



Leveraging COTS Hardware for AI Implementation in Space

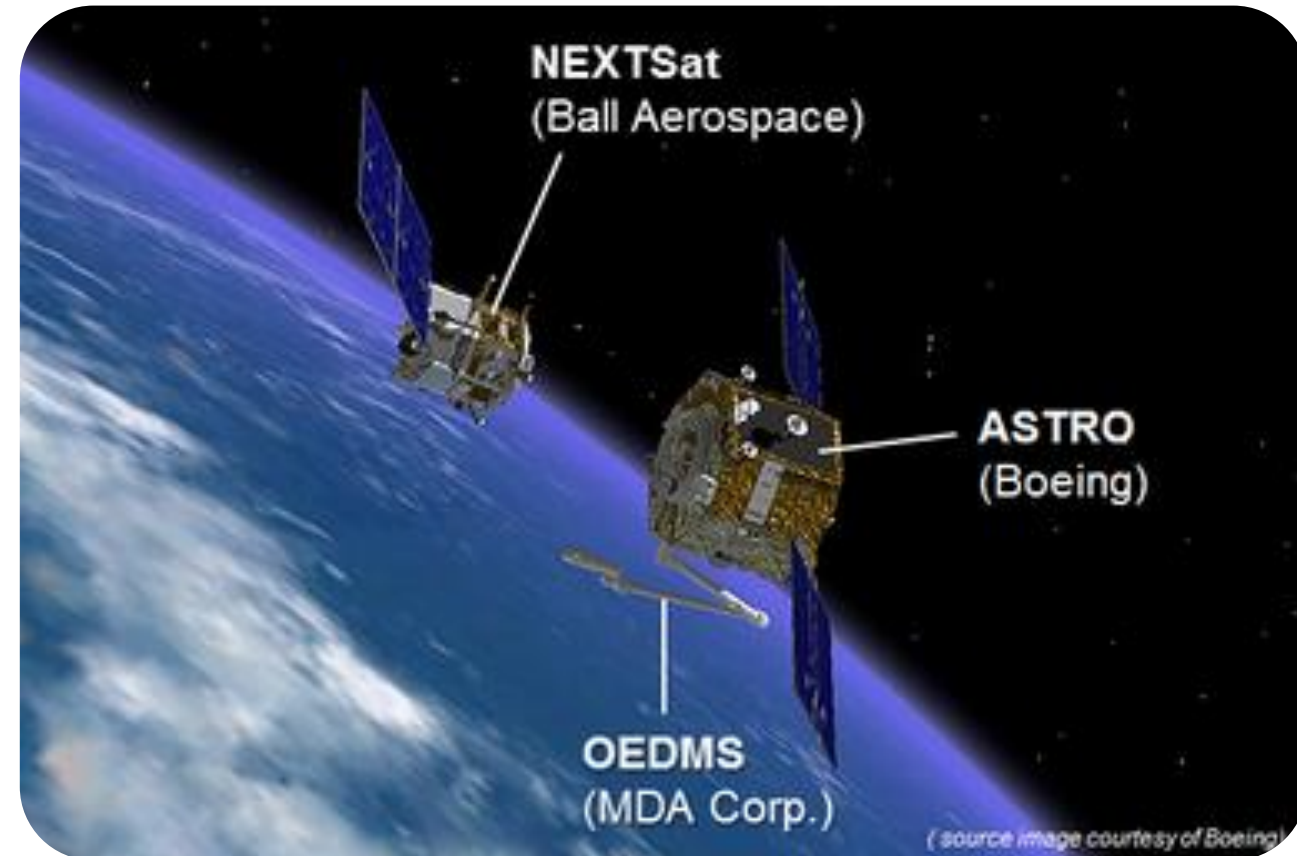
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Aitechsystems.com

