Energy for Earth from Space: Architecture for a CubeSat Space Solar Power Constellation

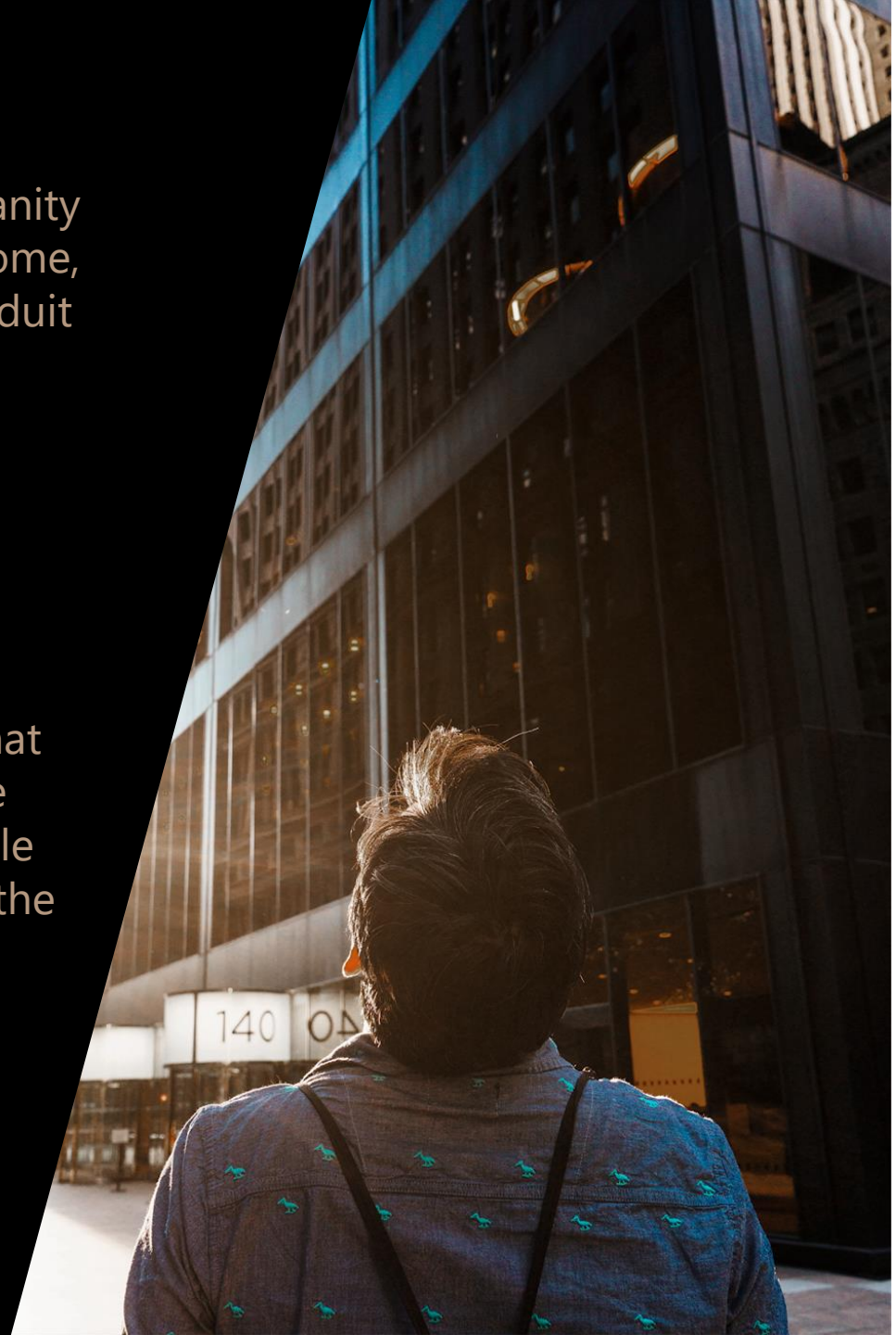
Dr. Thomas Sinn,
CEO Deployables Cubed GmbH

Our Vision

To power humanity for worlds to come, and be the conduit for a cleaner tomorrow.

