

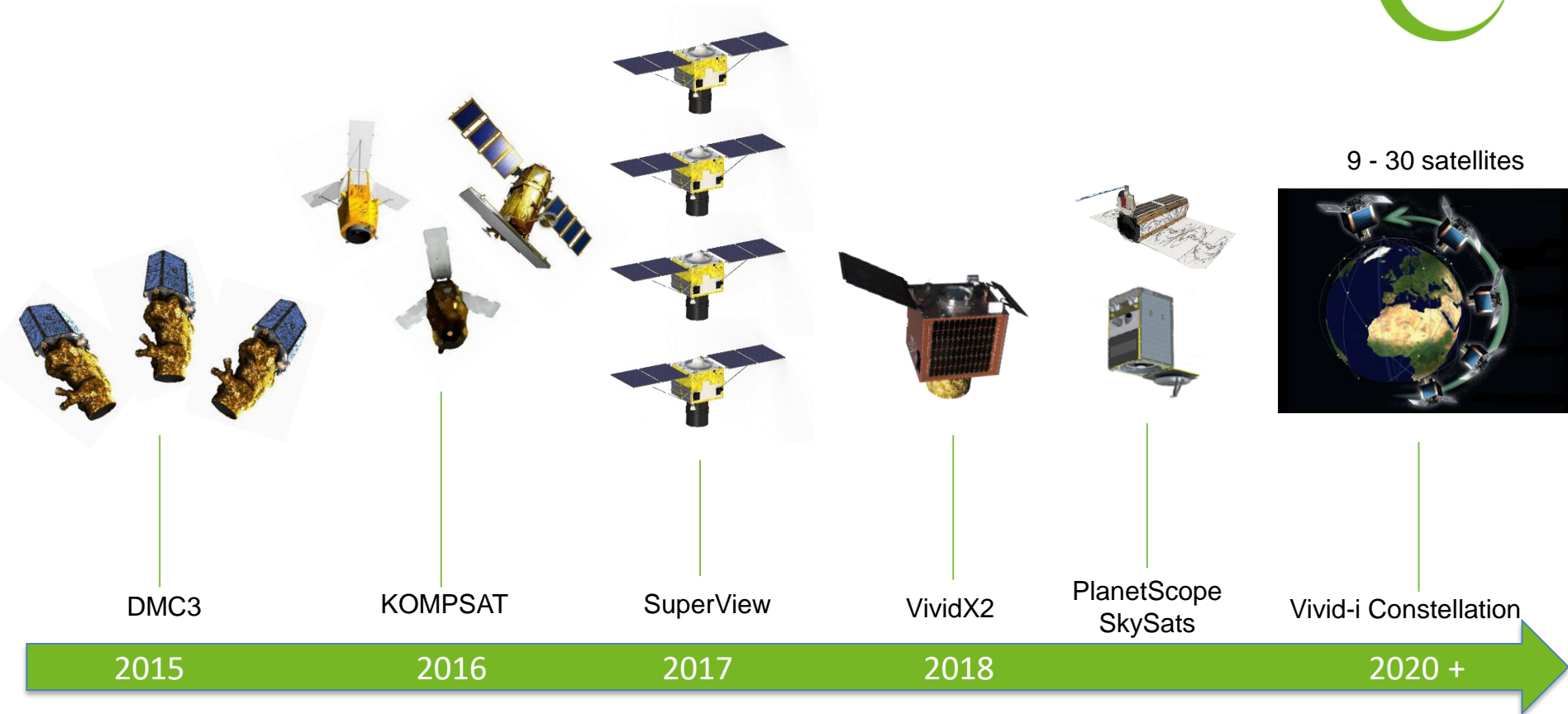


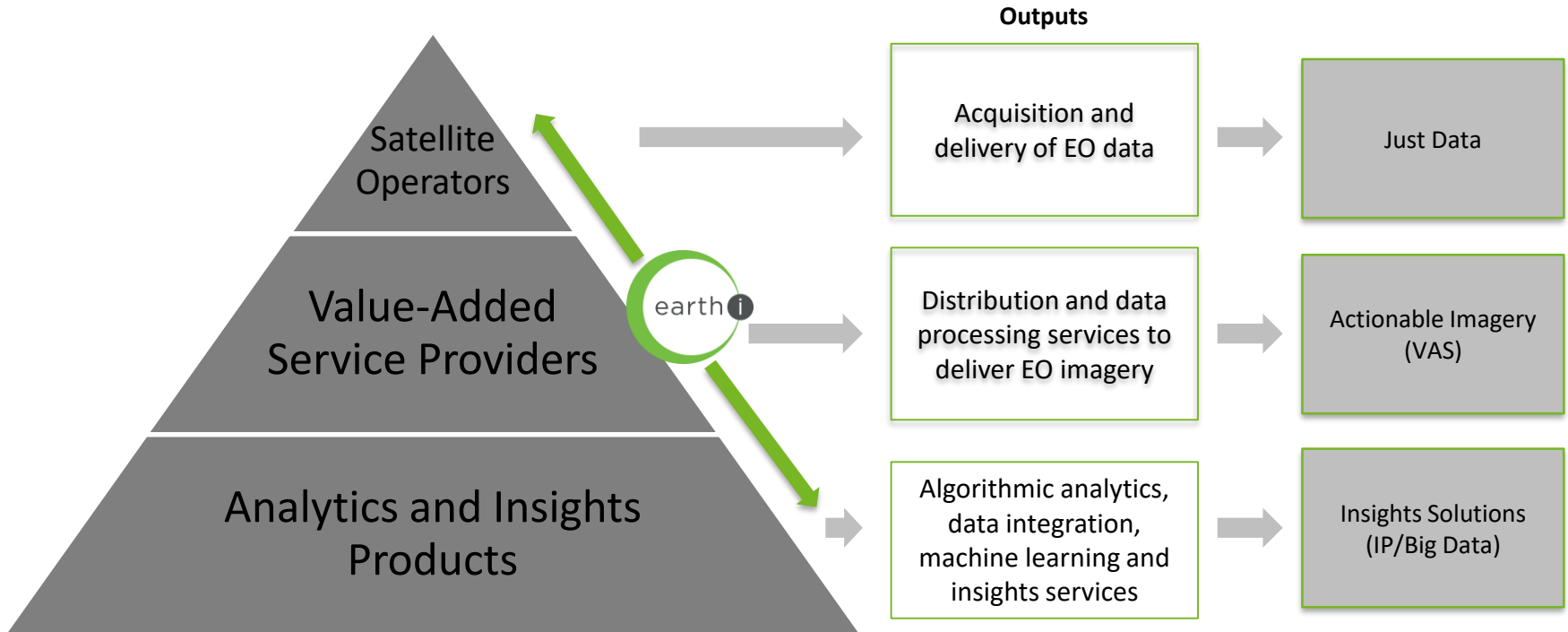
# Distributed edge and cloud processing for EO and implications for future missions and applications

Owen Hawkins, Chetan Pradhan

CEOI Emerging Technologies Conference  
Abingdon, 02 May 2019

# EARTH-i TIMELINE









WHERE WE ARE

Customer needs	Analytical Capability	Satellite Data Sources	3 <sup>rd</sup> Party Data Sources	Delivery Capability	Resources	Route to Market	Vertical Expertise	Accessible Market
Infrastructure this	Mapping	Vivid-i	AIS	Web GIS	Grants	In country partner	Spirit guide	Quantifiable market
Power that	Indices	KompSat	News	Print	Internal funding	Partner company	Expert in partner	Probable contract