COTS in Space Applications: Discussion Overview

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



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



Systems-based Approach

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 & On-board Computing

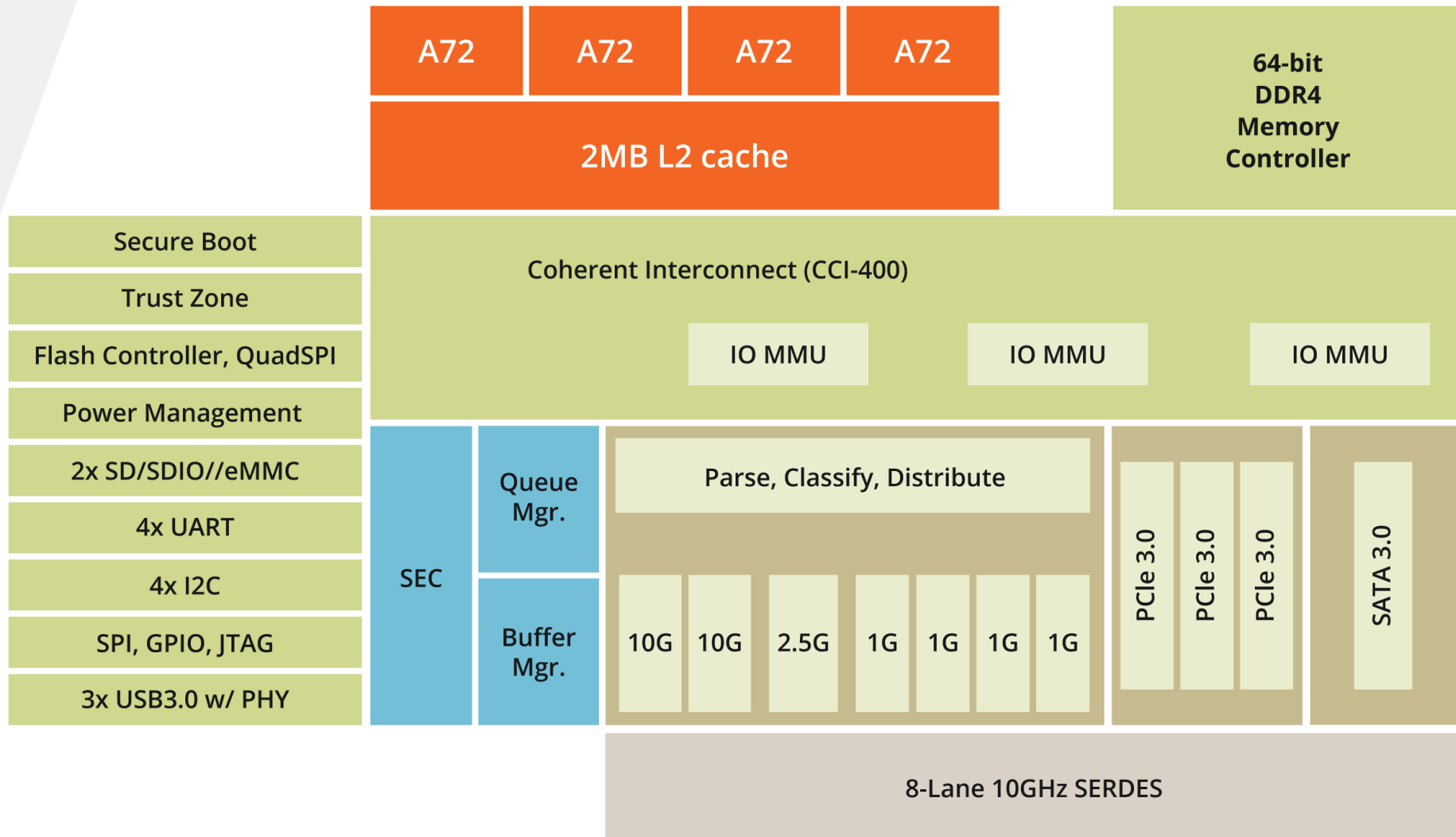
Increased memory and bandwidth for fast data processing

- 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)



