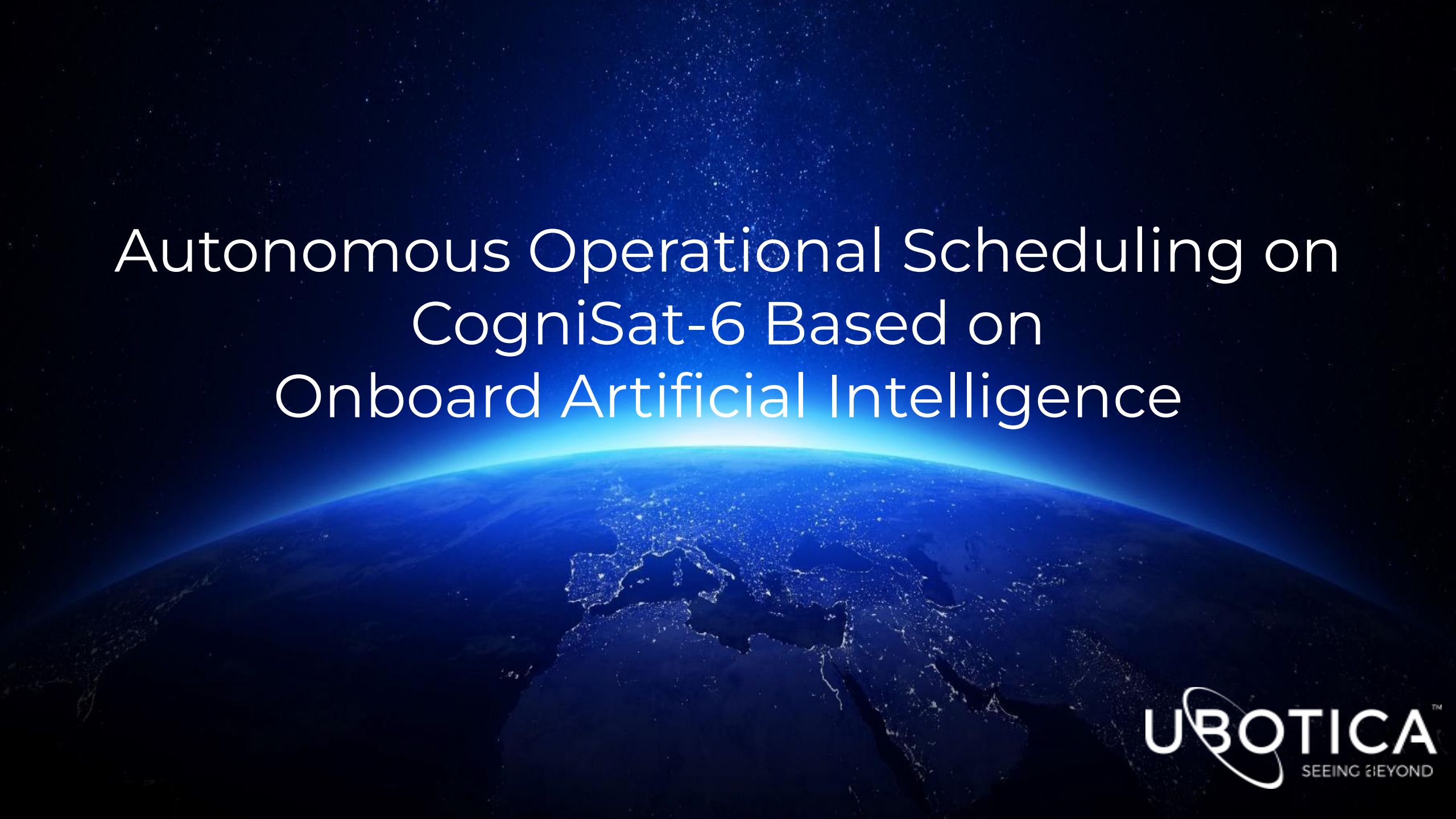
Autonomous Operational Scheduling on CogniSat-6 Based on Onboard Artificial Intelligence



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Content

1. Introduction
2. Related work
3. System overview
4. Autonomous scheduling
5. Conclusion

Introduction

Ubotica's Purpose

To disrupt the Satellite Services Market by transforming satellites into smart, autonomous, collaborative robots that generate persistent, real-time, insights of high value

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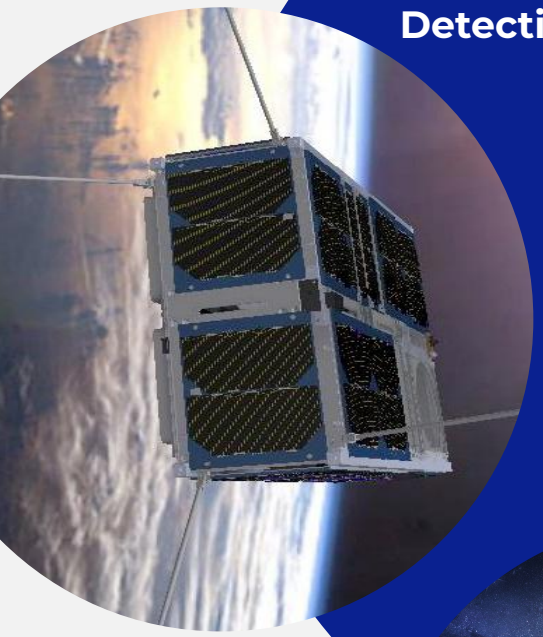
Our Space Flight Heritage



