# ICE CUBES – AI BOX

ICECUBES@SPACEAPPLICATIONS.COM

ICE Cubes service – AI in space

Advantages of AI-in-Space:

- Simplify infrastructure and reduce overall mission costs

- Extend battery (power budget) life – by allocating onboard resources in an 'intelligent' manner

- Analyze massive amounts of data produced by satellites / space assets

- Enhance in-orbit capabilities

- Improve systems, unlock and enable new applications

- Inject 'exponential' technologies into orbit

- Speed-up commercialization

- Higher reliability and security
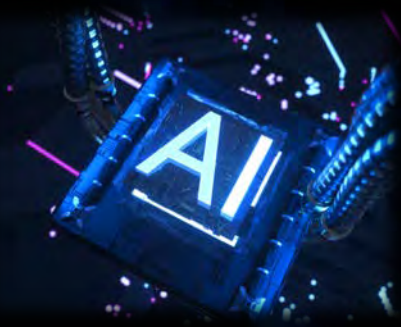
Adoption AI-ML techniques in space for various applications:

- Robotic Assistants/Devices: e.g. for in situ image classification, object detection

- AI-Assisted Medical Care: for fast and automatic in situ analysis of medical data (also from different sources /devic

- Big/Fast Science Data processing: for real time/in-situ processing of data

- Educational (STEM) Initiatives: e.g. competitions for studer to introduce them to AI/ML concepts in programming

- Radio Frequency (RF) systems: e.g. in processing of low-power/noisy signals, reducing the need of amplifiers

ICE Cubes service – AI-Box

Architecture

- 1U Cube on ISS inside ICE Cubes facility
- NVIDIA Jetson Xavier NX computer (21 TOPs)
- 500 Gb On-board storage
- Real-time commanding & monitoring
- Possibility to connect with other ICE Cubes payloads and external devices for in-situ data processing

Used to:
- Upload and run AI (neural networks) previously trained on ground, or
- Train the AI models directly on board (for example if a new AI model is to be trained using lots of on-board imagery, this can avoid the need for downlinking all that imagery).

AI-Box is permanently hosted inside the ICE Cubes Facility and offered on loan to users, who can upload their models and run AI-ML tasks in support of their payloads/equipment.

ICE Cubes service - AI-Box

The "AI-Box" is permanently hosted inside the ICE Cubes facility and accessible by other ICE Cubes cabled payloads or external devices connected via the interfaces offered by the ICE Cubes facility.

Current Configuration is based on:

1. NVIDIA® Jetson XAVIER NX™ computer (21 TOPS) *

2. NVMe M.2 SSD drive with total capacity up 500 GB

NVIDIA® Jetson NX can run modern neural networks in parallel and process data from multiple high-resolution sensors, opening the door for embedded and edge computing devices that demand increased performance, but are constrained by size, weight, and power budgets.

* The Jetson XAVIER NX is powered by a CPU 6-core NVIDIA Carmel ARM®v8.2 64-bit CPU6MB L2 + 4MB L3.
 The GPU is a 384-core NVIDIA Volta™ GPU with 48 Tensor Cores

It supports popular machine learning platforms like TensorFlow, PyTorch, Caffe, Keras and MXNet.

ICE Cubes service - AI-Box sensors

Built-in sensors :

- Relative humidity
- Atmospheric pressure
- Temperature
- Acceleration (on X, Y, Z axes)
- Rotation (on Z, Y, Z axes)
- Magnetic field (on X, Y, Z axes)
- CO_2 concentration, particulate matter

The AI-Box also contains Advacam's MiniPIX TPX3 sensor, which is a miniaturized and low power radiation camera with the state of art Timepix3 chip.

