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# ONBOARD ARTIFICIAL INTELLIGENCE (AI) TECHNOLOGIES FOR EARTH OBSERVATION

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## ONBOARD ARTIFICIAL INTELLIGENCE (AI) TECHNOLOGIES FOR EARTH OBSERVATION

1. Artificial Intelligence and Machine Learning
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3. Technologies
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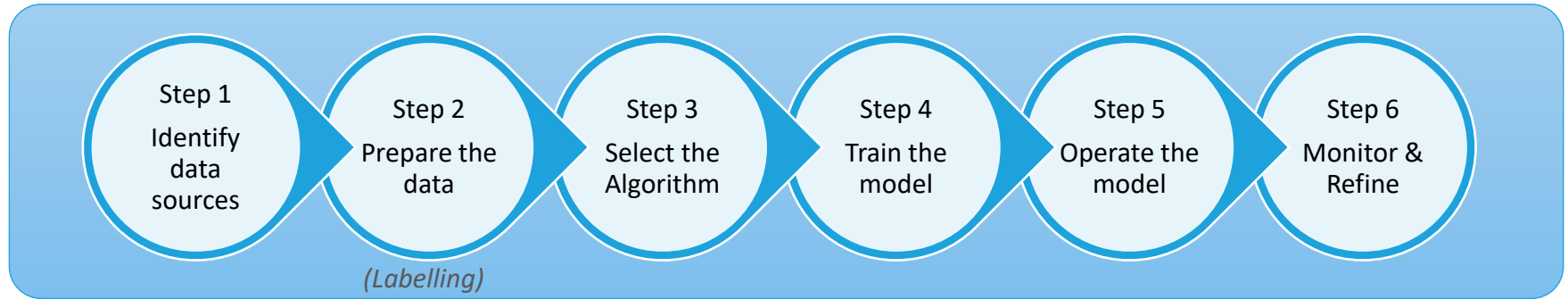
# ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING



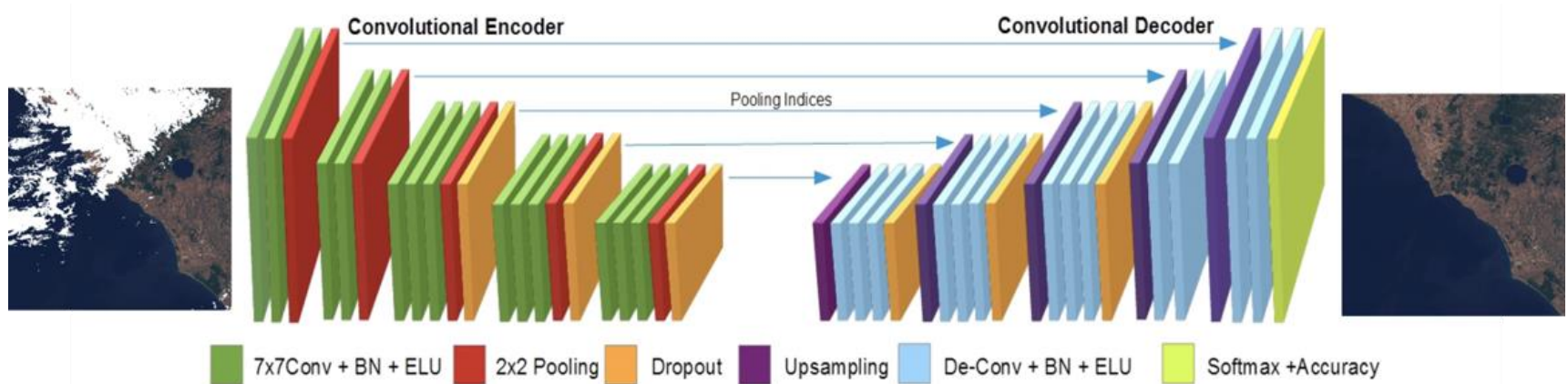
All implementations of AI to date have utilised ML algorithms