Our Mission

To develop innovative technologies that are pushing the boundaries while only physics is the limit.



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(established in 2019)

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Supported by:

esa business incubation centre Bavaria

Gefördert durch: Bundesministerium für Wirtschaft und Energie aufgrund eines Beschlusses des Deutschen Bundestages

eXIST Existenzgründungen aus der Wissenschaft

Europäische Union

ESF Europäischer Sozialfonds für Deutschland

Zusammen. Zukunft. Gestalten.

$48,000,000,000,000

The International Energy Agency (IEA) estimates a $48 trillion investment needed to meet global demand of energy by 2035.

Is there an Issue to solve?

Power to Everyone

In the darkest moments

For a greener Future

While strengthening E-Mobility

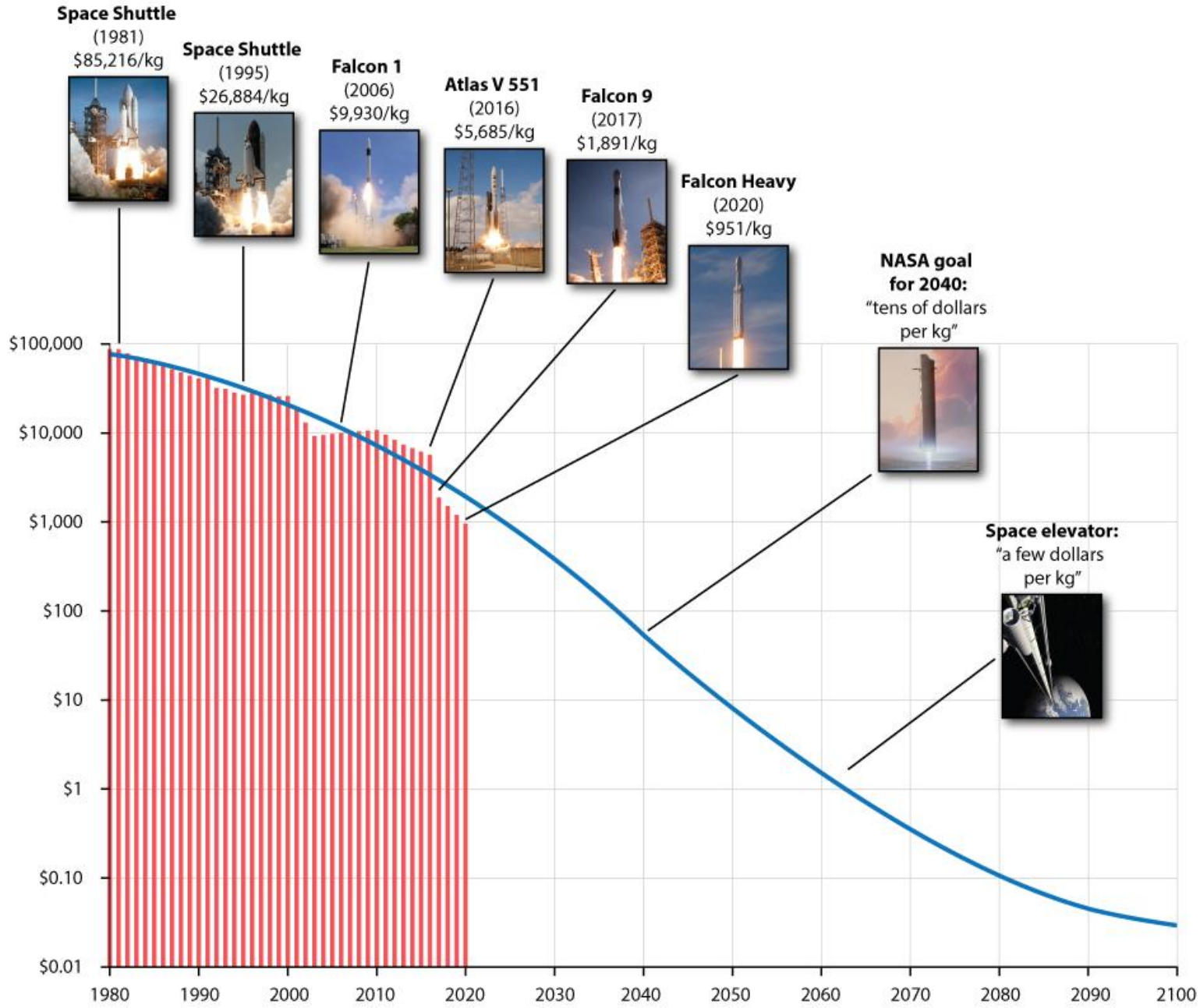
To go Further

For exploring the great outdoors

WHY NOW?

Because of **NEW SPACE**

- New Space means **business** in space.
- Higher risk acceptable for **faster development**.
- Significant decrease in launch costs opening **new markets** especially for **new space companies**.

