spire

Spire constellation connectivity use case

IoT4EO 2023 Workshop

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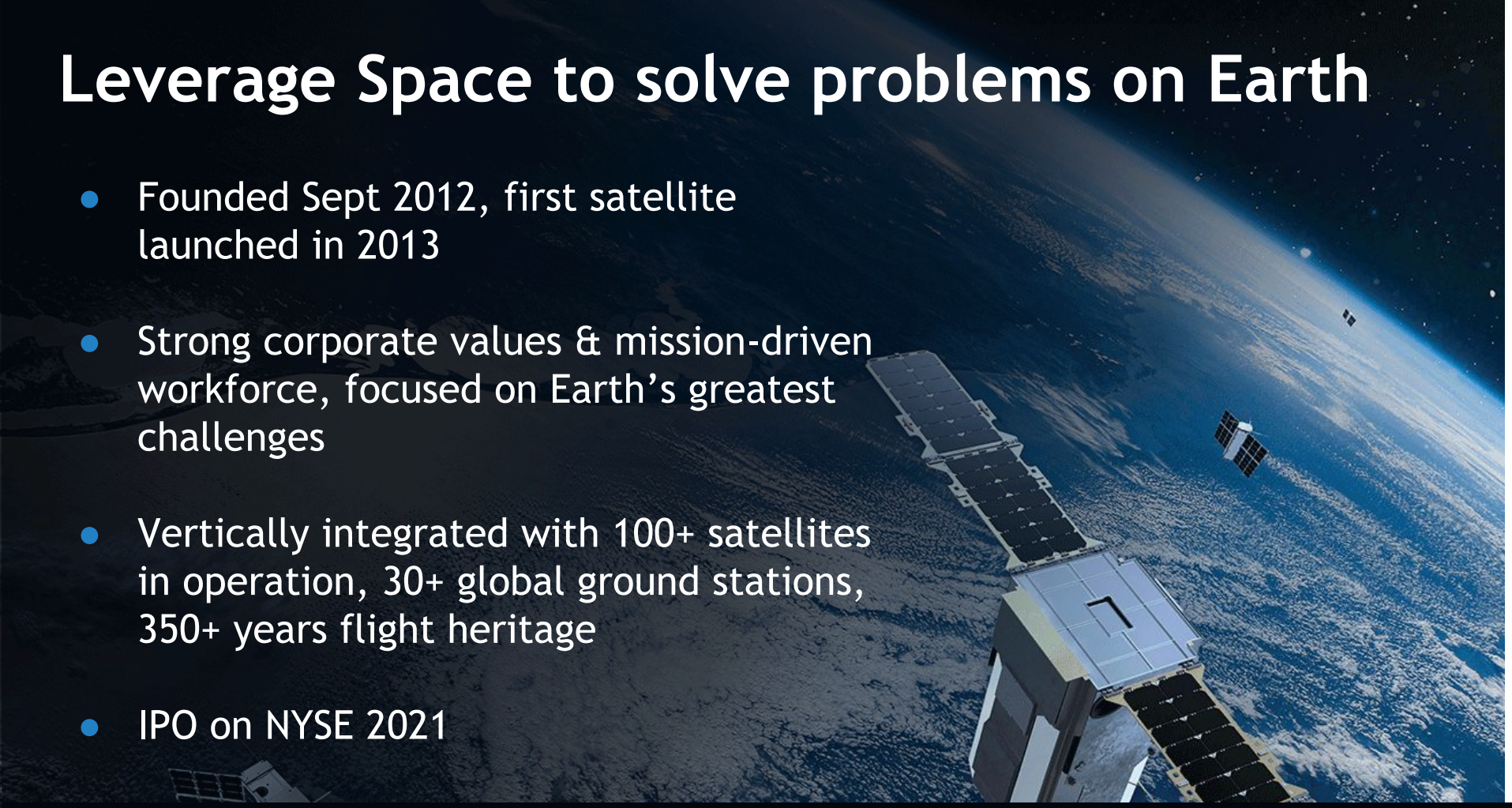
Jeroen Cappaert

CTO

Leverage Space to solve problems on Earth

- Founded Sept 2012, first satellite launched in 2013
- Strong corporate values & mission-driven workforce, focused on Earth's greatest challenges
- Vertically integrated with 100+ satellites in operation, 30+ global ground stations, 350+ years flight heritage
- IPO on NYSE 2021



"To inspire, lead, and create the business of space for the benefit of all"

Peter Platzer
Co-founder and CEO

Proudly serving over 700 clients including:

Met Office · ECMWF · esa · UK SPACE AGENCY · DLR · NOAA · NASA · esri · Chevron · MAERSK

