COTS and AI Transforming Space Operations

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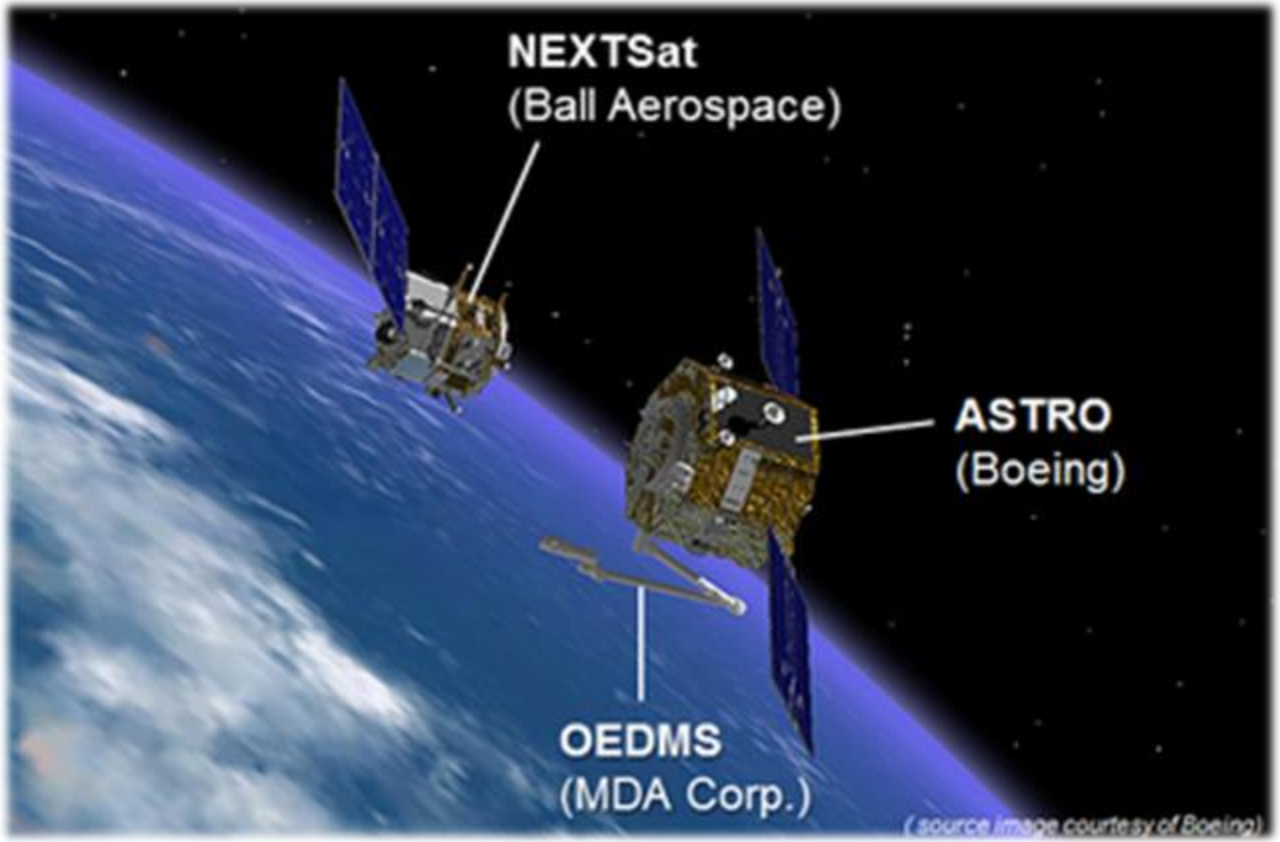
COTS in Space Applications: Discussion Overview