Algorithm	Learning type	Used for
<b>K Means Clustering</b>	Unsupervised	Categorising unlabelled data
<b>Artificial Neural Networks</b>	Reinforcement	Deep Learning
<b>Support Vector Machine</b>	Supervised	Filtering data into categories
<b>Linear Regression</b>	Supervised	Understanding data relationships
<b>Logistic Regression</b>	Supervised	Estimating statistical outcomes
<b>Naïve Bayes Classifier</b>	Supervised	Feature led predictive classification
<b>Decision Trees</b>	Supervised	Outcomes classification
<b>Random Forests</b>	Supervised	Regressive based classification
<b>Nearest Neighbours</b>	Supervised	Data grouping

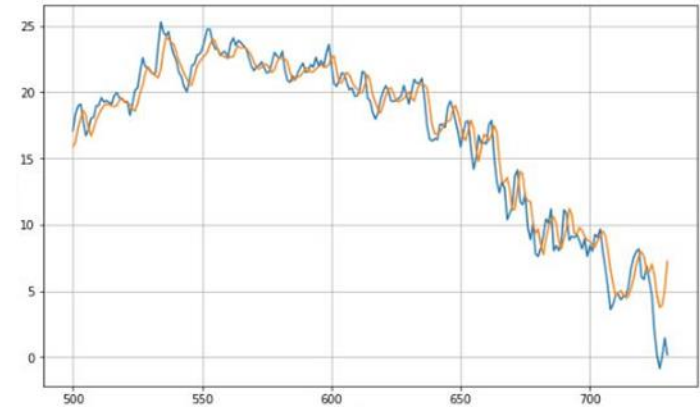
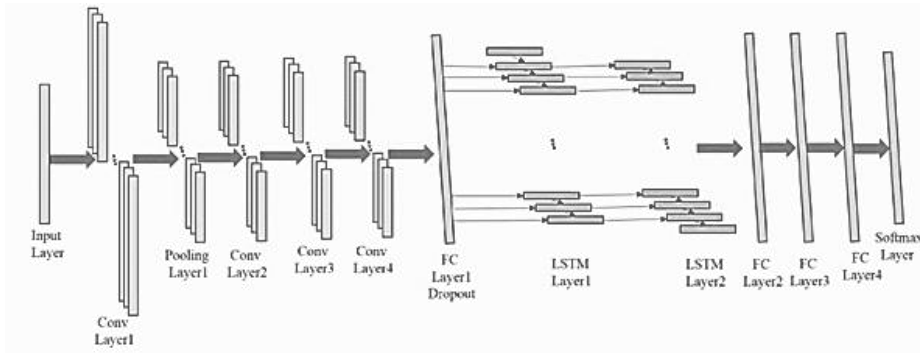
## AI Development Sequence



## Deep Learning – image processing



## Deep Learning – signal processing



Orange – predicted  
Blue - validation

# APPLICATIONS



There are four places for AI applications in the standard space supply chain:

1. Upstream Satellites



2. Downstream Satellite control centres



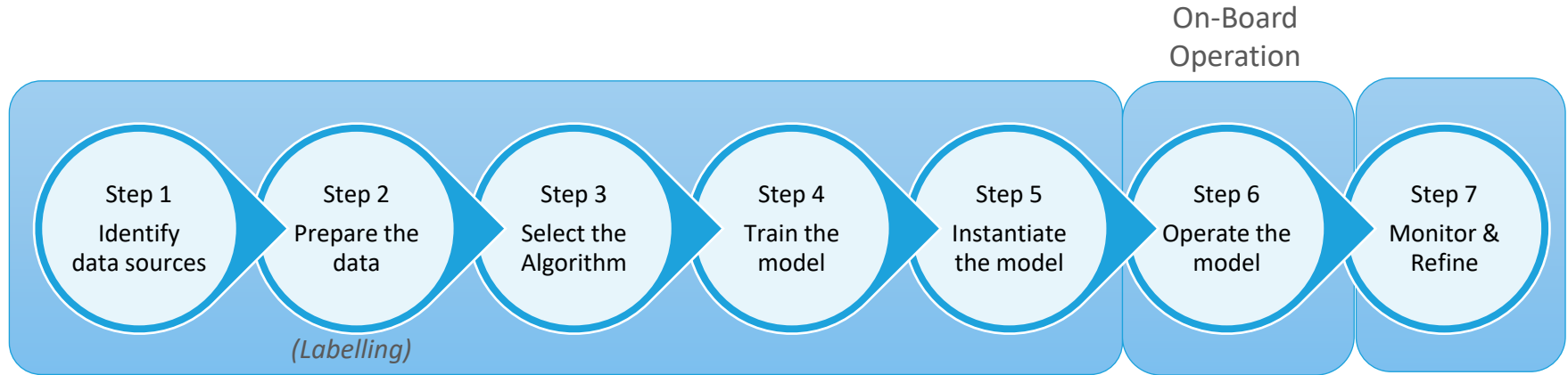
3. Downstream Mission control centres



4. Downstream platform applications



## AI Development Sequence for Onboard operation





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# APPLICATIONS

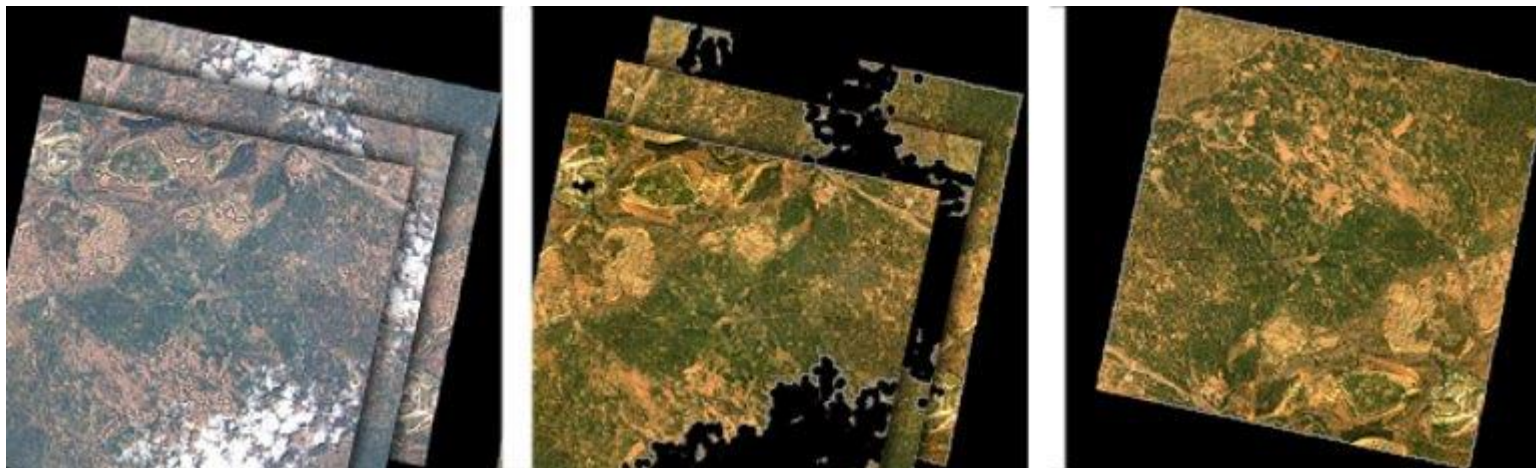


There are many use cases for Onboard AI application:

1. **Compression** (object detection, object rejection) ... objects, clouds, ...
2. **Enhancement** (scaling, denoising, stitching,...) ... super-resolution, noise reduction, ...
3. **Prediction** (scheduling, location, range, monitoring) ... safety on board, anomaly detection, ...

