



AI Situational Awareness Foundation for Advancing Automation — AISA

Engage Thematic Challenge 2 Workshop - Automation, AI and ML

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On-line meeting, 3 Sep 2021



What do we want from AI/automation?



*European Aviation/ATM industry and European Network operations shall rely on **Trustworthy Human Centric AI** solutions to:*

- *improve its operational performances and international competitiveness*
- *support the realization of recent EU initiatives focusing on aviation/ATM digitalization*

Further exploration of the potential of AI in aviation/ATM should be strengthened in areas of:

- *high impact on aviation/ATM performance and environment*
- **human-machine collaboration**
- *safety-critical operations*
- *safety intelligence tools and cyber threat intelligence services*

- **European Aviation/ATM AI High Level Group**
FlyAI Report, 2020

Humans:

- Adaptable
- Flexible
- Resilient
- Broad knowledge and experience
- Universal learners
- Powerful heuristics
- ...

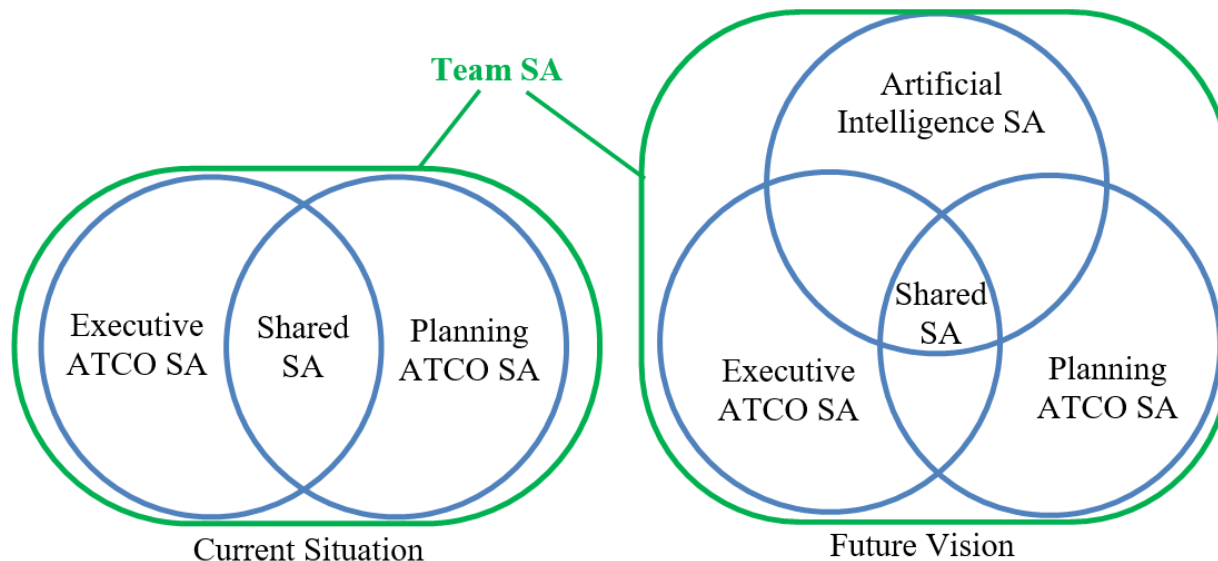
Machines:

- Fast
- Excel at well-defined repetitive tasks
- No fatigue
- Large-scale multitasking
- Consistent
- ...

Complementary traits

Situational awareness or situation awareness (SA) is the perception of environmental elements and events with respect to time or space, the comprehension of their meaning, and the projection of their future status.

- Endsley



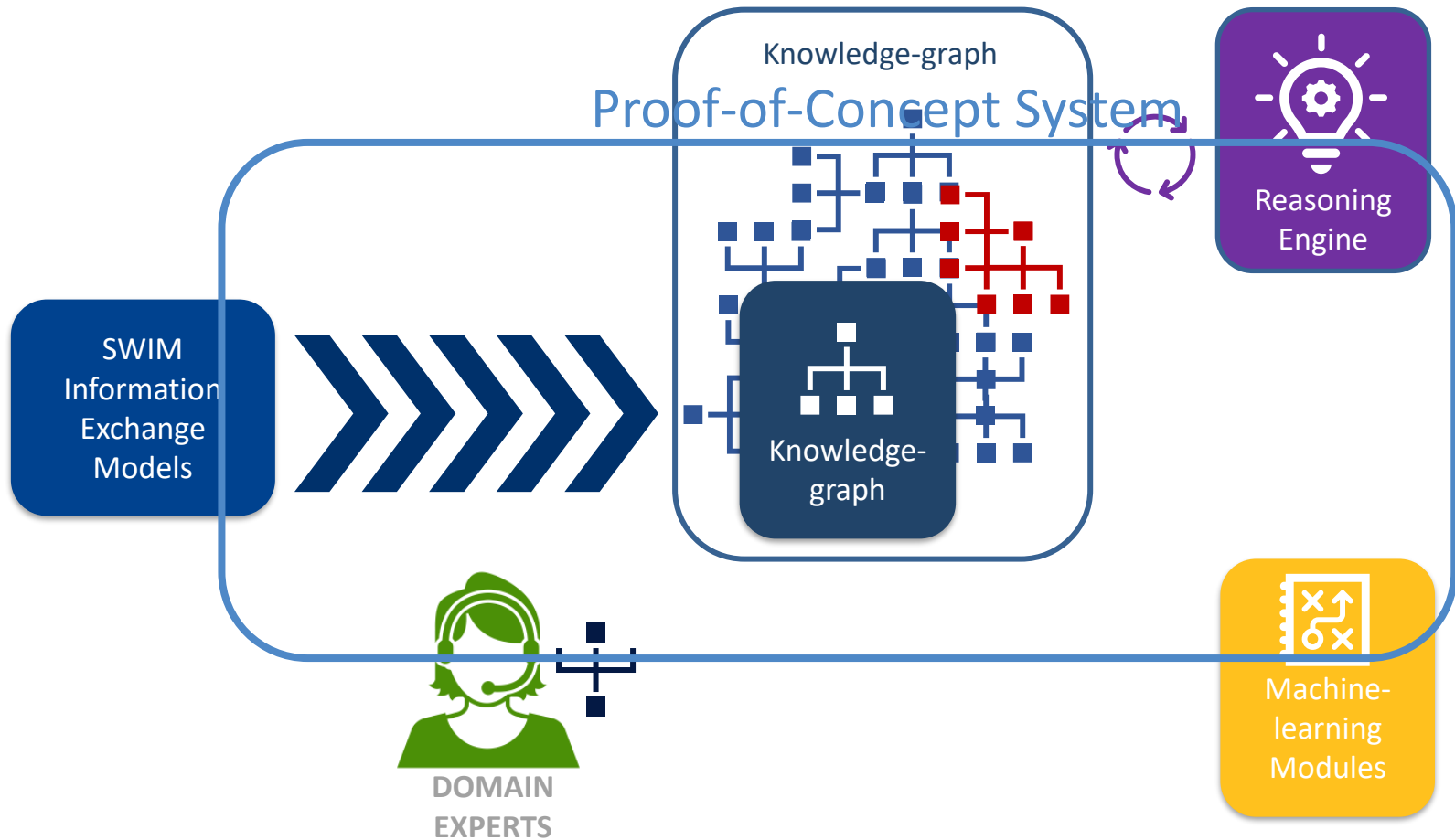
Artificial Situational Awareness as a Foundation for Further Automation