Water the other	Machine Learning	SuperView	ADS-B	API	Customer funding	Integration partner	Internal expert	Known tenders
Issue	Ortho	TripleSat	River gauge sensors	Mobile	Enthusiastic people	Direct to customer	Academics	Lead customer
Problem	GIS	Airbus	LIDAR	Bulk	ODA	...	Internet research	Forecast market
Desire	...	Sentinel	Drone data	3D web	Bootstrap		NGOs	...
Need		Planet	Aerial data	...	...		Government partner	
...		...	...				...	

**The key for us is to reflect the needs of all of these tasks and users within our technical infrastructure**

## INTERNAL DEVELOPMENT

Developing:

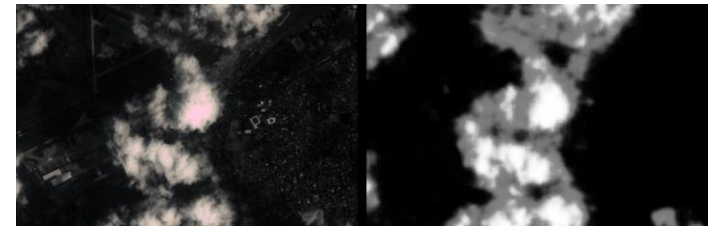
- Object detection
- Feature detection
- Semantic segmentation
- Change detection
- Image stacking etc.



