Ralph Grundler, Aitech Systems

OpenVPX Transforming Space Operations

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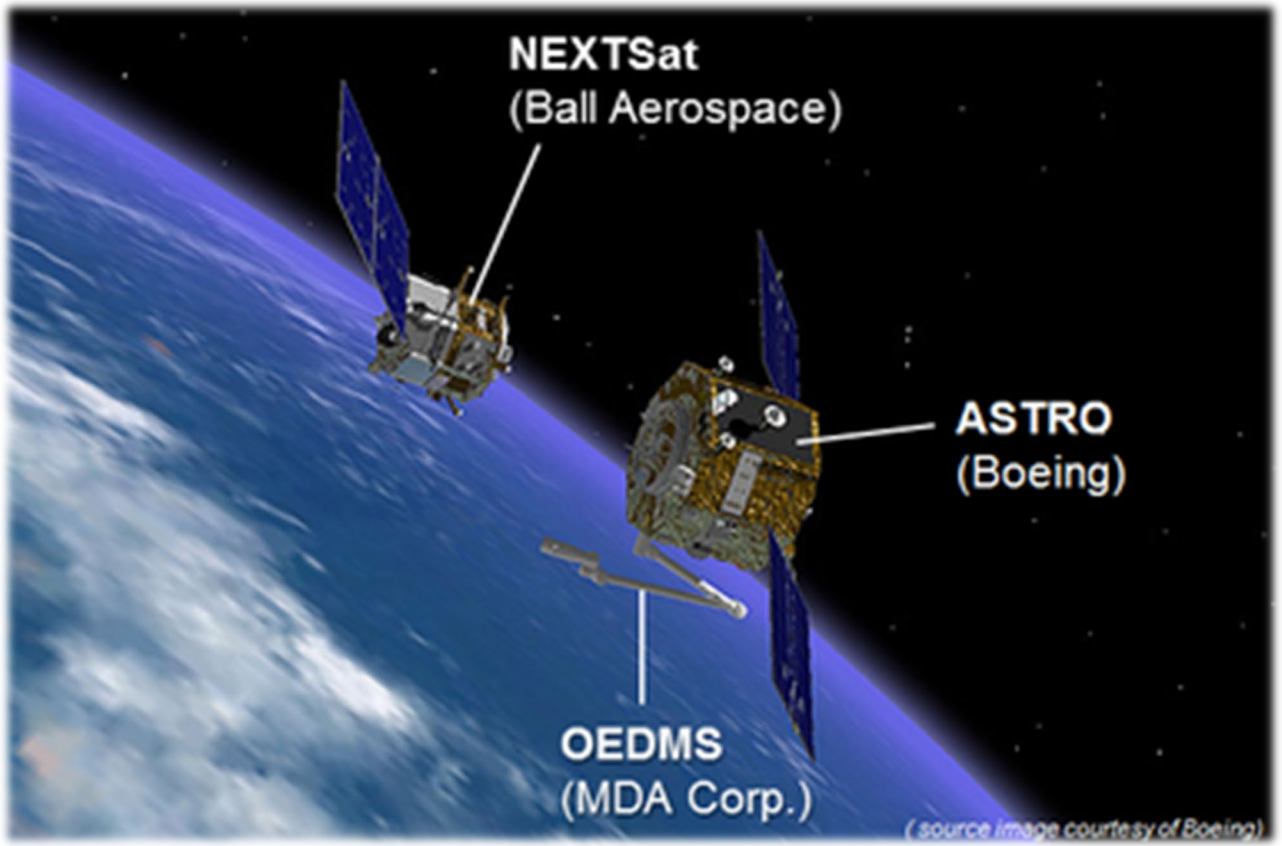
Open Standards in Space Applications: Discussion Overview

- Space Digital Backbone
- Systems-based Approach
- Next-gen Open Standards Hardware
- AI Enablement in Space
- Space Implementation Examples