Overall objective:

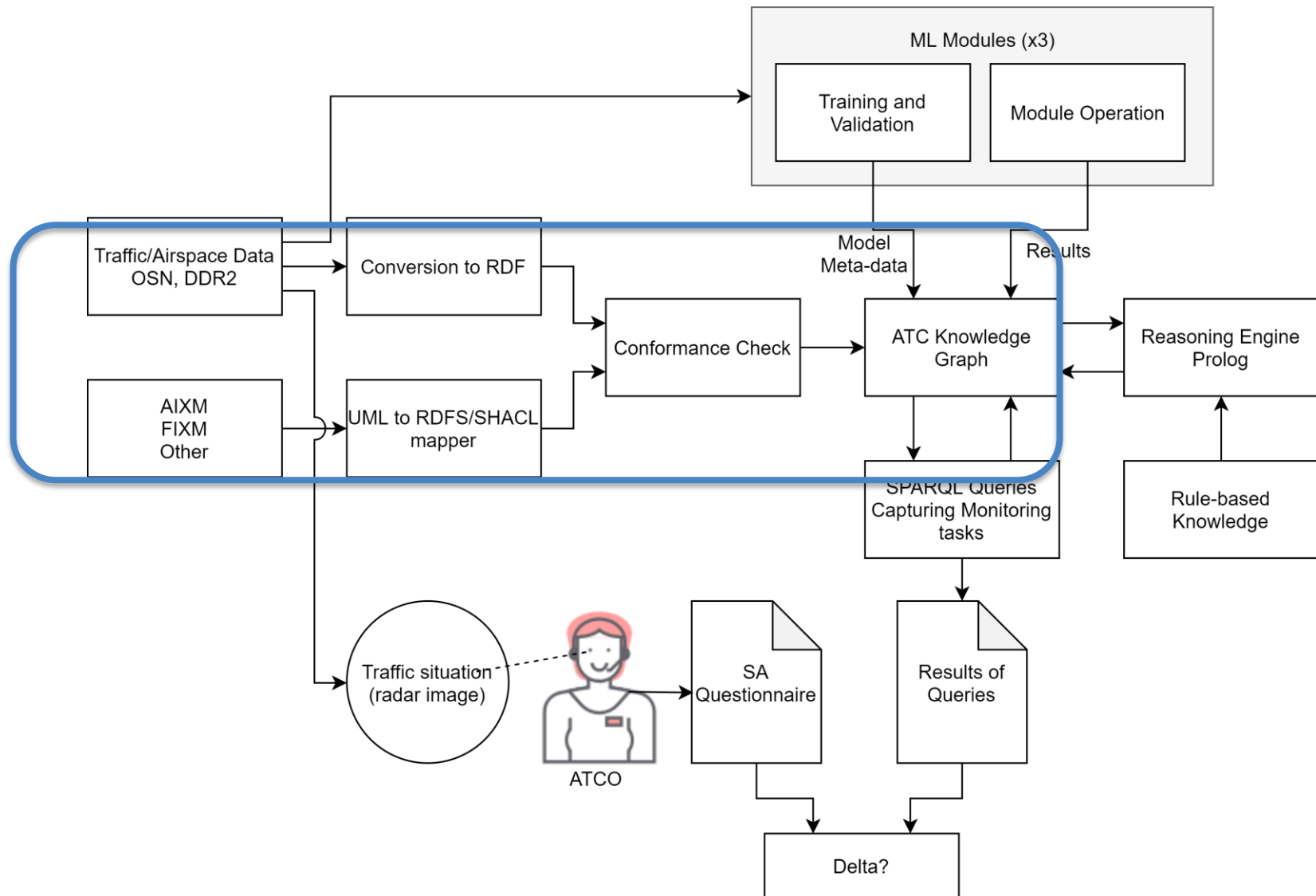
- Increase the possibility for introduction of automation in air traffic management.