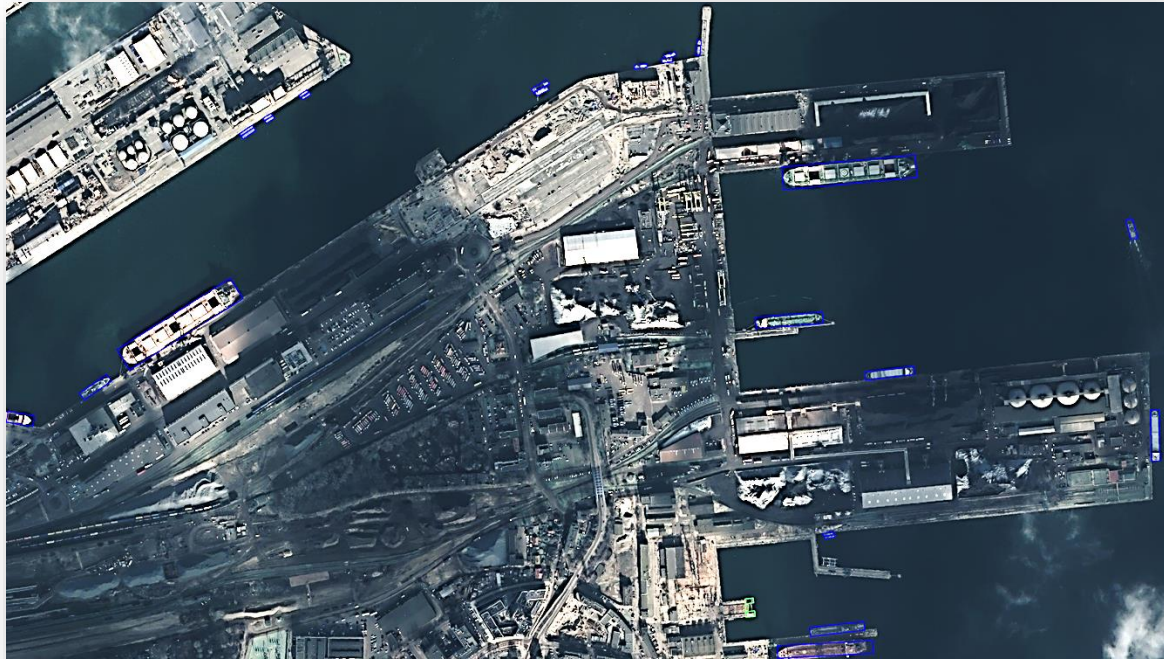


AI Onboard - Cloud-free mosaicking – onboard downlink compression





## AI Onboard – Object detection – onboard downlink compression



# APPLICATIONS

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## AI Onboard – Enhancement - Colour Imagery from SAR



# APPLICATIONS

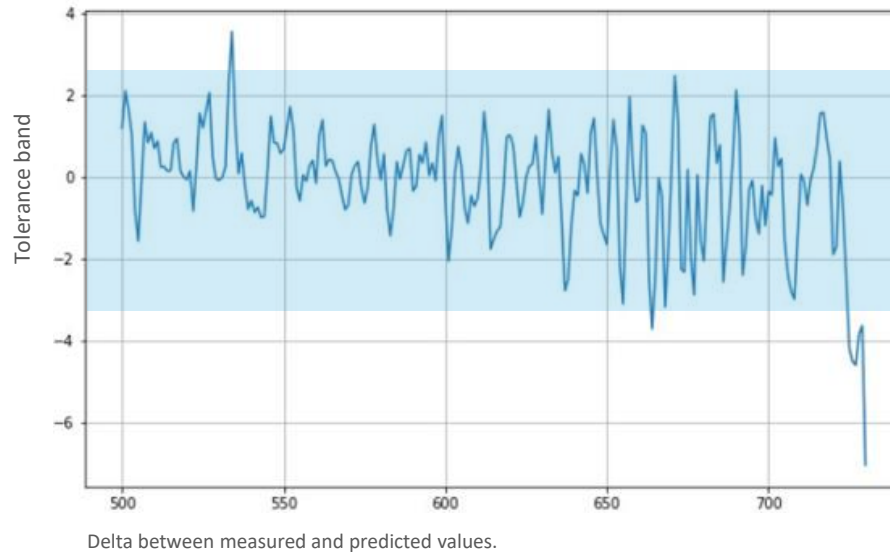
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AI Onboard – Enhancement - colour imagery super resolution