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Space Digital Backbone

Unified Data Architecture

Primary Elements

1. Open Standard Networking
2. Network Attach Storage (NAS)
3. Edge Computing with AI/ML
4. Security

Connected Infrastructure

- Modularity
- Scalability
- Interoperability
- Maintainability

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Strengthening the Space Business Model

Expanded Opportunities for Exploration & Efficiencies

- Command & Data Handling (C&DH)
- Earth Observation
- Communication
- Power Control
- Robotics with Vision

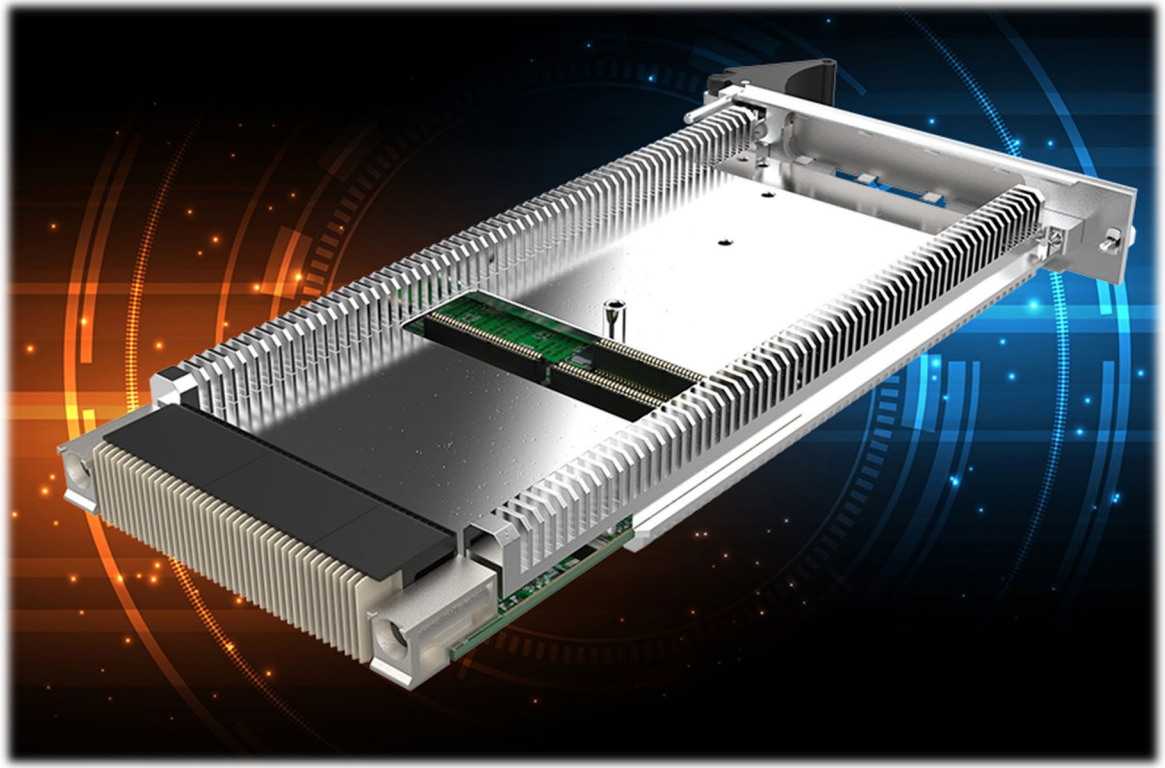
Systems-based Approach

Space-rated Open Standards-based SBC

Improved Computation & Networking

Edge Processing & On-board Computing

Increased Memory & Bandwidth for Fast Data Processing



- High Speed PCIe Fabric Bus
- High Performance CPU
- Low Power
- Large Storage: (Internal & Space Graded SSD)
- Generic Form Factor – 3U VPX
- Flexible Architecture & I/O
- LEO, NEO, GEO, Deep Space
- Provisions for AI & Deterministic Network (TSN)

