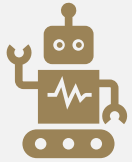
AWARE projekt

Légiforgalmi irányítás és AI: probléma és megoldás

Introduction – AI in general

Acceleration of technological development

Automation is everywhere



Emergence of artificial intelligence

AI vs traditional automation

	Uncertainty	Creativity
Traditional automation	NO	NO
Human being	YES	YES
Artificial intelligence	YES, but decreasing	YES, and increasing

Source: own work in AISA D2.2

Core AI domains

Reasoning	data transformation into knowledge
Planning	designing organised set of actions
Learning	Machine learning (ML): capability of the systems to automatically learn
Communication	Natural Language Processing: to identify, process, understand and/or generate information
Perception	computer vision and audio processing: ability of the system to become aware of their environment through the senses

Source: own creation on the basis of AI watch

Transversal AI domains

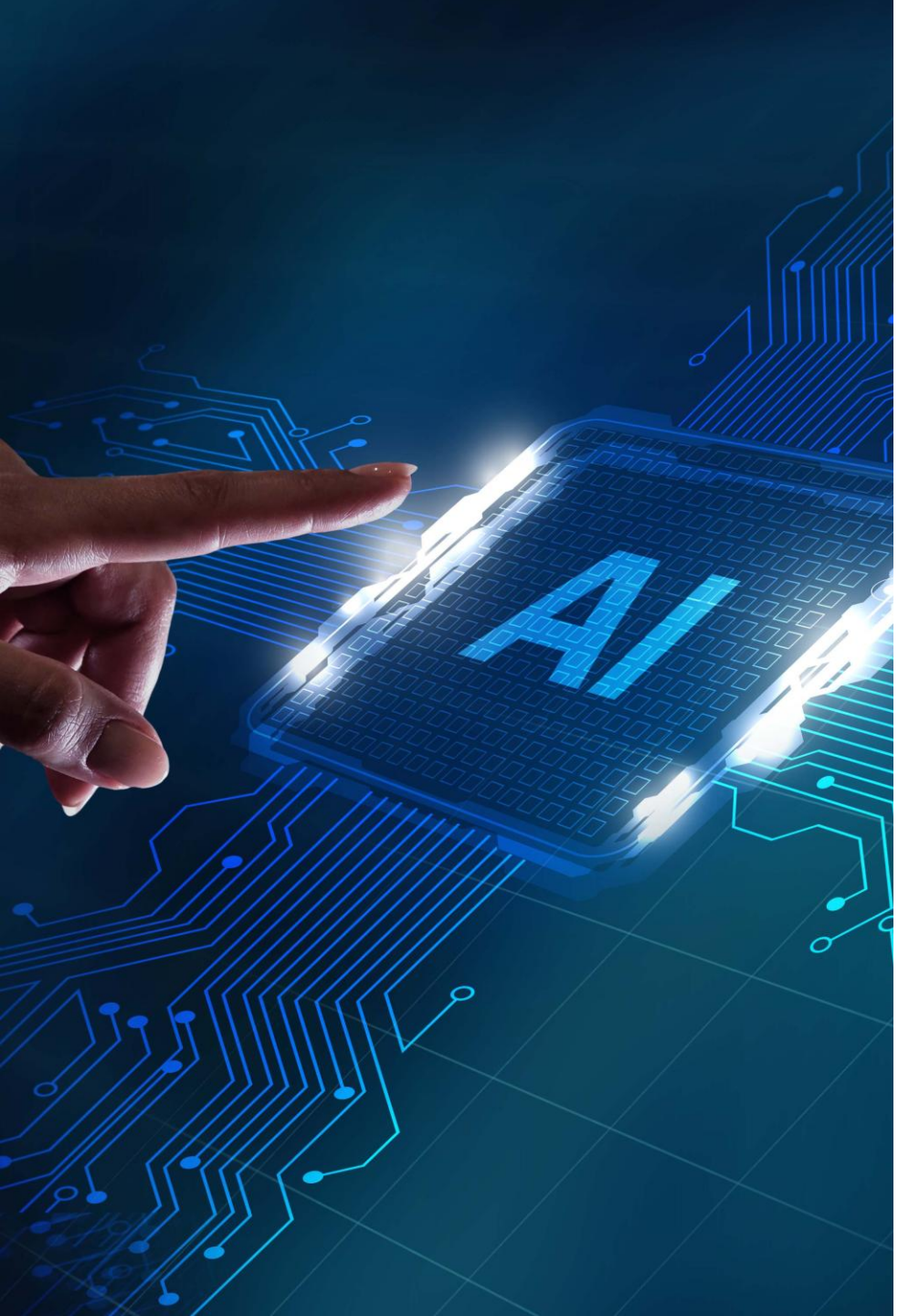
Integration and Interaction	combining the core domains with different characteristics (autonomy, cooperation, integration, etc.)
Services	usually cloud platforms - off the shelf products
Ethics and Philosophy	significant impact on human and society: solutions should be compliant with ethical principles and applicable regulations

Source: own creation on the basis of AI watch

Guidelines for trustworthy AI

- human agency and oversight
- technical robustness and safety
- privacy and data governance
- transparency, diversity
- non-discrimination and fairness
- societal and environmental wellbeing
- accountability

Source: HIGH-LEVEL EXPERT GROUP ON ARTIFICIAL INTELLIGENCE



Issues with AI

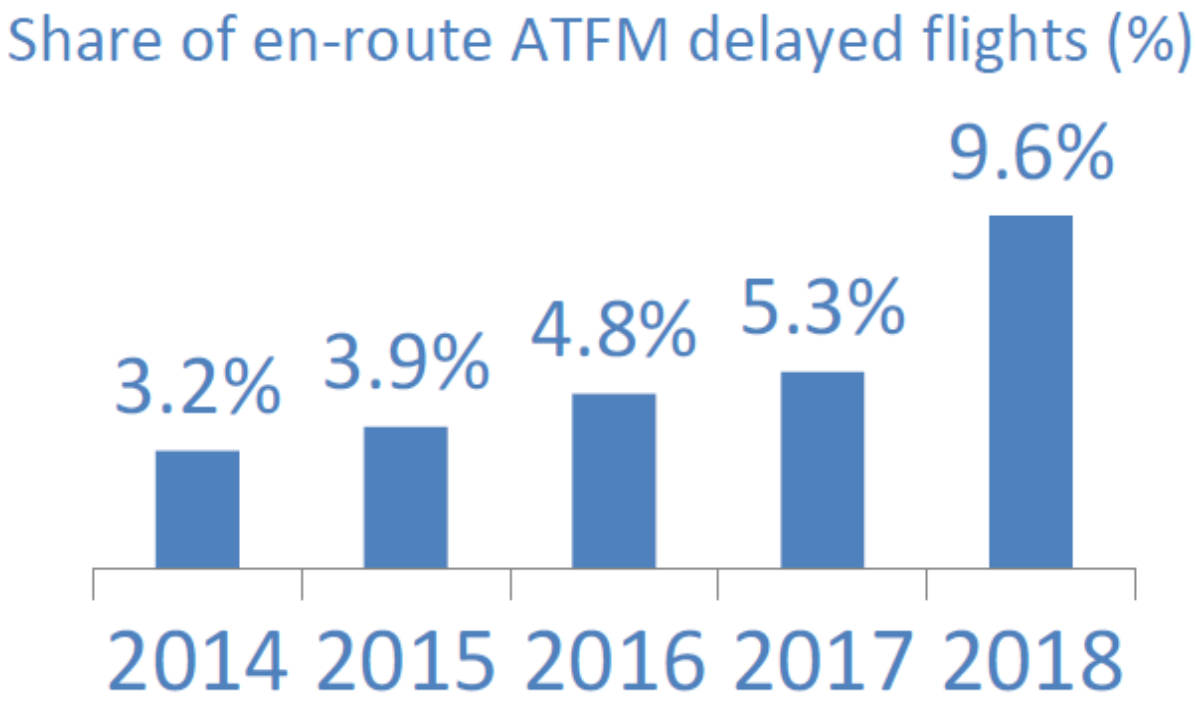
- new technology
- boundaries are unknown (yet)
- ethical concerns
- regulations are in progress (The EU Artificial Intelligence Act)
- standardization is lagging behind

