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LEO-Based Hybrid RF-Optical Data Relay Network Architectures

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November 15, 2018

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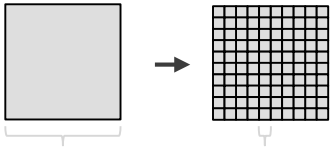
Remote Sensing & the Downlink Bottleneck

DATA CREATION INCREASING - LATENCY REQUIREMENTS DROPPING

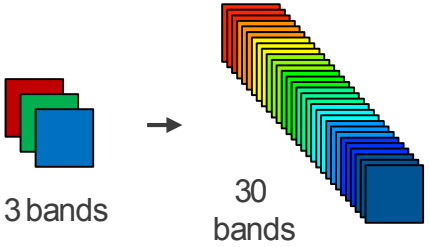
Data products are getting more data intense:

Spatial Resolution



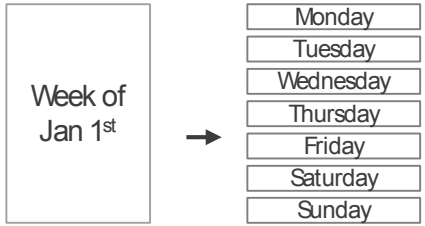
100x

Spectral Resolution



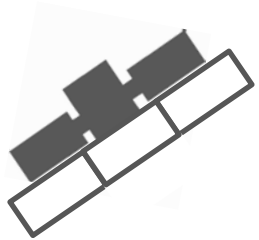
10x

Temporal Resolution



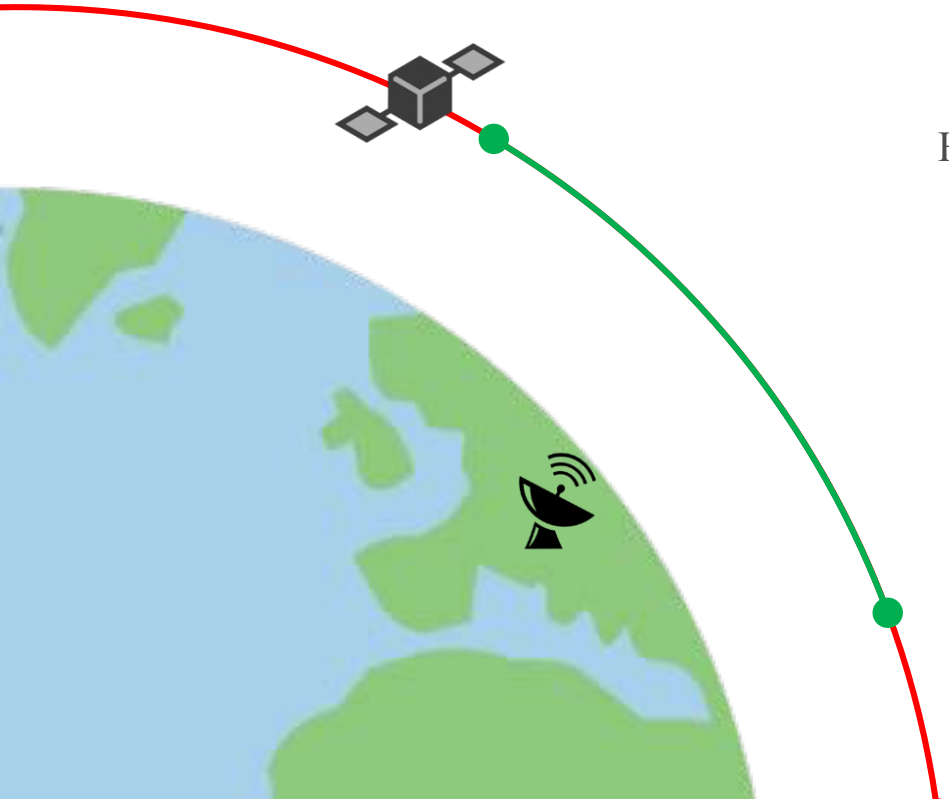
7x

New Instruments



New applications are driving stringent latency requirements:

DATA DOWNLINK BOTTLENECK



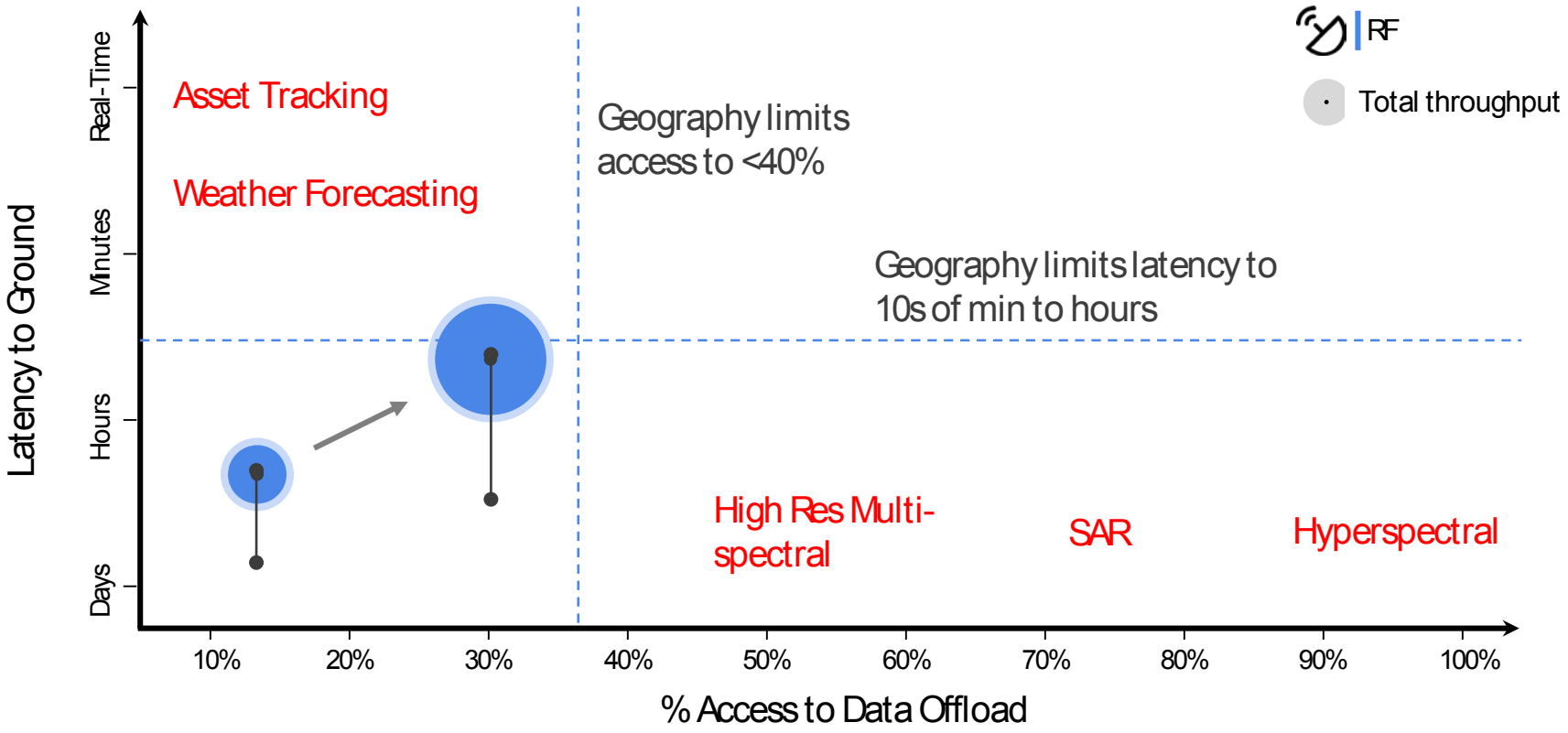
Data Downlink Today:

High spatial/spectral/temporal resolution imagery:
Intensive data transfers

Time per day available for downlink to global ground terminal network:
2-3 Hours

Time between image capture and analysis
Hours to days

IMPACT OF ASI DATA RELAY NETWORK



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Analytical Space Network

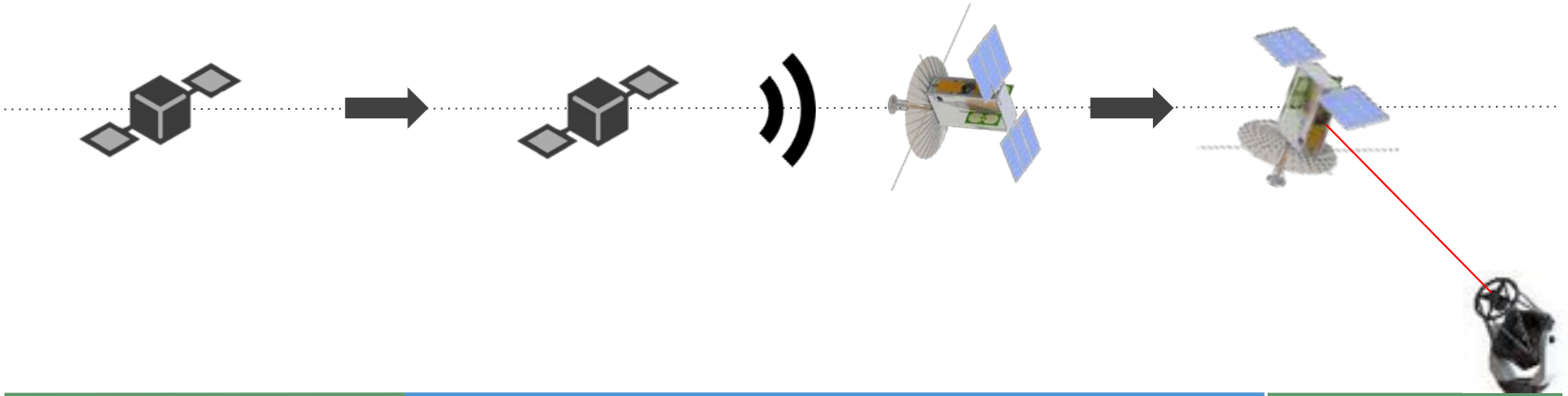
OVERVIEW

Analytical Space (ASI) is building a network of data relay satellites in Low Earth Orbit that use **optical downlink** to provide **high-throughput, low latency** data downlink service for remote sensing satellite operators.

HYBRID RF/OPTICAL DATA RELAY

ASI Data Relay Solution

1. Client **images** while over land
2. Client **crosslinks** to co-orbital ASI satellites over the ocean
3. ASI **downlinks optically** over land (with RF backup)

