

# Leveraging AI and automation to achieve innovation in operations

*Gabriele De Canio, Artur Palowski, Michelle Baker*

*European Space Operations Centre, European Space Agency*

## 2022 SpaceOps Workshop

1<sup>st</sup> June 2022

# ESOC 2025+ Strategic Vision & Initiatives



## Centre of Excellence

A world-class Operations Centre, manager of Space Safety, driver for innovation and enabler of industry

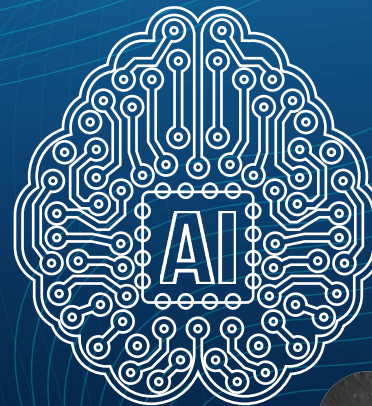
Foster excellence in execution today and tomorrow

Be at the forefront of innovation

*By 2030, we want demonstrated AI technologies to enhance operational efficiency and enable twice as many ambitious missions, by embracing fast iterations, and by refocusing intellectual and financial resources*

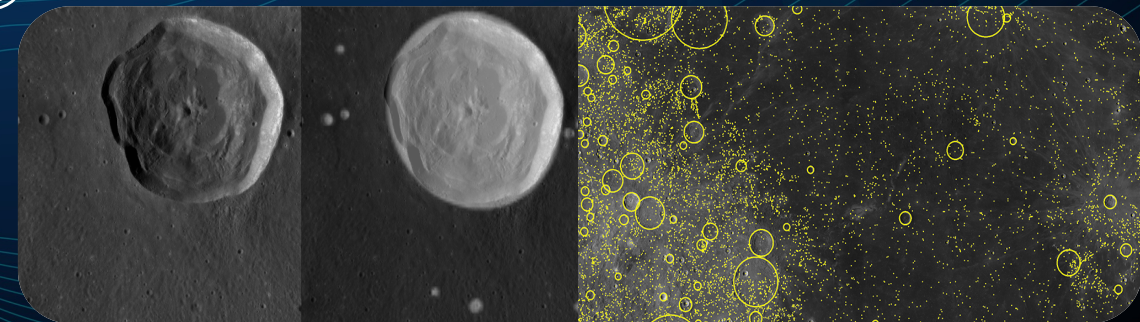
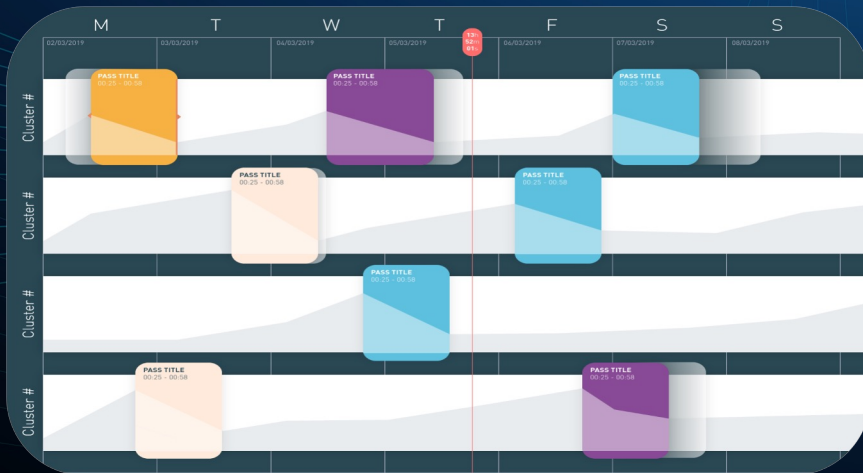


# Significant potential for AI in mission operations



→ **Collision Avoidance Challenge**  
To manoeuvre or not to manoeuvre ... that is the question.