PhiSat-1

launched September 2020
Detecting clouds in EO data in real-time
First ever On-Satellite Hardware Accelerated AI Inference

ISS

launched March 2021

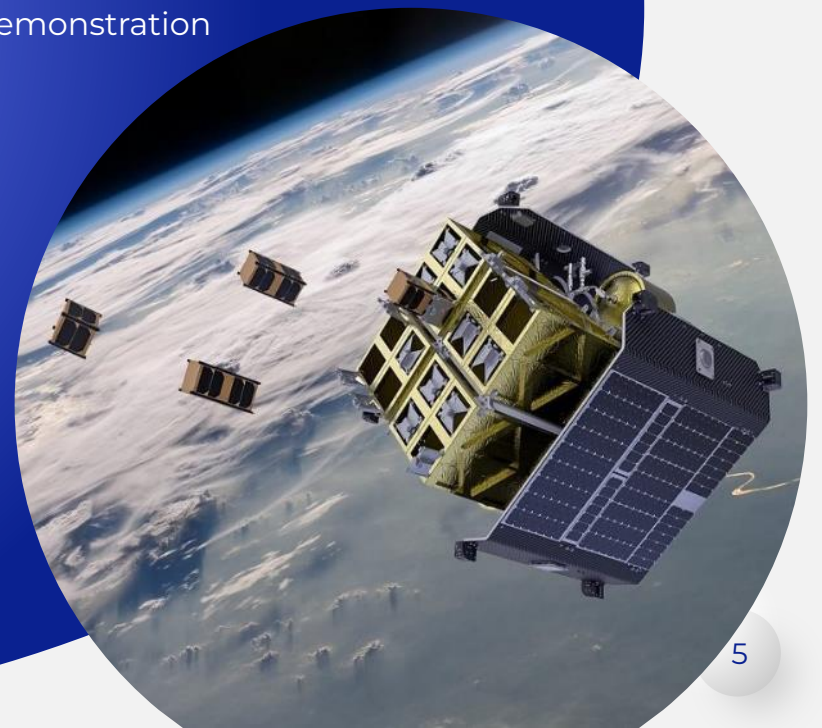
Landmark detection, Flood Detection

D-Orbit ION Wild Ride

launched June 2021
Cloud Computing on satellite

The world's first space mission using radiation–tolerant advanced heterogeneous computing technologies

Ship detection demonstration



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Why AI on board matters - the EO story

Problems:

1. EO spacecraft collect significant amounts of non-valuable data
2. System resources are limited (storage, downlink, power)
3. EO spacecraft typically operate in “mow-the-lawn” fashion

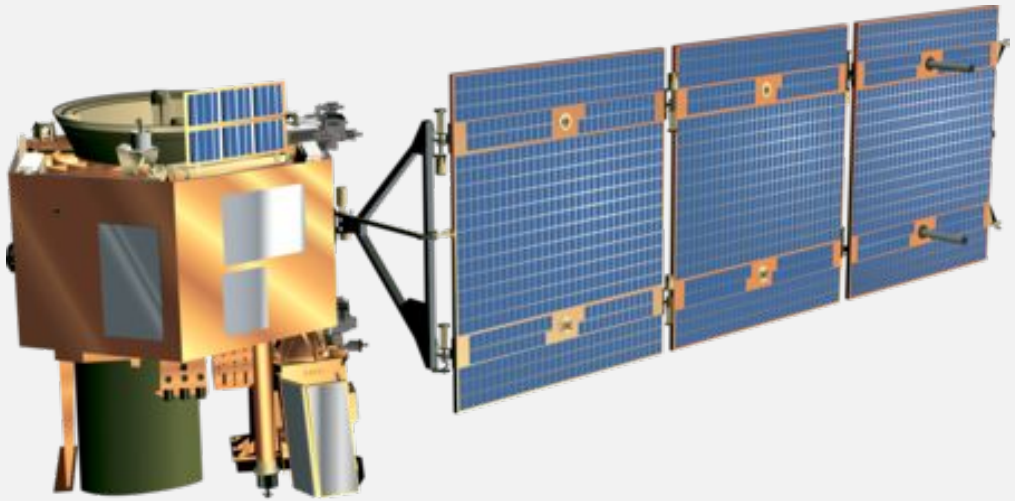
Solutions:

1. Non valuable data can be identified
2. System resources can be used more efficiently by prioritising valuable information or discarding non-valuable data
3. EO spacecraft can operate dynamically by interpreting context

A Non-Exhaustive Overview of Autonomous Scheduling Up To Now

EO-1

- Operational from 2004-2017
- Extracted events that are of the highest science value using decision trees and SVM's.
- Autonomous onboard planning
- 550+ kg