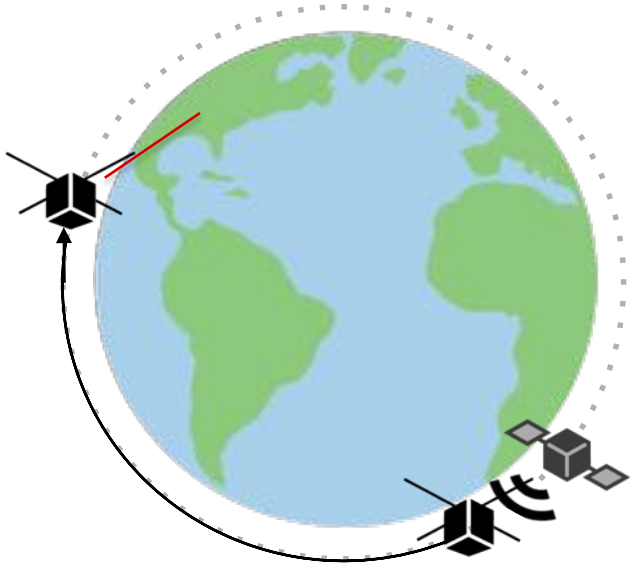


Land
30% of Earth's Surface

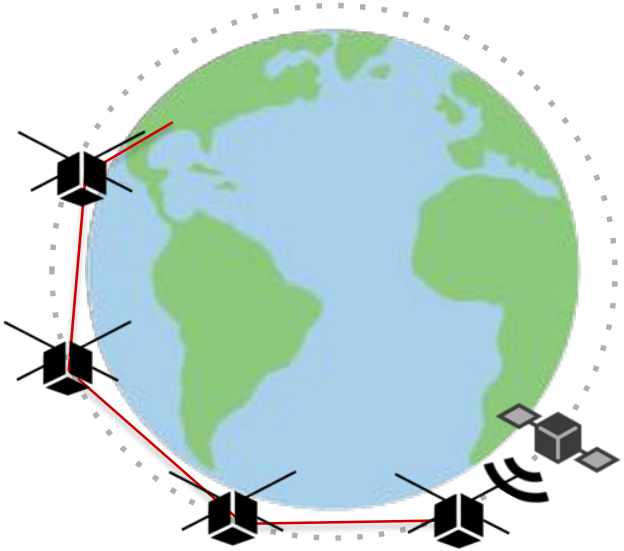
Ocean
70% of Earth's Surface

CAPABILITY EVOLUTION

Store & Forward



Low-latency Routing

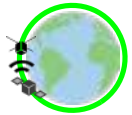


BENEFITS FOR REMOTE SENSING SATELLITES

Store & Forward

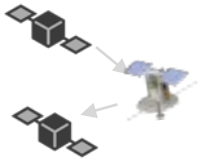
Low-latency Routing

Greater Efficiencies



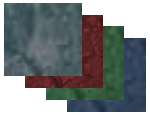
Higher asset utilization

Smaller asset base