Questions on progress with AI

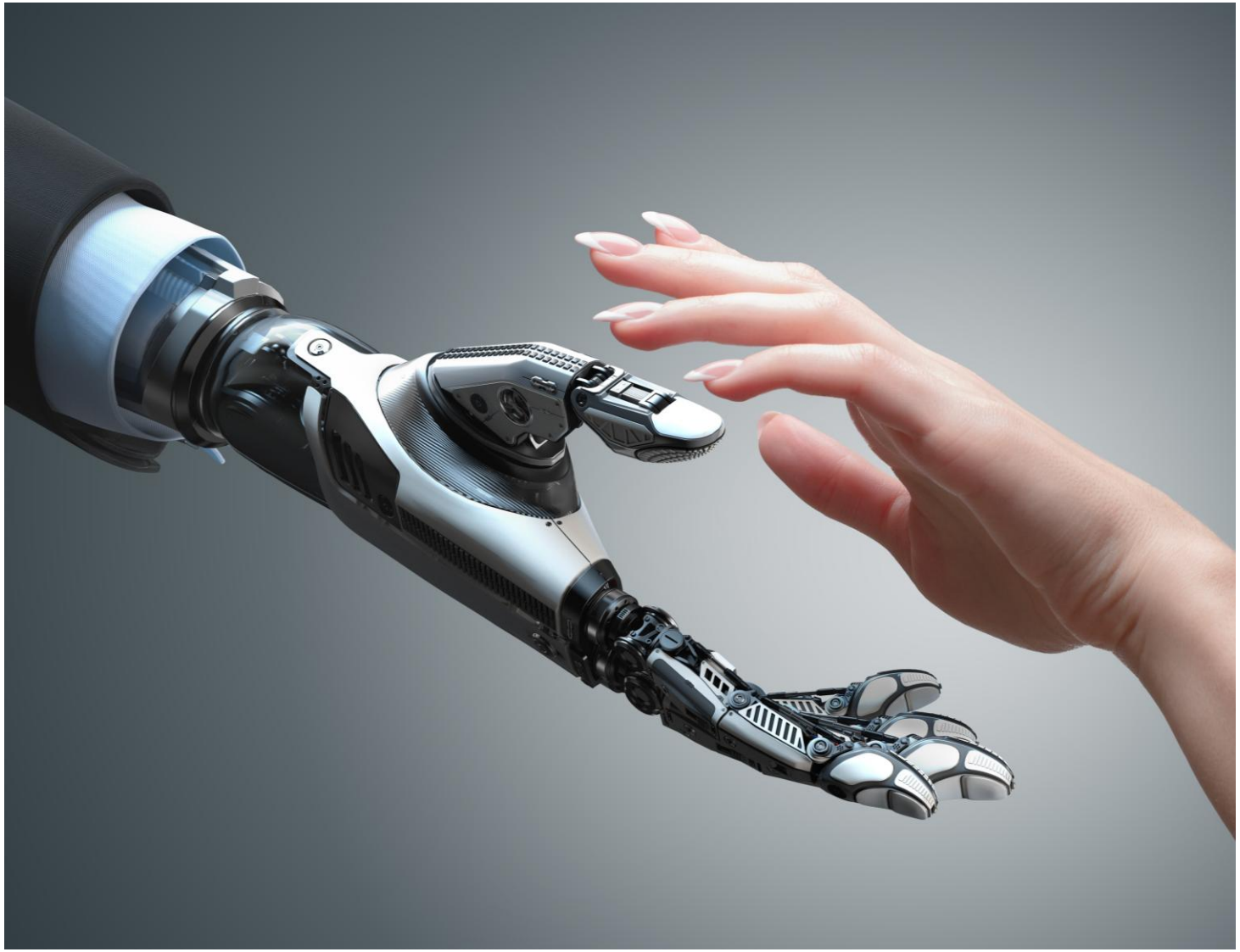
Will artificial intelligence be used in primary systems in safety critical industries?

If yes, what are the main steps to be taken?

Air traffic control – capacity problems



Source: EUROCONTROL

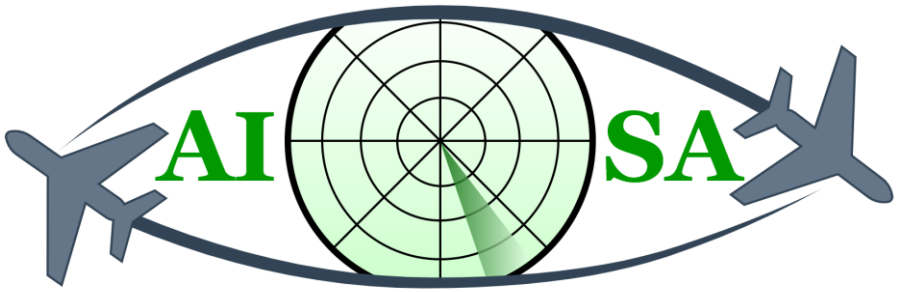


Automation is needed

SESAR: new solutions should provide substantial and verifiable performance benefits but maintain the safety level

AI is already in used in ATC, BUT: not in primary activities

Challenge: how to make human and machine cooperate efficiently?

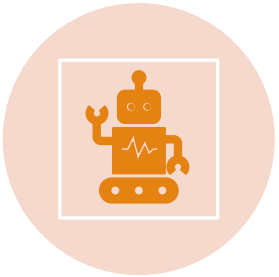


SUPPORTED BY sesar JOINT UNDERTAKING

AI Situational Awareness Foundation for Advancing Automation — AISA

2020 - 2022

The objectives of the AISA project



Exploration of the effects of human-machine distributed situational awareness

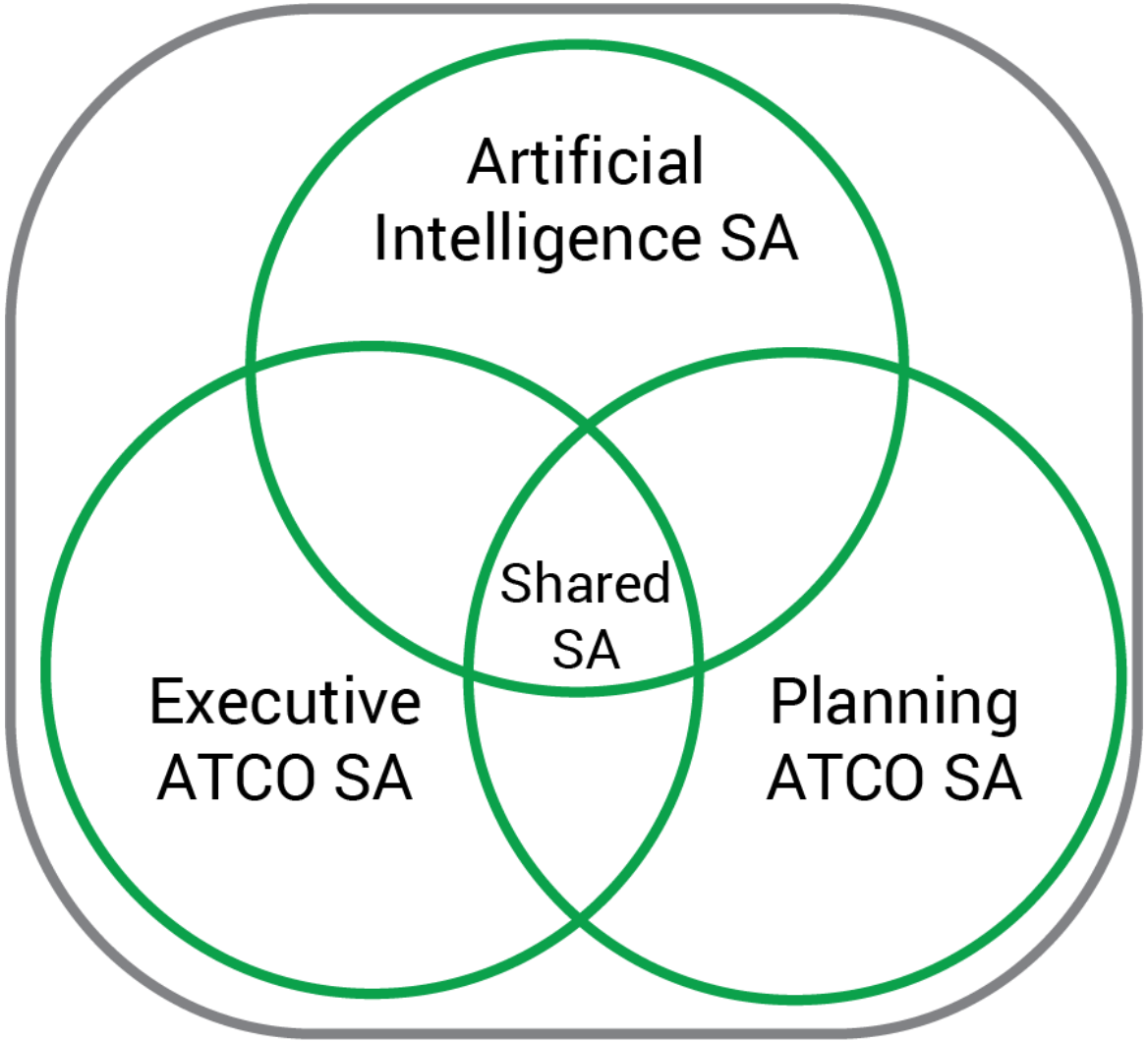
Search for opportunities for automation of monitoring tasks in en-route operations