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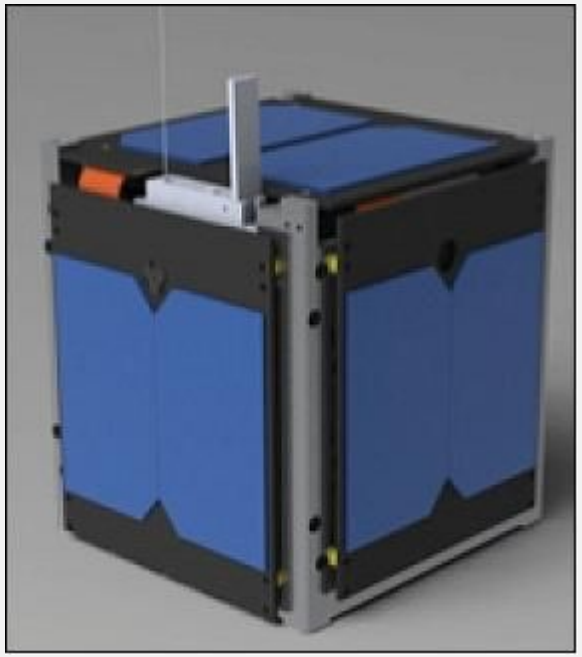
IPEX (Intelligent Payload Experiment)

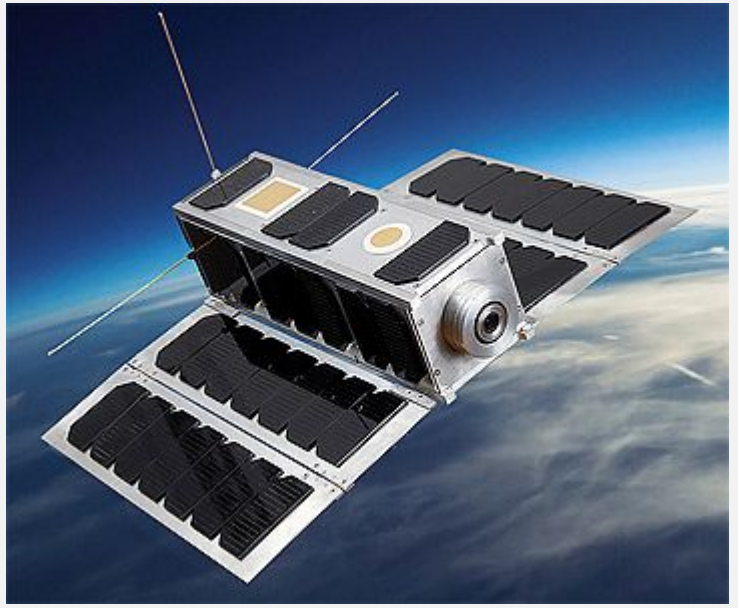
- Operational from 2013-2015
- Machine learning methods, SVM, spectral unmixing techniques, TextureCam random forest classifier, and image salience analysis
- Onboard scheduling of follow-on acquisitions
- 1U CubeSat



NASA

OPS-SAT

- Operational from 2019-now
- First demonstration of onboard training of AI models
- Installation of “apps” via NMF
- AI-in-the-loop EO
- Autonomous planner tested on ground
- 3U CubeSat



ESA

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CogniSat-6

- Joint mission Ubotica and Open Cosmos
- Operational from Q1 2024
- High resolution hyperspectral sensor
- Onboard AI accelerator
- Inter-satellite communication
- 6U CubeSat