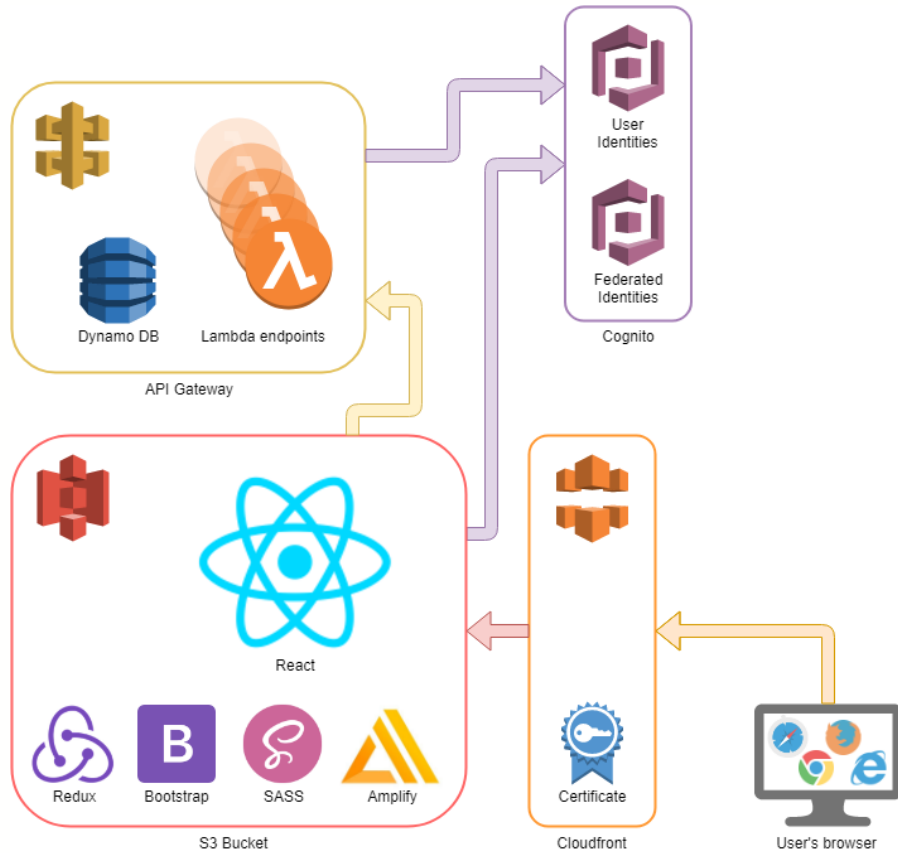
## CEOI OVERPASS

Developing:

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



**Developments able to be deployed on resource limited platforms, e.g. on satellite  
Work is needed on the systems to administer these on-board capabilities**



Deployed secure cloud infrastructure relocatable to any AWS location (globally distributed). Deployable back and front end services, for example:

Server based and/or dockerised modular deployments of certain software for image processing

- PCI geomatica, ENVI, ArcGIS, Spacemetric Keystone
- OGC web streaming services (geoserver etc.)
- Rapid machine learning model deployment with AWS Sagemaker etc.

Statistical and mathematical calculations using python libraries with Dynamo DB

Many services could be duplicated to the edge where they are not resource or IO hungry, though compatibility is a factor.



WHERE COULD WE  
GO?