Identifying the data needed by air traffic controller

Finding methods for adaptation to changes of the environment

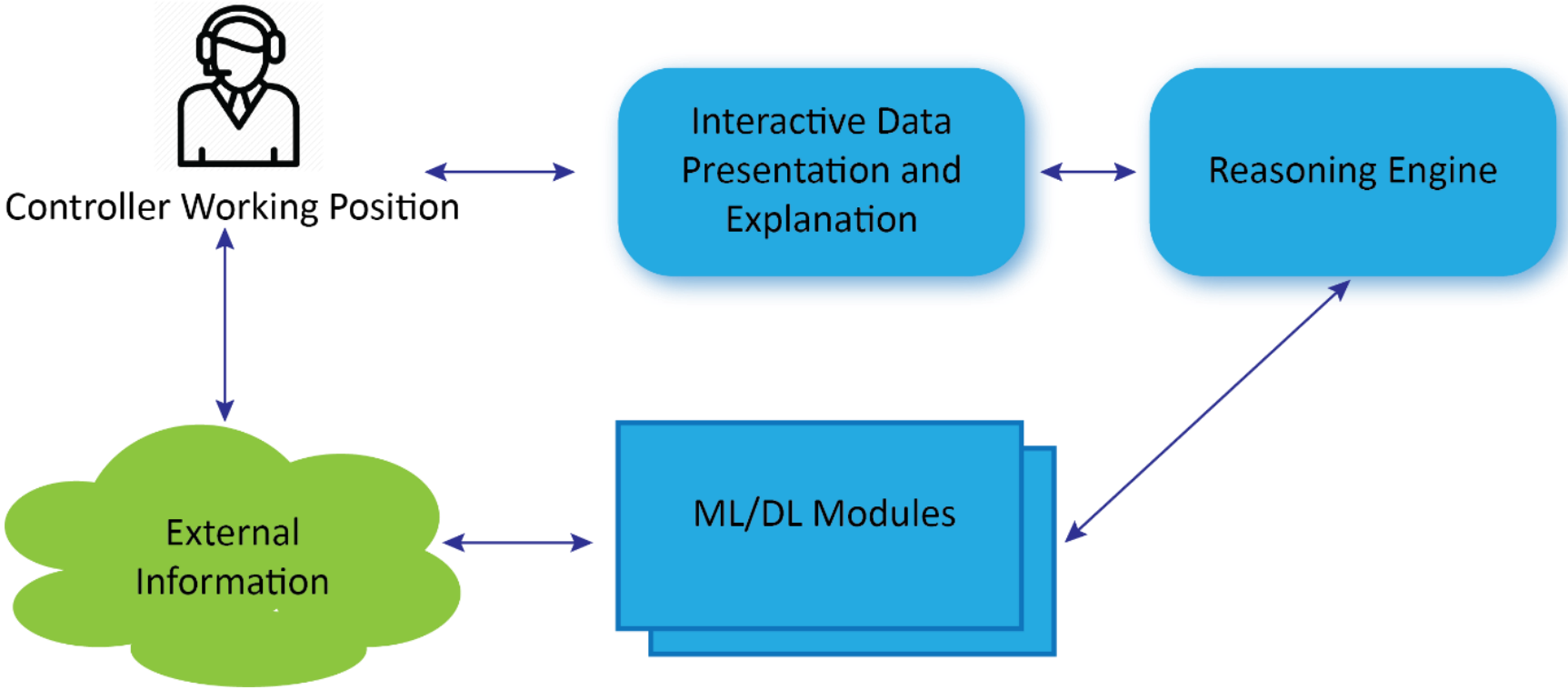
AISA: AI Situational Awareness Foundation for Advancing Automation is a SESAR ER project, 892618

Aim: Team Situational Awareness



Future Vision

own drawing on the basis of the AISA concept



The main conceptual elements

own drawing on the basis of the AISA concept

Gradual implementation approach

AI	ATCO	PROBABILITY
Support	Apply	High
Propose	Approve	Low
Apply	Monitor	Unlikely

The forecasted roles of human and AI at particular tasks by 2035

Source: own work in AISA D2.2

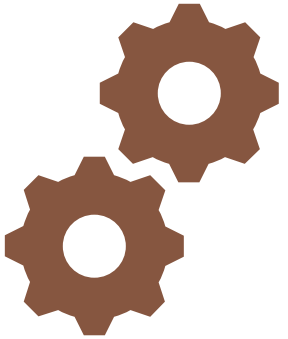
AI	ATCO	PROBABILITY
Support	Apply	High
Propose	Approve	Medium
Apply	Monitor	Low

The forecasted roles of human and AI at particular tasks by 2050

Source: own work in AISA D2.2

First Tasks of AI in ATC systems

A, Relatively simple monitoring activities



B, Already automated

Examples

detection of incoming traffic

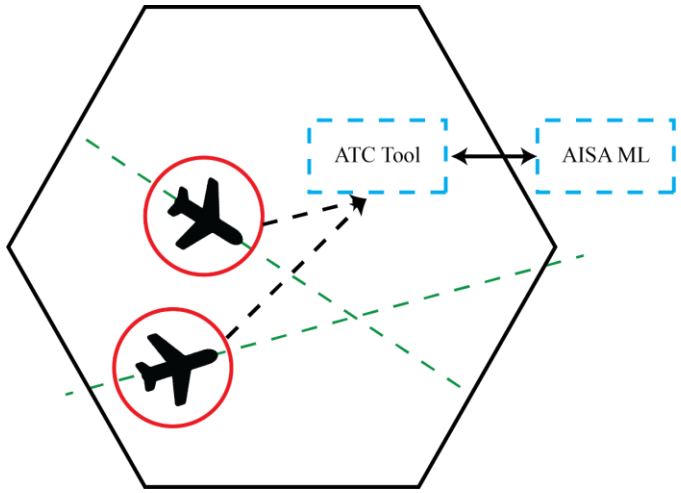
monitoring conformance of aircraft to the planned trajectory

identifying conflicts

monitoring adverse weather areas and restricted airspace

monitoring of the status and performance of ATC sub-systems

Examples of results - ML



Source: own drawing on the basis of Perez-Castan, A. et al, 2022

Focus: Situation of Interest (SI) prediction

Using classification, regression techniques

- updates the prediction in a certain period of time
- realises both the aircraft currently in the sector and the ones approaching it
- utilising historical 4DT (4D trajectory) data and the current ADS-B data (position, velocity, heading), makes prediction for each aircraft.
- supports the tactical ATCO in his/her airspace monitoring work

Promising results:

100% right: predicted minimal distance between pairs within 5 NM

97% right: predicted minimal distance between pairs 5 – 10 NM

AISA results (1)

- 48 monitoring tasks automated (artificial situational awareness)

  Risk assessment: library of more than 70 risks and hazards, more than 140 mitigation measures

- 2 human-in-the-loop experiments

Photo of experimental run in January 2022: One of two stations with participating ATCO, pseudo pilot, assisting scientist and SME ATCO (not visible)

AISA results (2)

1st Experimental run:

- to gather data,
- to compare human vs artificial SA,
- 20 licensed ATCOs,
- 5 exercises each
- Objective situation awareness indicators
  - Identification of non-compliance (hdg, speed, level)
  - Flights assumed (accepted) – flights transferred
  - QoS opportunities

- Out of 1400+ events over 20 scenarios:
- 27 times human SA was degraded
- 0 times for machine

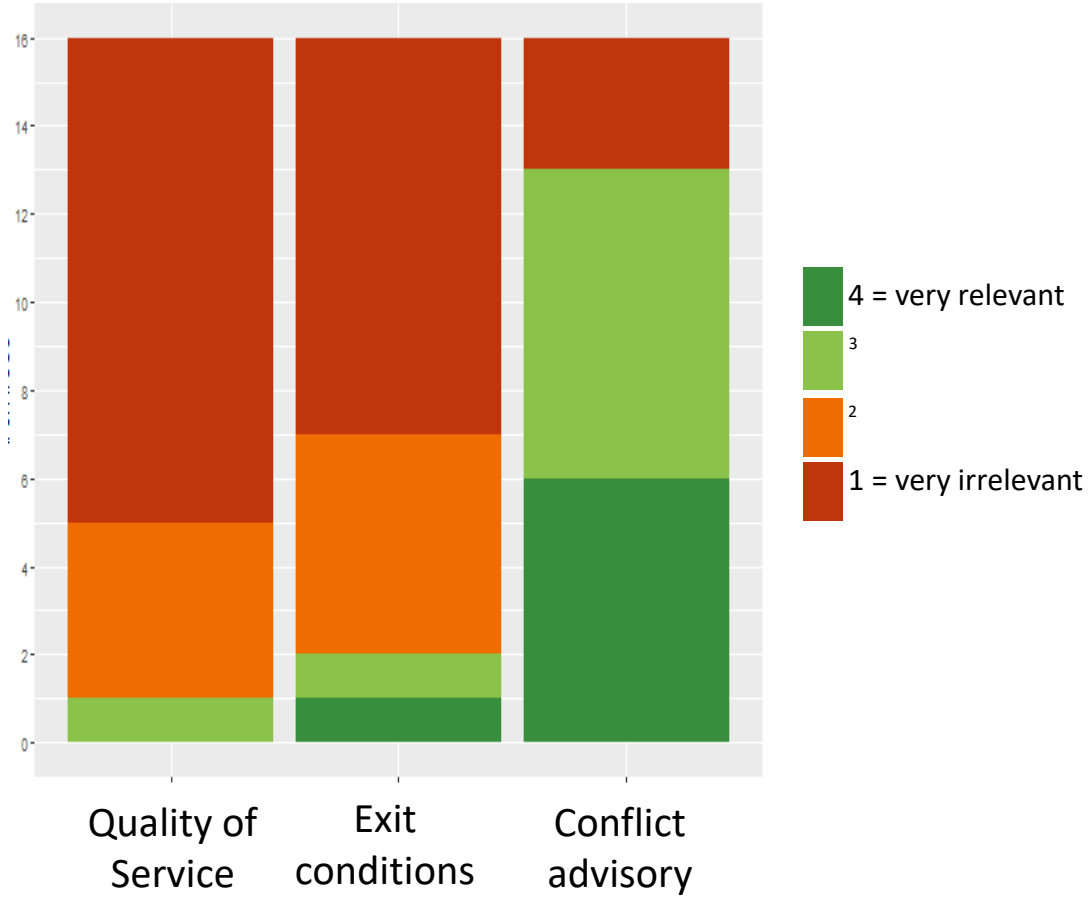
Result: **in the scope of the experiment, human and artificial SA are comparable**

AISA results (3)

- 2nd Experimental run:
- to see how much support can be provided to ATCOs,
- 16 ATCOs,
- 5 exercises each,
- providing support via audio

Result: **ATCOs dislike receiving support via audio, support deemed not relevant, support not useful, support is often not provided at the required time, plenty of room for improvement**

How **relevant** were AI SA inputs in Mil 1 scenario?