SP1 Rad-tolerant 3U VPX SBC

Next Gen Computing for Space Systems



Strategy for AI Implementations

Leveraging COTS 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

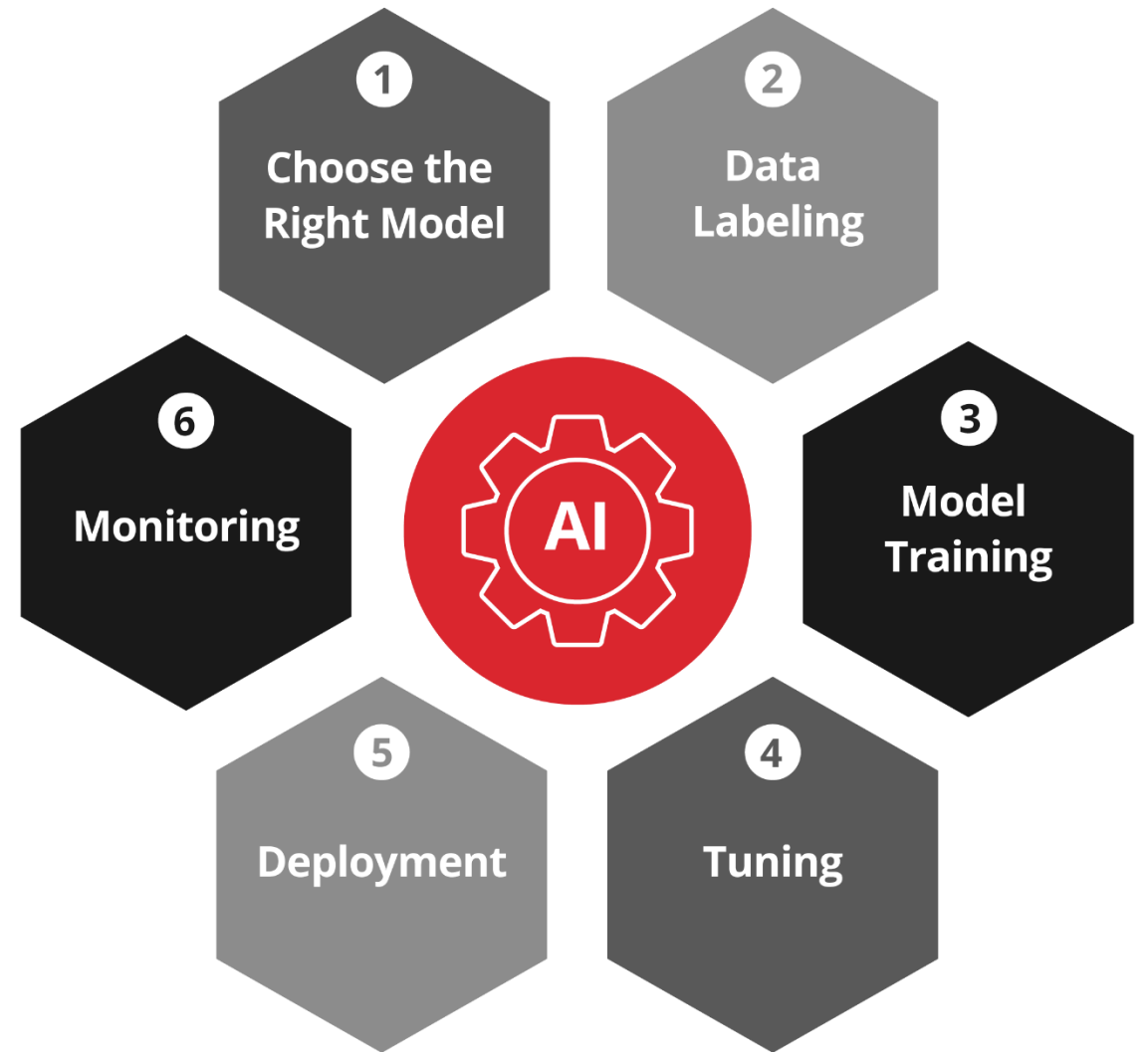
Continuous Learning

Training Sets Using Collected Data

- Transfer Learning
- Online Learning
- Fine-tuning

Real-time Analysis & Action

Facilitate Mission Safety & Success



Hardware Data Processing

Edge AI for Space

GPGPU

- Parallel vs Serial Processing
- Enabling More AI Approaches

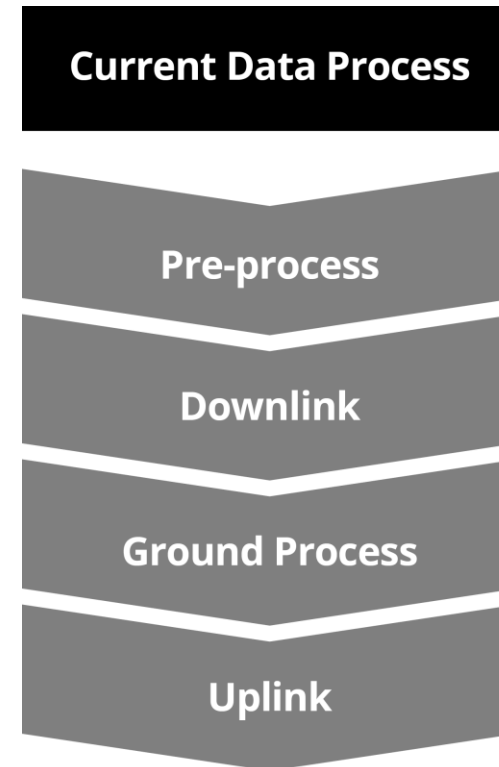