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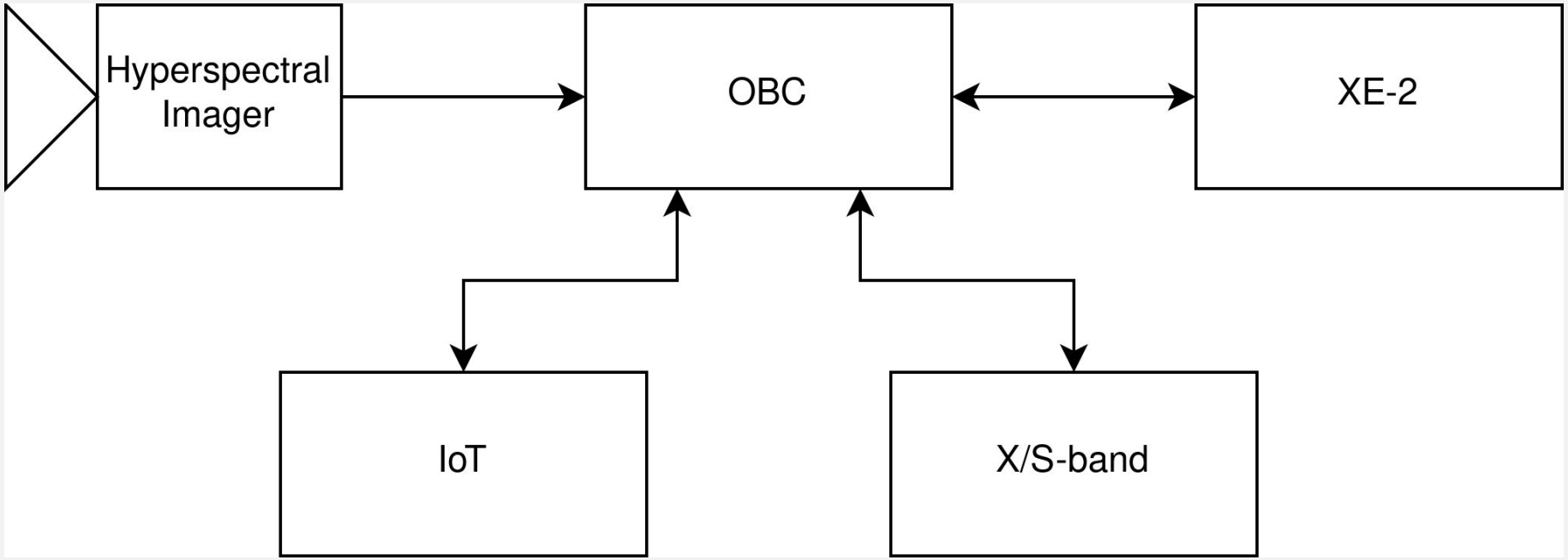
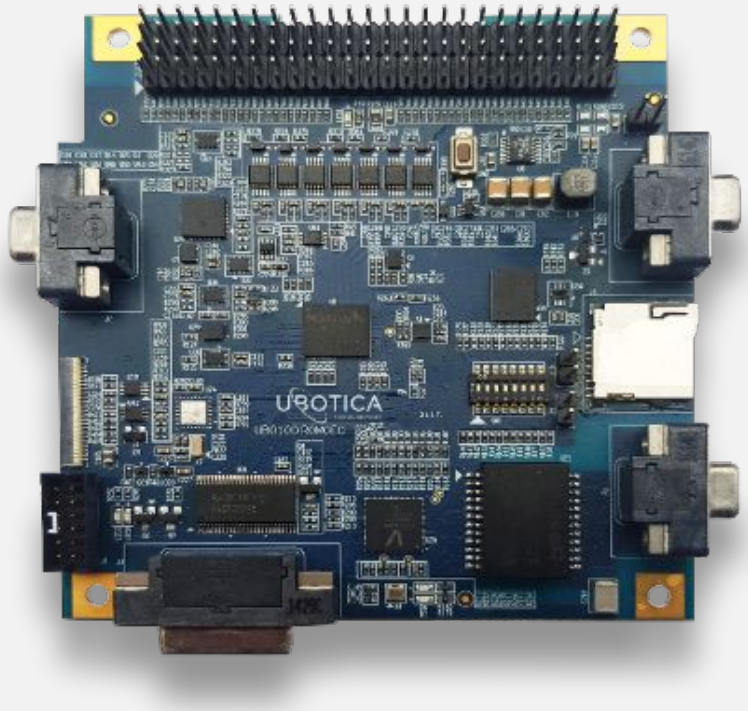
System Overview