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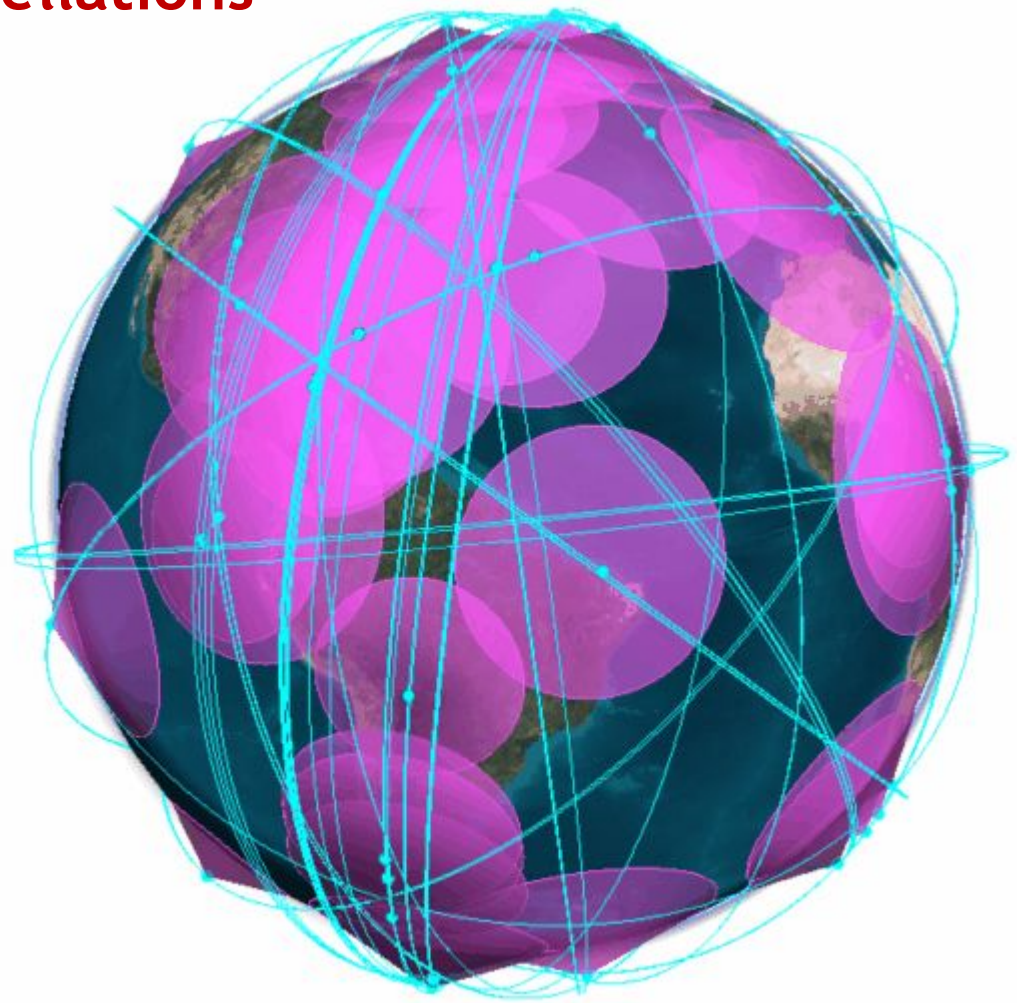
The Spire constellation

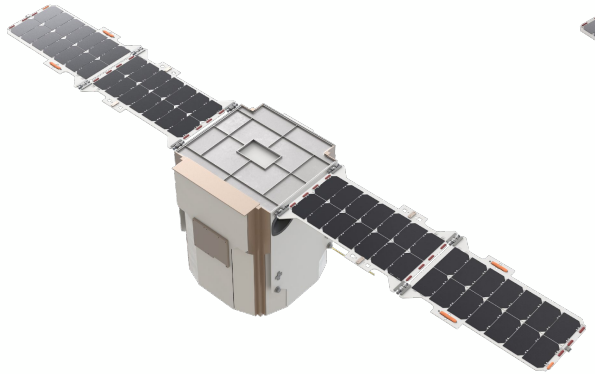
One of the largest commercial constellations

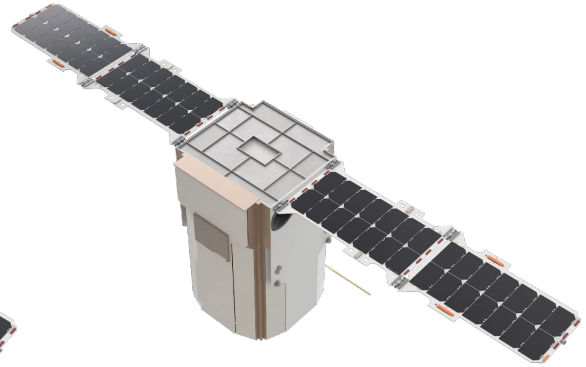
- The LEMUR is Spire's CubeSat platform used to track maritime, aviation, weather and other activity from space
- We operate one of the largest RF sensing fleets and are one the largest producers of radio occultation and space weather data
- Our data provides a global view with coverage in remote regions like oceans and poles
- We are continuously launching improved sensors and upgrading them in-orbit
- Currently observing every spot on Earth >100 times a day
- >100 satellites in operation across polar, mid-latitude and equatorial orbits



The LEMUR family

150+ satellites launched, carrying 500+ years of space heritage





3U Satellite

1U Payload Volume

Up to 15W Payload OAP

4GB Data download

(per sat per day)

6U Satellite

4U Payload Volume

Up to 20W Payload OAP

Up to 10GB Data download

(per sat per day)

12U Satellite

8U Payload Volume

Up to 50W Payload OAP

Up to 320GB Data download

(per sat per day)

16U Satellite

12U Payload Volume

Up to 50W Payload OAP

Up to 320GB Data download

(per sat per day)