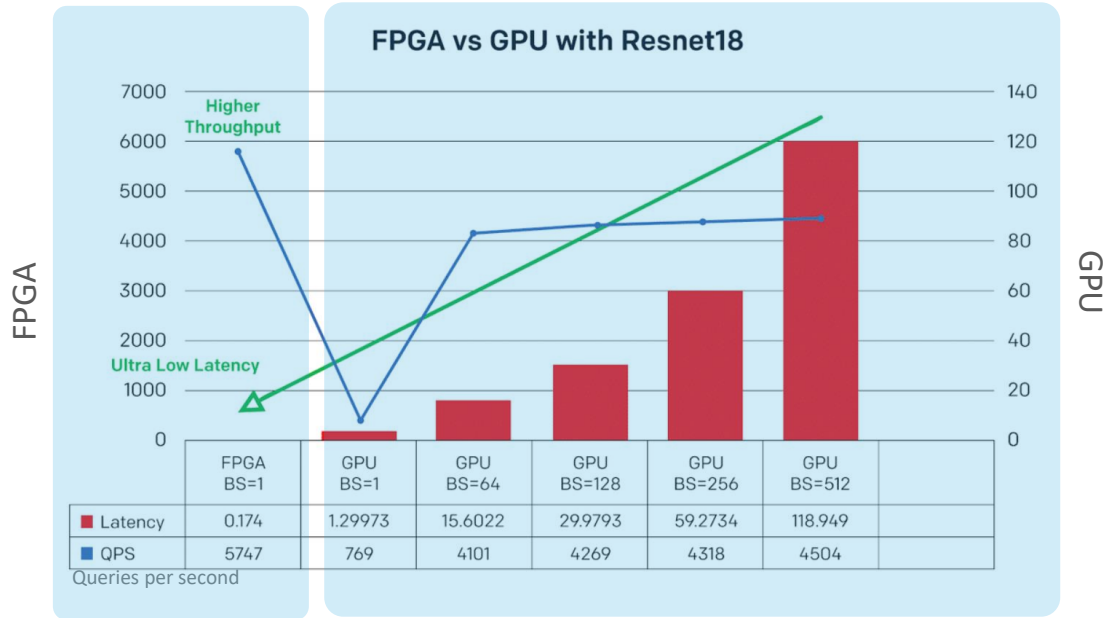




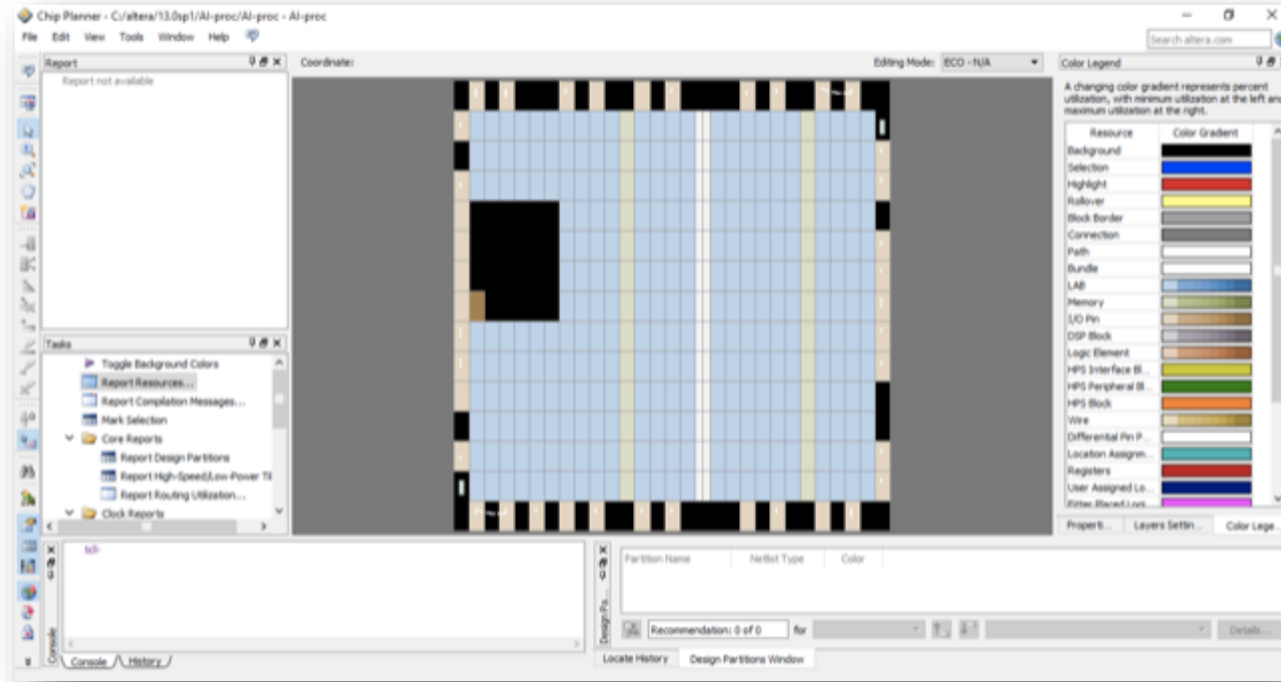
## AI Onboard – Prediction - Anomaly detection