Specific objectives:

- Explore the effects of human-machine distributed situational awareness
- Identify the data needed by air traffic controller (ATCO) to ensure that the proposed solution is correct
- Investigate methods for adaptation of the automated system to changes of the environment ensuring business continuity and safety



Project Scope



Knowledge Graph

Knowledge graph:

- Populated from trustworthy sources
- Schema based on existing SWIM exchange models
- Instance data of KG need to conform to schema

Must be expanded with local rules (operational procedures, coordination rules etc)

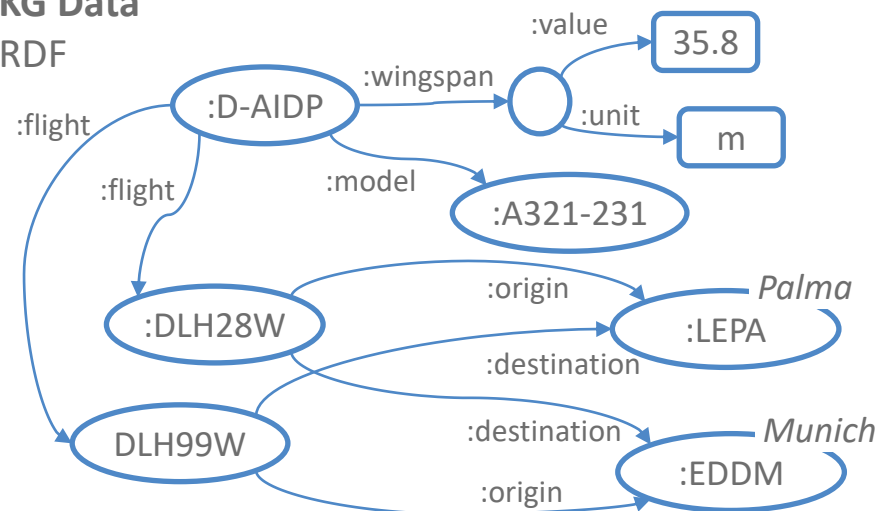