[Take Part](#)



ESA UNCLASSIFIED – For ESA Official Use Only



→ THE EUROPEAN SPACE AGENCY

# We followed a rigorous and fast-paced approach



- Use cases collection
- Benchmarking analysis and assessment
- Mapping to OPS processes

- Use cases exploration
- Analysis of strategic connections

- Prioritization based on impact and feasibility
- Business case development
- Development of actionable roadmap

- Ideation
- Development

- Production
- Testing and validation
- Ideation
- Development

14 weeks

10 weeks

12 weeks

**70+** mission operations and AI experts engaged

**10** ideation workshops

**150+** hours of interviews and brainstorming

McKinsey & Company

QUANTUMBLACK  
A MCKINSEY COMPANY

**AIRBUS**

# A<sup>2</sup>I: Artificial Intelligence for Automation Roadmap

5 Mission Operations domains prioritized – 14 use cases



Pre-launch

Post-launch

## 7 archetypes

AI-enhanced modelling



Automated content generation



Automated diagnostics



Automated prognostics



Decision recommendation engine



Visually enhanced simulation



AI enabler



# The roadmap is being validated via 2 prototypes

**OCAI: AI assistant to support decision making of Flight Control Teams**

**ESTIM: AI-based root cause explorer for ground station passes**



**Technology – AI**



**Change management – Agility**



**Adoption – Value creation**



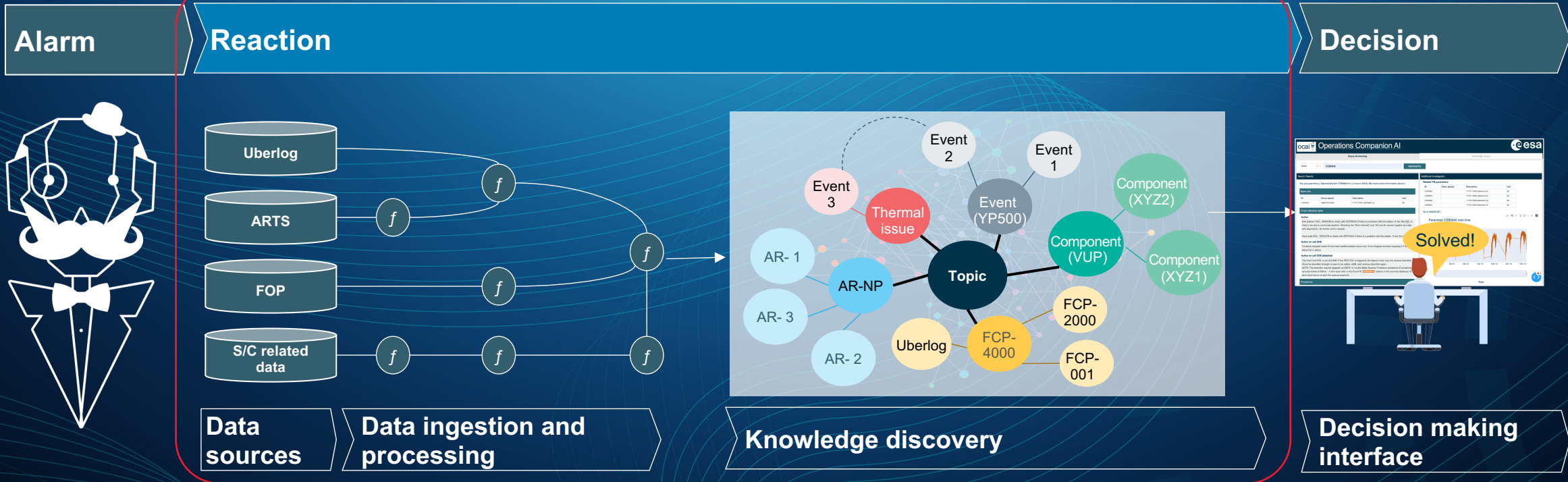
**Increase efficiency**



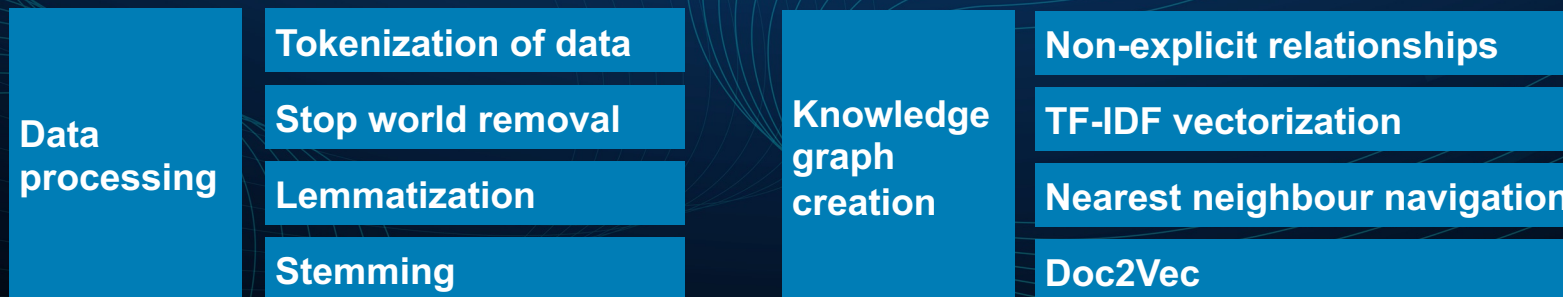
**Tangible impact – Refocus resources**



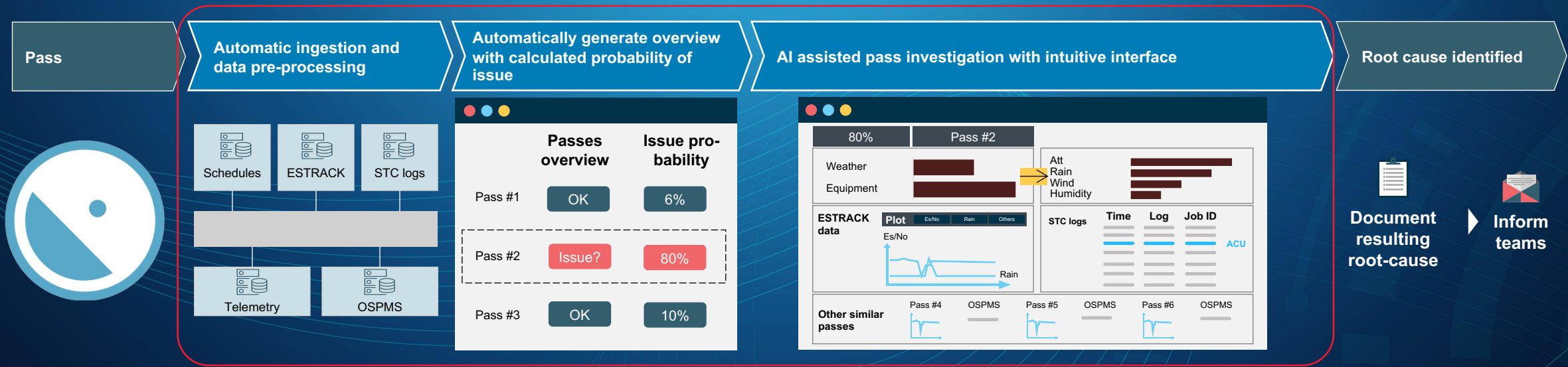
# OCAI – Operations CompAnlon



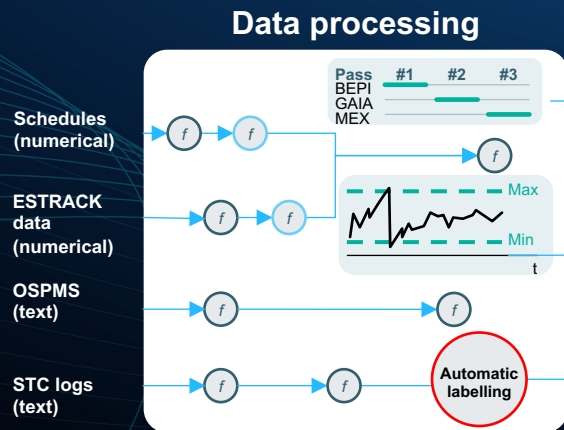
## AI elements



# ESTIM – EStRack Investigation & Monitoring



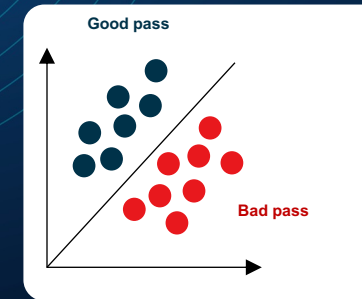
## AI elements



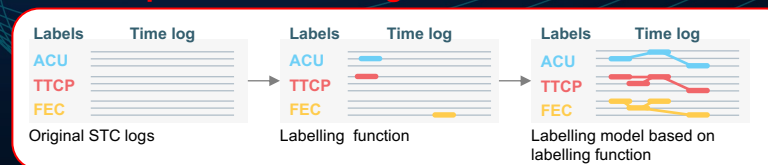
## Root cause analysis and anomaly detection