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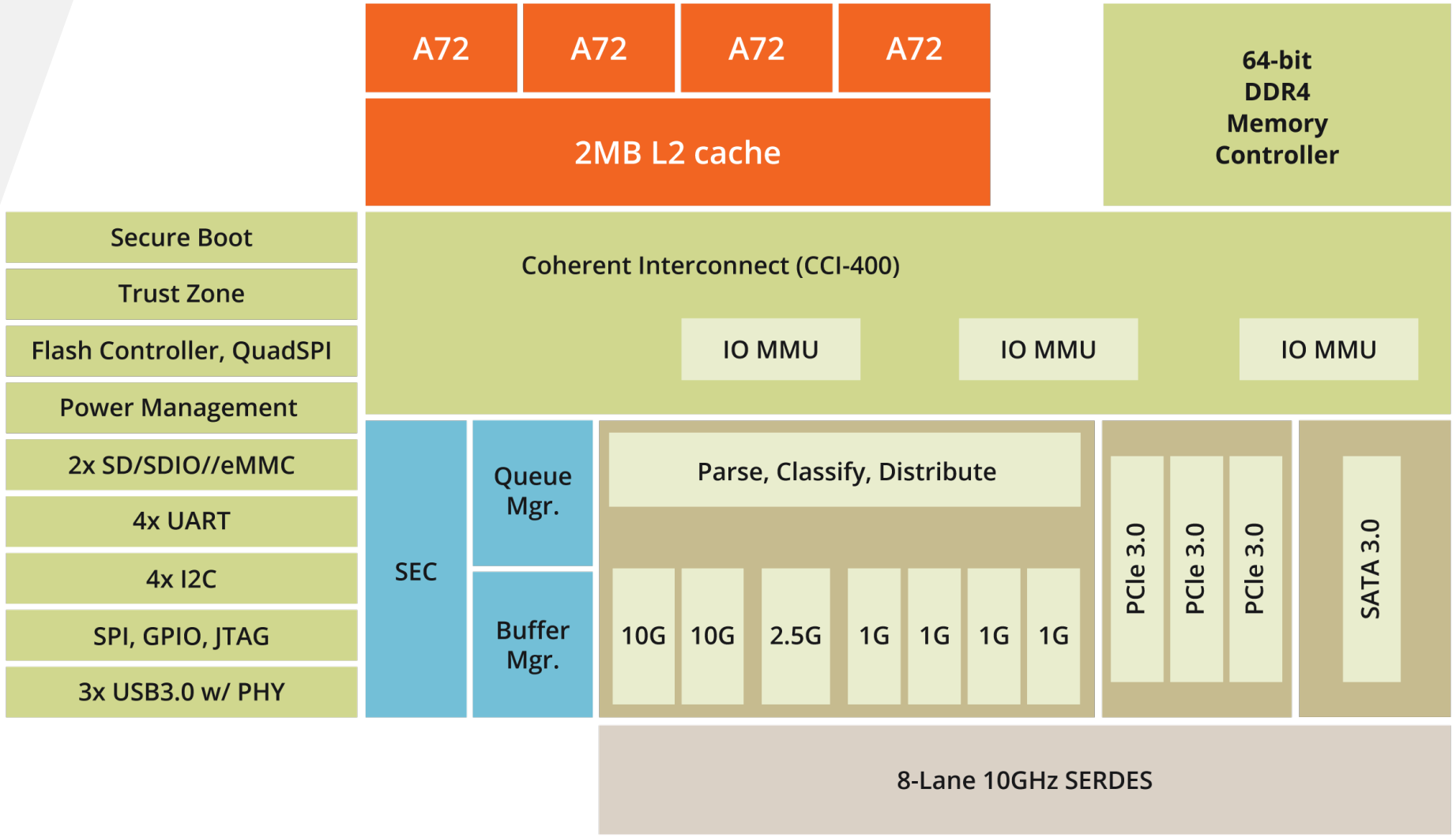
SP1 Rad-tolerant 3U VPX SBC