CogniSat-6 System Overview



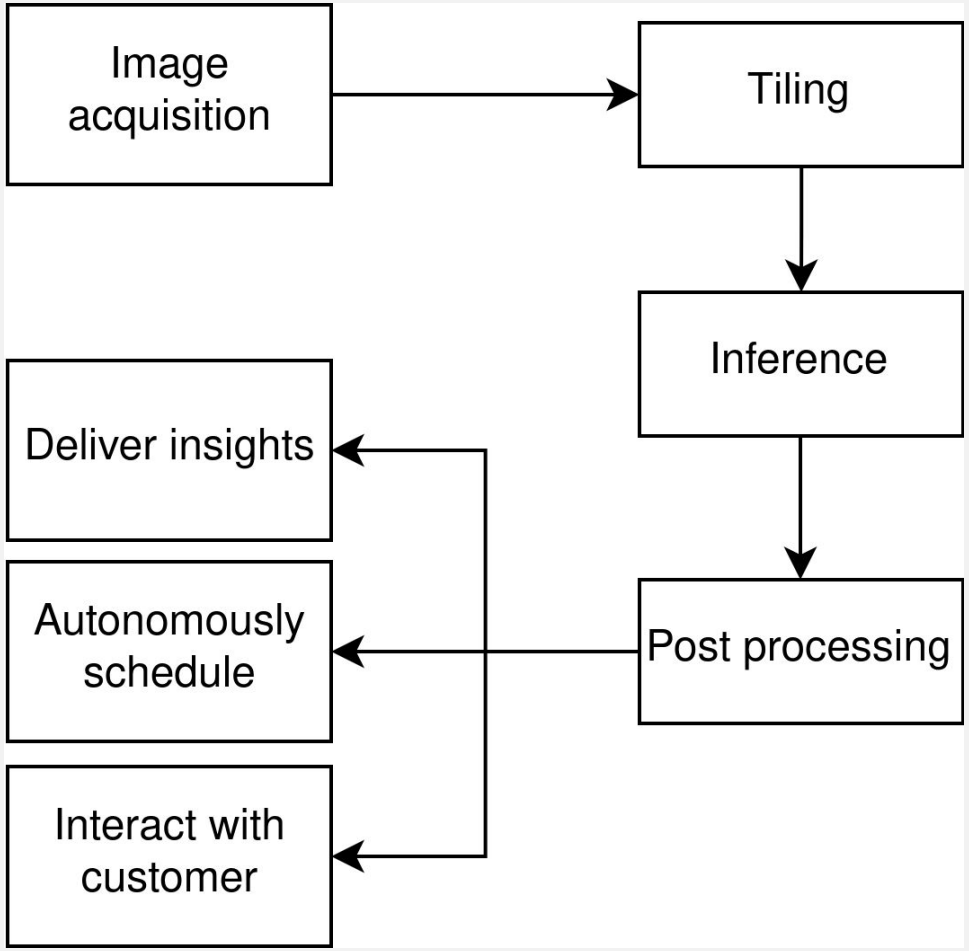
CogniSat-XE2 Processing Platform

- 1 TOPS NN compute
- 4 TOPS Imaging/Vision acceleration
- Low power: 1.5-3.5W when inferencing
- Latch-up protection on all internals
- Radiation tested
- Small (0.2U) and light (55.9 grams)



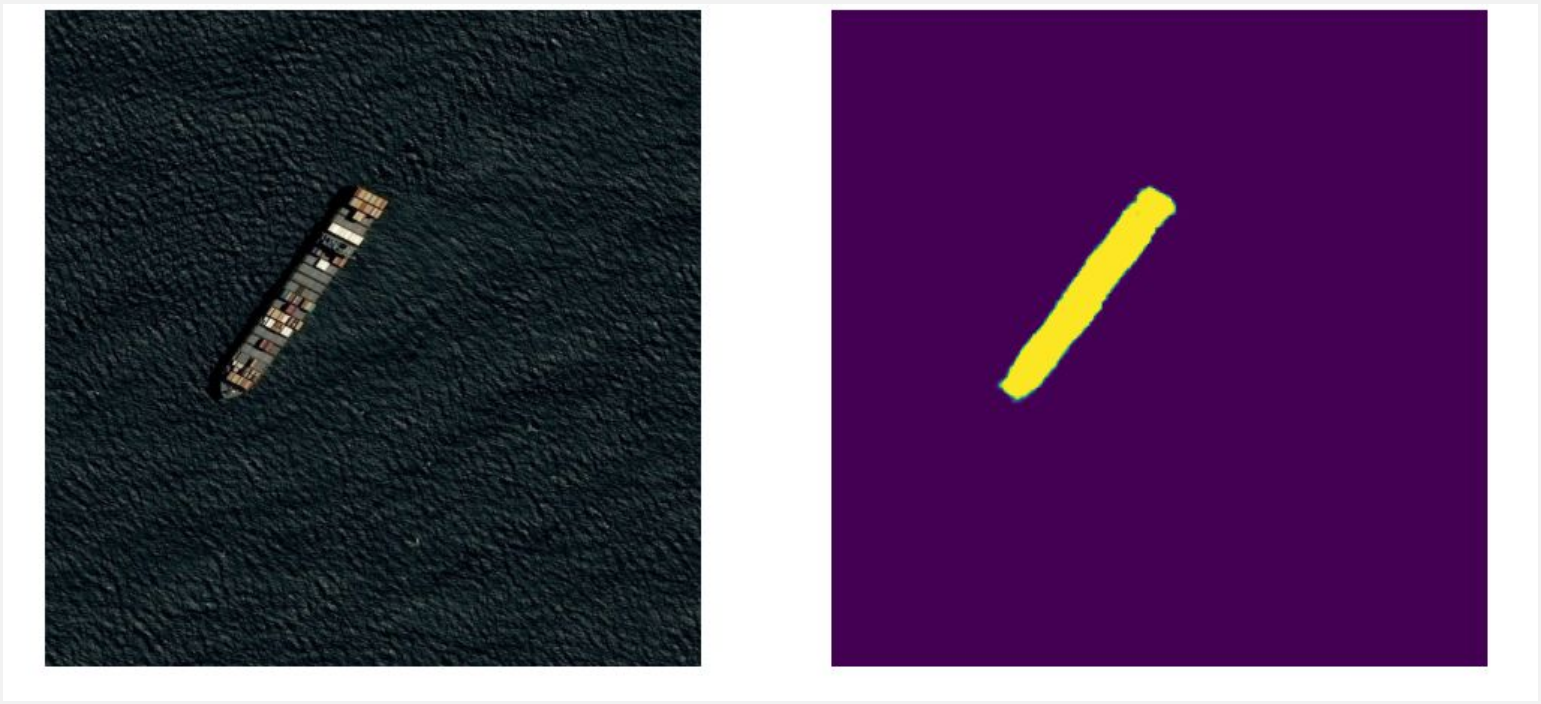
Processing Data

- End-to-end delivery of information extracted from 20x20 km image within 5 minutes from acquisition to end user on ground
- Neural Networks can be dynamically selected