További információ

https://www.aisa-project.eu/

AWARE

SUPPORTED BY sesar JOINT UNDERTAKING

Az AWARE projekt bemutatása

Project 101167442 — AWARE

Funded by the European Union

This project is supported by the European Union, the SESAR 3 Joint Undertaking and its founding members. Views and opinions expressed are, however, those of the author(s) only and do not necessarily reflect those of the European Union or SESAR 3 Joint Undertaking. Neither the European Union nor the granting authority can be held responsible for them.

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УКРАЕРОРУХ UkSATSE

Slot Consulting

University of Zagreb Faculty of Transport and Traffic Sciences

General project information

Duration: June 2024 – November 2026

Part of SESAR Digital European Sky *AI Flagship*

Addresses the call topic '*ATM application-oriented research for Artificial Intelligence (AI) for aviation*'.

Exploratory research – Application-oriented research

Positioning: TRL 1 -> TRL 2 (Technology concept and/or application formulated)

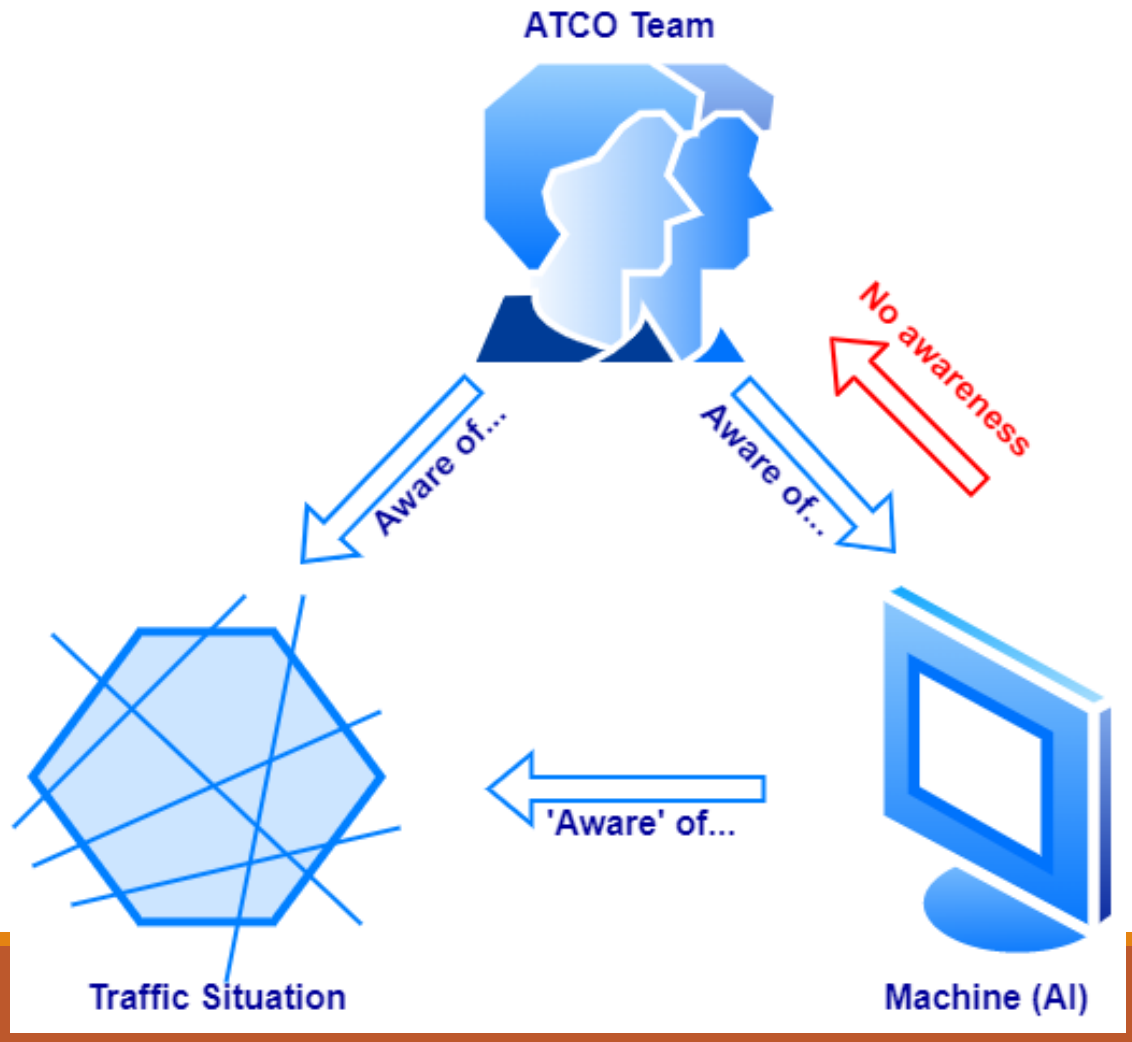
Scope: en-route ATC

Motivation

Humans are trained to understand the capabilities, limitations, and functionality of the machines they use.

Machines, on the other hand, **remain disconnected from humans and lack understanding** of them.

In a complex environment the necessity for machines to comprehend the humans and to be able to **close the loop of reciprocal understanding**, grows more important.



Project objectives

General objective of the project:

To develop an AI assistant application designed to support ATC operations by building a platform based on enhanced artificial situational awareness solution.

Specific objective 1

To develop an enhanced artificial situational awareness system by implementing methods for assessment of ATCO's intent and goals.

Specific objective 2

To develop a method for the adaptable selection and implementation of actions that support ATCOs, utilizing both ML and non-ML tools.

Project objectives

Supporting technical objective 1

To develop the capability to **track human visual attention** in combination with other inputs

Supporting technical objective 2

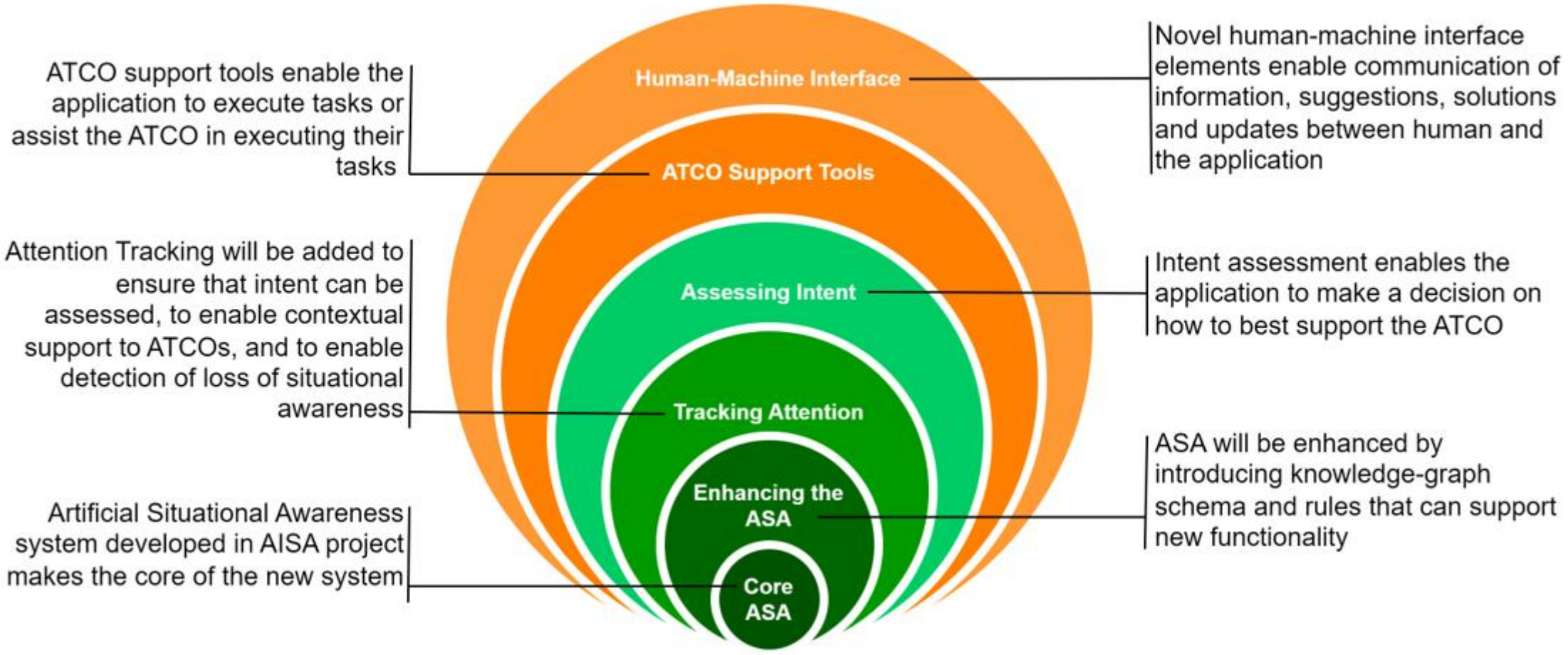
Research the methods of **identifying loss of situational awareness.** exploring options for bringing the human back into the loop