Next Gen Computing for Space Systems



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Leveraging OpenVPX in Space Applications

Solid, Standardized Architecture

- 3U VPX SBC: Heart of System
- Integrated & Interoperable
- Speeds System Development

Complex AI Processing

- Facilitates High Density Computing
- Integrated GPU & CPU

Physical Baseline for SpaceVPX

- Inherently Rugged, Conduction-cooled
- Allows for Hybrid Implementations (OpenVPX/SpaceVPX)

Steps to Achieving AI

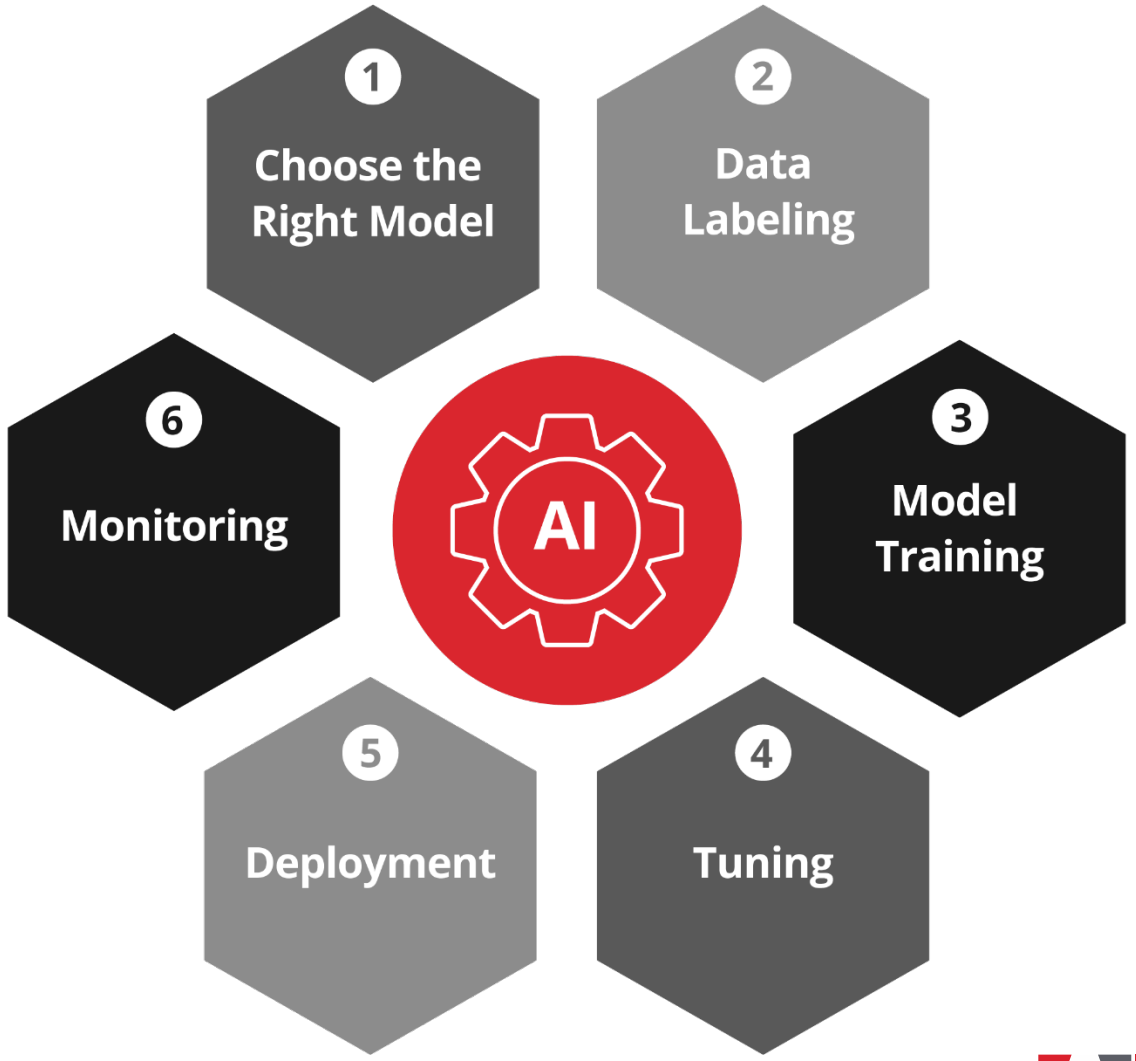
Continuous Learning

Training Sets Using Collected Data

- Transfer learning
- Online Learning
- Fine-tuning

Real-time Analysis & Action

Facilitate Mission Safety & Success



Hardware Data Processing

AI-at-the-edge for Space

GPGPU

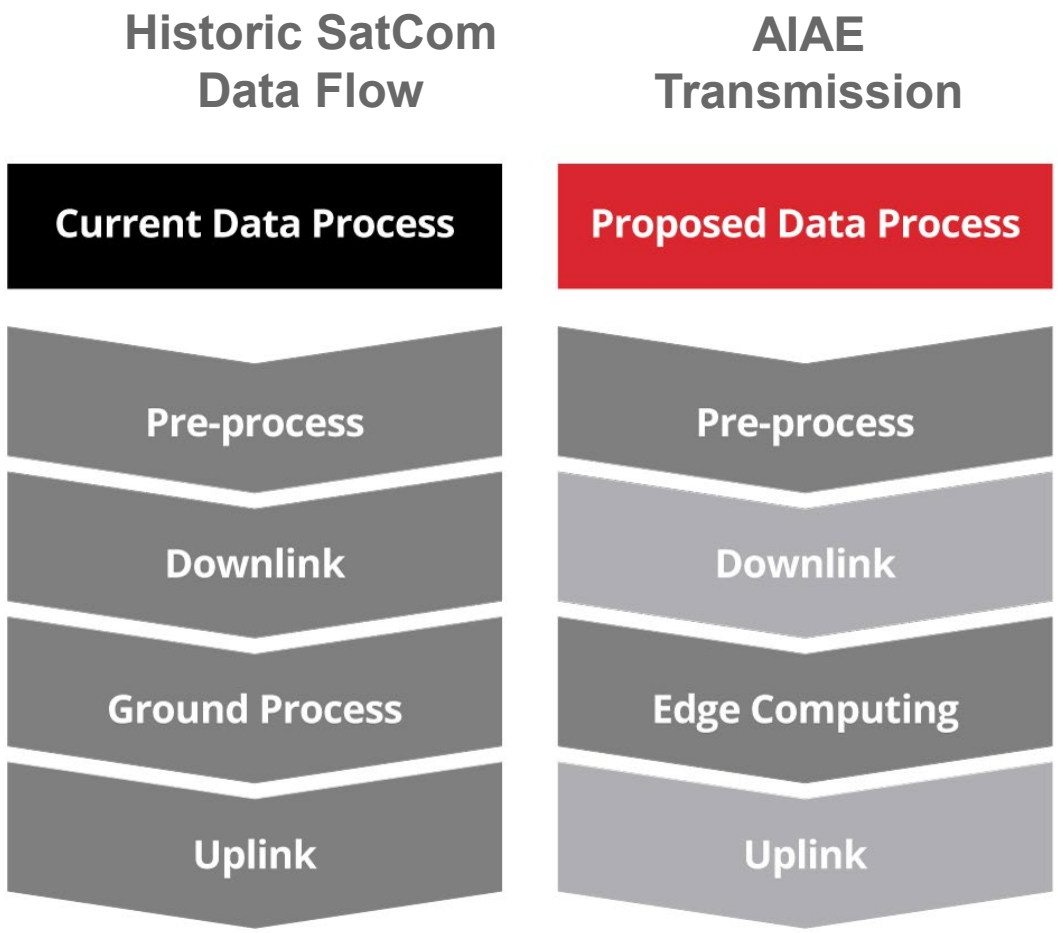
- Parallel vs Serial Processing
- Enabling More AI Approaches