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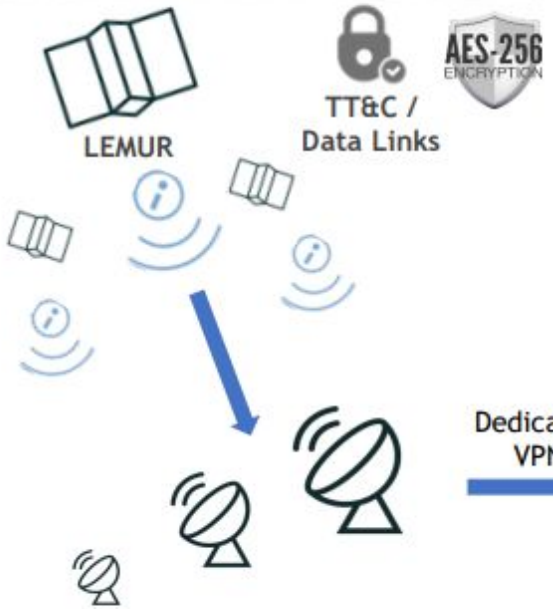
Scaled systems & automated operations

SPIRE'S PROPRIETARY TECHNOLOGY STACK IS PROVEN, AT SCALE, AND FULLY OPERATIONAL

Spire LEMUR Constellation

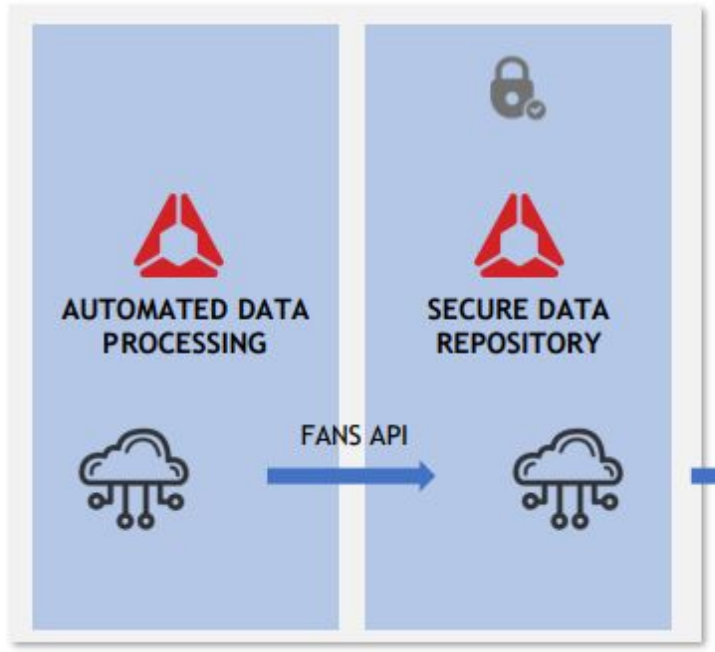


Spire Ground Stations

Collects space-based data and transmits to a proprietary ground station network

40k+
Average Nanosat Contacts / Month[1]

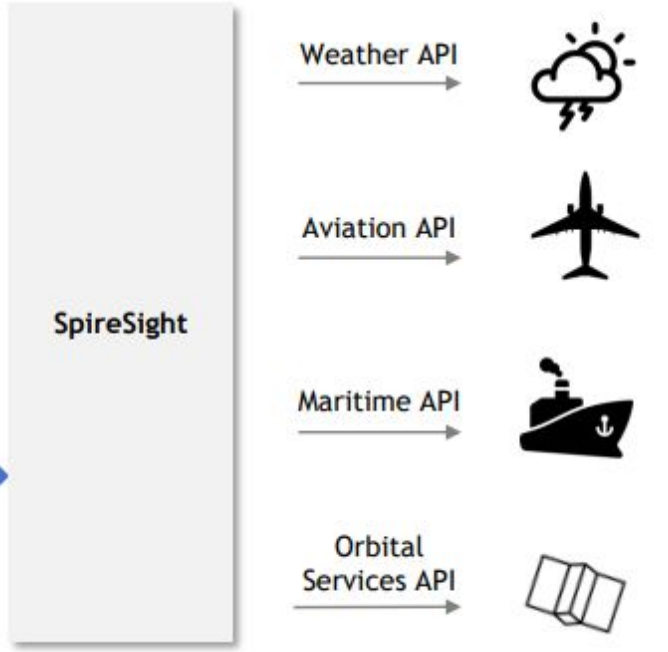
Spire Data Platform



Data moved from ground stations to proprietary data store for cleansing, standardization, fusion, and analysis — all without a human in the loop

~99.9%
System Uptime[2]