Neural Networks

- Hardware Efficiency
- Optimized Communications

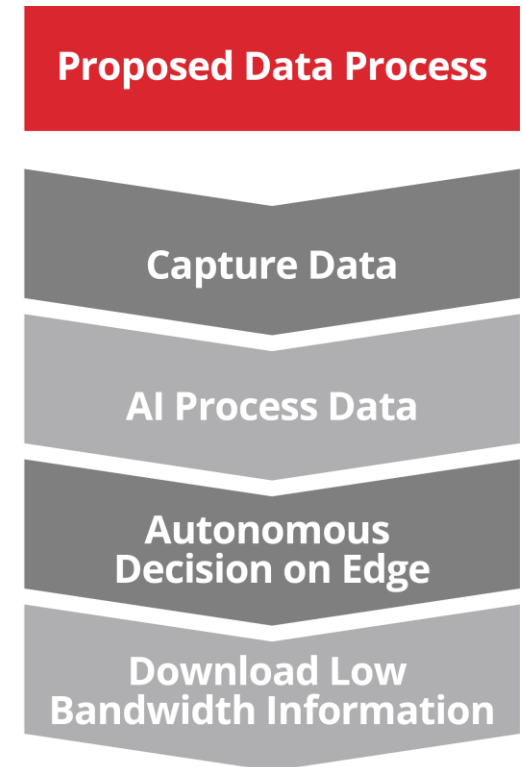
Processor Vector Extensions

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

Historic SatCom Data Flow



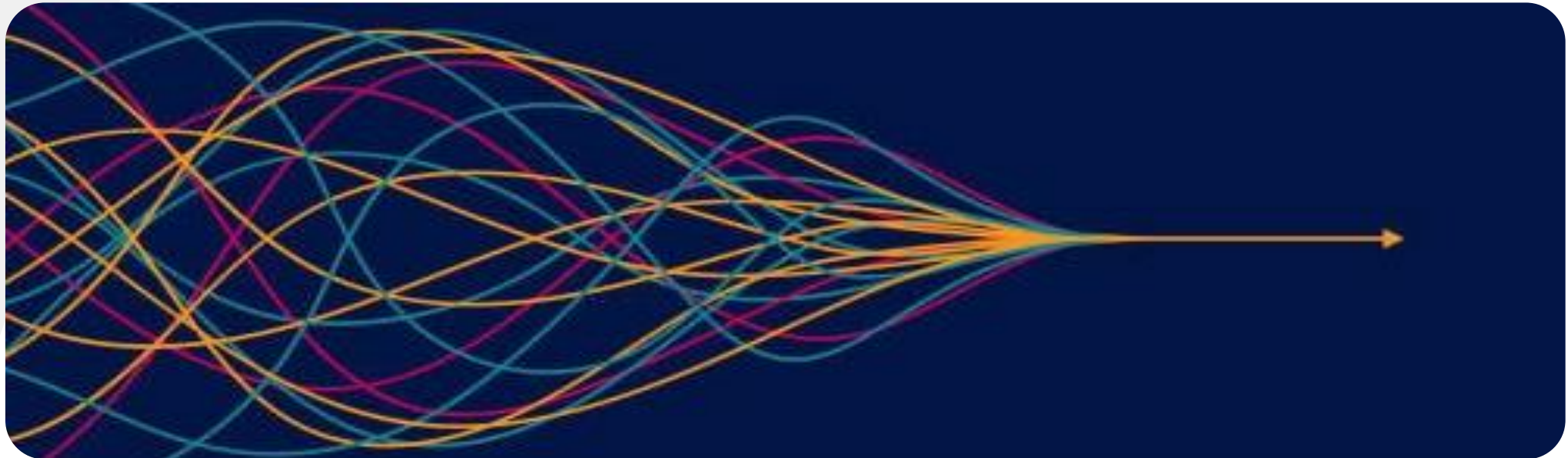
Edge AI Data Transmission



Applying AI to Space

Implementing AI Algorithms & Models

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



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

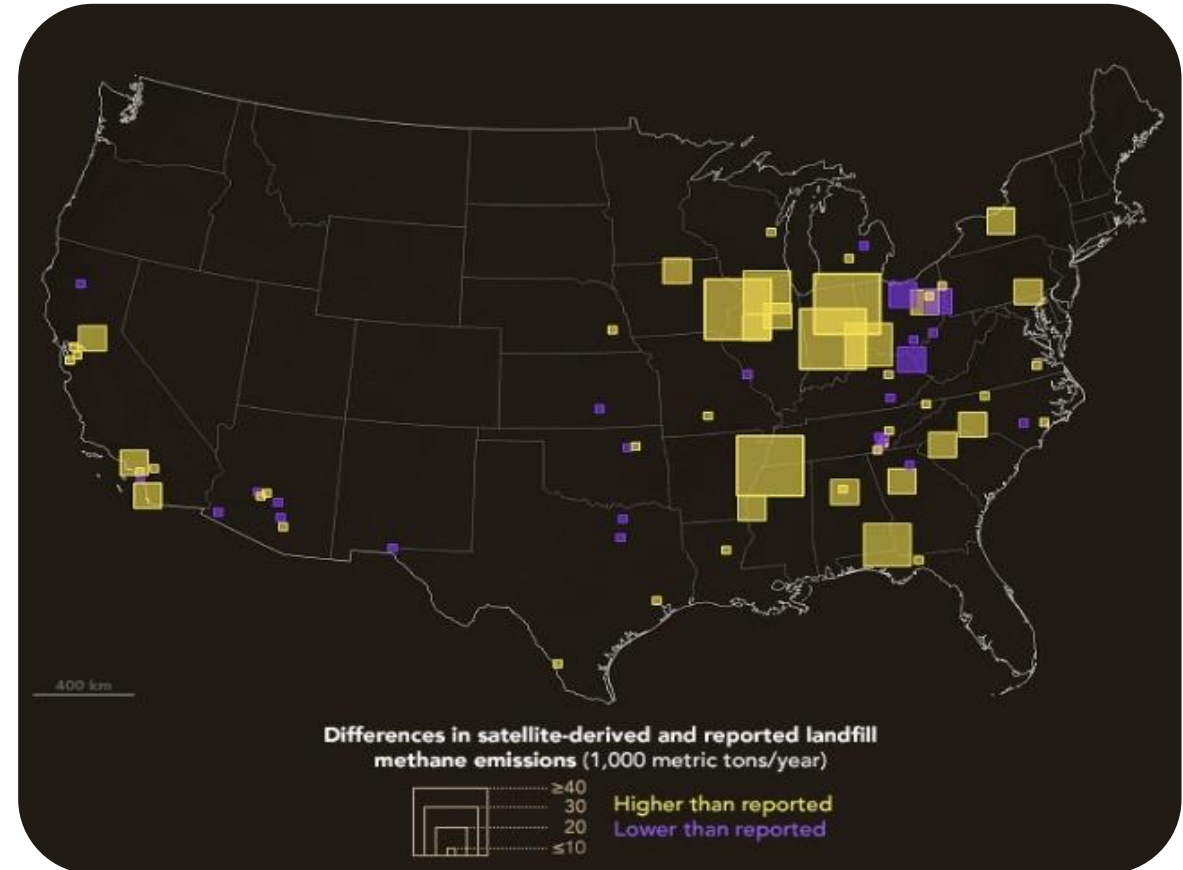


Photo Credit: Michala Garrison, NASA Earth Observatory

Sidus Space LizzieSat-1 March 2024

In-orbit Networked Communication

- First-ever In-flight Autonomous Systems Software Mission
- 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 (SP0-S) Systems (S-A1760 & S-A6640)
 - Better Data Sharing
 - Improved Processing



Photo Credit: Sidus Space

Data Processing for Critical Intelligence

- Successful In-orbit Capture & Processing of Video at the Edge
- First Use of GPGPU-based AI Supercomputer in Space (S-A1760)
- Control & 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