Supporting technical objective 3

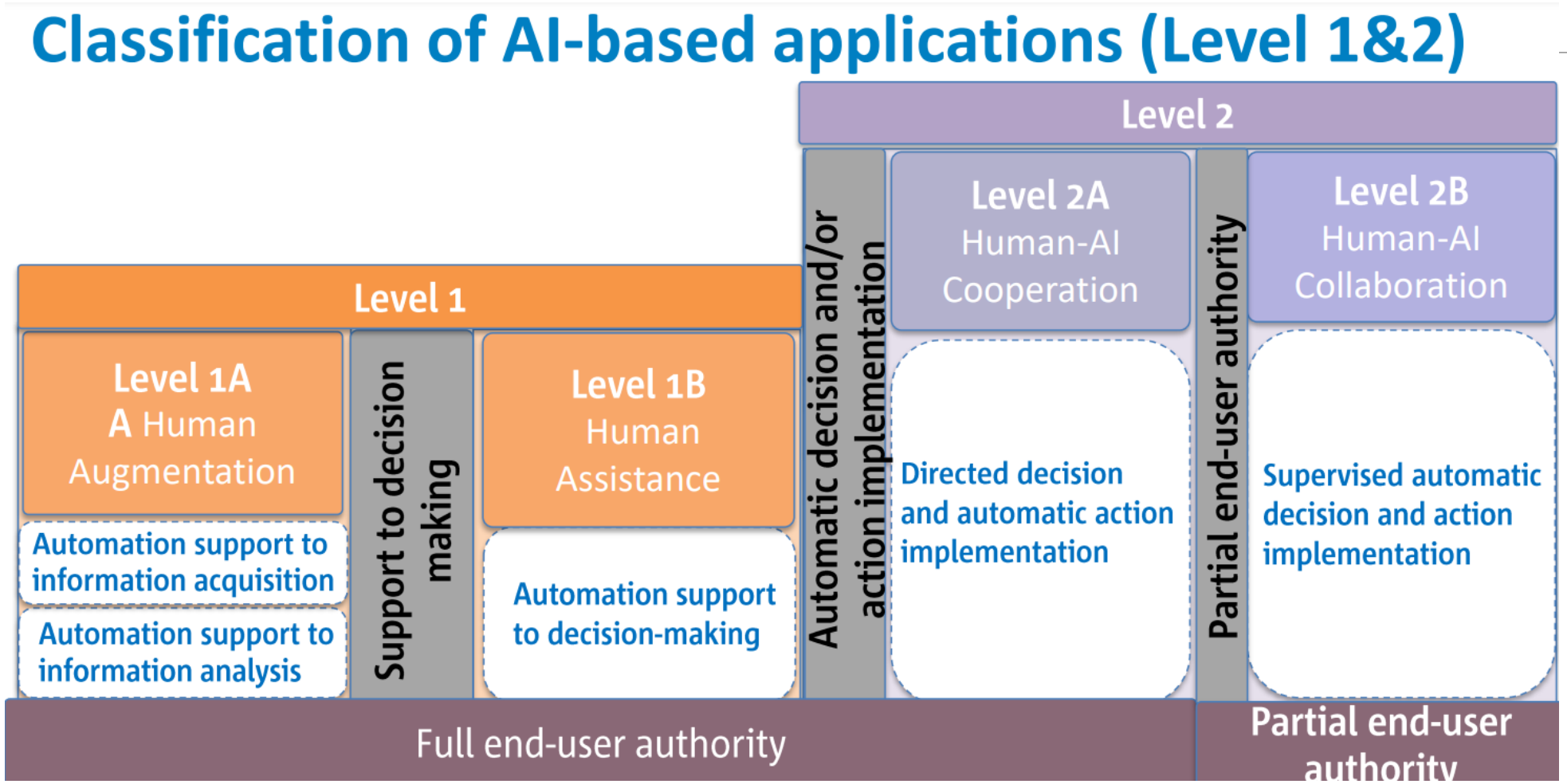
To **define specifications for interoperability** with other systems and roles in ATM

to explore benefits of artificial situational awareness system beyond ATC tactical operations: certification process, cybersecurity benefits and novel threats, possible improvements on pre-tactical operations

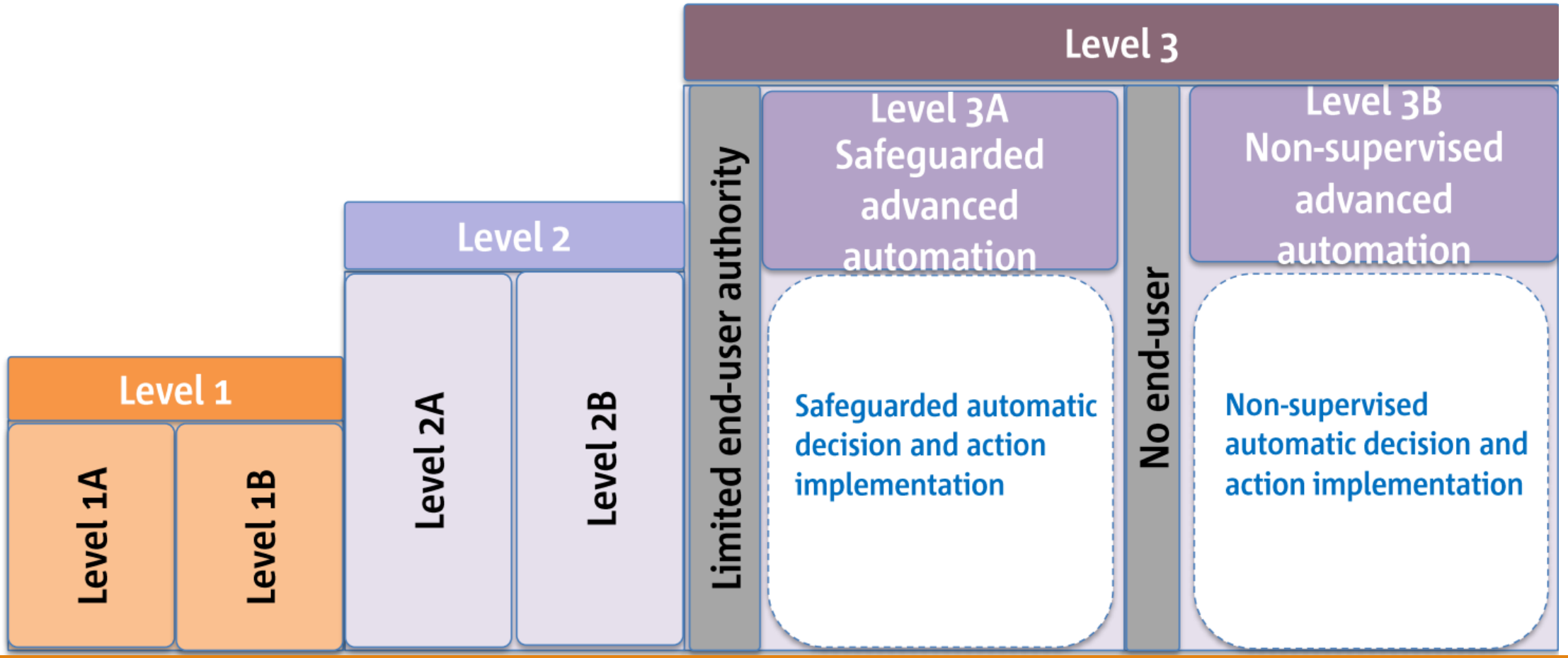
Artificial situational awareness system - Concept