Neural Networks

- Hardware Efficiency
- Optimized Communications

RISC-V Vector Extension

- Manage AI Capabilities Faster
- Compact, Power-efficient for Broader Application



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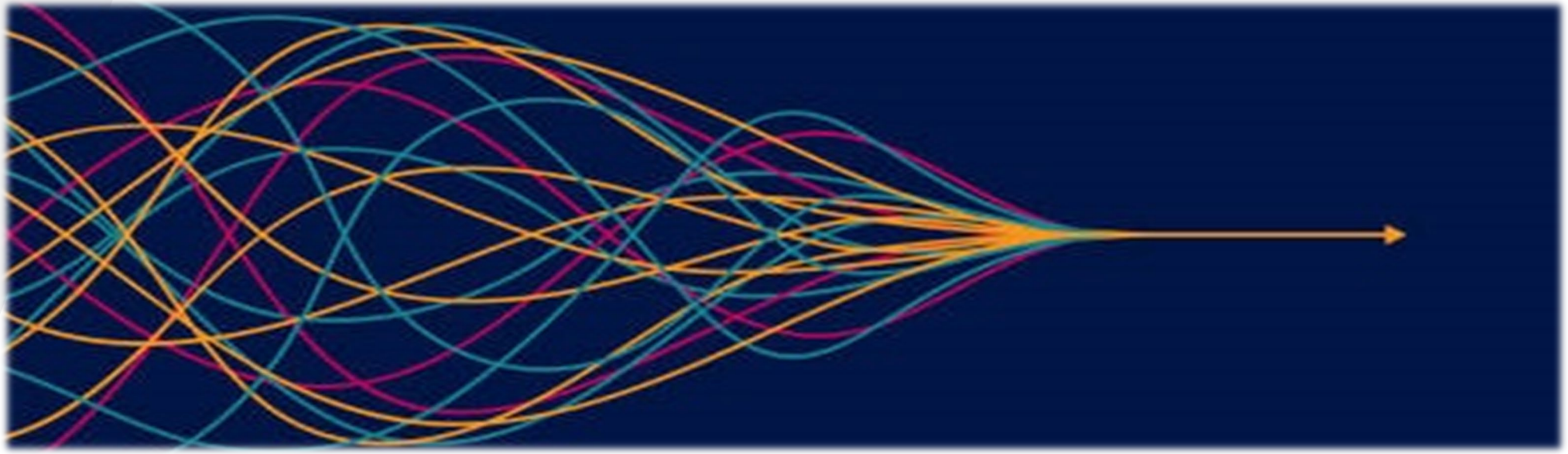
Implementing AI Algorithms

- Addressing Anomalies
- Managing Risk
- Autonomy Versus Human-in-the-Loop AI (AILAI)
- Proactive & Predictive Actions



EPA: Methane Gas Emissions

Earth Observation & Analysis

Transformative AI

- Impacts Resource Management
- Provides Accurate Analysis of Earth Activities

Satellite-based Observation

- Manage Climate Change
- Identify Reporting Discrepancies
- Track Changes in Land Cover, Water Resources, Weather Patterns