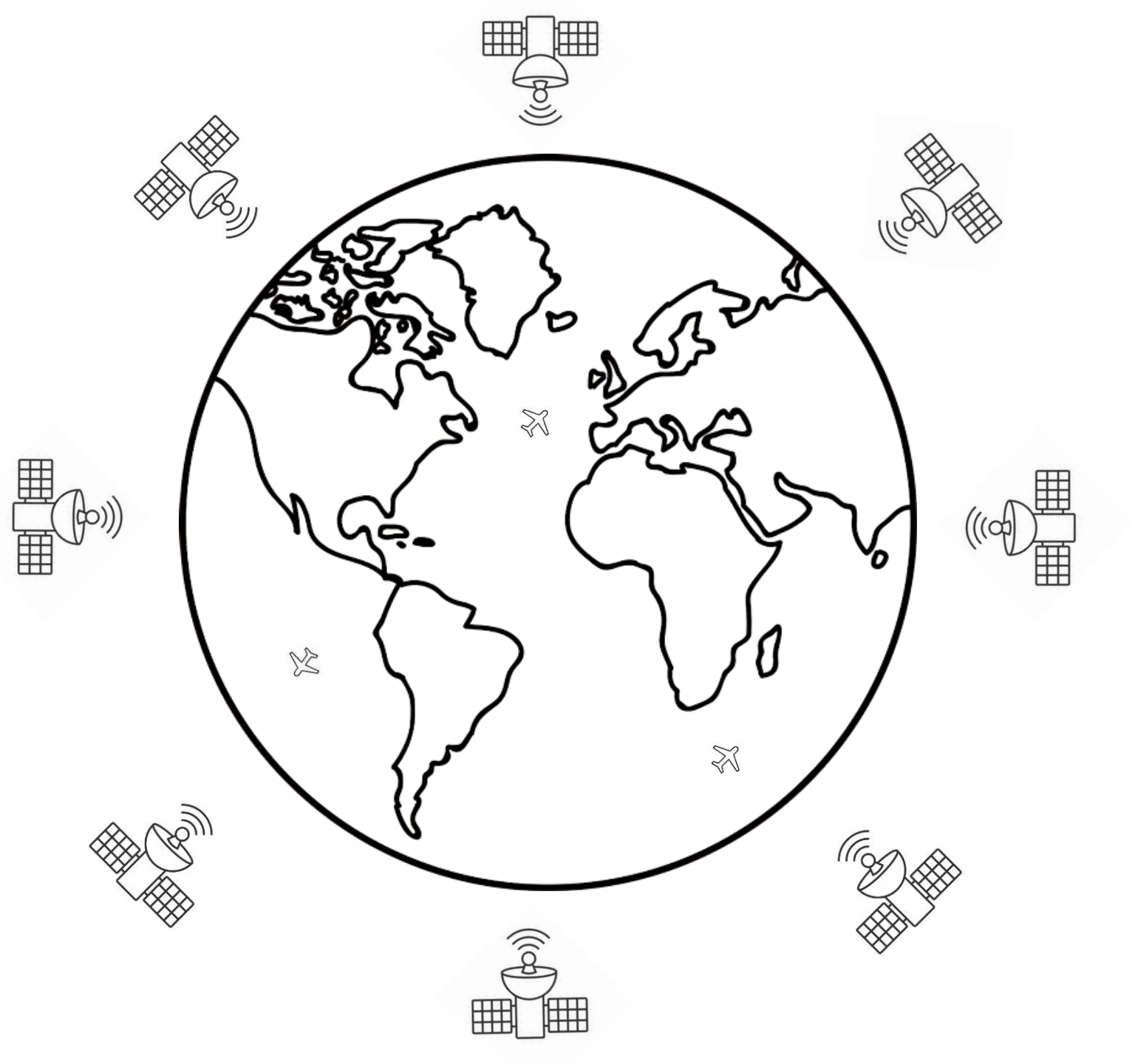


How to do it?

Constellation of Space Power Satellites with Nano satellites

Low Earth Orbit (only 300-500 km between satellite and target)

Global Coverage (similar to internet from space)



What are the Challenges of Space Solar Power (SSP)?

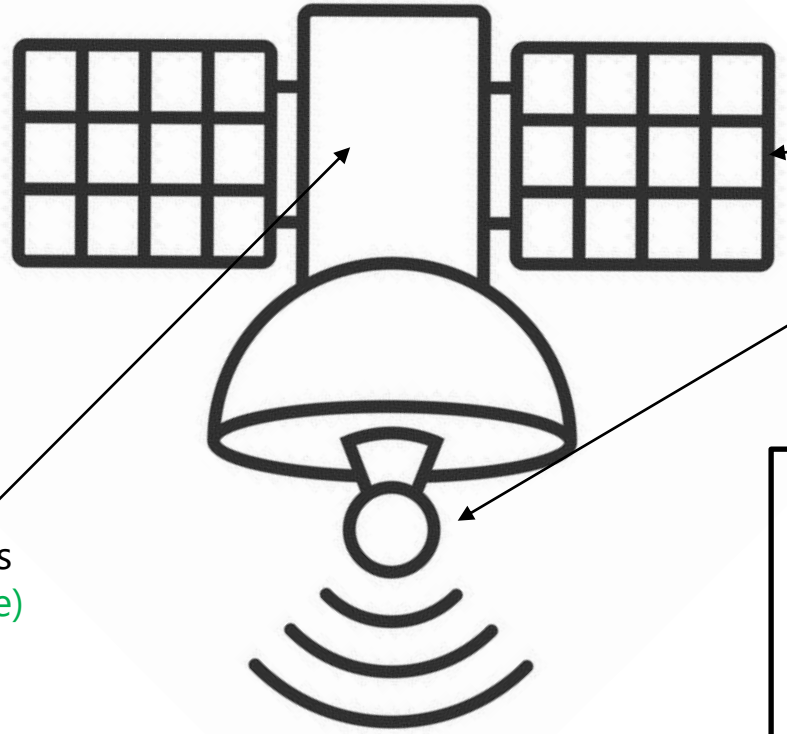
Challenge	Solution
High Cost	Significant decrease in launch costs expected, especially in LEO (500$/kg by 2030) economic megaconstellation due to COTS satellites.
Competitiveness	Unlikely to replace terrestrial renewable energy (0.15$/kWh). But attractive for remote applications like search and rescue/disaster relief, e-mobility, outdoor activities (<500$/kWh).
Technology Readiness	Solar Arrays, SmallSats, Wireless Energy Transmission are proven technologies. Space Solar Power in-space tech demonstrator mission planned for Fall 2021.
Efficiency	Solar cells efficiency of up to 32%, microwave transmission efficiency of 54%. SSP efficiency only limited by legal transmission limits. High SSP efficiency of 100W/m^2 compared to terrestrial photovoltaic of 25W//m^2.
Danger to People and Animals	1985 experiments (at 250W/m^2 @ 2.45GHz) with 2x IEEE and 5x ICNIRP standard for human exposure showed no danger for birds.
Power Transmission Regulations	100W/m^2 are currently allowed within existing safety standards.
Atmospheric Interference	Frequencies of 2.45 GHz and 5.8GHz have minimum atmospheric attenuation.
Misuse as Weapon	Not possible, as power density is within existing safety standards (<100W/m^2).
Microwave Frequency Spectrum	Frequency allocation is needed and power beaming not yet in a Telecommunication Union.
Availability	Constant coverage, independent of weather and seasons due to LEO constellation.
Resource	Hourly solar energy hitting Earth ($1.2x10^{14}$ kWh) > energy humanity needs annually ($1.1x10^{14}$ kWh).