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



Space Digital Backbone

Unified Data Architecture

Primary Elements

1. COTS 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

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

Systems-based Approach

Space-rated COTS-based SBC

Improved computation and networking

Edge processing and on-board computing

Increased memory and bandwidth for fast data processing

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

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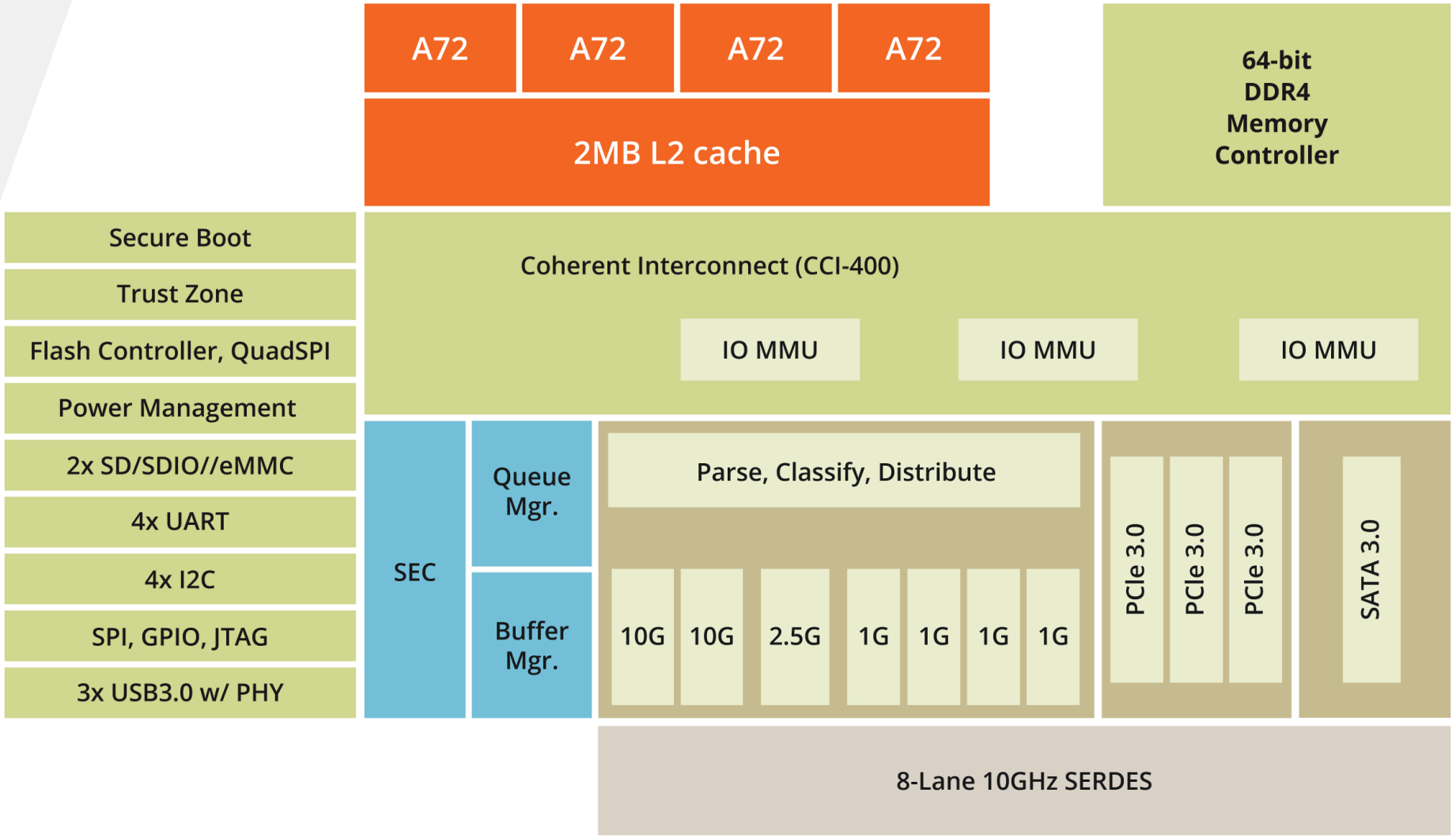
SP1 Rad-tolerant 3U VPX SBC

Next Gen Computing for Space Systems



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Leveraging COTS in Space Applications

Solid, Standardized Architecture

- 3U VPX SBC: heart of system
- Integrated and interoperable
- Speeds system development

Complex AI Processing

- Facilitates High Density Computing
- Integrated GPU and CPU

Physical Baseline for SpaceVPX

- Inherently rugged, conduction-cooled
- Allows for hybrid implementations (OpenVPX/SpaceVPX)