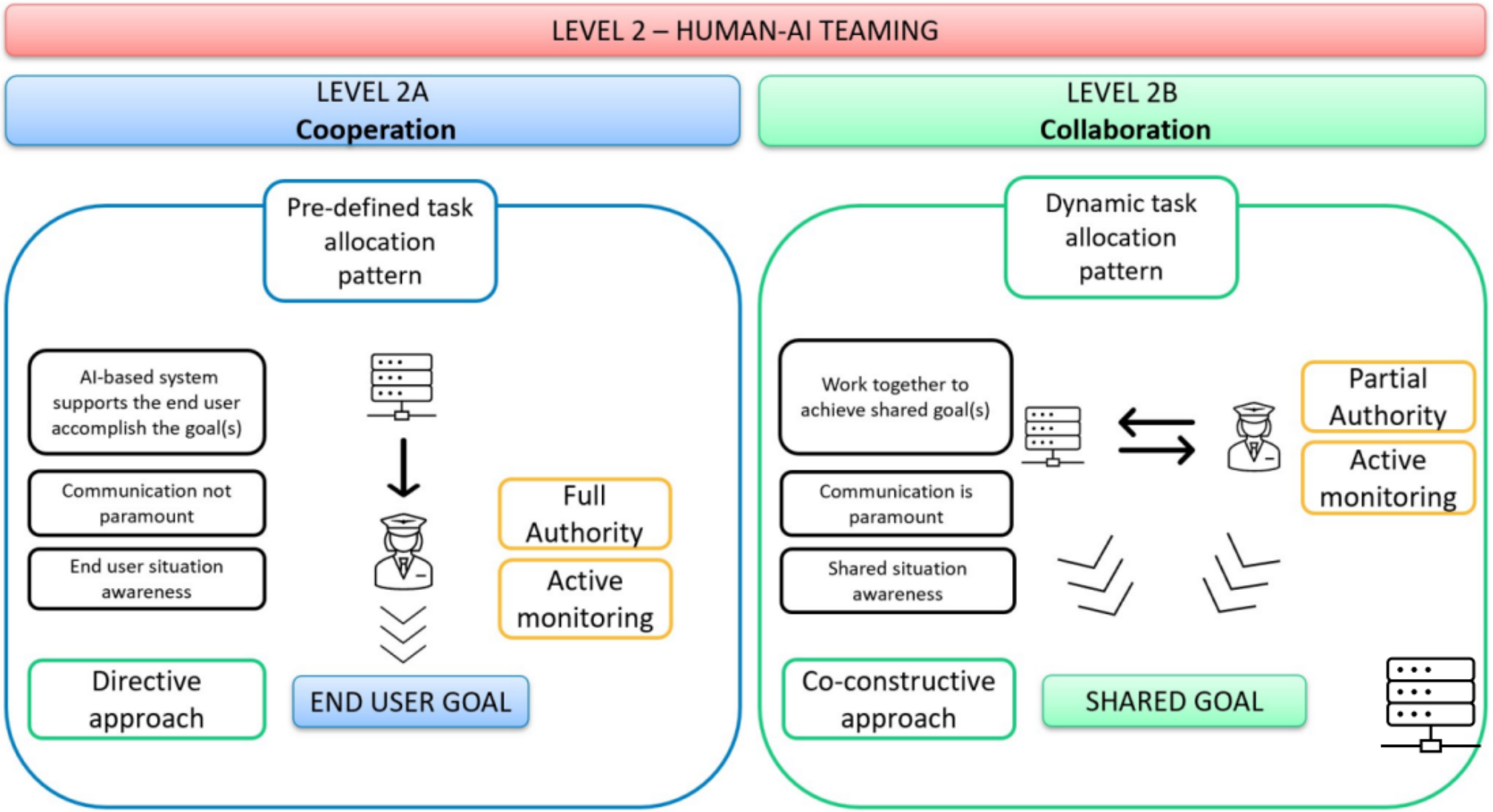
Context


Classification of AI-based applications (Level 1&2)
Level 2
Level 1
Level 1A
A Human
Augmentation
Automation support to information acquisition
Automation support to information analysis
Support to decision making
Level 1B
Human
Assistance
Automation support to decision-making
Automatic decision and/or action implementation
Level 2A
Human-AI
Cooperation
Directed decision and automatic action implementation
Partial end-user authority
Level 2B
Human-AI
Collaboration
Supervised automatic decision and action implementation
Full end-user authority
Partial end-user authority

Classification of AI-based applications (Level 3)



Enabling the Human-AI teaming concept



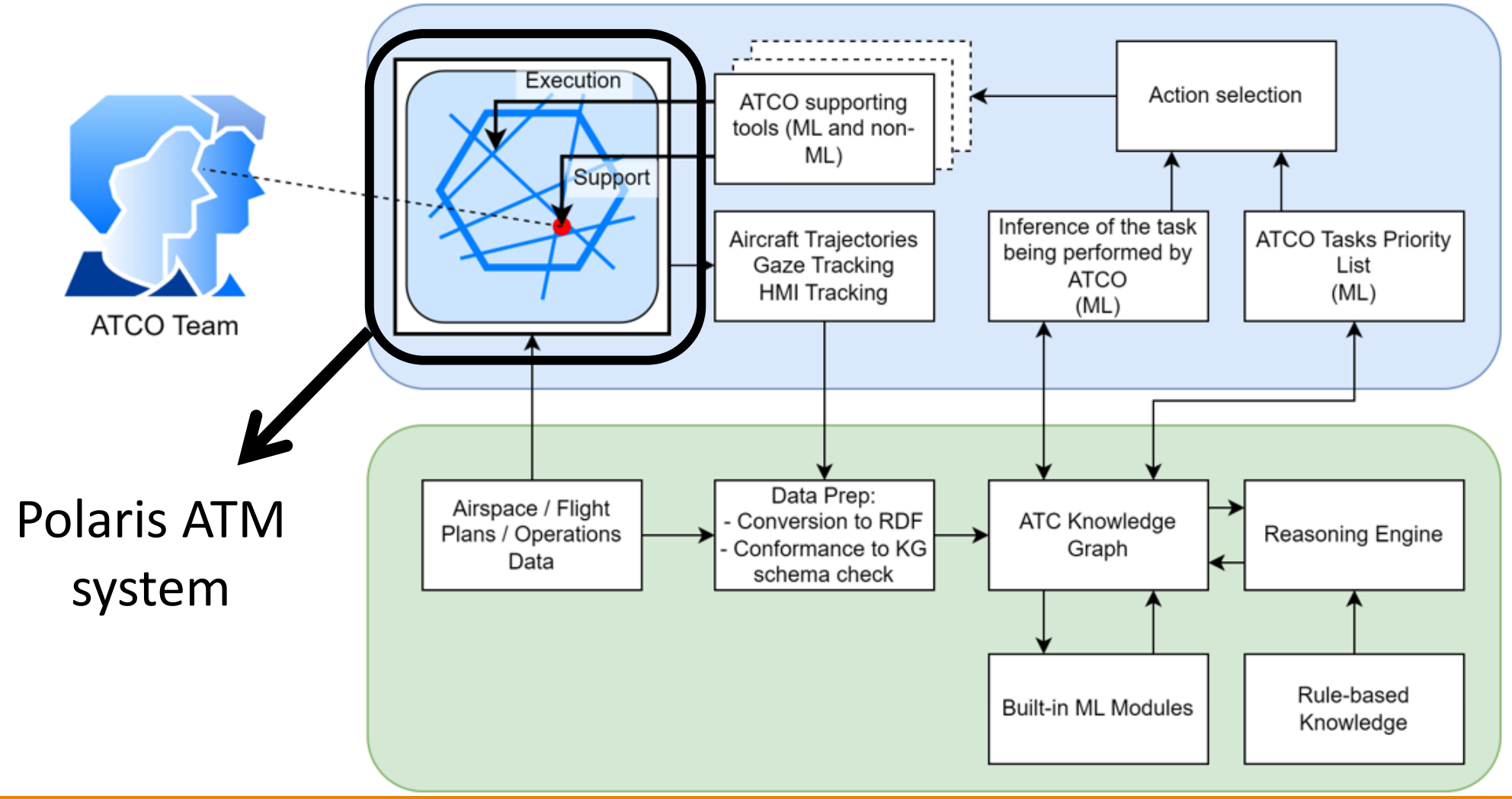
Innovation potential

Human-aware artificial situational awareness system

Novel methods for:

- ATCO’s intent evaluation
- ATCO tasks prioritization
- adaptable selection and implementation of actions that support ATCOs
- identifying loss of situational awareness

AI Assistant Application



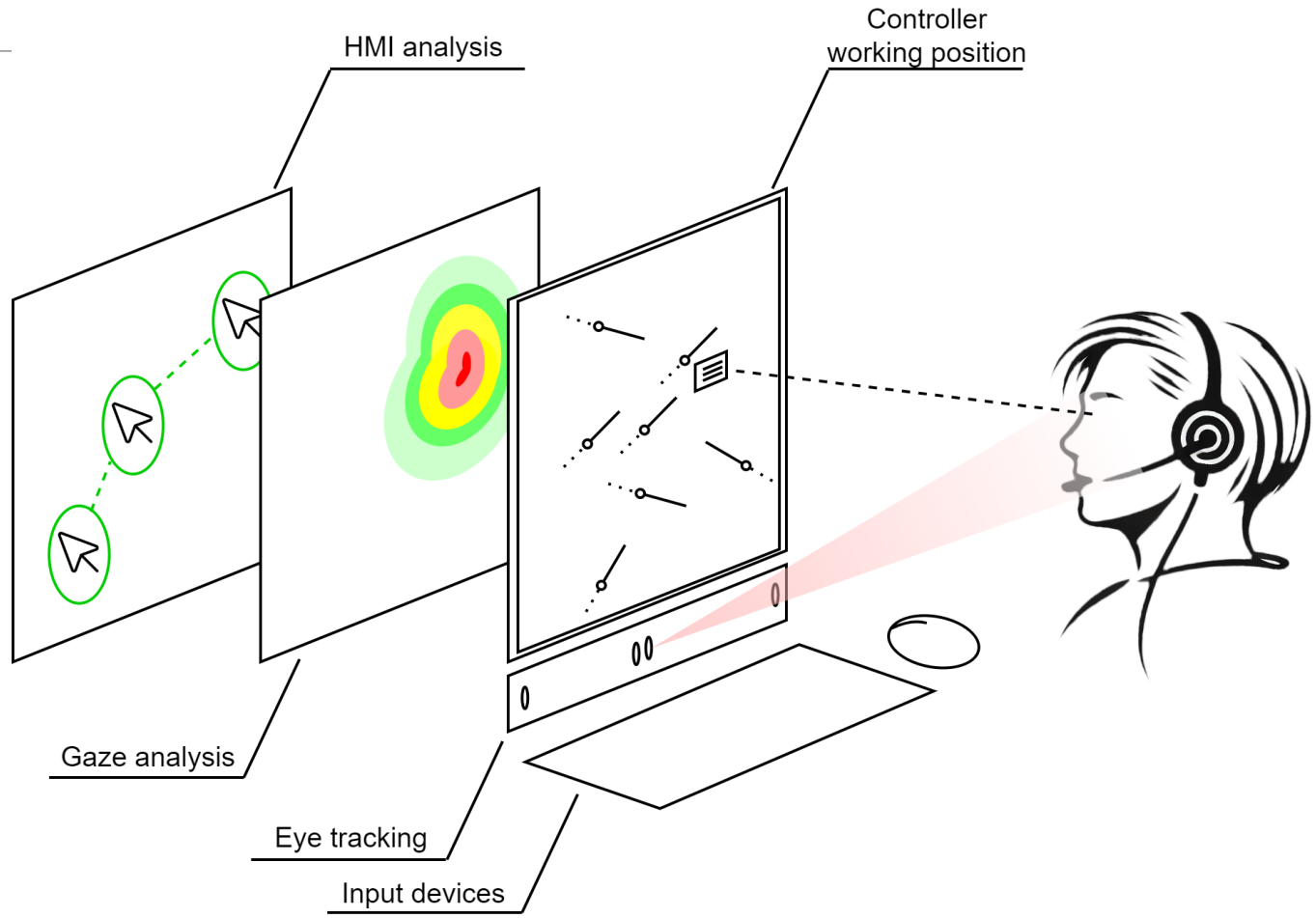
Concept of Operations

Building a Team:

The project's AI system: to enhance human-AI team's performance while preserving ATCOs' skills through collaboration.