Ship Segmentation

CogniSat-6 will perform inference on raw EO data



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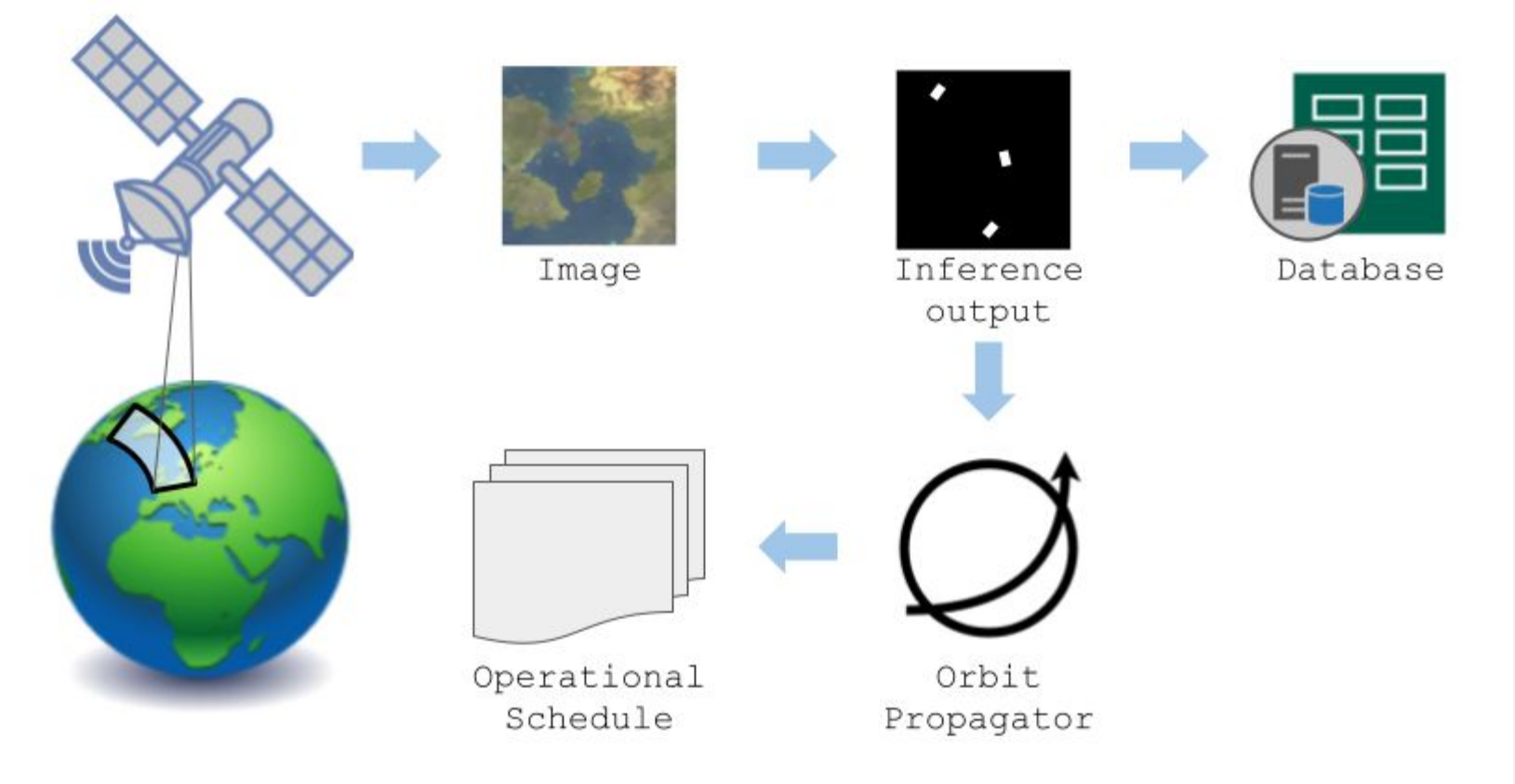
Autonomous Scheduling