Steps to Achieving AI

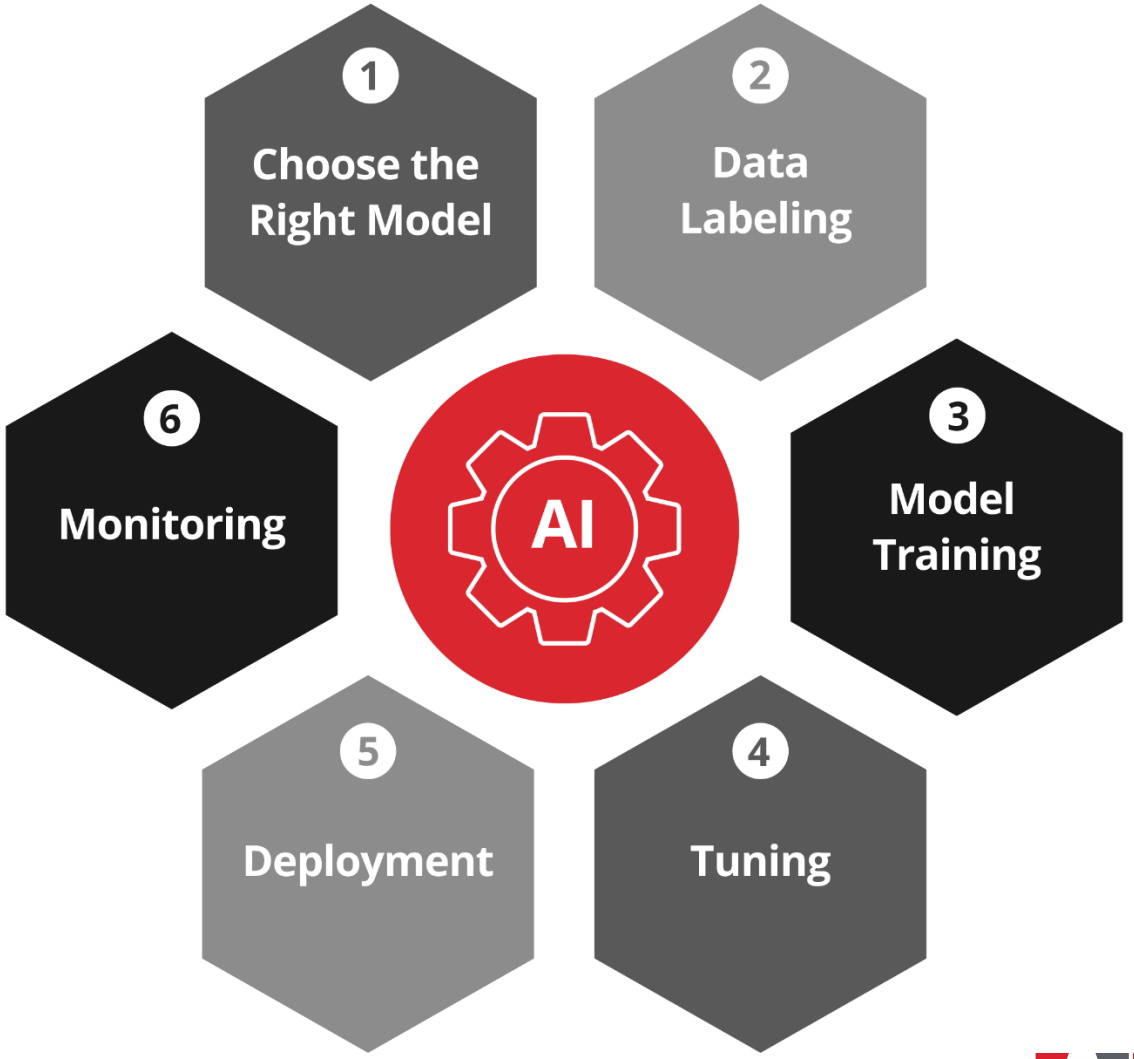
Continuous Learning

Training Sets Using Collected Data

- Transfer learning
- Online Learning
- Fine-tuning

Real-time Analysis & Action