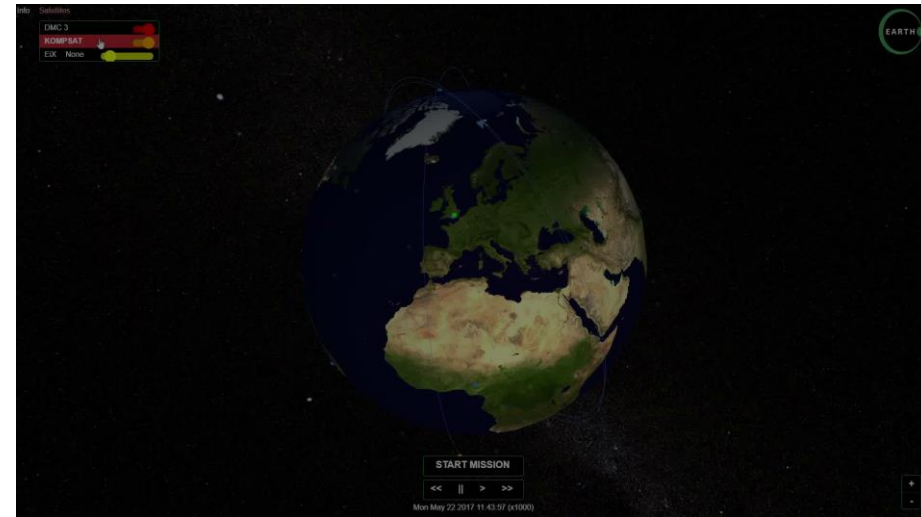




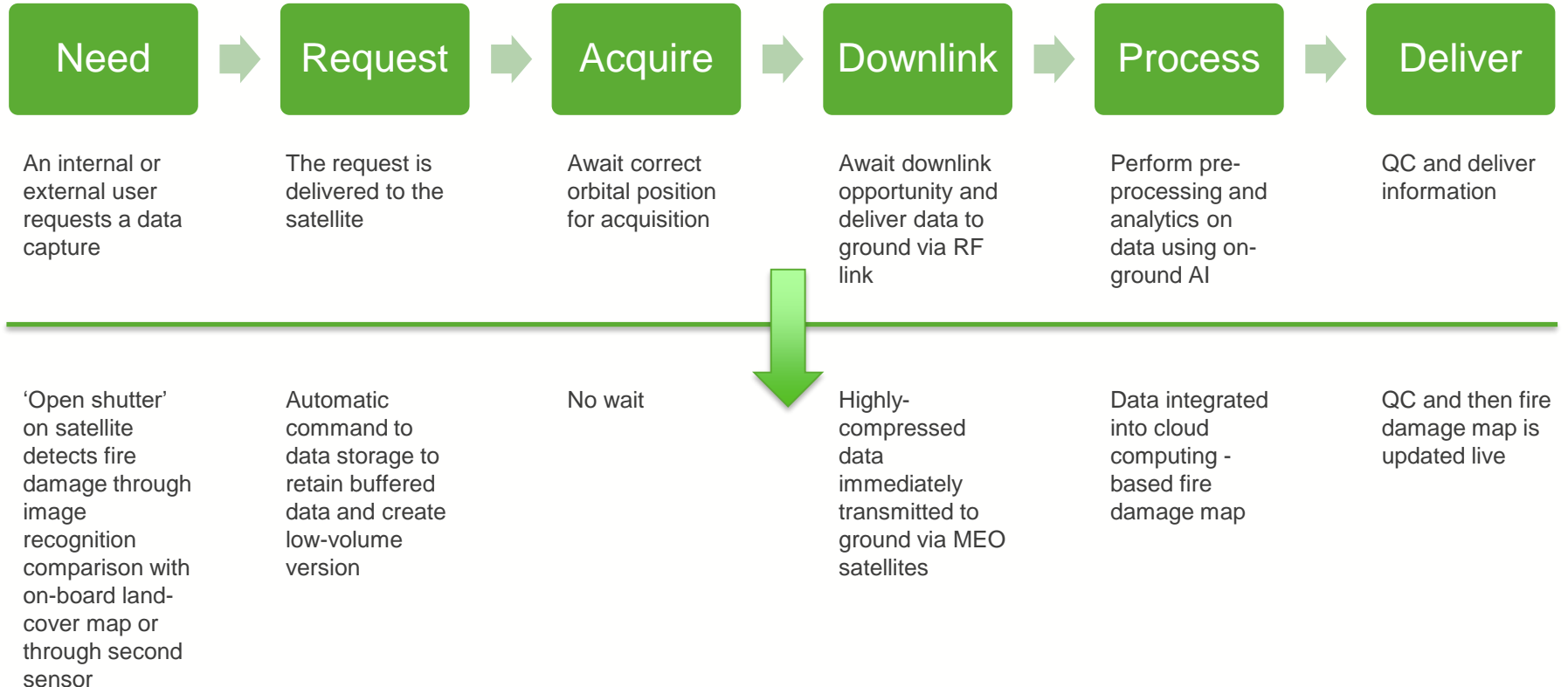


## VIVID-I

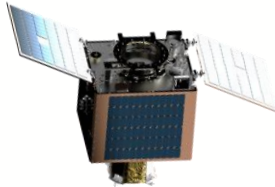
- The first batch of **5 fully commercial satellites** scheduled to be launched 2020-21. Life 5+ yrs.
- Our intention is to launch batches of 5 satellites at 9 -15 month intervals thereafter, cadence dependant upon demand.
- The Vivid-i constellation will provide imaging opportunities throughout the day and night, with satellite rollout from 2020.
- Each acquisition opportunity offers the potential of video collection