Timepix3 is CERN's latest pixel detector chip that records position, energy and time for every detected quantum of radiation - https://advacam.com/camera/minipix-tpx3

- fully spectral X-ray imaging (X-ray fluorescence imaging, X-ray radiography in low flux)
- spectral gamma ray imaging (scintigraphy, SPECT, radiography with
- radiation monitoring (particle type sorting, spectroscopy, directional
- Readout Speed: 2.35 Million hits/s
- Frame rate: 16 fps

ICE Cubes service – AI-Box

- by ground User Home Base (UHB), for S/W maintenance/administration and files transfer, via MPCC
- by other payloads on board Columbus connected via Gb Ethernet and ICE Cubes proprietary Wi-FI at 5GHz
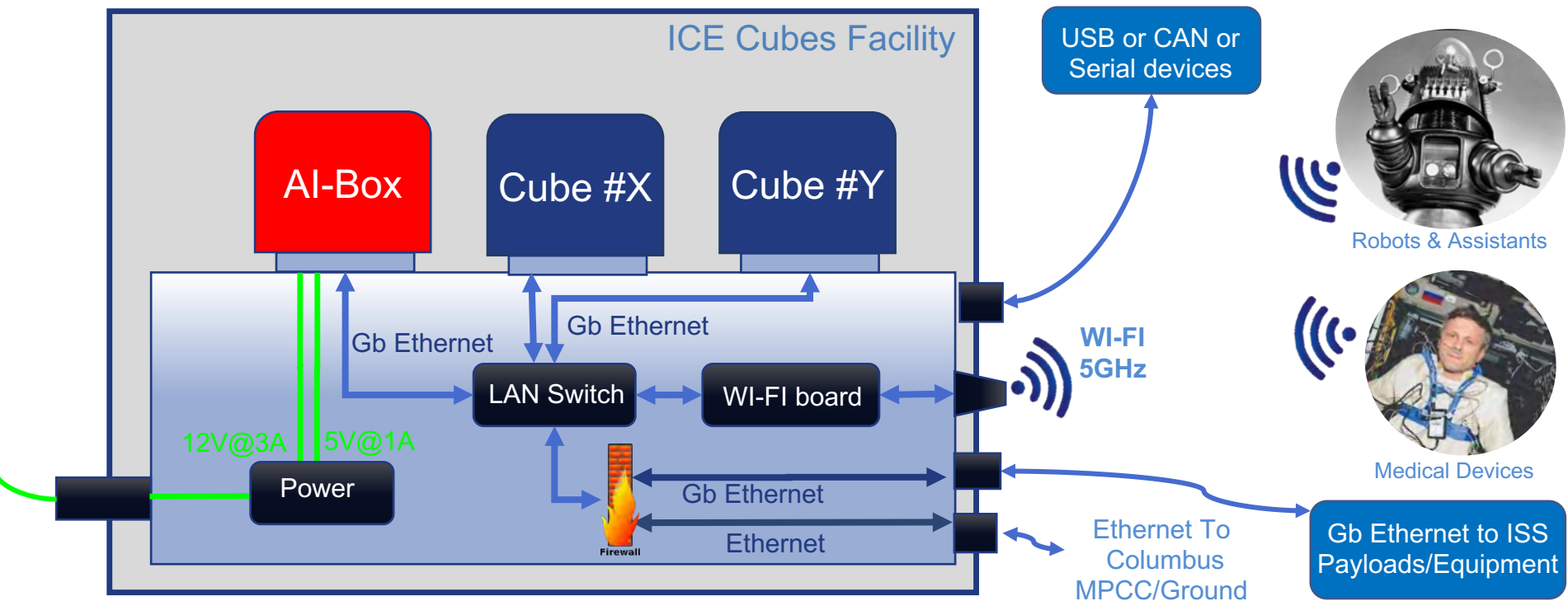
ICE Cubes service – AI-box use cases

- S/W demo & validation

- Big Science Data processing

- In-situ analysis

- Embedded & Edge computing

- Image classification, object detection, segmentation

- Speech processing

- Crew Applications

- Assistance, health monitoring

- Fault analysis & prediction

Examples

- AI Space Challenge: university teams

https://aichallenge.space

- Games in Space based on AI

- Operational orbit deviation warning system

- Predict Single-Event Upsets by Machine Learning

- Magnetometer-based position determination

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