Dynamic tasking

New Capabilities

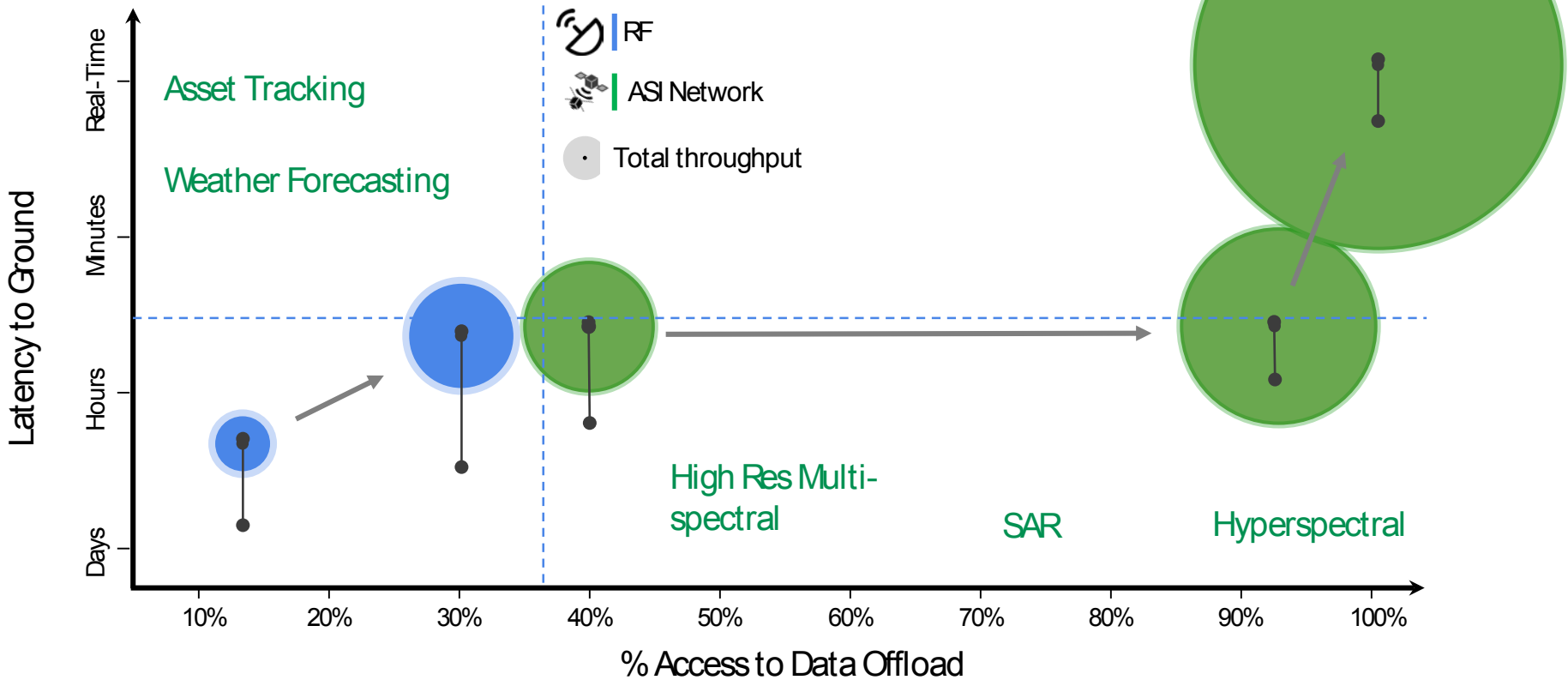


New data products

Image
↓
Analysis

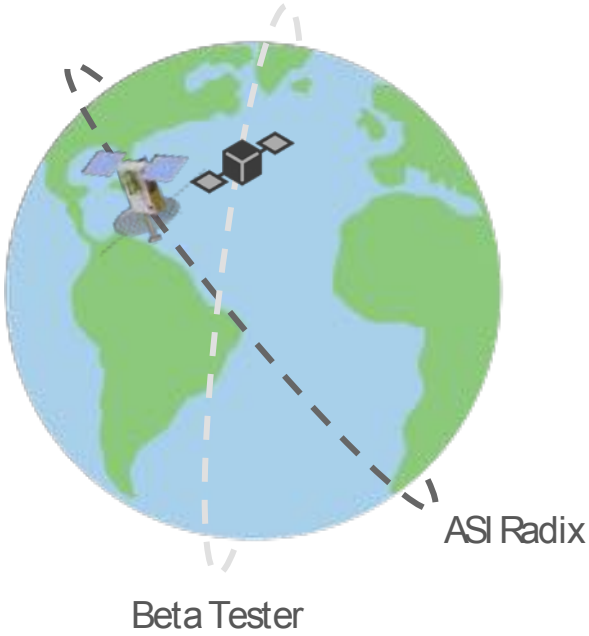
Near-real-time data delivery

IMPACT OF ASI DATA RELAY NETWORK



BETA MISSION - RADIX

Single Satellite in ISS Orbit



Mission Goals

Deployable Antenna

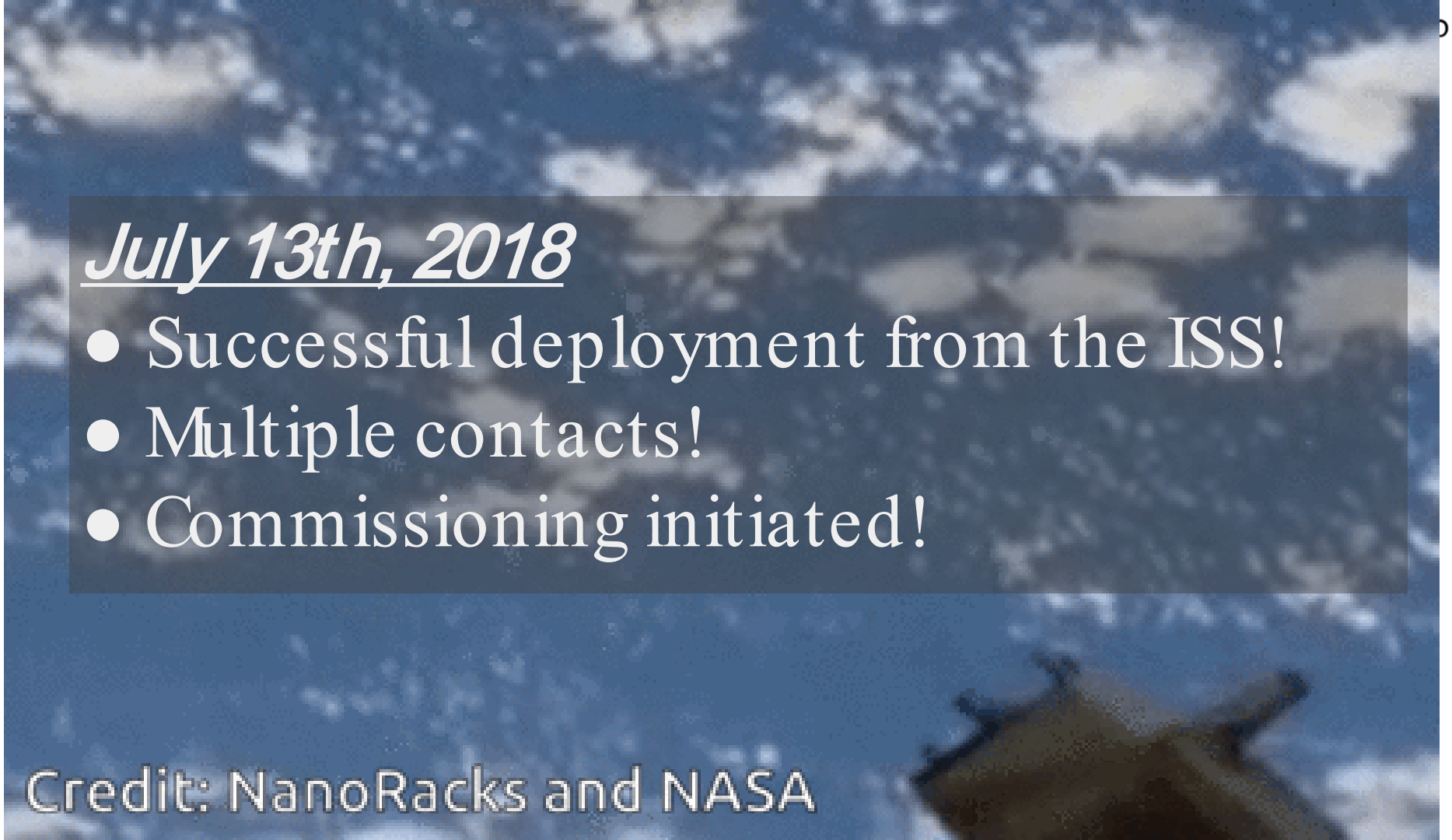
First to deploy very high-gain antenna on a commercial nanosatellite platform to enable duplex LEO operations