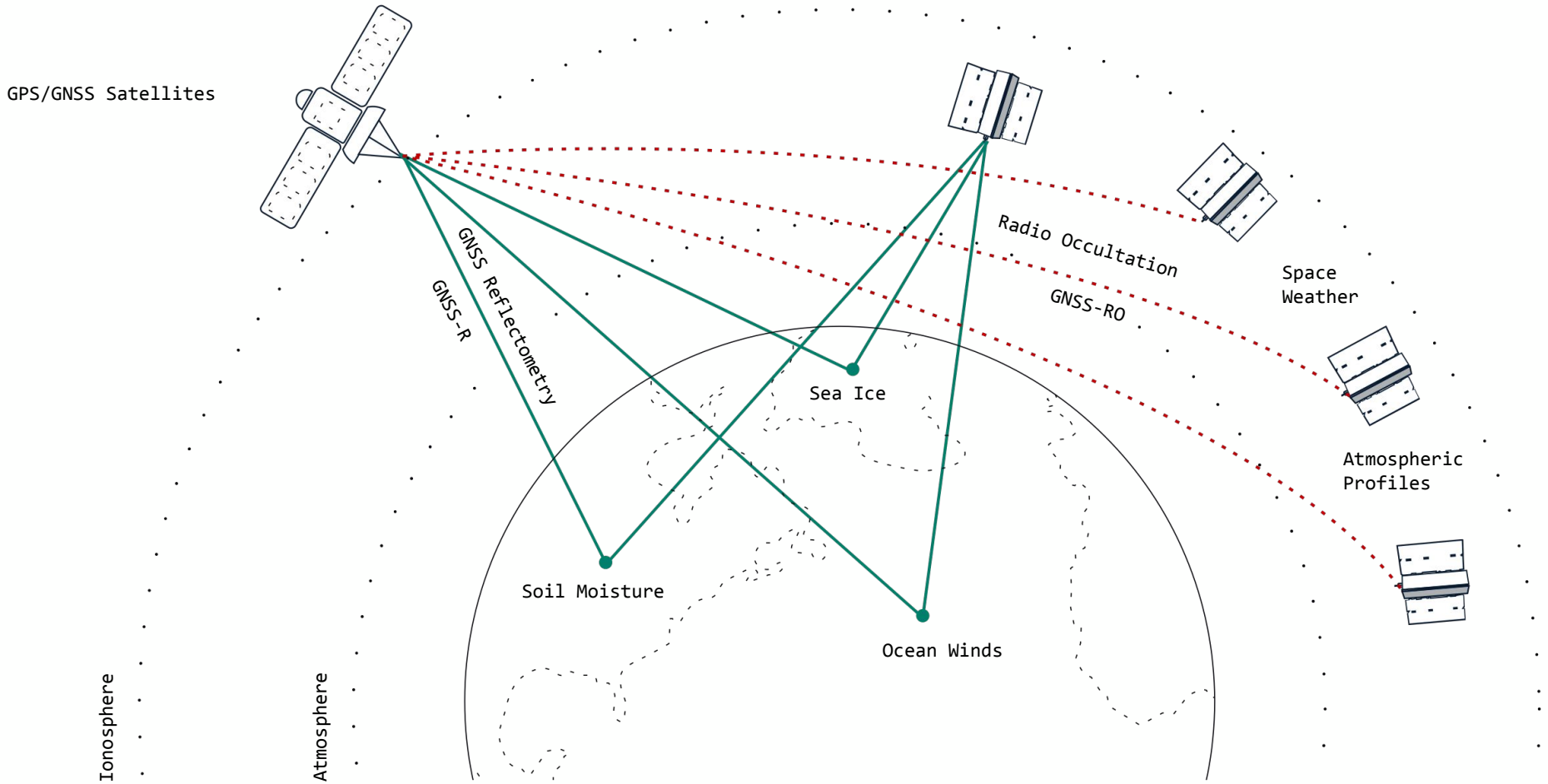
SpireSight Software Analytics



Customers receive proprietary data delivered seamlessly, in real-time via SpireSight API

~1 Terabyte
Data Served to Customers / Day[3]

Earth Intelligence Observables



- Atmospheric sounding for NWP, climate
- Ionospheric sounding for space weather monitoring
- Thermospheric density through precise orbit determination

- GNSS-R scatterometry: soil moisture, ocean winds, sea ice
- Grazing angle (low elevation) GNSS-R for sea ice altimetry and classification using RO sats (as opposed to conventional, near-nadir GNSS-R)

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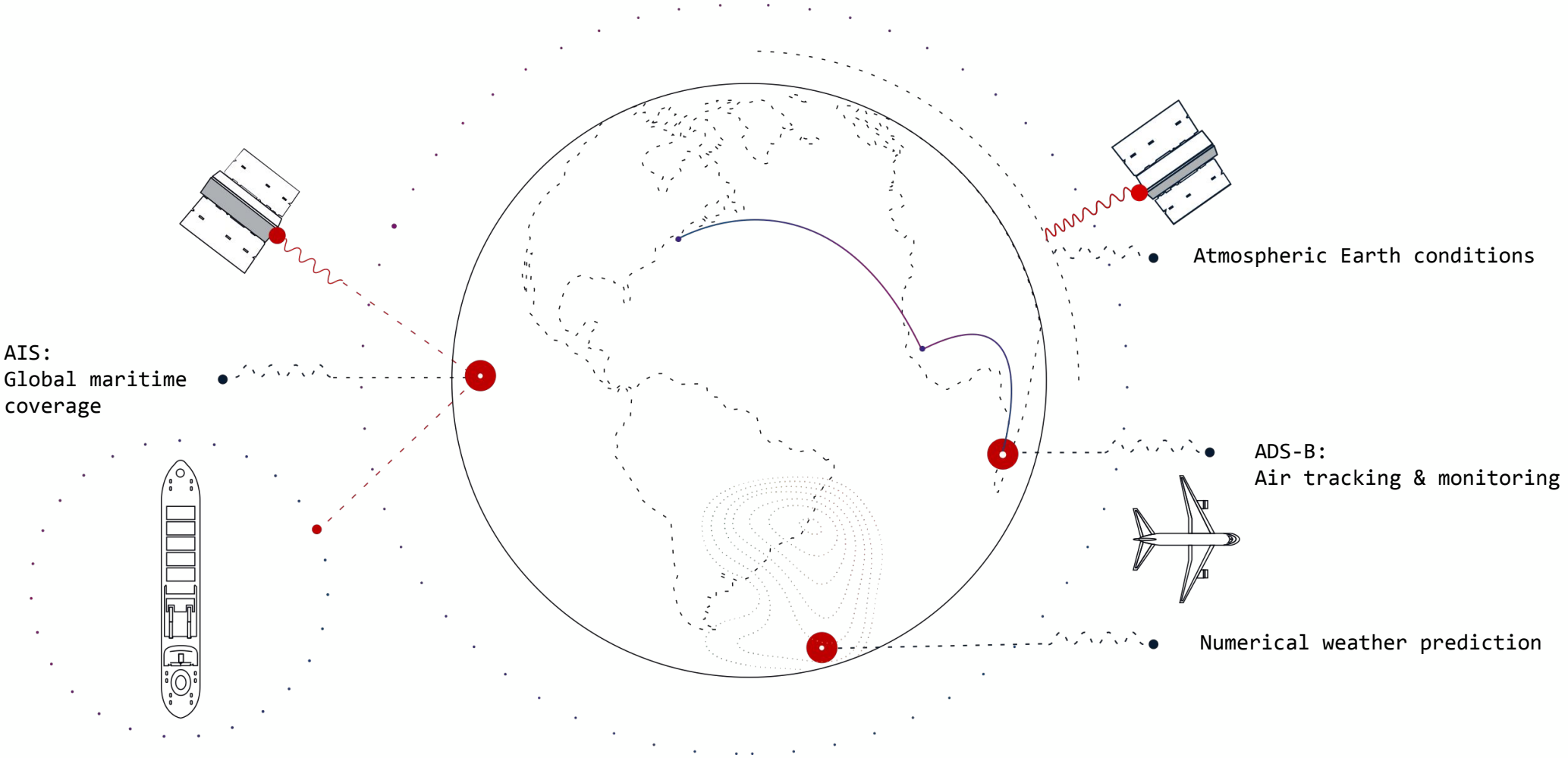
Spire data and analytics