Effective team: requires understanding other team member's states, including their goals, needs and intent.

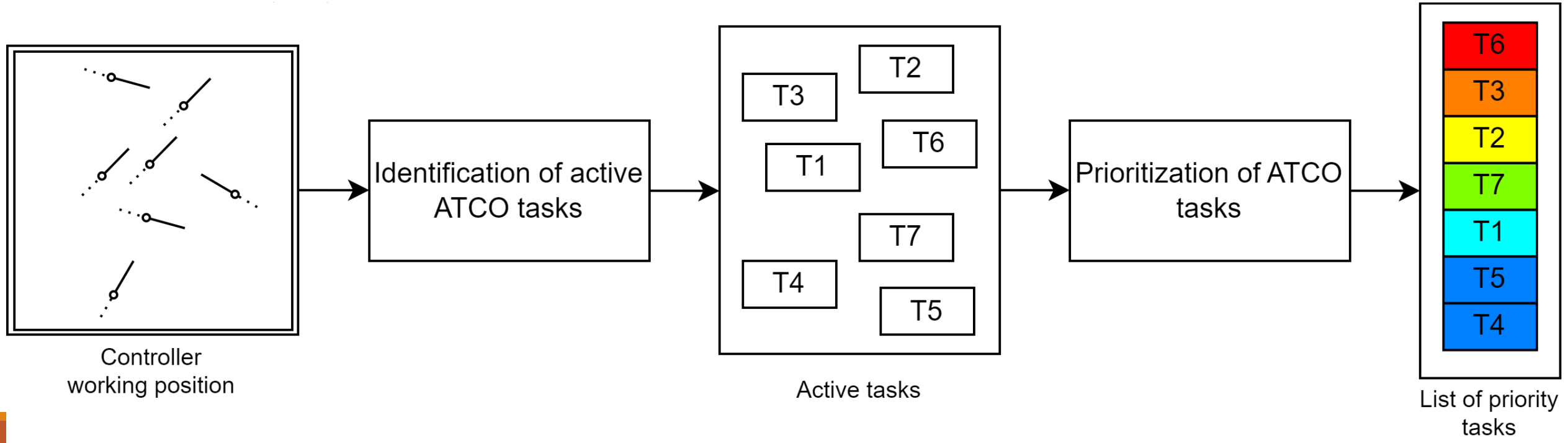
AWARE: tracking ATCO's human-machine interactions and gaze, putting them into the context of the current traffic situation and environment



Concept of Operations

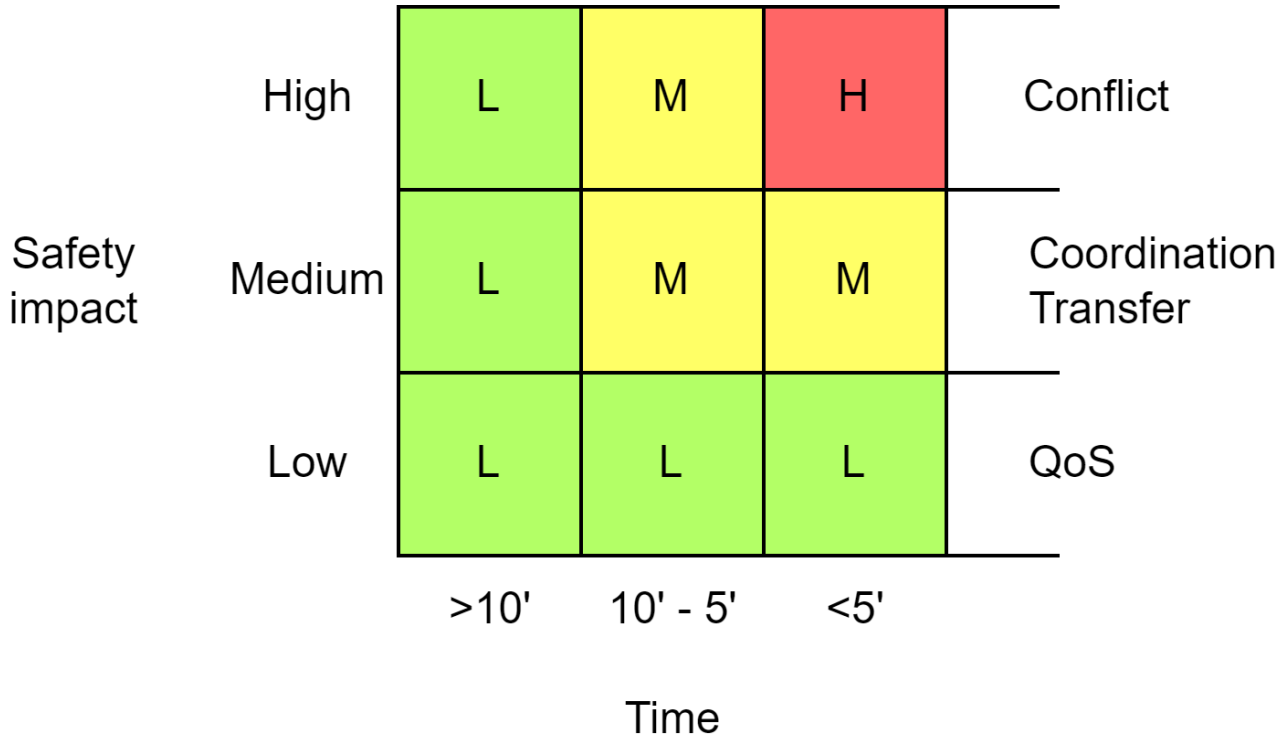
Intended vs Priority tasks

AWARE system: intent information to estimate which task the ATCO is trying to solve compared to the list of all tasks sorted by priority



Concept of Operations

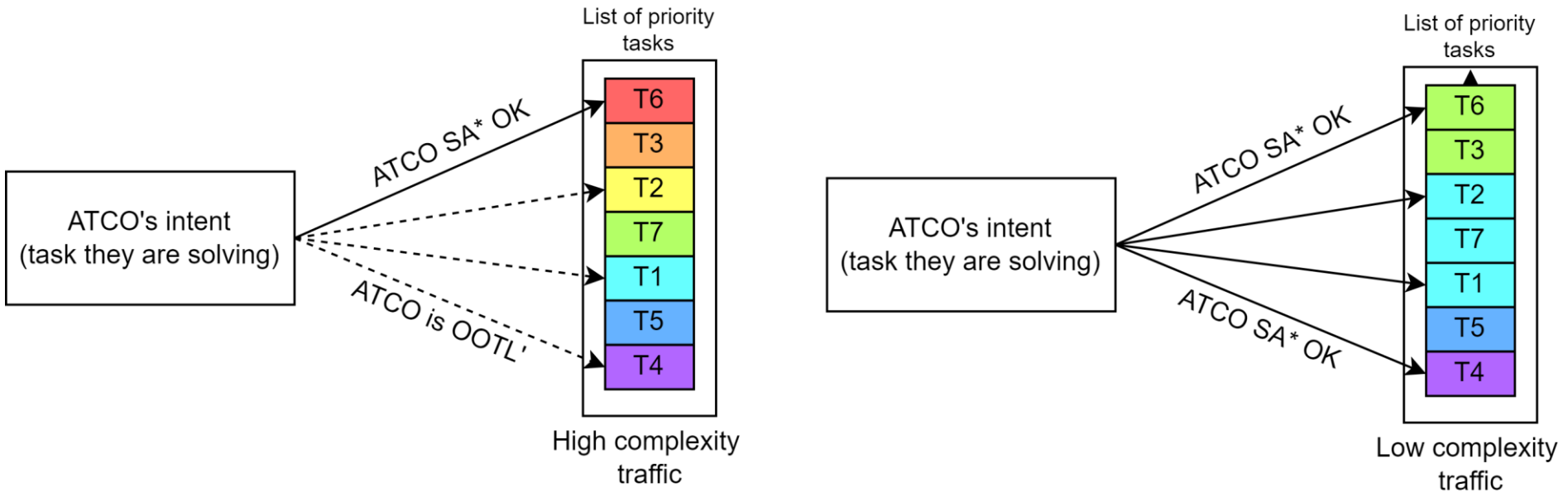
Prioritization of tasks should be objective. We propose the relative safety vs time matrix, e.g.:



Concept of Operations

Degraded Situational Awareness (Out-of-the-loop effect)

The system will also be able to detect loss of situational awareness in ATCOs to help bring the ATCO back into the loop if it infers that the human is focused on tasks which are not of the highest priority. We believe that this process will be the basis for expanding the scope of collaboration between the human and the AI.