What is needed to make this vision a reality?

All technologies are already existing (in space + terrestrial applications)

To do:
Mature terrestrial technologies and combine them

Our focus is on key technology: deployable solar / transmission arrays



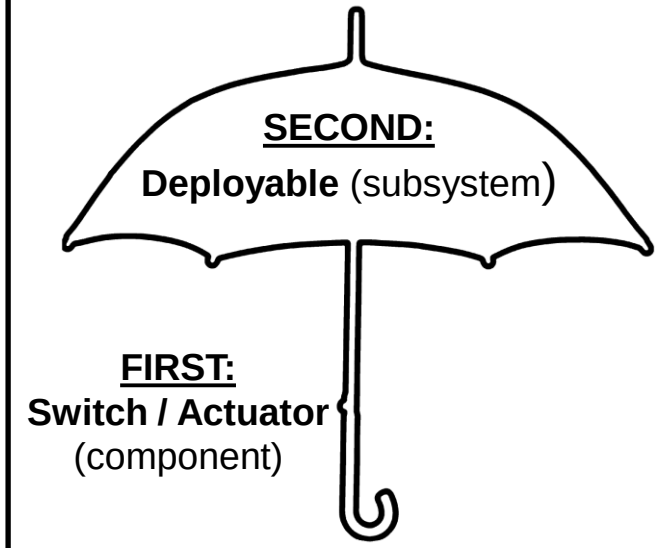
Our Key Technologies:
Large Deployable Solar Arrays