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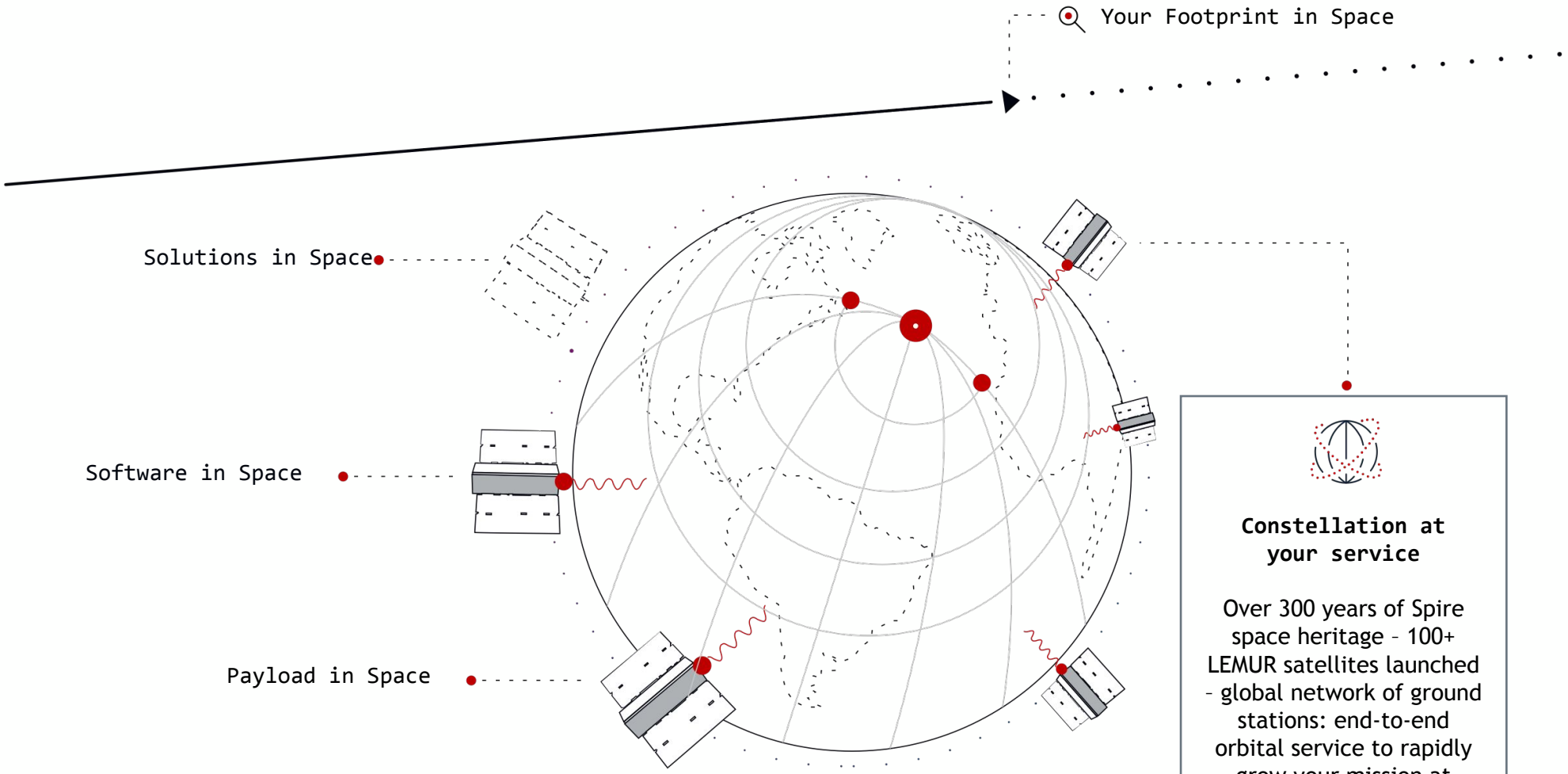
Space Services