Facilitate Mission Safety & Success



AI-at-the-edge for Space

GPGPU

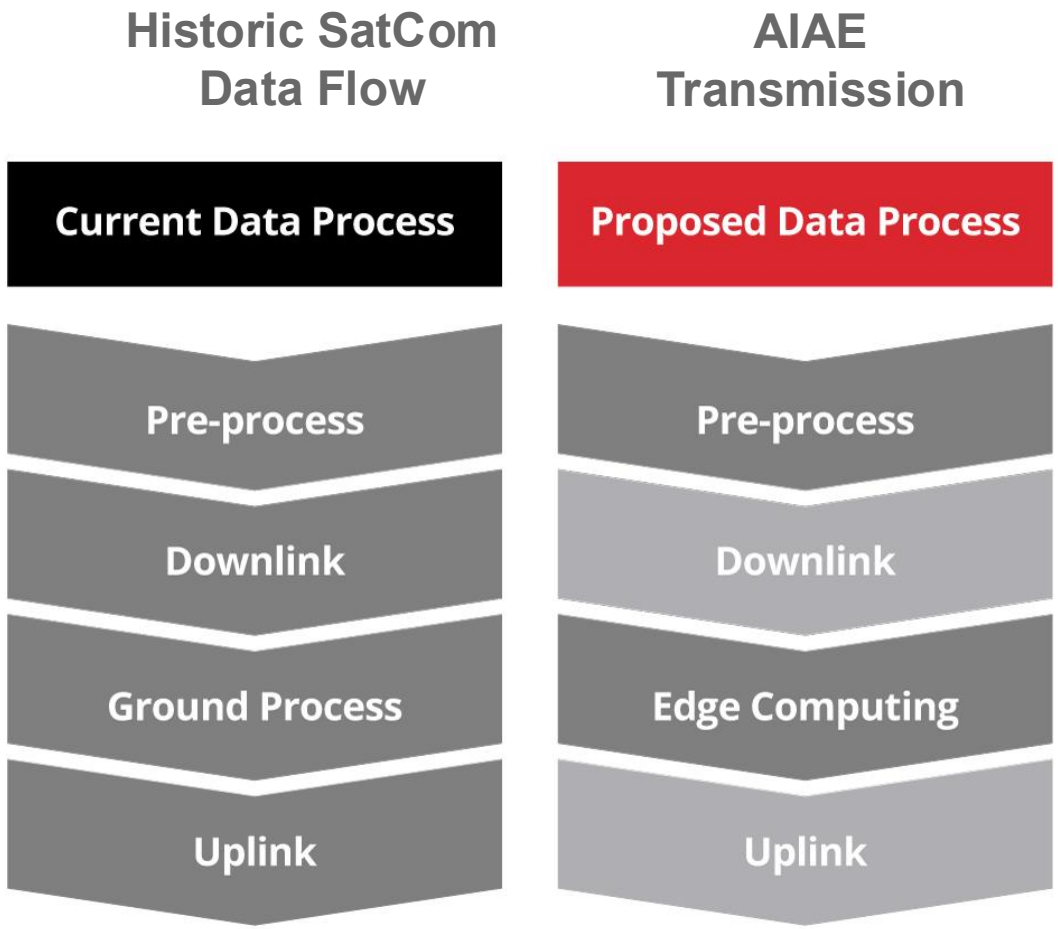
- Parallel vs Serial Processing
- Enabling More AI Approaches