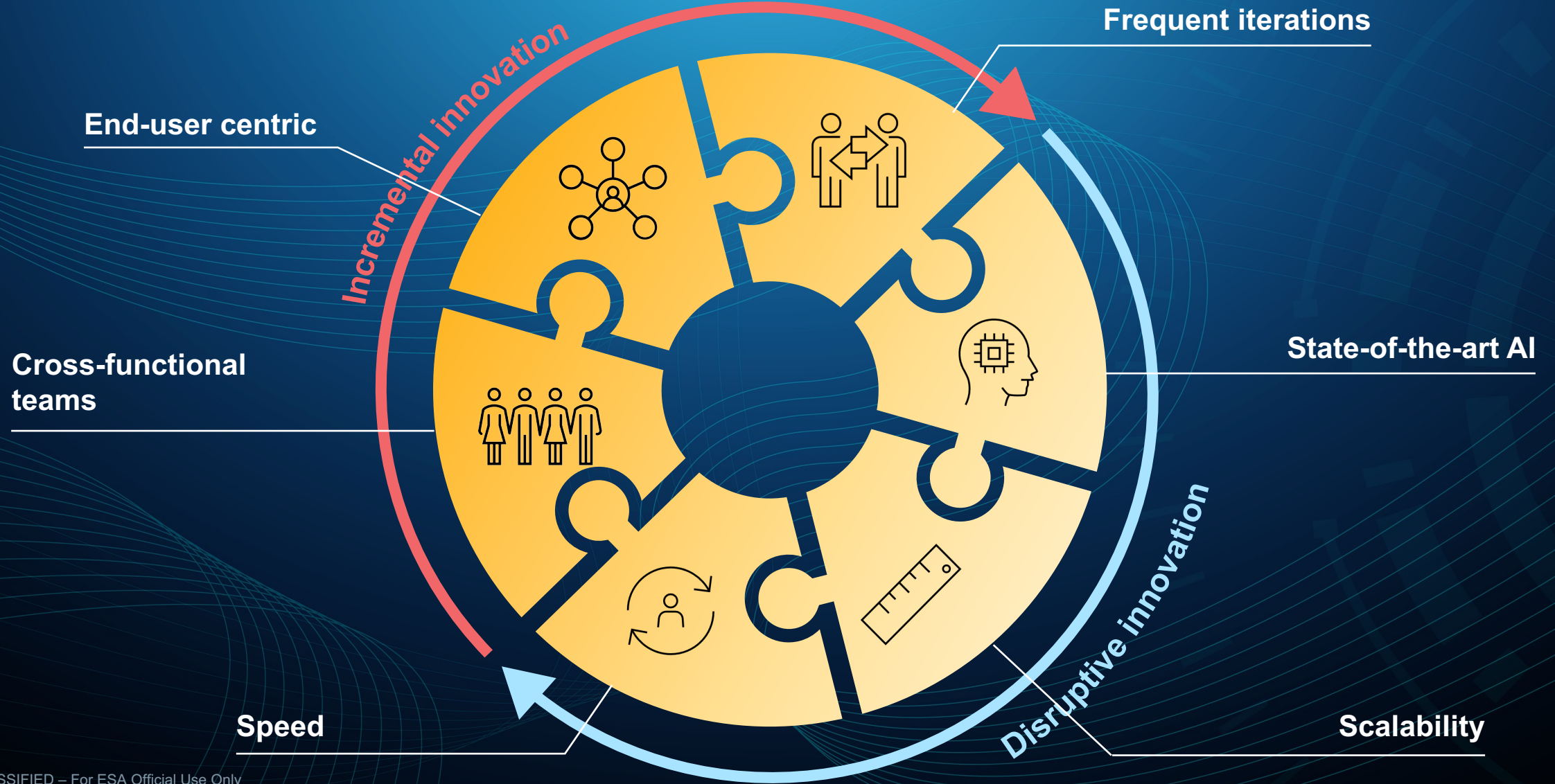
## Classification model



## Weak supervision labelling



# Incremental and disruptive innovation



*Thank you!*

Gabriele De Canio, [gabriele.decanio@esa.int](mailto:gabriele.decanio@esa.int)  
Transformation Officer  
Strategy and Transformation Office  
European Space Operations Centre  
European Space Agency

# A<sup>2</sup>I: Artificial Intelligence for Automation Roadmap



Roadmap

Domain	Use cases			
<b>A Ground system maintenance and ground operations</b>	<b>A1</b> Machine learning based incident classification and root-cause analysis assistance	<b>A2</b> AI-based predictive maintenance		
<b>B Mission simulation and analysis</b>	<b>B1</b> AI techniques to improve mission analysis (e.g. DEM / DTM generation)	<b>B2</b> Intelligent MAG and CReMA document generation		
<b>C Operations preparation and operational simulation</b>	<b>C1</b> Intelligent assistance for automated procedure generation and validation	<b>C2</b> AI assistance to support simulation validation and failure identification	<b>C3</b> Spacecraft digital twin	<b>C4</b> Fast surrogate simulator for model consistency validation
<b>D Flight control team &amp; ground stations</b>	<b>D1</b> AI decision support tools for controllers	<b>D2</b> Intelligent digital planning platform	<b>D3</b> Operations planning through human behaviour modelling	
<b>E Flight dynamics</b>	<b>E1</b> Data driven physical models orbit determination and prediction			
<b>F Satellite health monitoring and data processing</b>	<b>F1</b> Intelligent telemetry data anomaly detection	<b>F2</b> Intelligent root-cause investigation and AI-assisted handling	<b>F3</b> AI-based long-term satellite health forecasting	<b>F4</b> AI-based short-term satellite health forecasting
<b>G Space Debris</b>	<b>G1</b> AI-supported catalogue fusion	<b>G2</b> Machine learning dashboard for collision avoidance support	<b>G3</b> Intelligent maneuver recommendations	
<b>H Systems testing and validations</b>	<b>H1</b> Deviation analysis in validation and regression testing outputs	<b>H2</b> AI-supported test case creation	<b>H3</b> Automated test report generation	
<b>I Space weather</b>	<b>I1</b> Intelligent portfolio optimization	<b>I2</b> Intelligent UX	<b>I3</b> Smart space weather data lab	<b>I4</b> Automated description of metadata <b>I5</b> Automated central service desk