## AI-at-the-Edge, AI-at-the-Endpoint: CPUs, GPUs, FPGAs

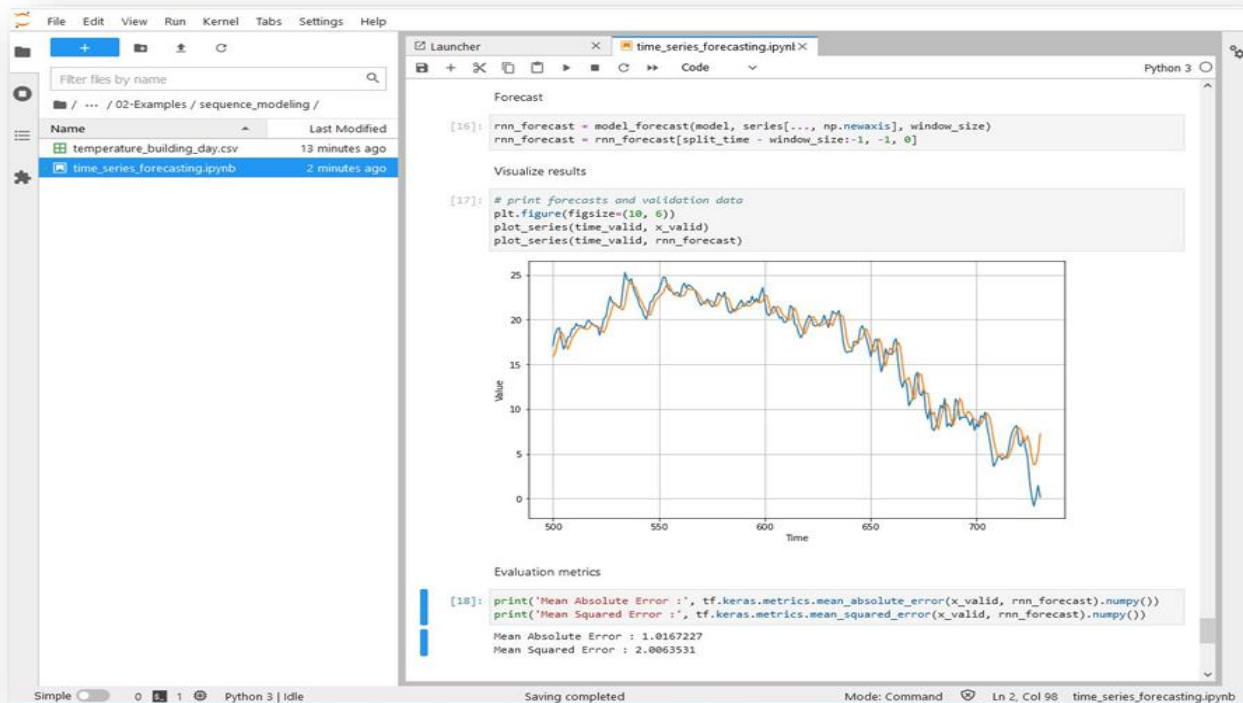


## AI at the Edge, AI at the Endpoint: CPUs, GPUs, FPGAs



32-bit AI  
Soft Processor  
with AI accelerators  
on FPGA





## Opportunities for new aerospace architectures

- AI Onboard allows for better monitoring of onboard systems, anomaly detection, systems monitoring and preventative maintenance
- AI Onboard compression reduces communication link rate requirements
- AI Onboard enhancement supports direct to user platforms, or more accurate feature processing in support of data compression and reduced link rates
- AI Onboard supports hybrid Radar and Earth Observation satellites, or constellations, allowing imagery to be downlinked independent of weather
- AI Onboard supports any onboard scenario: vehicles, drones, aircraft, spacecraft