Neural Networks

- Hardware Efficiency
- Optimized Communications

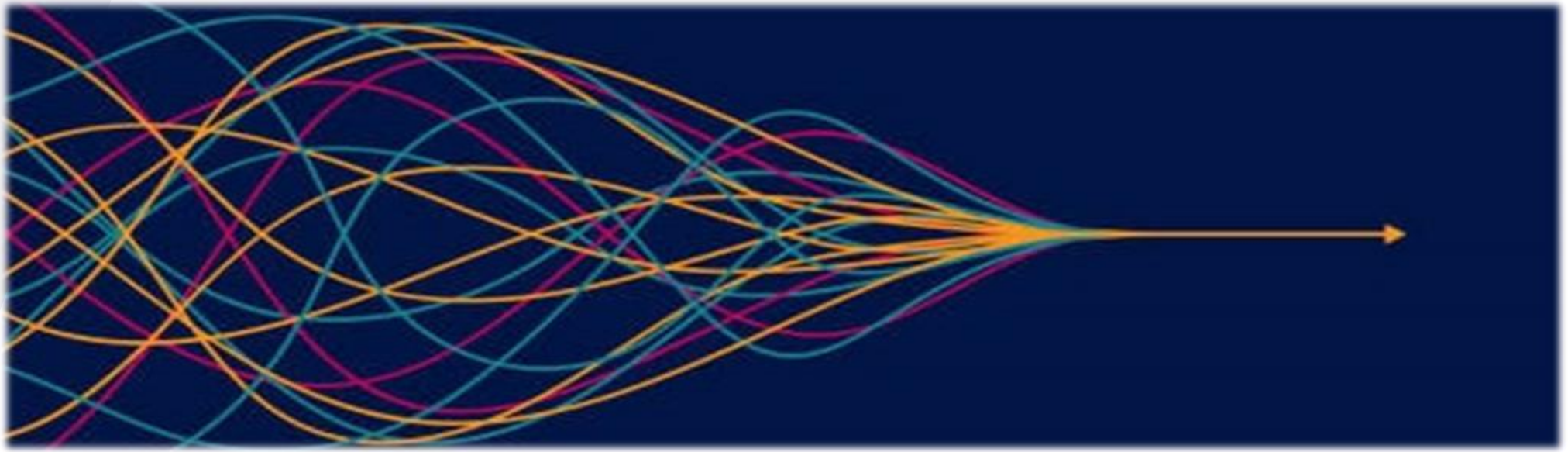
RISC-V Vector Extension

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



Implementing AI Algorithms

- Addressing Anomalies
- Managing Risk
- Autonomy Versus Human-in-the-Loop AI (HITL)
- 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