AI Hardware is Not Just an Upgrade; It's a Fundamental Enabler

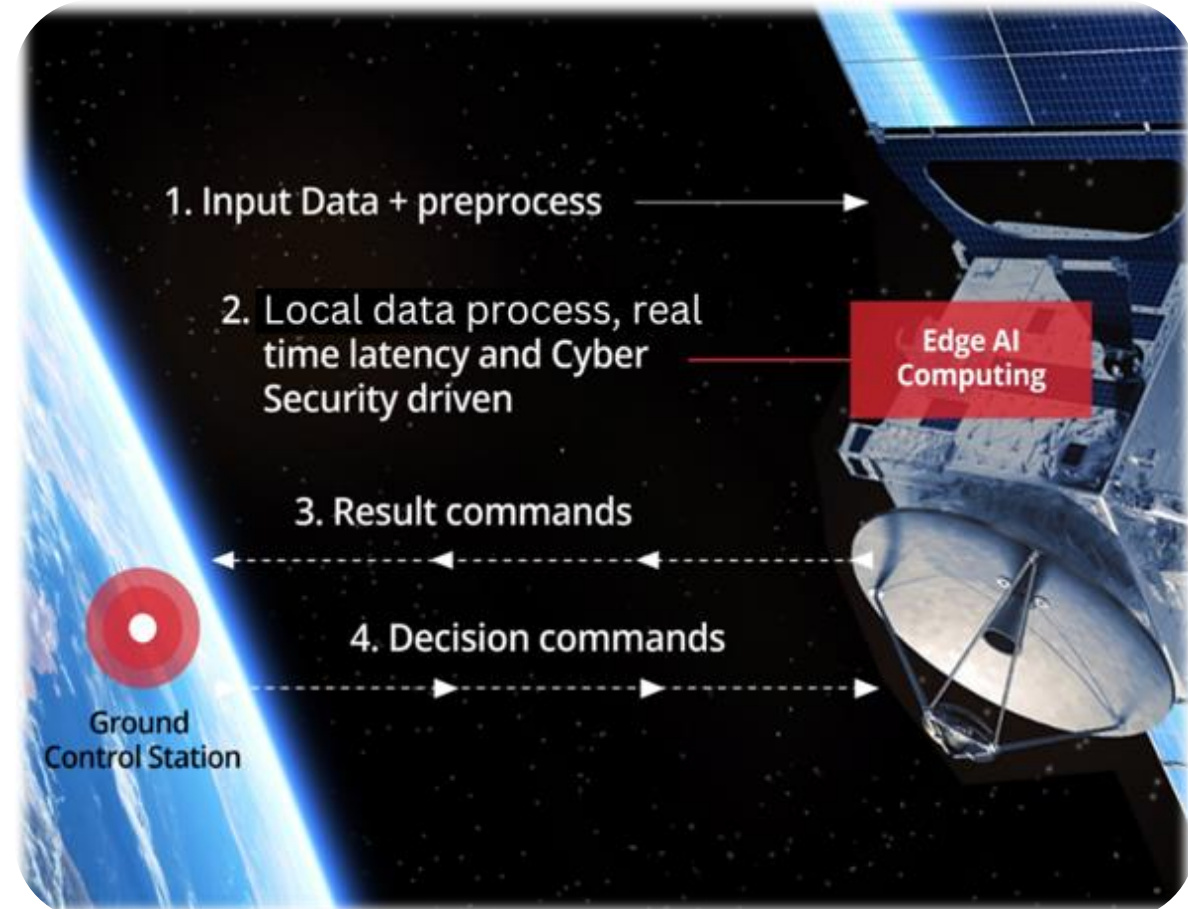
On-board Decision Making

Reduced Human Intervention

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

Critical Focus Areas

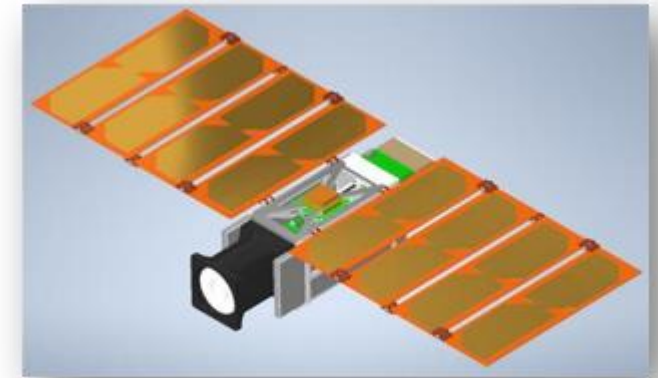
- Debris Avoidance
- Alter Orbits & Trajectories
- Optimize Landings