Laser Downlink System

First to demonstrate high-speed commercial laser downlink, surmounting many technical barriers

Satellite Crosslink

First to establish high-data rate commercial nanosatellite relay communication


July 13th, 2018
• Successful deployment from the ISS!
• Multiple contacts!
• Commissioning initiated!
Credit: NanoRacks and NASA

BETA MISSION - RADIX- TIMELINE

Start building Radix

The team begins assembly of the Radix platform.

Launch!

Radix launches out of Wallops, VA on the CYGNSS CRS OA-9E ISS resupply mission.

Handover of Radix

Satellite construction complete after only **1 year!**

Deployment and Commissioning

Radix is successfully deployed and commissioned. Preparations for key subsystem tests and technical demonstrations in progress.

ASI has a wide variety of Beta partners

- **Entity**: Government, Commercial, Academic
- **Orbits**: ISS, SSO, numerous altitudes
- **Nations**: A variety of countries around the globe
- **Mission**: Earth observation, technical demonstration, science missions
- **High Demand**: Waitlist of interested technical demonstration parties

BETA MISSION - RADIX- LASER DOWNLINK SYSTEM

GOAL: First to Demonstrate High-Speed Commercial Laser Downlink

Thermal Management

First to effectively manage the large thermal load on a commercial nanosatellite.

Power Management

First to manage the high power requirements for high-speed optical comms on a commercial nanosatellite.

Size Constraint

First to reduce a high-speed optical terminal to a form-factor suitable for commercial nanosatellites.

Pointing Accuracy

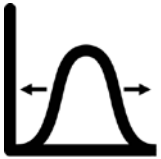
First to combining coarse and fine pointing mechanisms on a commercial nanosatellite platform to effectively close an optical link to ground.

BETA MISSION - RADIX- DEPLOYABLE APERTURE

GOAL: First High-Gain Deployable Antenna on a Commercial Nanosatellite

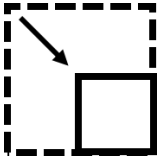
High Gain

A 0.5m dish on a 6U cubesat - nearly 2x the largest dimension of the satellite. Scalable to 1.0m.



Wide Frequency Range

Capable of communication in designated Earth Observation S-Bands. Technology demonstrated will pave the way to a high-gain dual-band X and S-Band antenna.



Size Constraint

Reduced the undeployed form factor to ~1U.

BETA MISSION - RADIX- HIGH DATA RATE SATELLITE CROSSLINK

GOAL: First to Transmit Payload Data via a Commercial Nanosatellite Crosslink

Backwards Compatible

Wide band antenna coupled with software defined radios allow for satellite crosslinks using their existing, on-board downlink systems.

High Data-Rate

High gain antenna, a robust data-handling computer and massive on-board storage allow for relay communication of data-dense payload data.

Orbital Flexibility

Lower altitude, yet close enough to establish high gain connections - acts as a “virtual ground station” capable of working with satellites from a group of different orbits.

NEXT STEPS

Analytical Space, Inc.'s Upcoming Missions

Technical Demonstration Completion

Wide band antenna coupled with software defined radios allow for satellite crosslinks using their existing, on-board downlink systems.

Second Relay Satellite

An improved relay satellite with improved capabilities - suitable for relay operations - is scheduled to launch in H2 2019 .

Networked Relay

A partial network capable of low-latency routing will launch in 2020.

THE ASI TEAM

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- 8 yrs with NASA and White House OMB, Piper Aircraft Company

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- Planetary Resources, Boston Consulting Group, White House OMB

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- Draper Lab Fellow, NASA Ames Research Center, World Economic Forum Global Shaper

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Investors

THE ENGINE
Built by MIT

FLYBRIDGE
CAPITAL PARTNERS

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