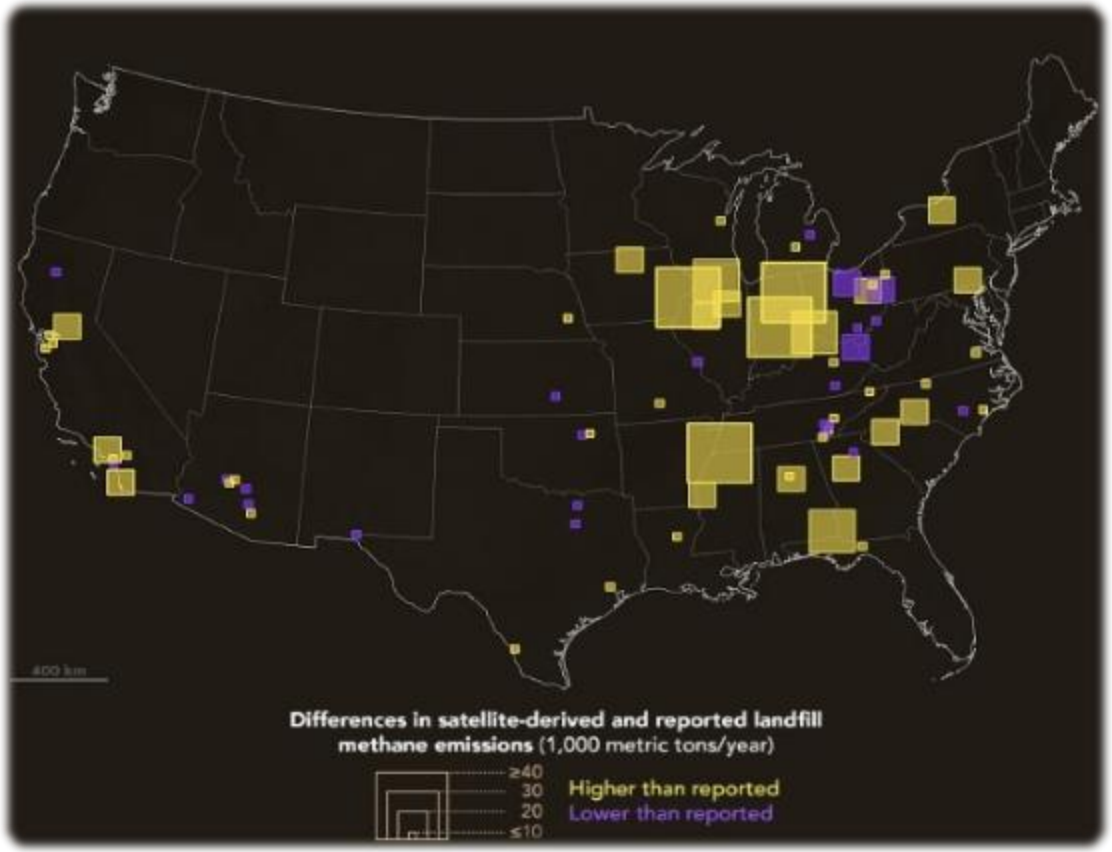


Photo Credit: Michala Garrison, NASA Earth Observatory

Increased Mission Resilience

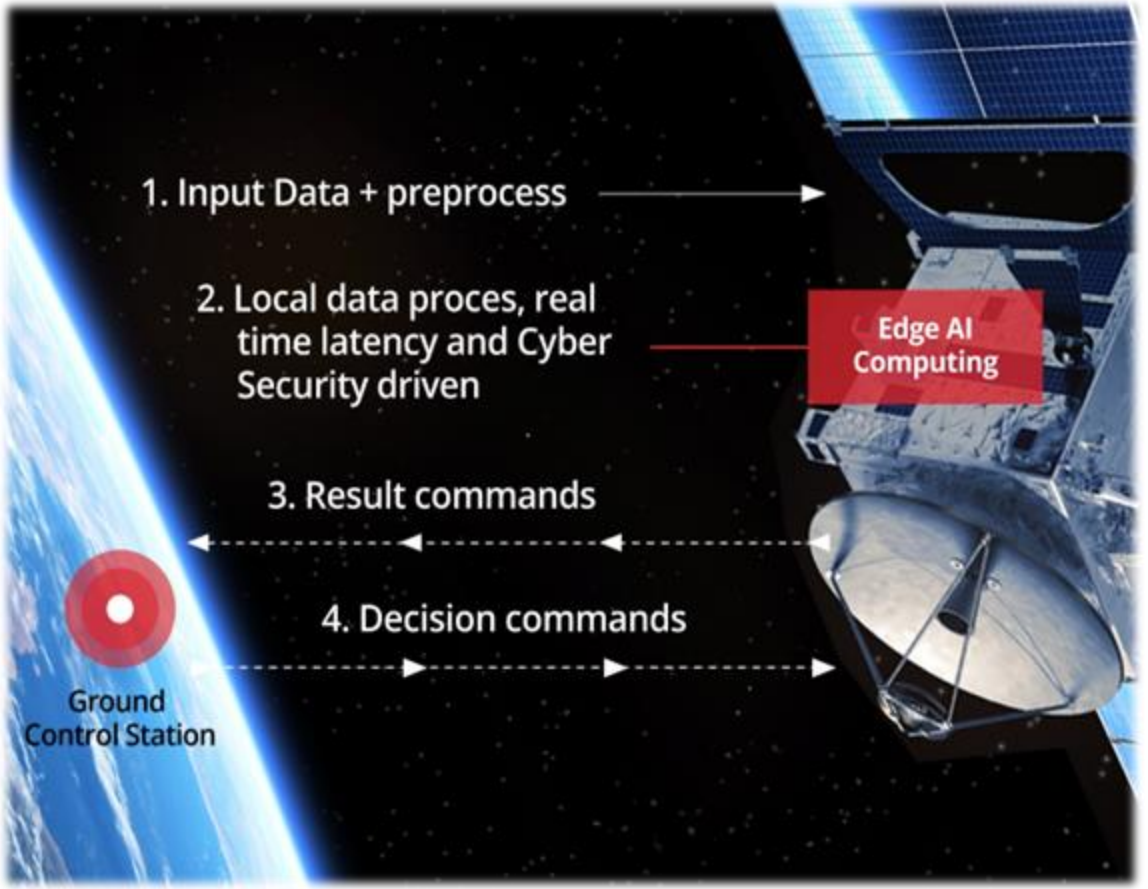
On-board Decision Making

Reduced Human Intervention

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

Critical Focus Areas

- Debris Avoidance
- Optimize Landings
- Alter Orbits and Trajectories



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NASA LOFTID

Data Processing for Critical Intelligence

- Successful in-orbit capture and processing of video at the edge (November 2022)
- First use of GPGPU-based AI supercomputer in space (S-A1760)
- Control and record visible and 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

COTS and AI Transforming Space Operations

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

Photo Credit:
Intuitive Machines

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Questions?

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