# TYPICAL EO SATELLITE USE CASE



## On Satellite



- Prepare images and videos for use
- Check quality and content
- Compress data for downlink
- Make comparisons with expected imagery features
- Derive basic information
- Make decisions about acquisitions and downlink
- Generate satellite commands in real time

## On Cloud



- Batch process large volumes of data, train neural networks
- Structure workflows
- Perform data fusion and data science tasks
- Manage GIS infrastructure
- Serve and deliver to customers

## On Premise/Private

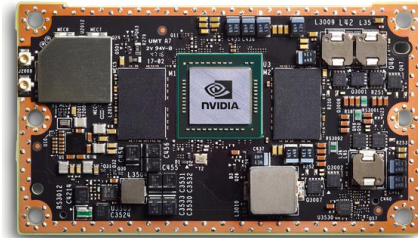


- Prototype services for use on board or on cloud
- Secure tasking and mission planning
- Deploy workflows to cloud and satellite

# SOME ENABLING TECHNOLOGIES



Myriad-X  
Low power deep neural  
network inference



NVIDIA Jetson TX-2 AI  
computing device, CPU,  
GPU, linux, multiple IOs



**AWS Ground Station**  
Fully managed ground  
station as a service



**KONGSBERG**

Flexible ground segment



Ongoing machine  
learning library  
development



Data on which to build  
satellite applications



Multi-sensor satellites  
for internal  
tipping/cueing





### Advancement of inter-sat comms for data backhaul

‘Always-on’ sat comms at sufficiently high bandwidth

### Fast satellite uplink for the transfer of models and software

To reload ever larger algorithms and supporting libraries

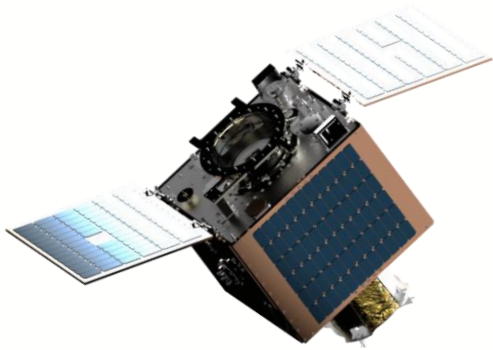
### More pre-trained models for satellite data analysis and/or labelled datasets

Many are available for standard photos, very few available for satellite data

### Geo-video enabled software platforms

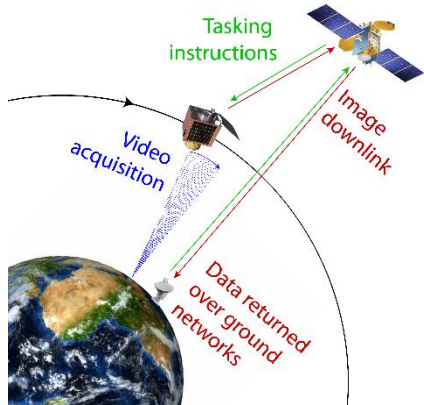
GIS packages that understand satellite video

### Advancements in satellite autonomy



Proposed next generation mission to enhance the utility of video from space

- On-board processing to downlink derived information quickly
- Inter-satellite links / data relay for 24/7 satellite contact, commanding and video return
- Additional spectral data for enhanced information content; inclusion of other sensors in the constellation
- More sophisticated mission planning and data processing
- Improved imagery resolution and fidelity





THANK YOU

Telephone (UK): +44 (0)333 433 0015  
Email: [info@earth.co.uk](mailto:info@earth.co.uk)  
Web: [www.earth.space](http://www.earth.space)

Earth-i Ltd  
10 Nugent Road, Surrey Research Park,  
Guildford, GU2 7AF, United Kingdom.