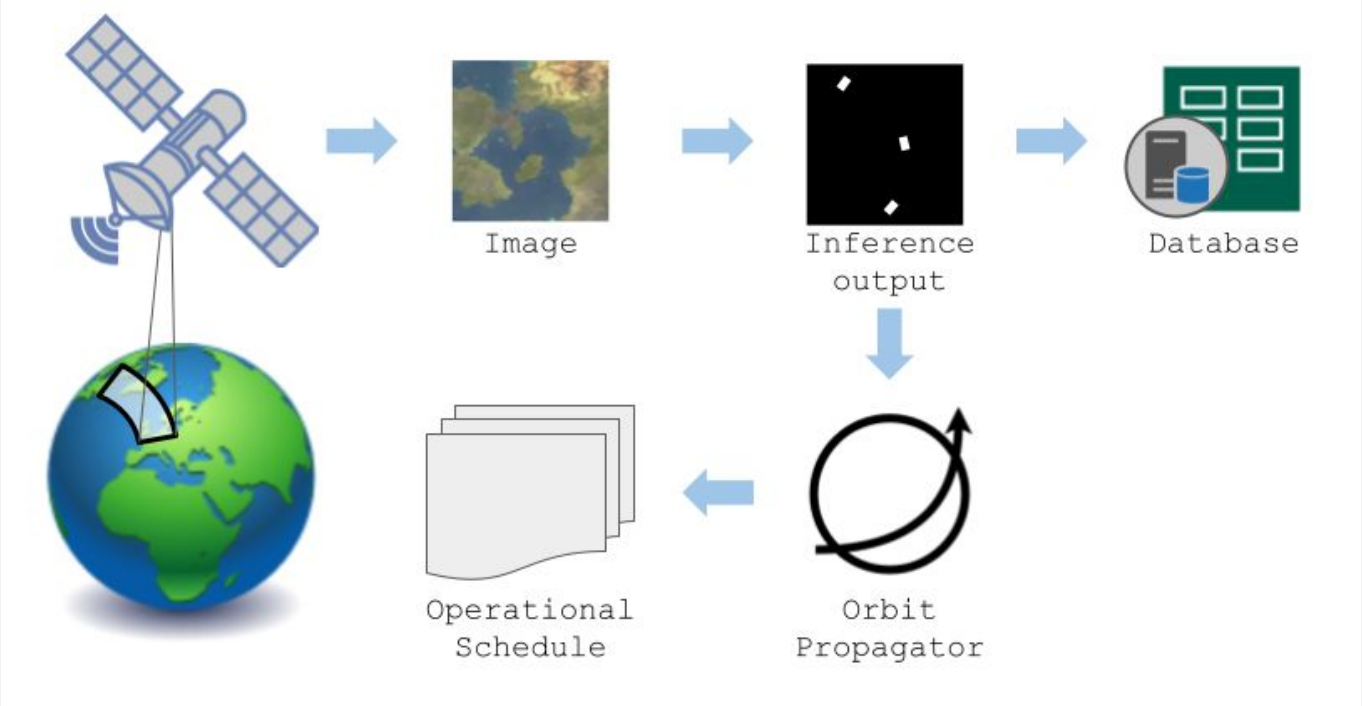
Autonomous Scheduling



All processed depicted here run on spacecraft

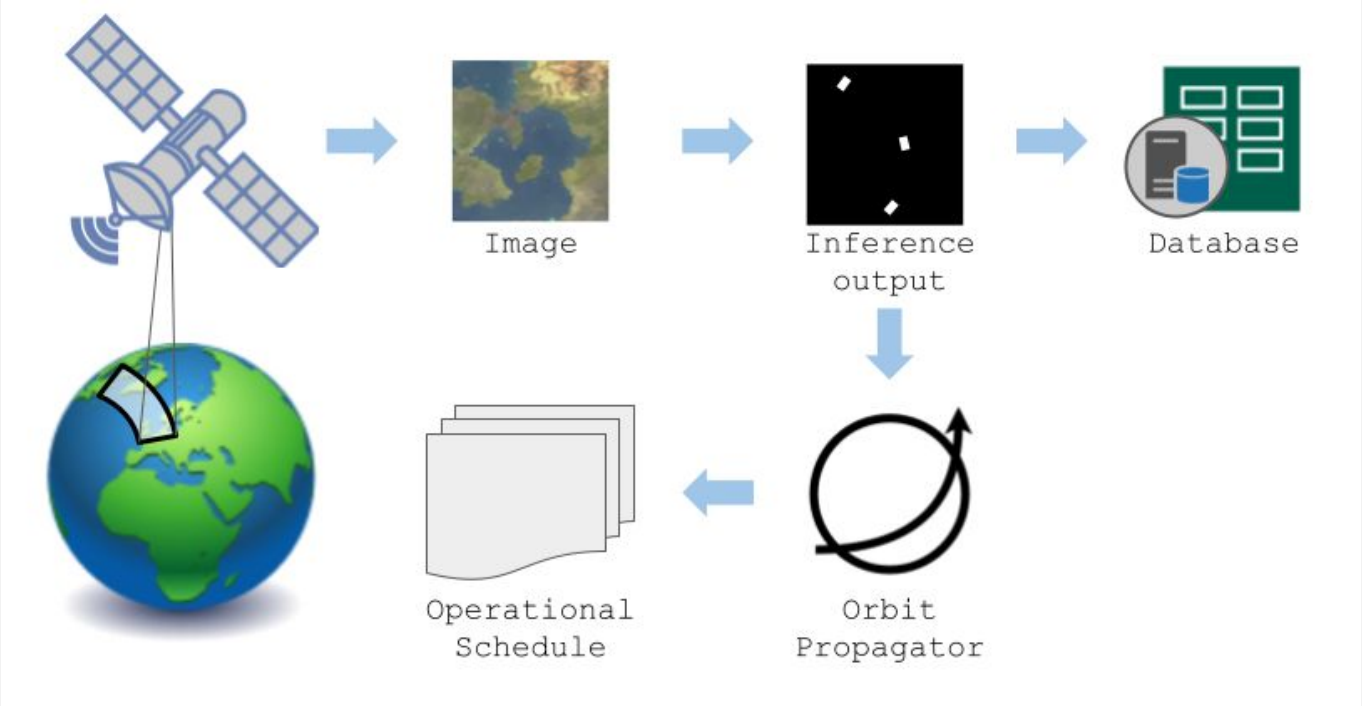
Autonomous Scheduling

- No ground station in the loop
  - Optionally, ground can be informed over ISL
- Ability to share locations of interest with other systems over ISL
- Runs on CubeSat hardware in real time