IQSat AI-enabled Picosatellite (PicoSat)

Future Missions: Swarm Edge AI

- High Order Low Resource Learning™ (HO-LRL™)
- Intuidex's Watchman for Space™ (W4S™)
- High Accuracy Pattern of Land Anomaly Detection
- Low Bandwidth Delivers Critical Information Directly to Point of Need
- Deployed in a Constellation of Five to Thousands

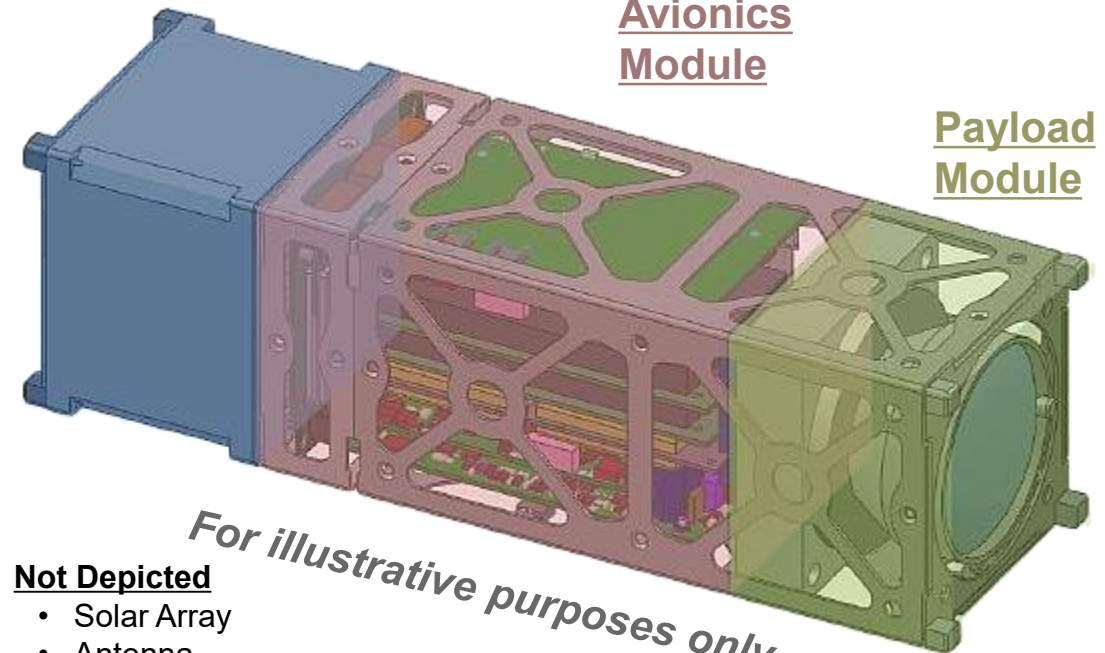


Concept with solar array and payload

Propulsion/Attitude
Control Module

Avionics
Module

Payload
Module



Not Depicted

- Solar Array
- Antenna
- Wiring

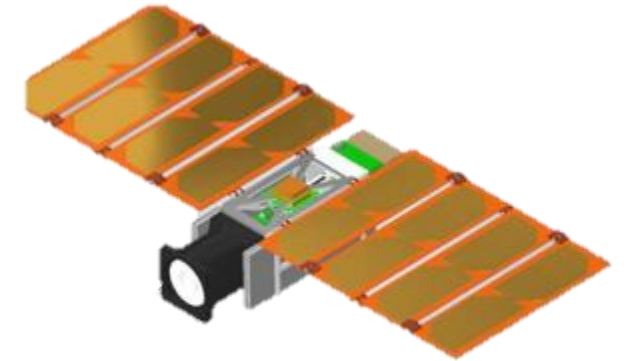
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Flexible Processing & Flexible Swarms

Future Trends & Outlook

Edge Computing Dominance

- Advanced Rad-hard AI Chips
- Increased Use of Reconfigurable AI Hardware
 - GPGPU
- High Order Low Resource Learning™
 - AI for Swarm Robotics & Distributed Systems
 - Coordinating Multiple Small Satellites or Rovers for Complex Tasks



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



Questions?

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