Deployable Power Transmission Array

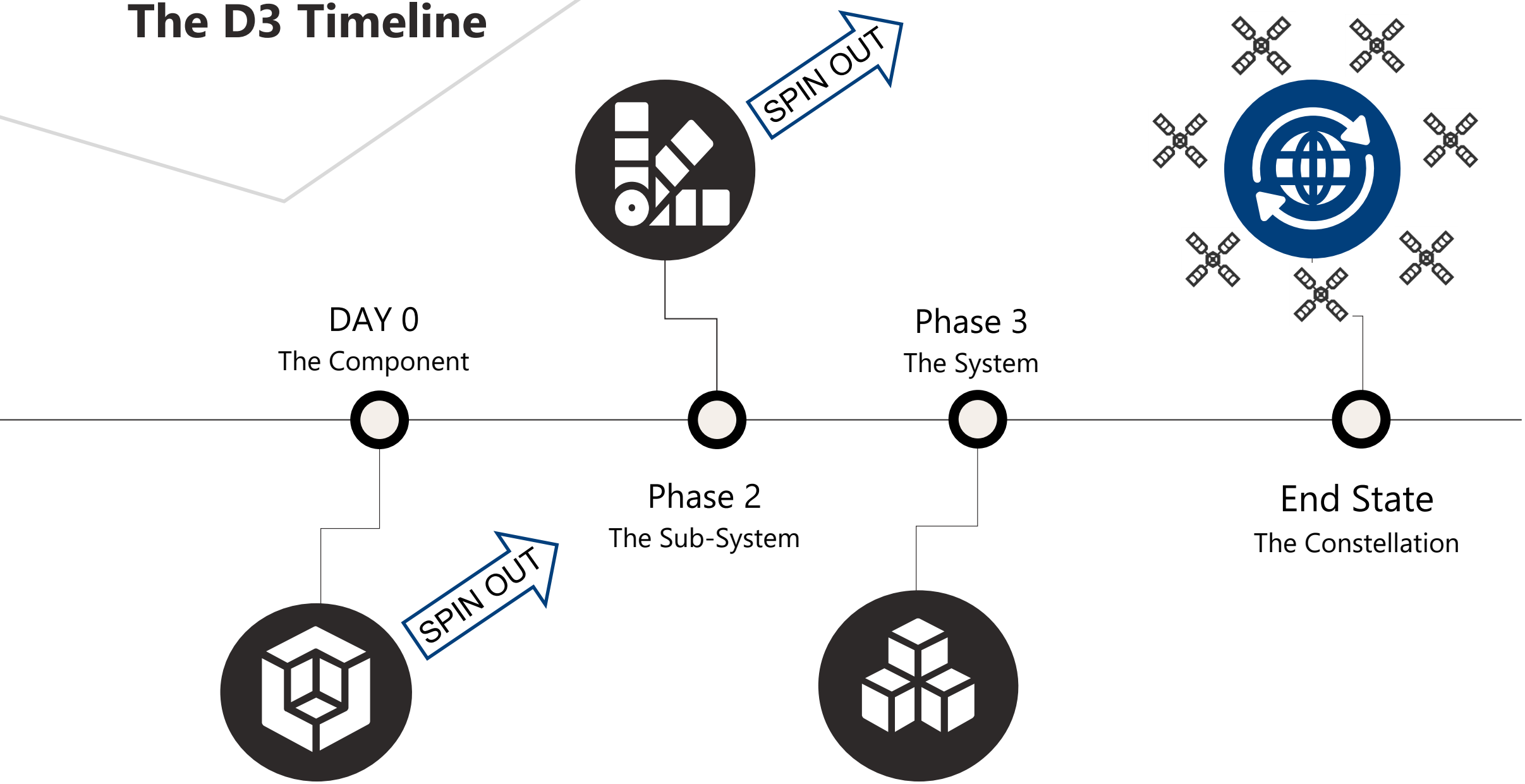
Nanosatellite Bus
(already available)

Groundstation Network
(already available)