*SA - Situational awareness
'OOTL - Out-of-the-loop

High priority — Low priority

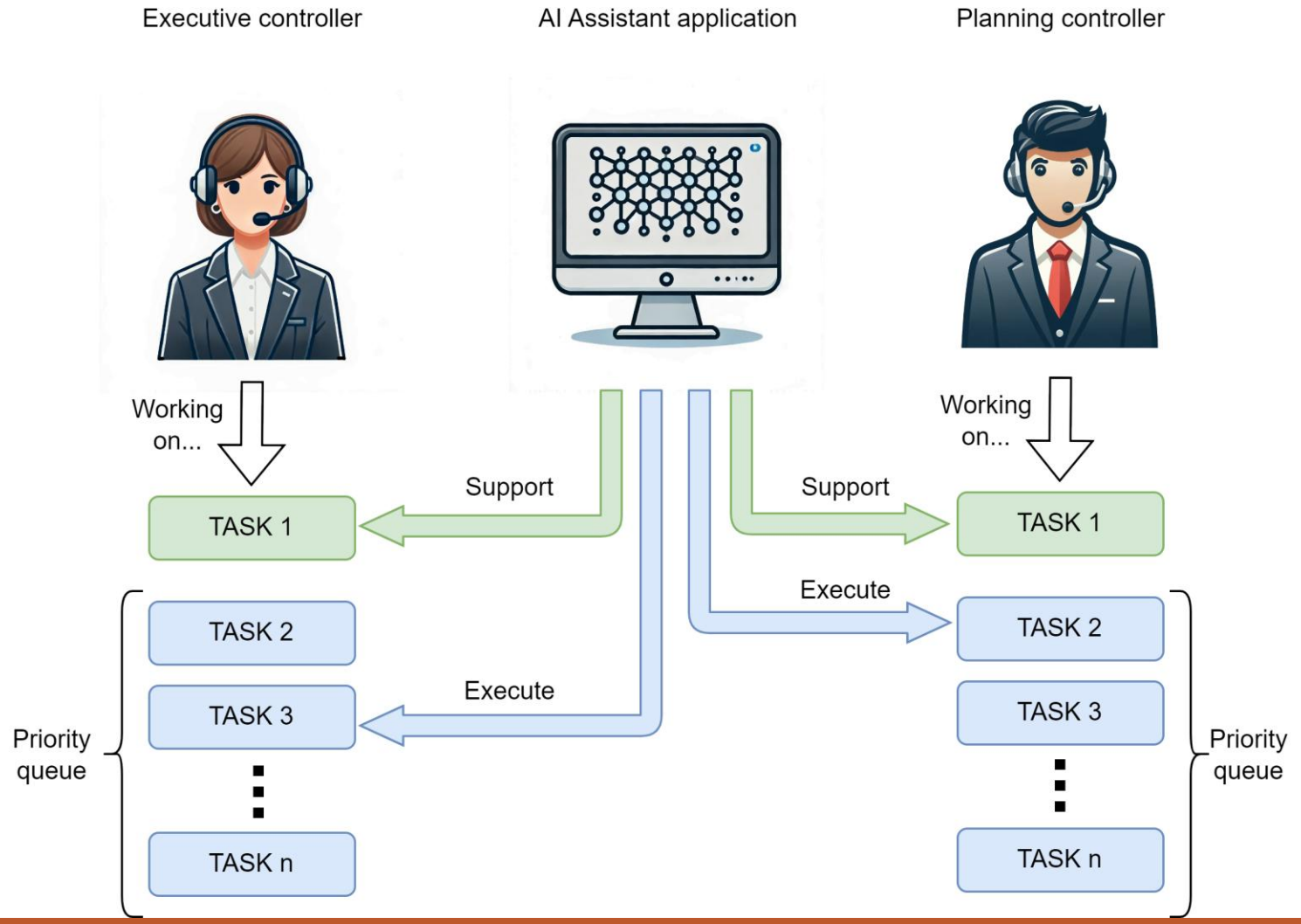
Concept of Operations

Building a Team:

System: option:

A, to support the ATCO in performing that task

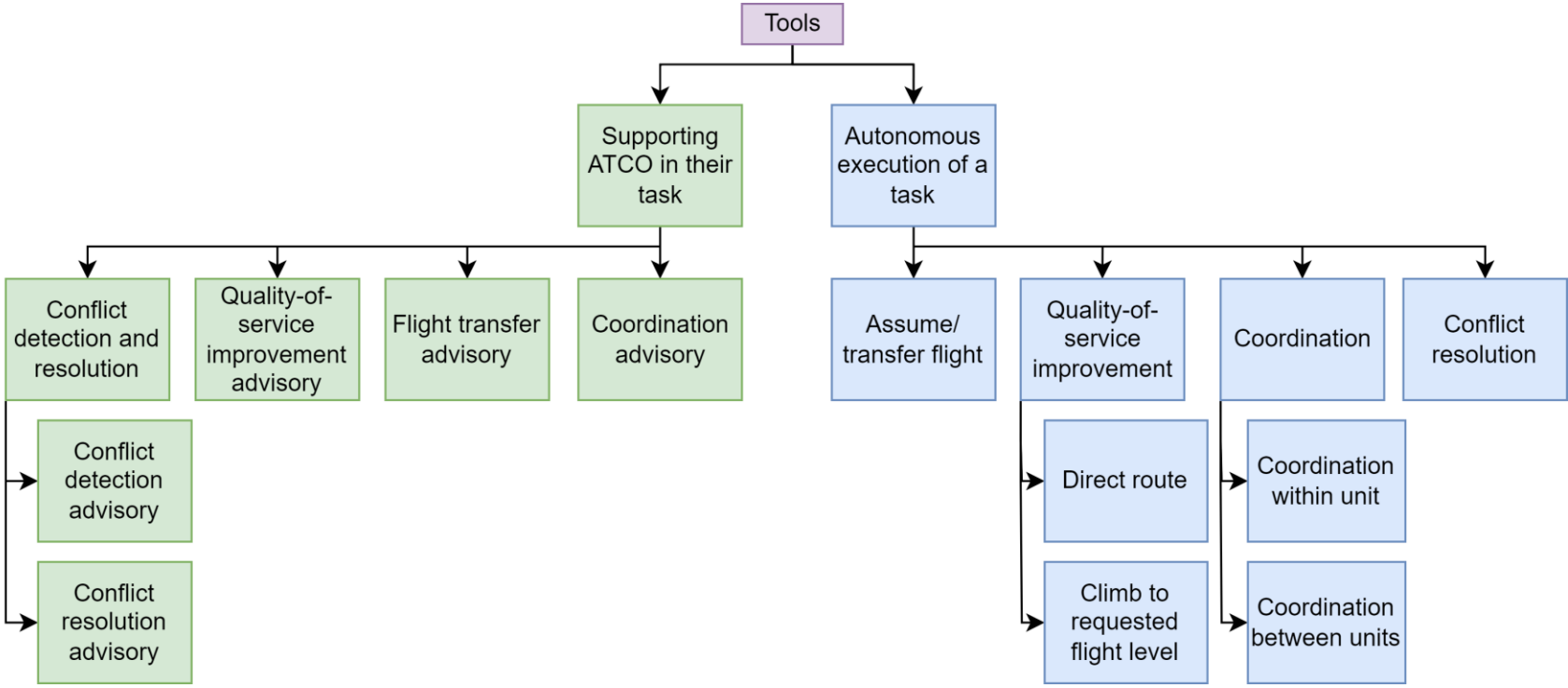
B, perform some other ‘housekeeping’ tasks autonomously



Concept of Operations

Tools

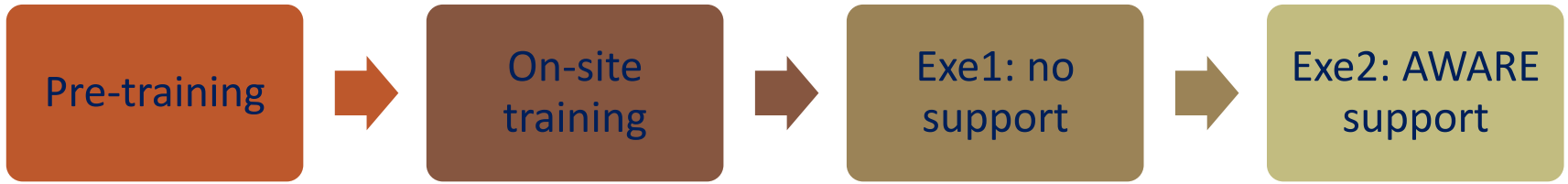
- AWARE explores varying levels of automation:
- from semi-autonomous support
- to fully autonomous actions, depending on traffic complexity and ATCO workload.
- shift towards supervisory roles by keeping ATCOs in active control.
- amount of support will be adjusted to allow ATCO: to always be exposed to all types of tasks: de-skilling would be avoided



Human-AI Teaming

Validation Methods:

- conducting human-in-the-loop (HITL) experiments:
- comparisons of AI-supported vs. conventional support systems (varying traffic complexities)
- psycho-physiological measures and task performance data
- with novice and experienced ATCOs.
- Criteria: like situation awareness, workload, and social acceptance



Lessons learnt: Implementing AI in primary systems of safety critical industries

- Promising opportunities
- *BUT:*
- Essential: Safety, security and transparency
- Important: Establishment of shared situational awareness
- Gradual approach is needed: starting with simple tasks

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Project website:
https://aware-sesar.eu/

LinkedIn:
https://www.linkedin.com/company/aware-atm-project/

Youtube:
https://www.youtube.com/watch?v=Yqzx1JCKayI