Constellation at your service

Over 300 years of Spire space heritage - 100+ LEMUR satellites launched - global network of ground stations: end-to-end orbital service to rapidly grow your mission at constellation scale

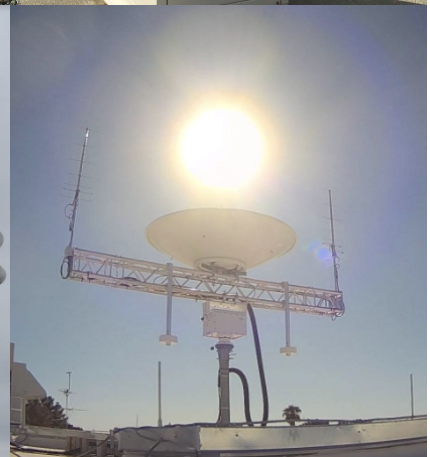
Data types and latency needs

- Data latency requirements depend on data type and application
- In general, a clear market push towards lower latency for most use cases

Data type	Example Use case	Order of Magnitude latency requirement
Weather data	Climatology, mapping	<24hrs
Weather data - time-sensitive	Operational forecasting	< 90min
Critical (space) weather data	Nowcasting, space weather	< 15-30 min
Logistics data (e.g. AIS, ADS-B)	Asset tracking and management	<15-30 min
RF intelligence	GNSS jamming detection	< 60 min
Safety critical, surveillance	maritime, aviation surveillance	< 1min (sometimes seconds)
Space Services	Wildfire monitoring, SSA monitoring, RF intelligence, IoT etc.	Wide range from “near real time” to >24hrs

Global groundstation network

30+
Ground Stations,
70+
antennas



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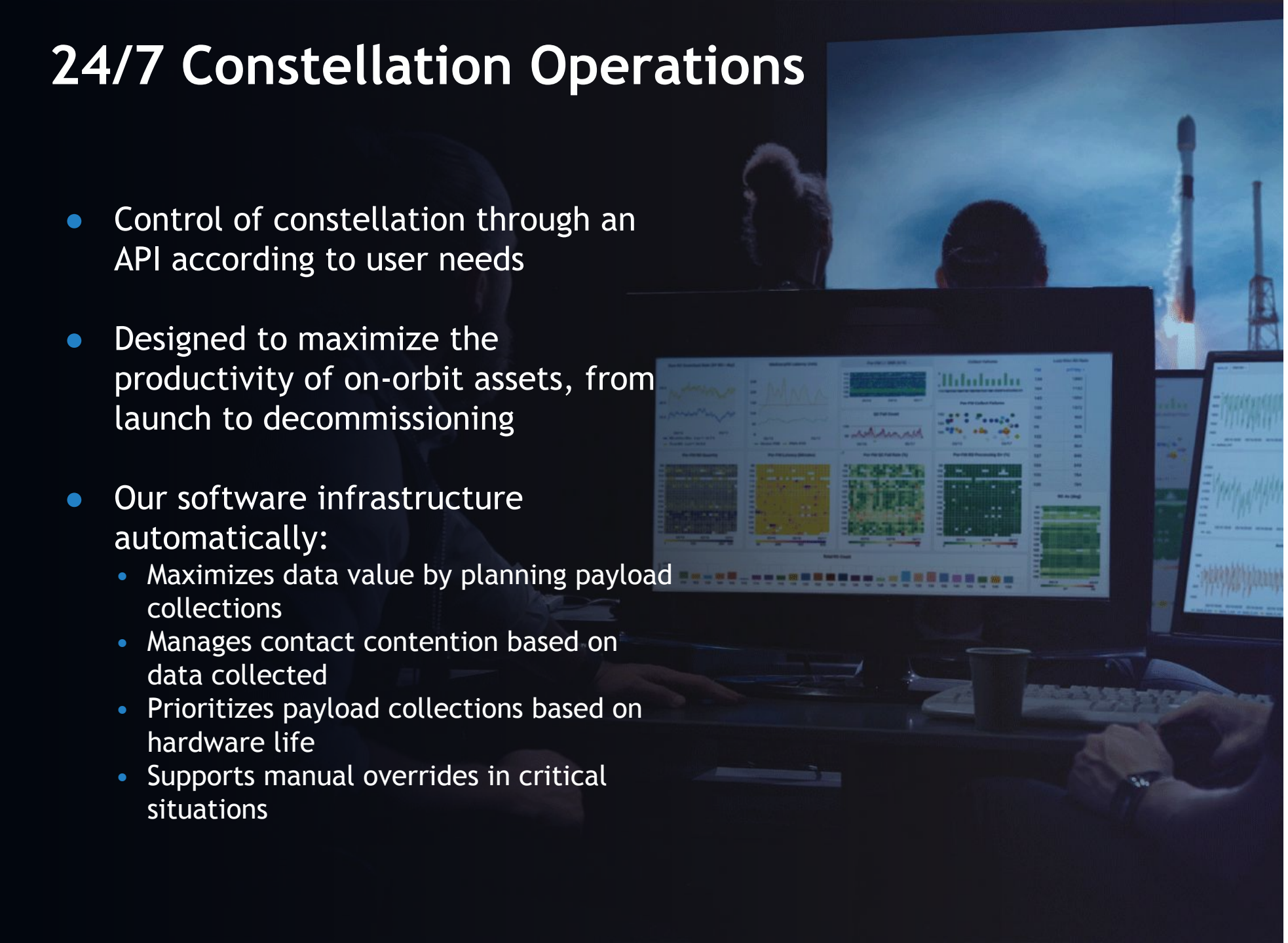
24/7 Constellation Operations