KG Schema

RDFS + SHACL

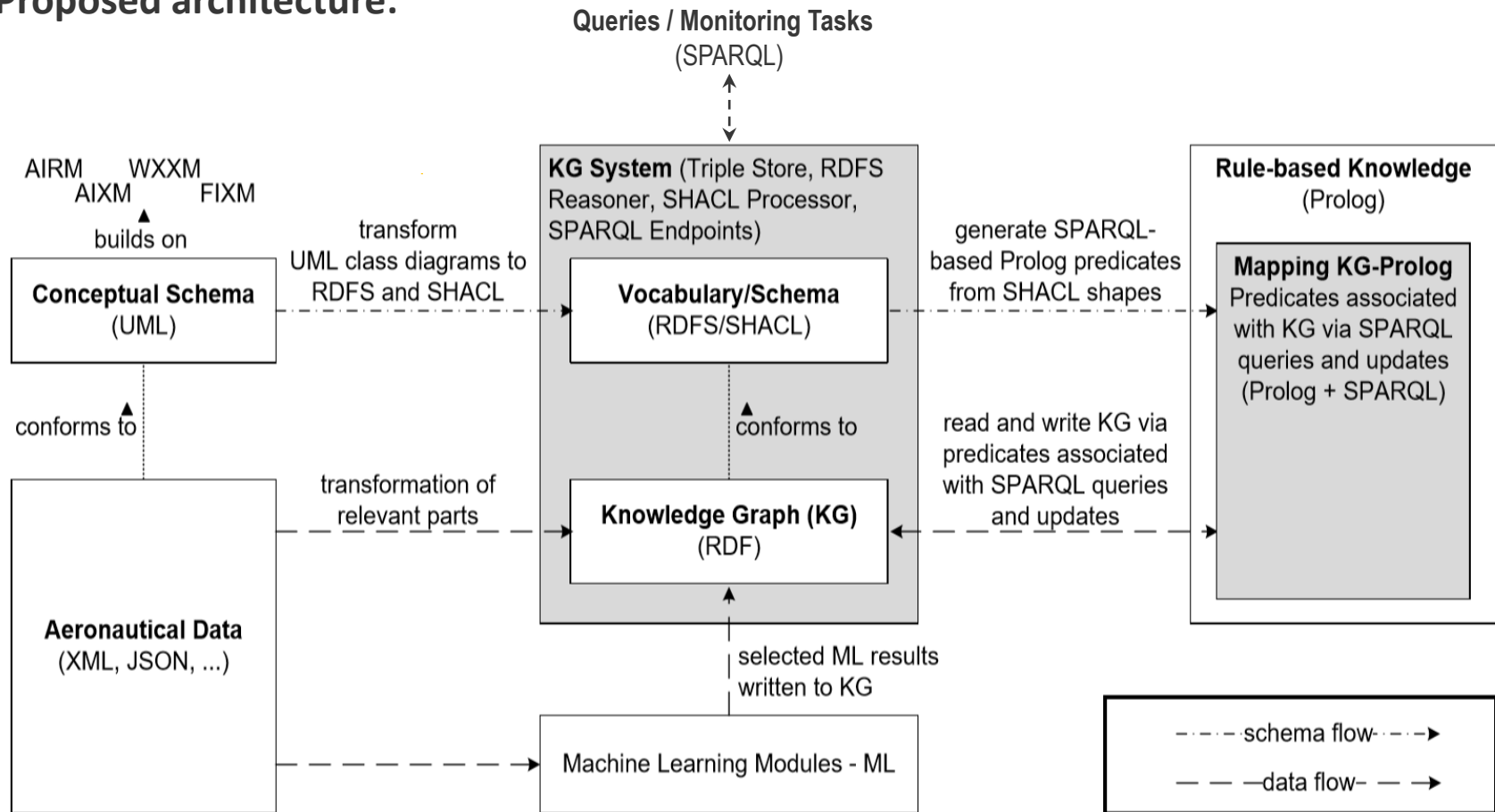


KG Data

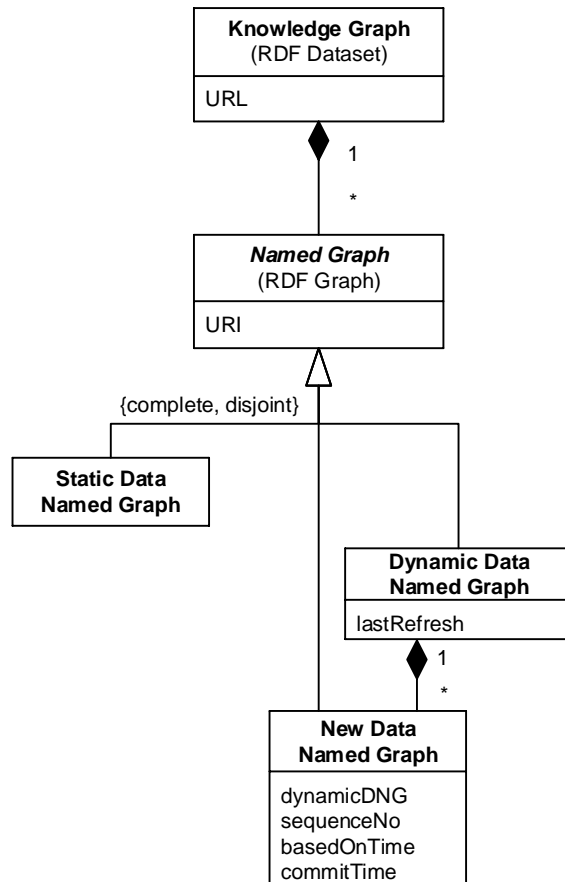
RDF



Proposed architecture:



Knowledge Graph (KG): RDF Data Set (AISA domain data)



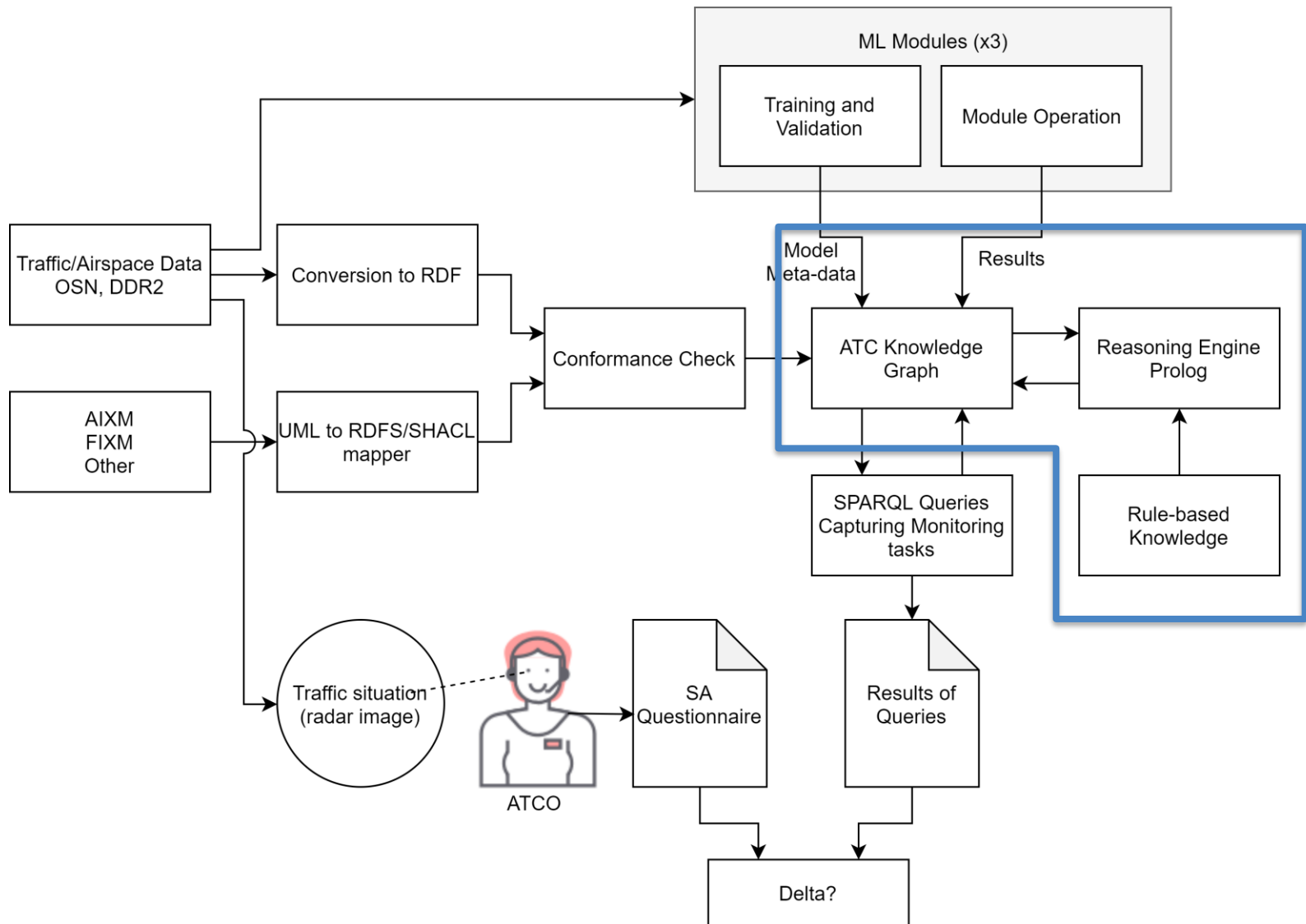
AISA domain data are either:

1. Static, such as AIXM-Data
 - come at once
 - do not change (no updates)
2. Dynamic, such as FIXM-Data
 - come in steps
 - no changes, only additions

KG maintains for dynamic data:

- A NewDataNamed Graph for each additions as primary source
- Dynamic Data Named Graphs may be maintained *optionally* by applications by repeated refresh (on demand)