Deployable: Umbrella Analogue

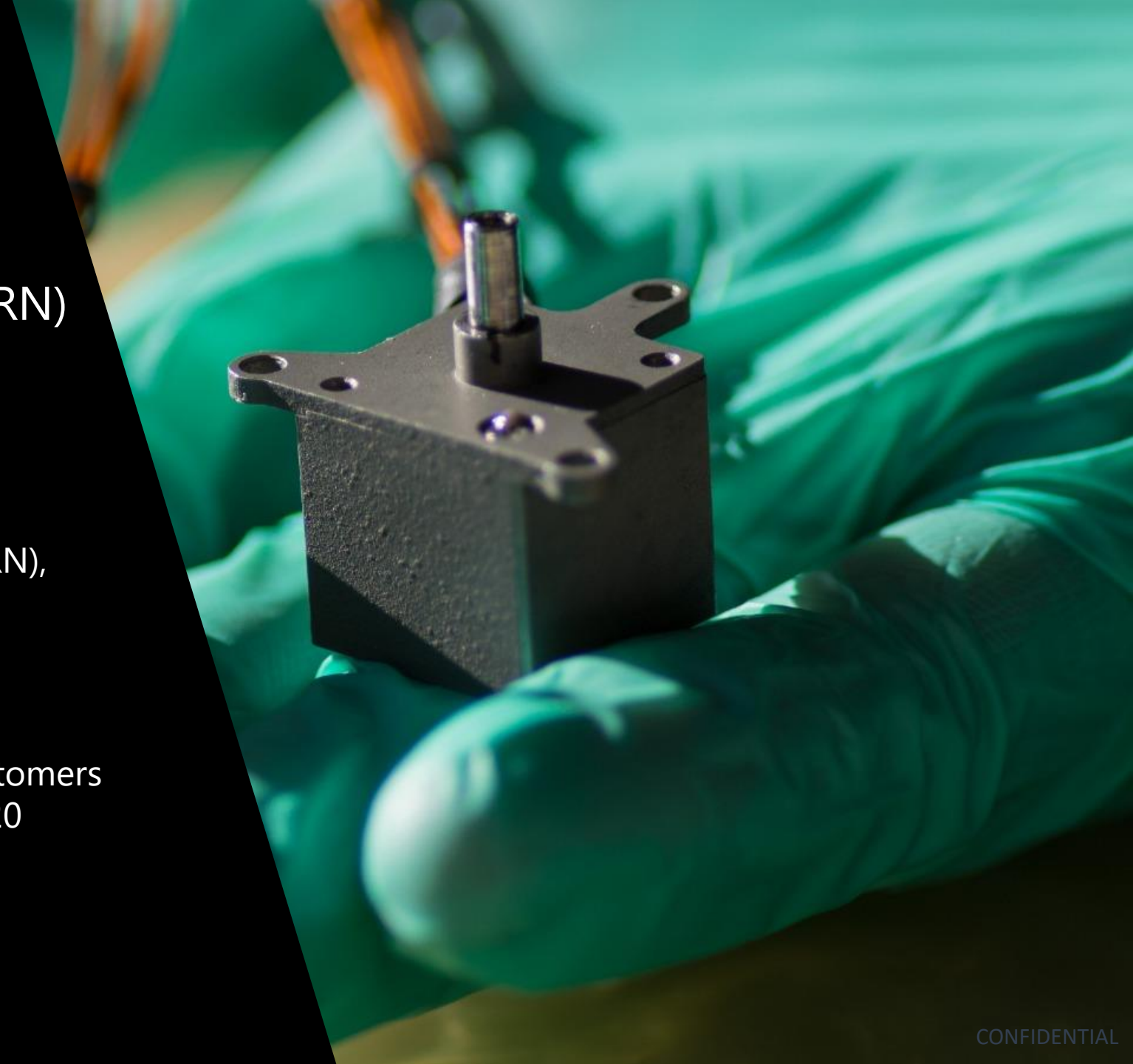


The D3 Timeline



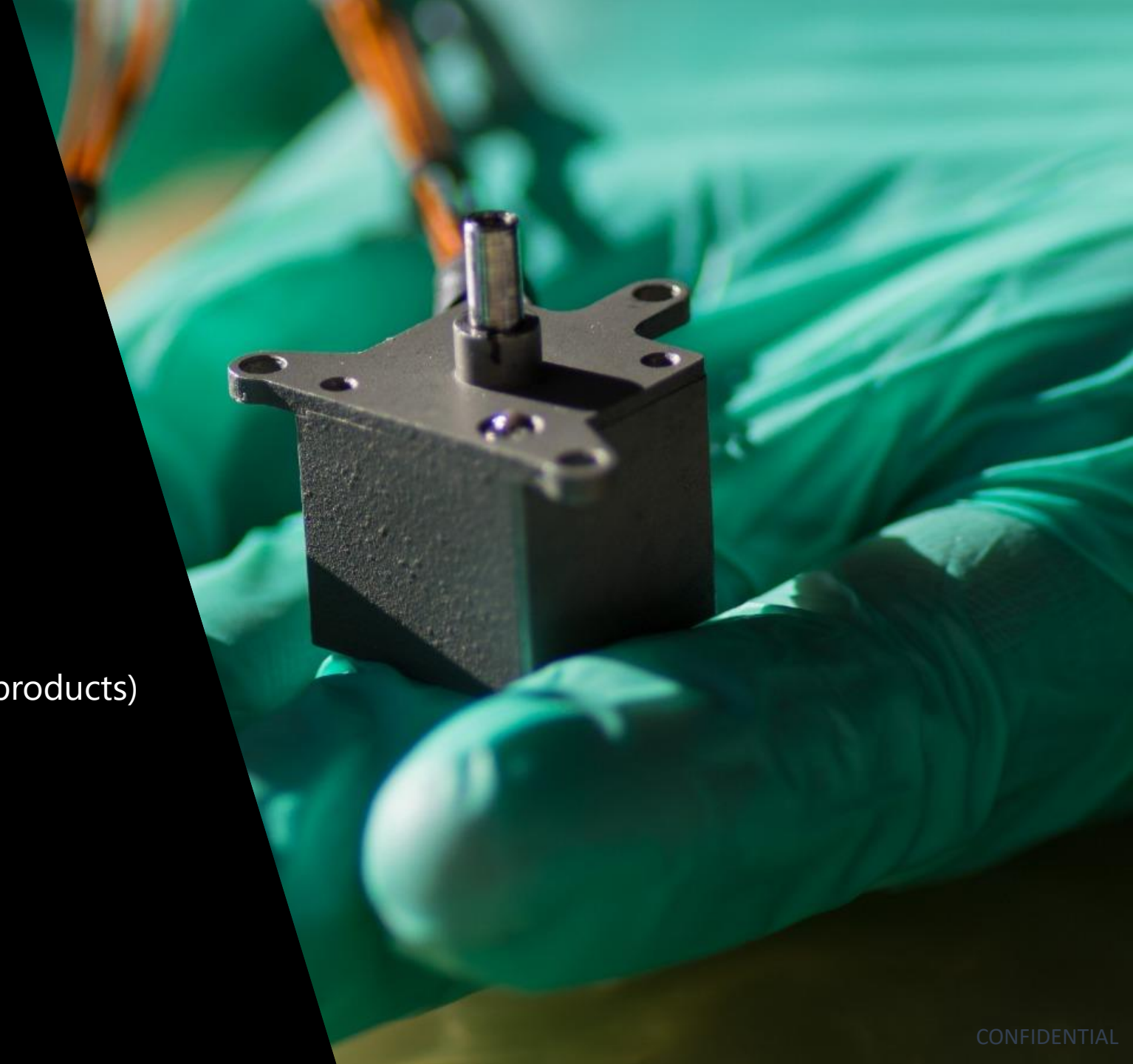
Component: Actuators (D3PP & D3RN)

- Novel Actuation Principle
- Pin Puller (D3PP) as well as Release Nut (D3RN), available in various sizes.
- Patenting Pending (filed in 02/2020)
- First two actuators (nD3PP) delivered to customers in US & New Zealand in 01/2020 and 02/2020
- Full Space Qualification by 06/2020
- Full Market Entry in 08/2020



USPs of Actuators (D3PP & D3RN)

- Smaller (then anything available in Europe)
- Cheaper (then any available worldwide)
- Export-regulation free (no EAR/ITAR like US products)



Subsystem: Deployables (D3DB & D3DA)

- Deployable Array is needed to collect required power in space
- Breadboarding currently ongoing with deployable boom (D3DB) forming deployable array (D3DA)
- Q4 2020: Space Qualification
- Q3 2021: Tech demo in space
- Q3 2022: Market Entry

USPs of Deployables

- Commercial Off The Shelf (COTS) Product
- Short Lead Time (ready within days and not months/years)
- Cheaper (focus on NewSpace/Nanosat customer)
- Excellent Customer Service

Thank you!

Do you have any questions?

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