- Control of constellation through an API according to user needs
- Designed to maximize the productivity of on-orbit assets, from launch to decommissioning
- Our software infrastructure automatically:
  - Maximizes data value by planning payload collections
  - Manages contact contention based on data collected
  - Prioritizes payload collections based on hardware life
  - Supports manual overrides in critical situations

3000+

Daily contacts

99.7%

Automated operations

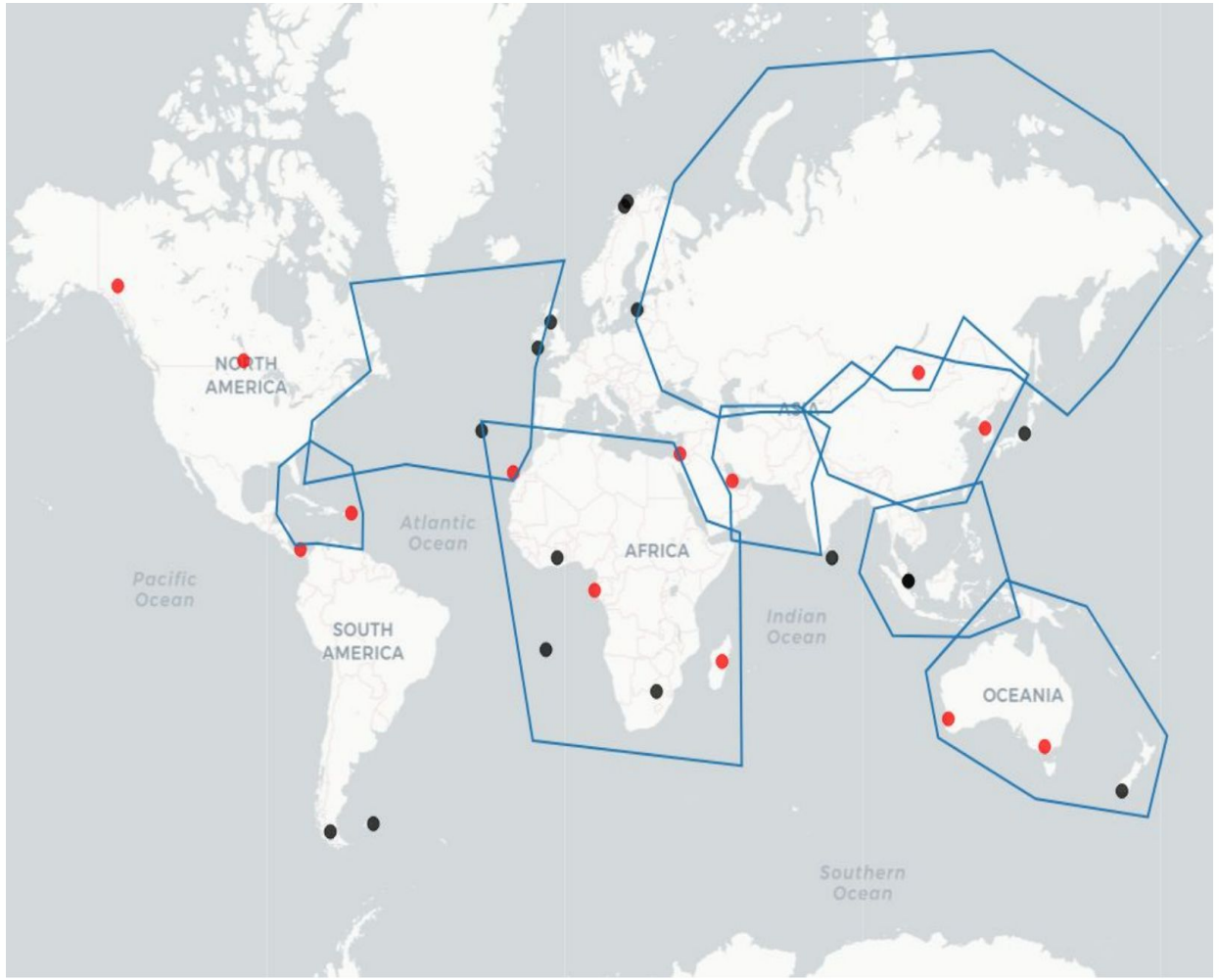
24/7

Mission support

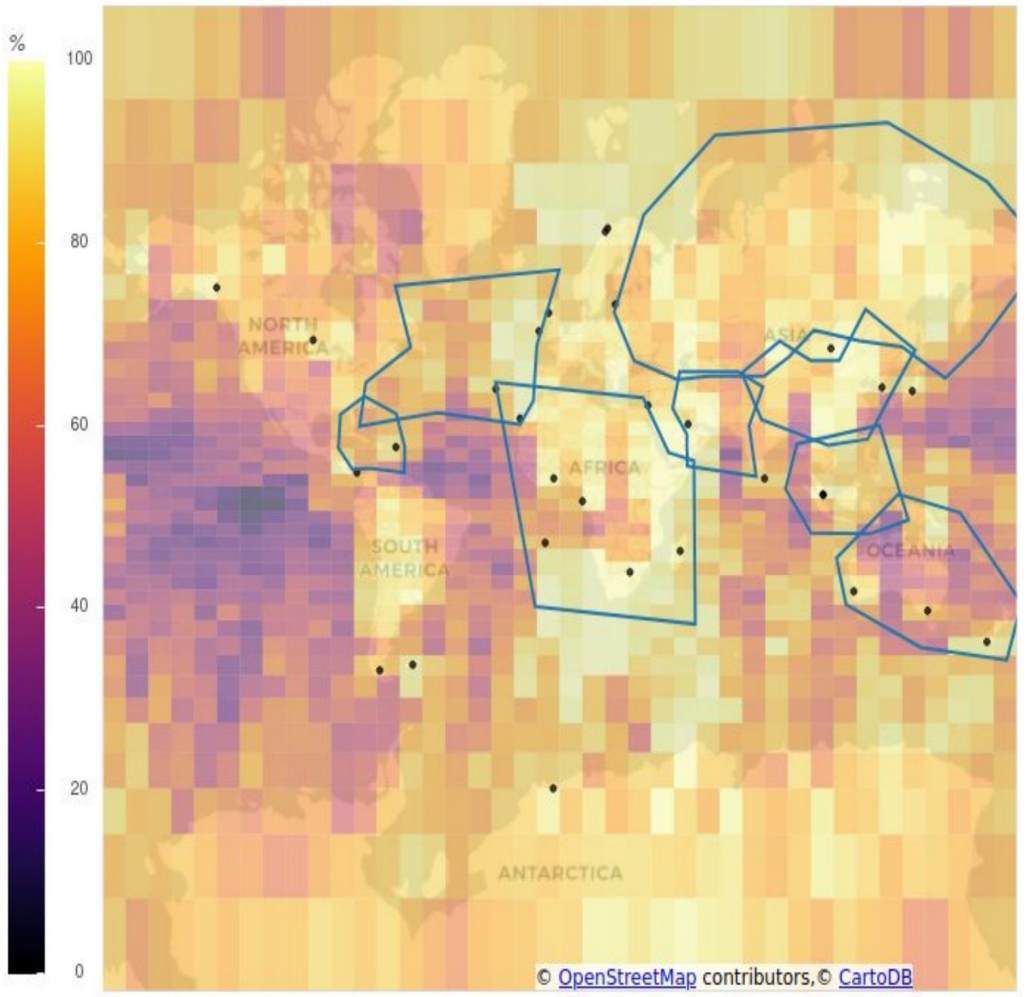
99.9%

API uptime

Performance drivers - focus on AoIs

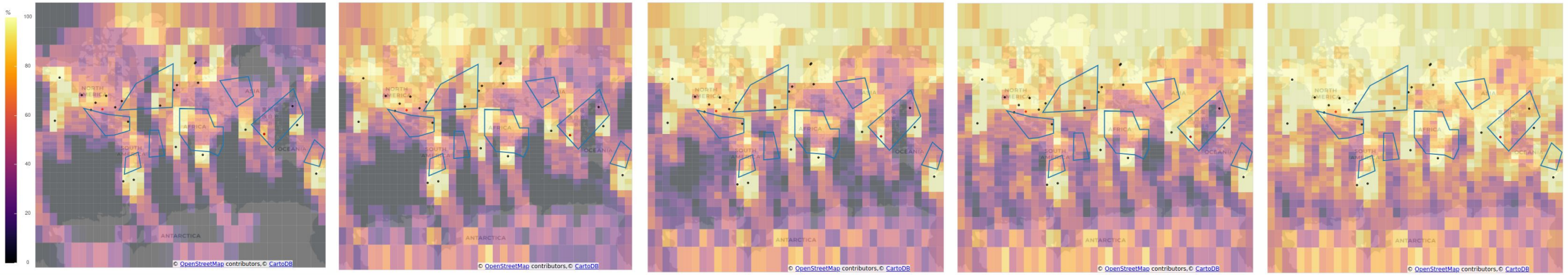


Groundstation network driven by Areas of Interest



Performance associated with AoIs - validating groundstation location design

Use of intersatellite links



No ISL | 2000 km | 3000 km | 4000 km | 5000 km

- Latency coverage critically dependent on ISL performance
- In the Spire model - high correlation with distance as that defines the number of possible contacts with other satellites
- Prefer more frequent shorter contacts rather than infrequent high-volume data dumping
- Trend towards higher data rates (e.g. using optical)
- Use 3rd party networks where possible

Summary

Backhaul infrastructure strategy

- **Downlink**
  - Spire-owned ground segment as core capability
  - Augmented with 3rd party ground segment providers for strategic capabilities and surge support
- **Inter-satellite**
  - Spire-owned intersatellite-links for constellation connectivity
  - Augmented with 3rd party providers for strategic capabilities and surge support
  - Posture could tilt more towards 3rd party if/when market matures

Critical performance characteristics and KPIs

- Capacity/Volume/Throughput
- SWAP-C requirements for space segment
- $/GB or $/min for ground segment/backhaul
- Latency
- Availability/persistence
- Responsiveness
- Compatibility/Interoperability
- Certifications

Thank you!

From our team, to yours.

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