Benefits of Autonomous Scheduling

- Guarantees value of next acquisition for end-user
- Reduces system response time to events
- Enables tip and cue scenarios for constellations
- Enables complex system responses based on context:
  - “If a forest fire is detected AND human activity is spotted within 500 meters from this event, reschedule acquisition”



Conclusion

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- Onboard AI increases value generation by EO systems by order of magnitude
- Future work will present other CONOPs and operational results

OLD
Centralised
Intelligence
Simple satellites

NEW
Edge
Intelligence
Smart satellites

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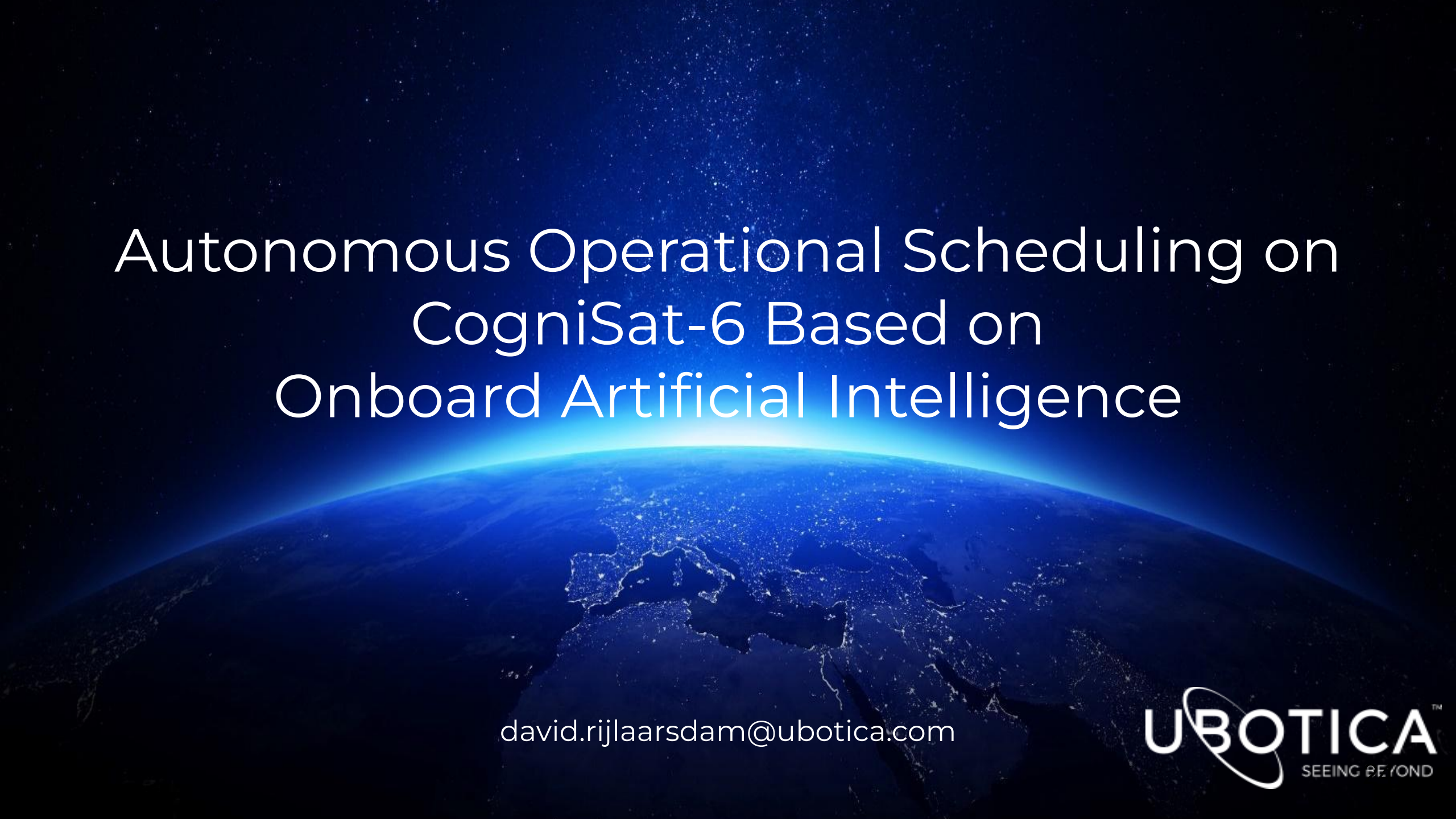

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