Project Scope



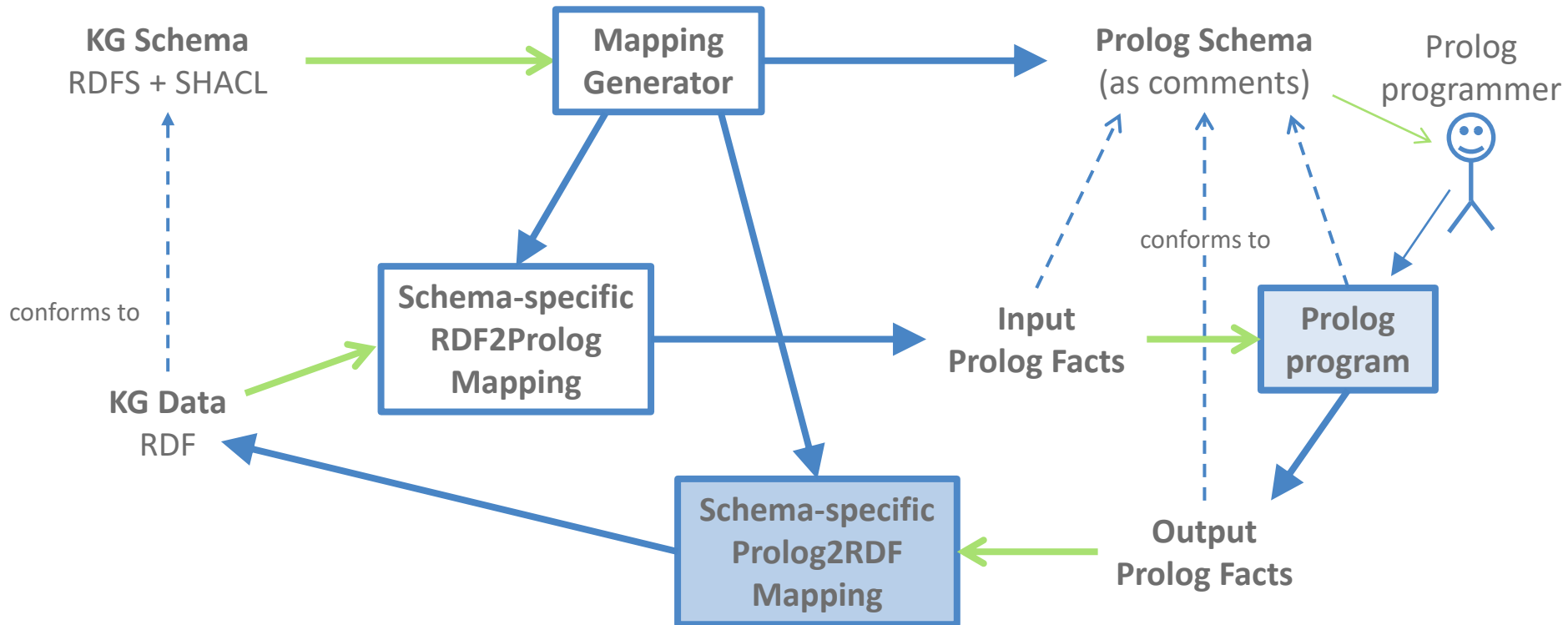
KG-Prolog Mapper Design Goal

Schema-aware Approach



- Offload more advanced reasoning to Prolog
- Improve access to the AISA Knowledge Graph from Prolog
 - ...by designing a schema-aware RDF2Prolog mapper
 - ...that provides the contents of the AISA Knowledge Graph in complex predicates according to the Knowledge Graph's SHACL schema,
 - ...so that Prolog programmers can easily develop Prolog programs, which read from and write to the AISA Knowledge Graph.

Schema-aware Approach

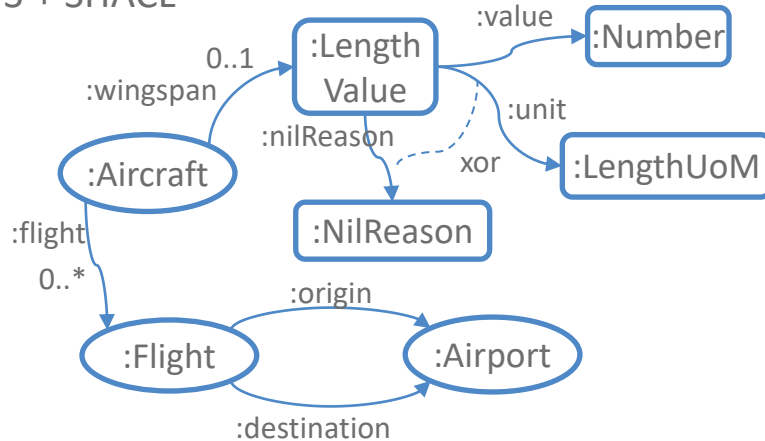


Legend:

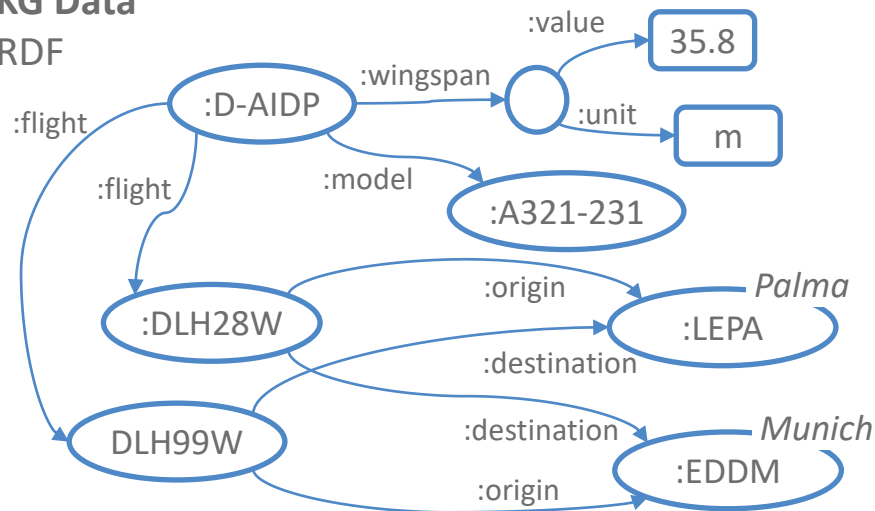
Input → Engine → Output

Schema-aware Mapping Example

KG Schema RDFS + SHACL



KG Data RDF



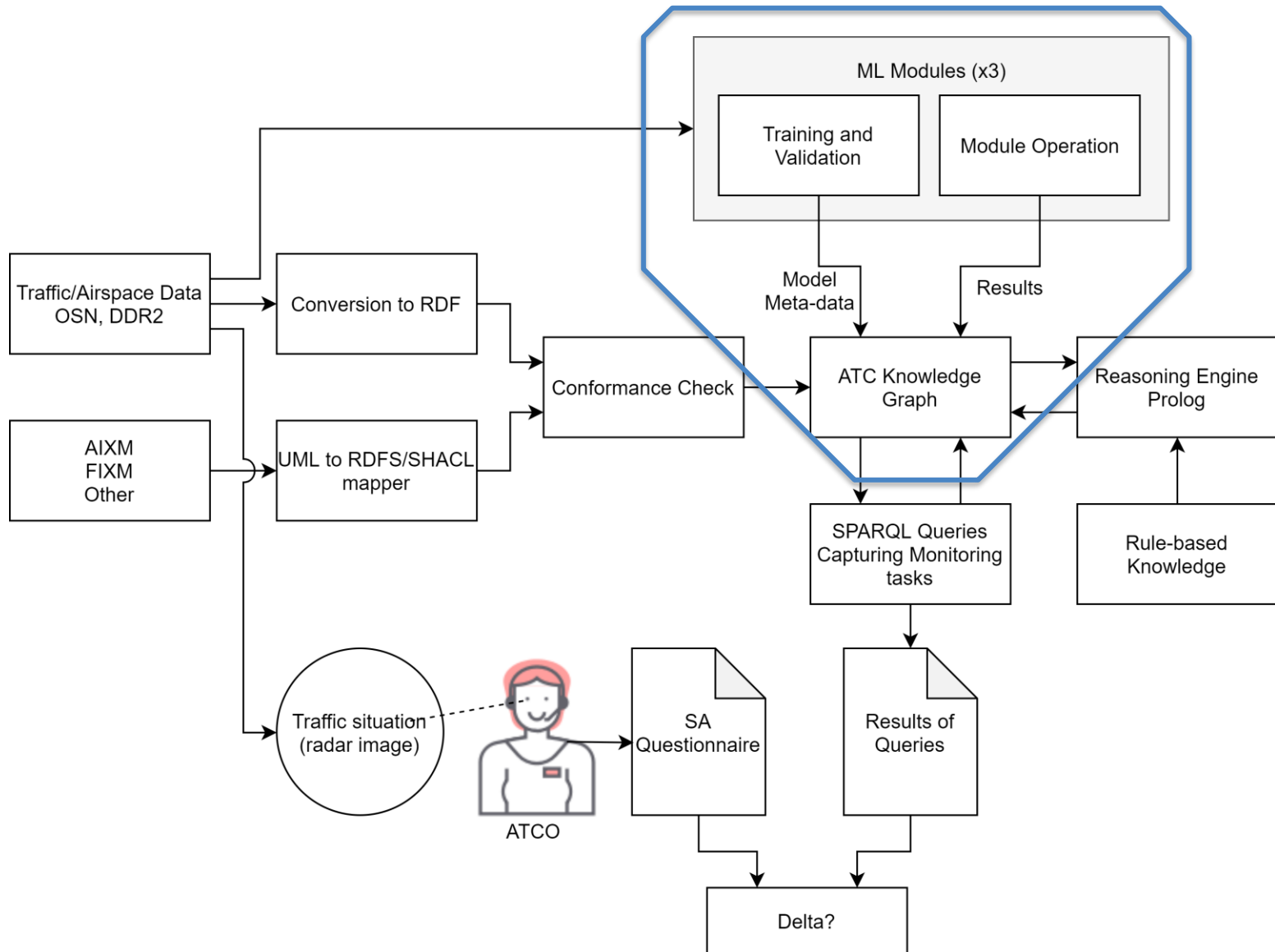
Prolog Schema (as comments)

```
% aircraft(graph,id,wingspan?,model?,flight*)
% flight(graph,id,origin,destination)
```

Prolog Facts

```
aircraft(:g1,:D-AIDP,val('35.8','m'),:A321-231,
        [:DLH28W, DLH99W]).
flight(:g1,:DLH28W,:LEPA,:EDDM).
flight(:g1,:DLH99W,:EDDM,:LEPA).
```

Project Scope

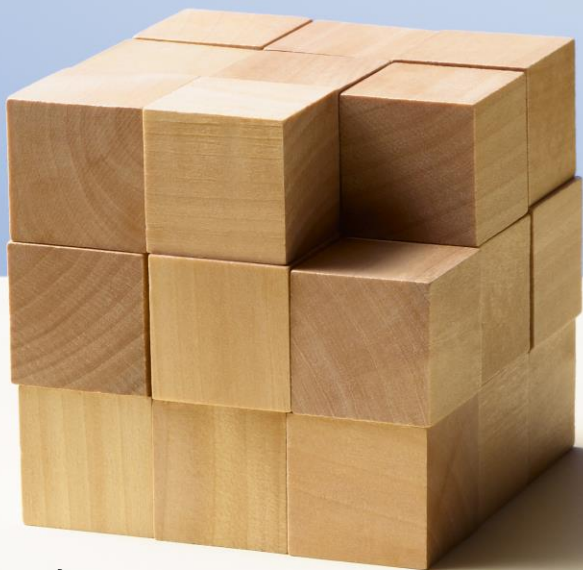


Three experiments:

- Conflict detection module
- Trajectory prediction module
- Traffic complexity module

Research questions:

1. To what extent can functioning of a ML sub-system be verified by a reasoning engine?
2. What is the best way to integrate ML modules into the KG-based system?

