# On-board VidEo Rapid ProceSSing (OVERPASS)

**CEOI Flagship Project**

Earth-i, UCL-MSSL, Cortexica, SSTL

Owen Hawkins
Product Development Director, Earth-i

# Project Objectives

- To develop, test and demonstrate EO data processing algorithms and techniques, involving both software and dedicated hardware
  - Target hardware: NVIDIA Jetson TX2; others also investigated including Movidius
  - Algorithms implemented and tested include:
    - Cloud Detection
    - Data Compression
    - Object Motion Detection & Tracking
    - Super Resolution Reconstruction
    - 3D Modelling
- Investigate how these capabilities could be deployed on-board future optical imaging EO satellites

# Target Missions and Main Benefits

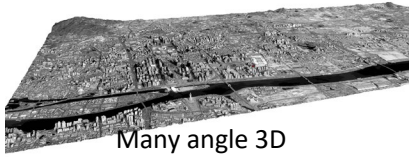
- Focus mission is the Vivid-i constellation
  - Based on Earth-i's Vivid-X2 prototype mission
    - Launched January 2018
    - 1m RGB point-and-stare video
  - Constellation to consist of 15 satellites
    - 3 launches of 5 satellites
    - 3 LTAN/LDTN times targeting mid-morning, mid-day, and mid-afternoon

- The benefits of on-board processing include:
  - Reduction in the amount of data stored and downlinked
  - Faster delivery of AR products direct to user – from sensing to reception
  - More cost effective mission
    - Optimise satellite utility during periods without imaging or GSN access
    - Using low cost COTS products for on-board processing, e.g. NVIDIA Jetson, NVIDIA Orin, AMD Ryzen, Intel Myriad VPU, Google Edge TPU

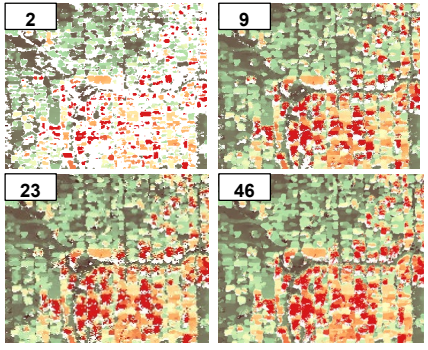
# OVERPASS

Developing, primarily for processing on-board the satellite:

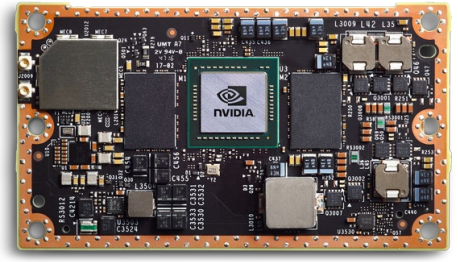
- 3D Surface reconstruction
- GAN based super-resolution
- Cloud detection
- Moving feature extraction
- Compression