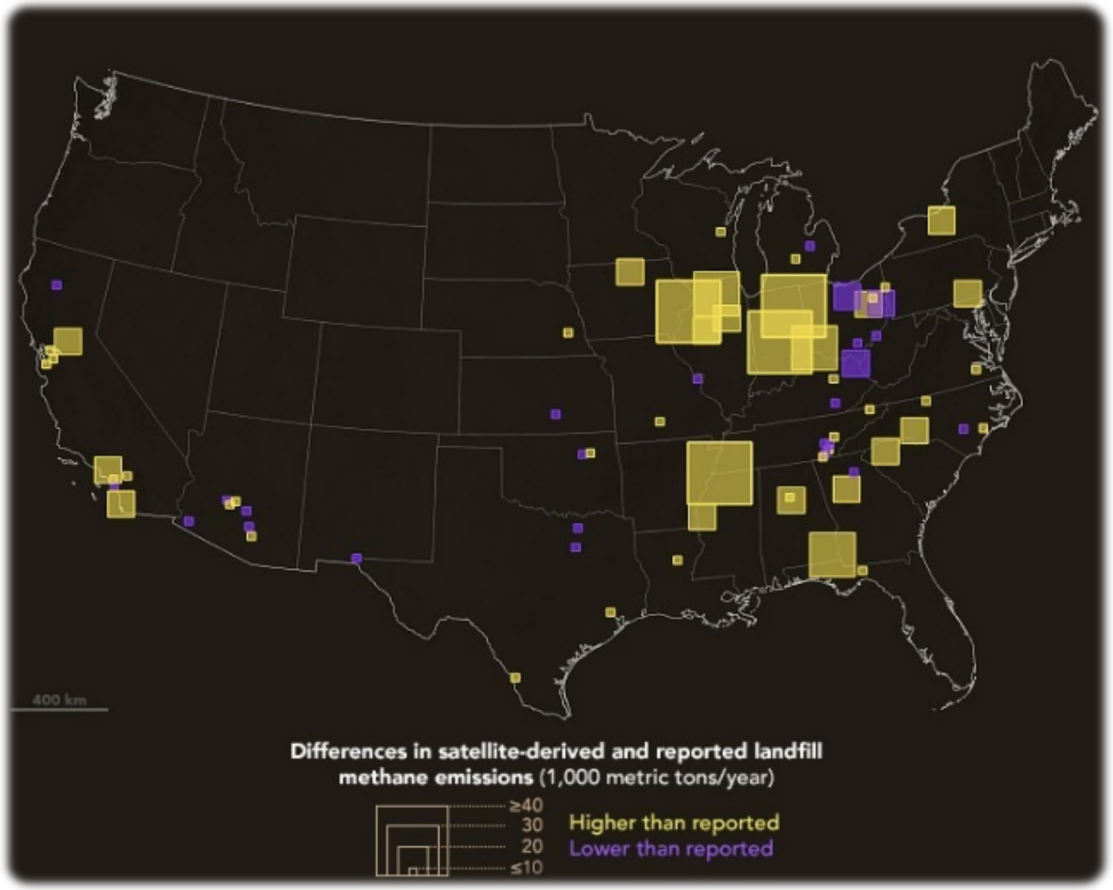


Photo Credit: Michala Garrison, NASA Earth Observatory

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Increased Mission Resilience