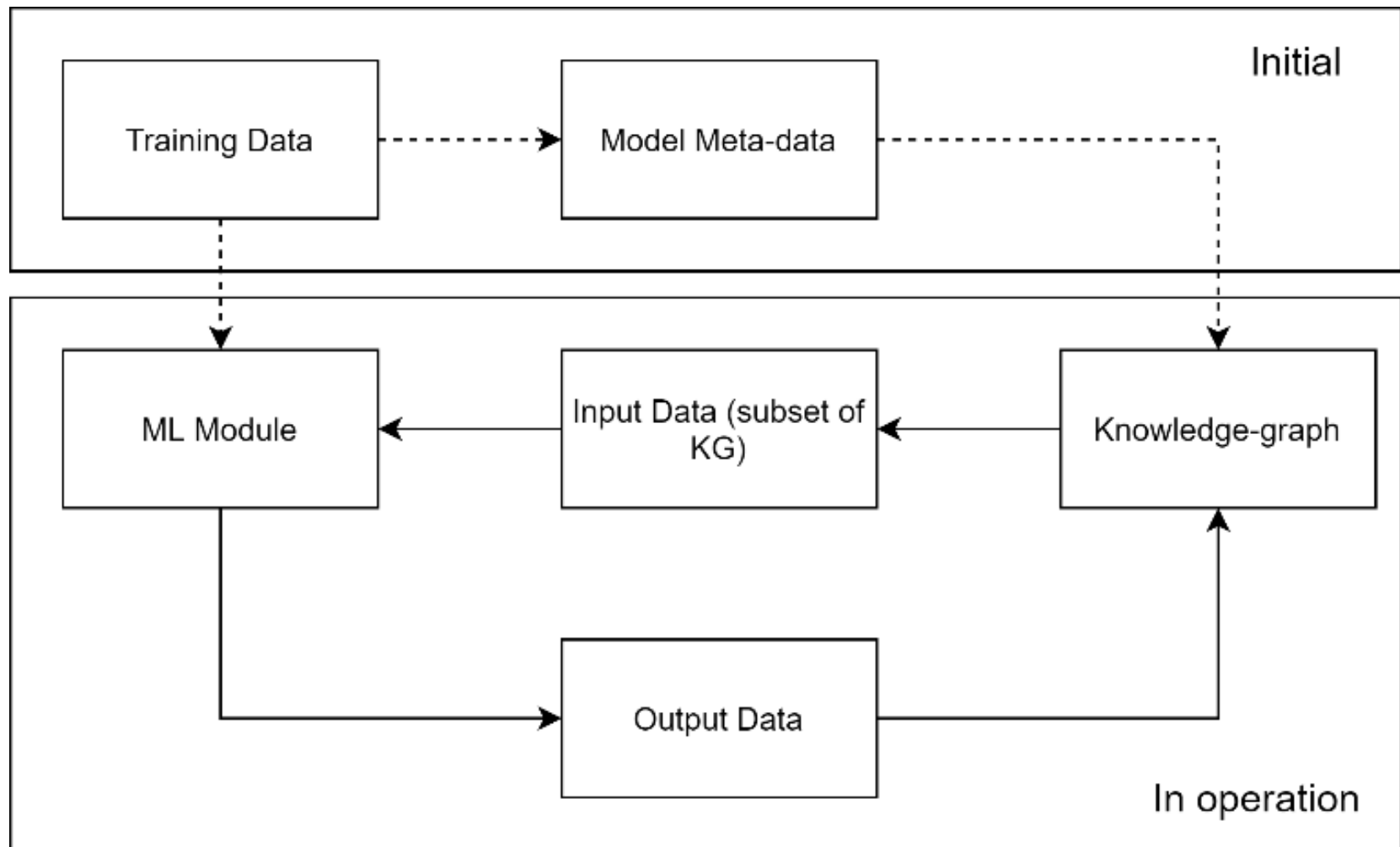


Knowledge Graph

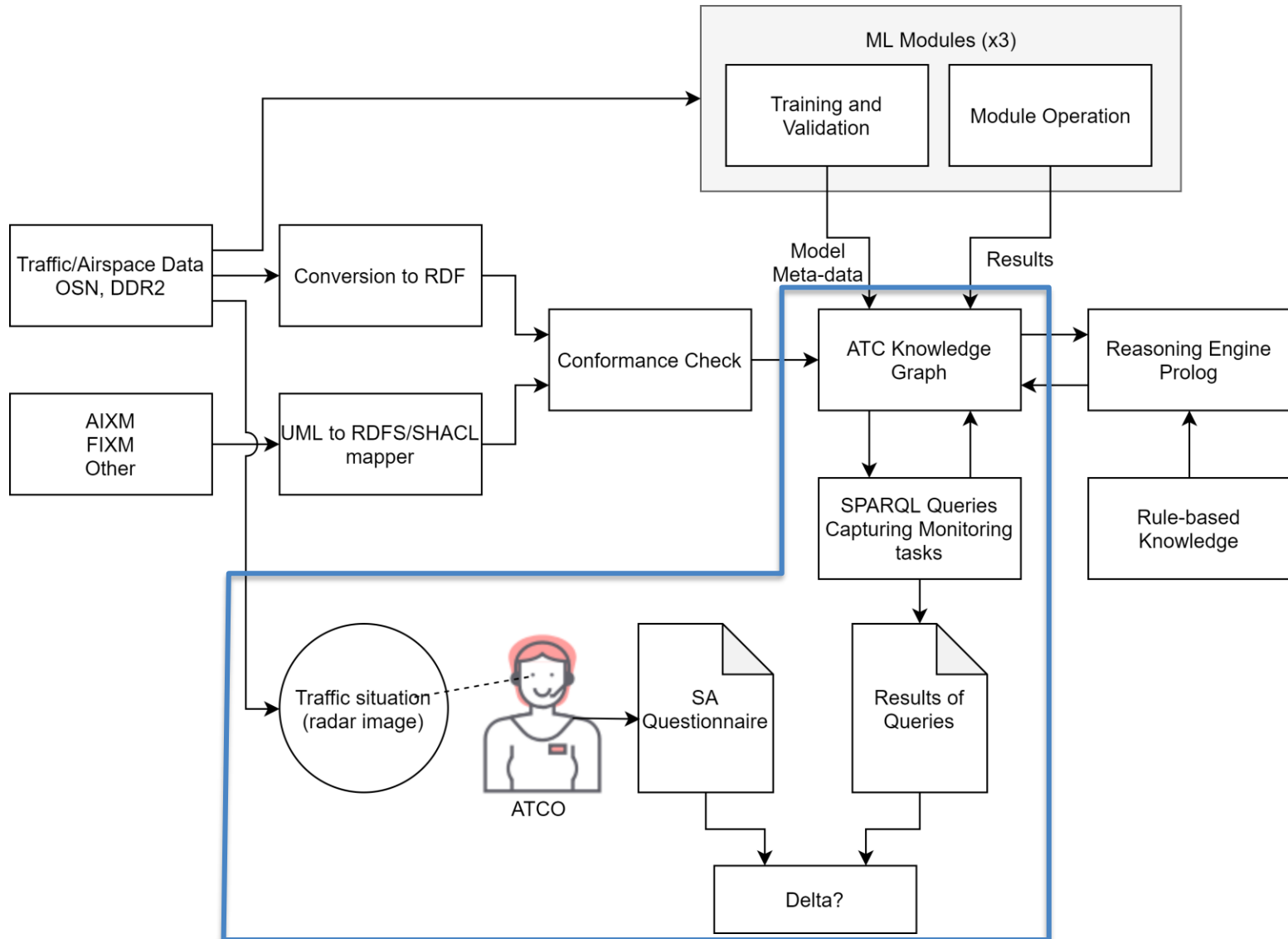


ML output

ML Modules



Project Scope



Experimental Design

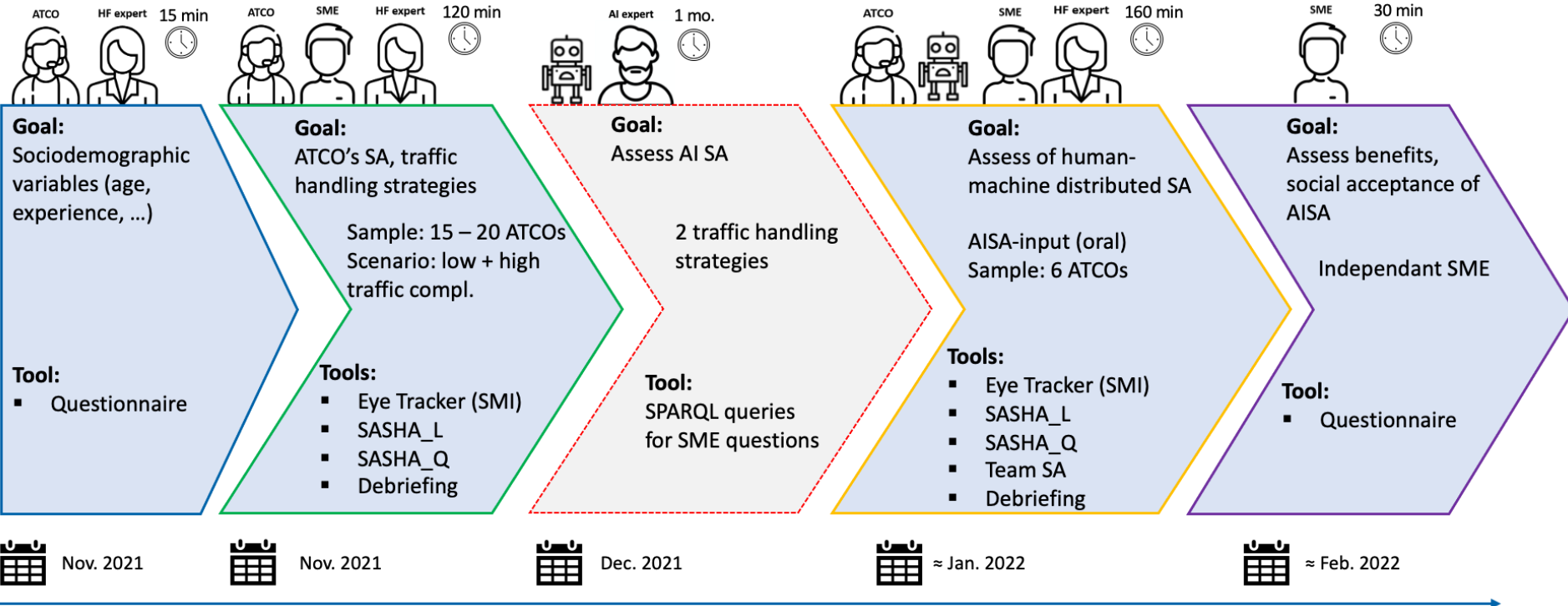
Participant preview

Experiment 1 HITL-Simulations

Data preparation

Experiment 2 Simulation with «AISA-input»

Evaluation



Legend

Executed by ZHAW in collaboration with skyguide.

Executed by FTTS, TUBS, UPM and ZHAW.



Thank You!

AI Situational Awareness Foundation for Advancing Automation
(AISA)



Founding Members