Many angle 3D

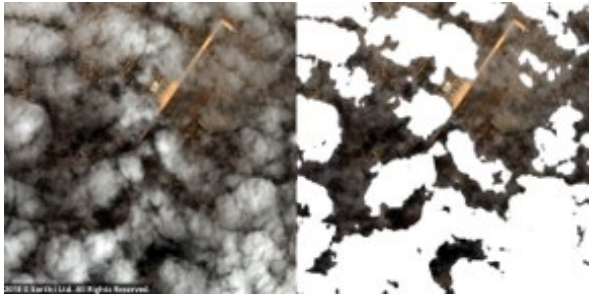


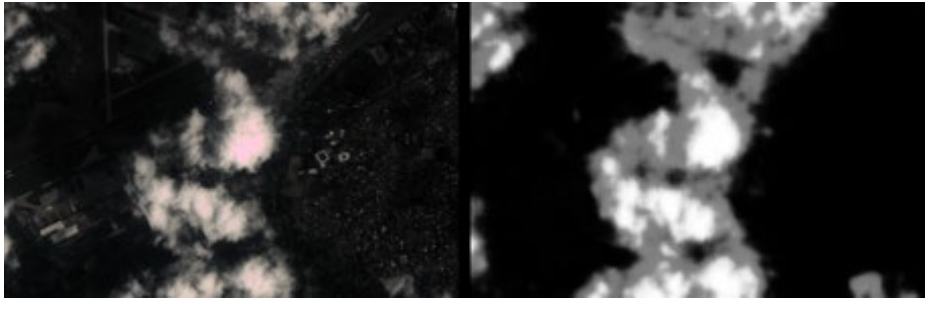

JETSON TX-2




Sea/land

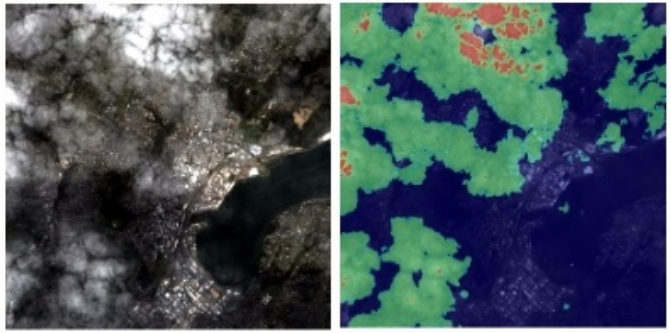
Cloud Detection in RGB





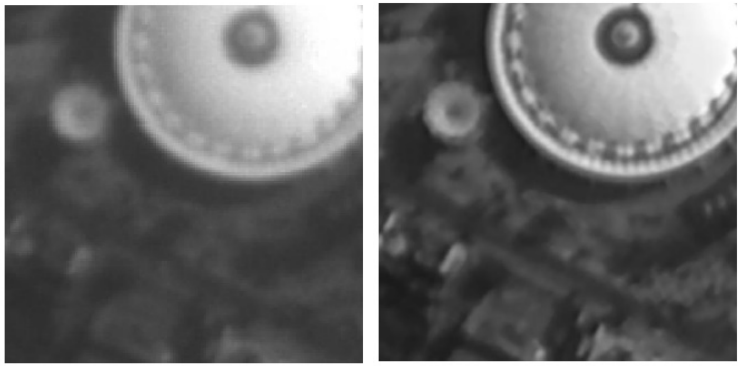
# Technology – 1

- Cloud Detection
  - ML algorithm inspired by U-Net
  - GPU implementation
- Data Compression
  - ML algorithm using R-GRU (Residual Gated Recurrent Unit) networks
  - GPU implementation
- Object Motion Detection & Tracking
  - CV algorithm based on a background subtraction technique
  - Tracking algorithm based on SORT (Simple Online and Realtime Tracking)
  - Multi-threaded CPU implementation

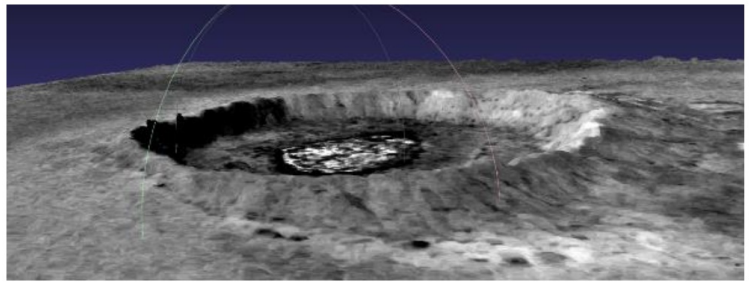


# Technology – 2

- Super Resolution Reconstruction
  - ML algorithm using CNN (Convolutional Neural Network) and GAN (Generative Adversarial Network)
  - Multi-threaded CPU implementation



- 3D Modelling
  - NASA ASP modified with custom algorithms
  - Multi-threaded CPU implementation



# Achievements and Current Status

- Project has been successfully completed. Efforts now underway to develop further and exploit commercially.
- Not all developed algorithms are suitable for on-board processing
  - Demands of the algorithms vs. on-board resources
- All algorithms developed have their uses for on-ground processing
  - Some are now being used on other ESA projects (e.g. the EO Video Exploitation and Analytics Platform, EOVEP)
- On-board processing beneficial for other tasks leading towards spacecraft autonomy, e.g. AOCS monitoring & correction, prioritisation of data capture & downlink, power and thermal regulation