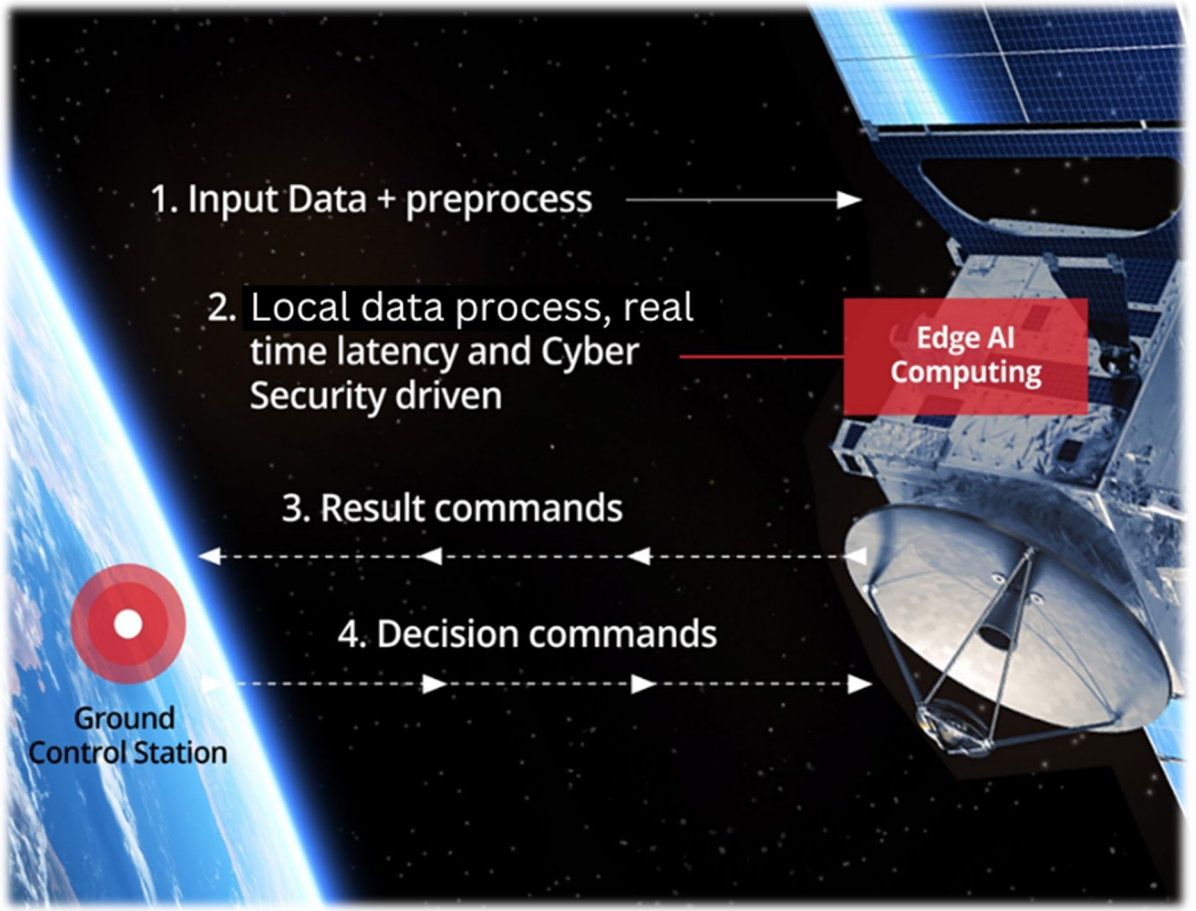
On-board Decision Making

Reduced Human Intervention

- Adjust Mission Parameters
- Anticipate & Manage Unforeseen Challenges
- Fulfill Complex Mission Requirements

Critical Focus Areas

- Debris Avoidance
- Optimize Landings
- Alter Orbits & Trajectories



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NASA LOFTID

Data Processing for Critical Intelligence

- Successful In-orbit Capture & Processing of Video-at-the-edge (November 2023)
- First Use of GPGPU-based AI Supercomputer in Space (S-A1760)
- Control & Record Visible & IR Camera Images from Six Camera Pods
- Backup Recovery of Camera Data Recordings
- Critical Intelligence on Heatshield Performance

Photo credit:
Greg Swanson, NASA

Sidus Space LizzieSat-1

In-orbit Networked Communication

- First-ever In-flight Autonomous Systems Software Mission (March 2024)
- Using AI for Methane Detection
  - NASA ASTRA (Autonomous Satellite Technology for Resilient Applications)
- Successful HW Operation Despite Very Active Solar Flares
- AI-based C&DH Systems (S-A1760 & S-A6640)
  - Better Data Sharing
  - Improved Processing

Photo Credit:
Sidus Space

Standards Enable Implementation

OpenVPX Transforming Space Operations

- Supporting a Space Digital Backbone
- Enabling Systems-based Approach
- Quickly Integrate Next-gen Open Standards Hardware
- Speed AI Enablement in Space

Photo Credit:
Intuitive Machines

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Questions?

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