SPACE MISSIONS: TIME TO SPIN-IN

By Tommaso Sgobba - IAASS | November 2026

From spin off to spin in

YESTERDAY: SPIN OFF

SPACE → **GROUND**

Materials, electronics, processes and software developed for space found their way into everyday products. Spin off became a main public argument for space budgets.

TOMORROW: SPIN IN

GROUND → **MOON | MARS**

Permanent bases need pumps, valves, analysers, cryocoolers, electrolysers, power and thermal systems that already exist on Earth. The task is to adapt them, not to invent them.

! **A washing machine is impossible on the ISS,** but perfectly conceivable on a lunar base, provided it is adapted to the local environment and designed with transportation constraints (i.e. volume/mass) in mind.

The proposition in one picture: “Lunarization”

Lunarization should take place inside the original manufacturer, supported on demand by space engineering specialists.

1 LUNARIZATION STANDARD

A stable environmental profile, test methodology and graded qualification levels, written in the MIL-STD-810 style.

2 ORIGINAL MANUFACTURER

The firm that owns the design, materials data, process and quality history adapts its own product.

3 “SINEQUANET" SPECIALISTS

Space engineers join the manufacturer R&D team for the duration of the project, then leave.

Result: a qualified lunar variant of a proven ground product, without the manufacturer restructuring its R&D organisation for a product with a limited market.

The environment ground products must survive

1 Regolith dust

Abrasive, sharp, electrostatically charged; attacks seals, bearings, optics and radiators.

2 Thermal extremes

About −170°C to +120°C at the equator, colder at the poles; a lunar night of about 14 Earth days.

3 Hard vacuum

Outgassing, lubricant loss and cold welding.

4 Radiation

Total dose and single event effects, with no magnetosphere for protection.

5 Reduced gravity

Changes boiling, two phase flow, sedimentation and convective cooling.

6 Gloved maintenance

Fasteners, connector mating and modular replacement designed for a crew member in a pressure suit.

The military precedent: a bridge the Moon still lacks

YESTERDAY: MILITARY

Commercial products → **MIL-STD-810 environment**
MIL-STD-461 EMC → **Military variants**
rugged computers, connectors, conformal coated electronics

TOMORROW: THE MOON

Ground niche products → **LUNARIZATION STANDARD**
does not exist yet → **Lunar variants**
for surface operation and crew servicing

- Ruggedization gave suppliers a known, stable set of tests, so they could decide on a clear basis whether a military variant was worth the investment.
- ECSS and NASA standards qualify flight materials mission-by-mission; they do not qualify a pump, valve or analyser to be transported to, operated and serviced on the Moon.

Niche technologies a lunar base depends on

Product (examples)	Role on a lunar base	Main suppliers
High vacuum pumps	Mass spectrometers and chemical analysers	Pfeiffer, Leybold, Edwards, Agilent, Shimadzu
Non evaporable getters, gas purifiers	Sealed instruments, cryogenic tanks, ultrapure gas lines for ISRU and life support	SAES Getters (near monopoly)
Long life cryocoolers	ISRU oxygen liquefaction, propellant storage, infrared sensors	Thales Cryogenics, Air Liquide, Sunpower, Northrop Grumman
Solid oxide electrolysis stacks	Oxygen from regolith derived water or CO2	OxEon Energy, Sunfire, Elcogen, Topsoe
Ion exchange membranes	PEM electrolysers, regenerative fuel cells for the lunar night	Chemours (Nafion), a few Japanese firms
Multijunction solar cells	Surface power above 30% efficiency	Azur Space, Spectrolab, Rocket Lab, CESI
Rad hard processors and FPGAs	Every autonomous system; an export control chokepoint	BAE Systems, Frontgrade, Microchip, 3D Plus
Miniaturised mass spectrometers	Cabin atmosphere monitoring, ISRU prospecting	INFICON and a few small specialists

A handful of units per decade: too small a market for these firms to build a space division, yet a lunar programme must treat them as critical dependencies, not catalogue items.

Why Lunarization belongs inside the original manufacturer

✗ Third party redesign

- Buys the product and adapts it from outside
- Works without the design knowledge and materials data
- Costly redesign with weaker heritage

✓ Original manufacturer

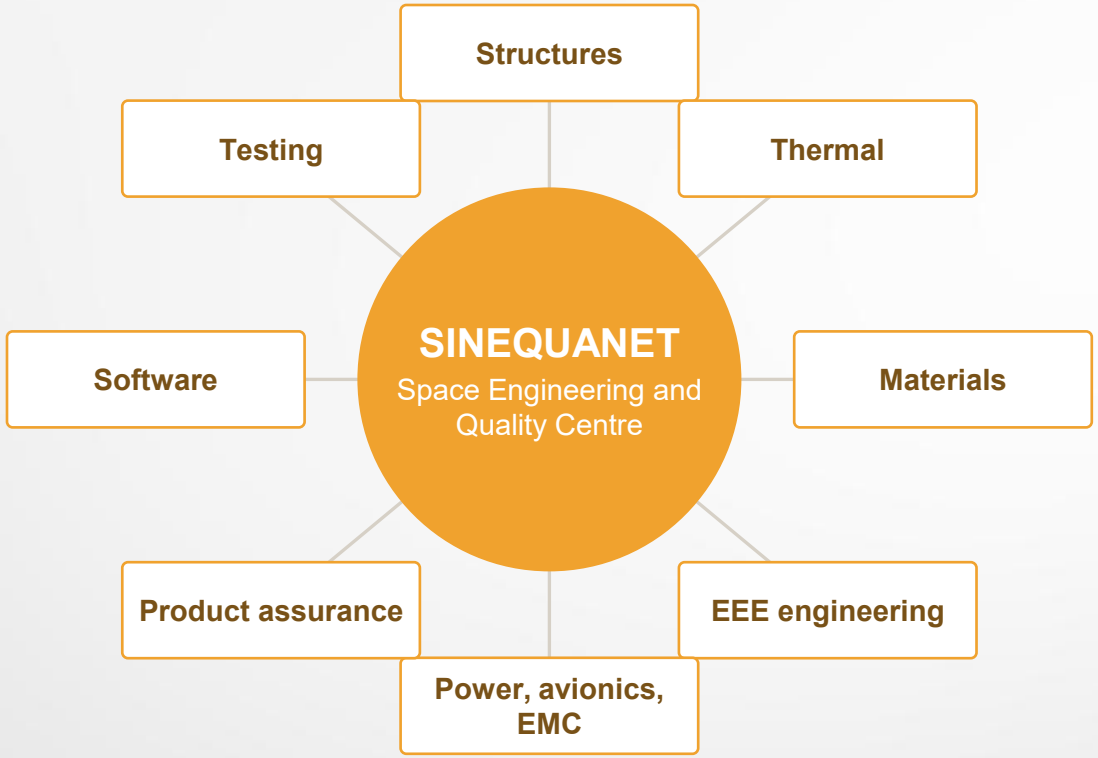
- Owns the design, materials data and production process
- Owns the quality history of the product
- Adapts a proven product, keeping its heritage

THE OBSTACLE IS ORGANISATIONAL

Structures	Thermal	Materials and processes	EEE parts	EMC	Product assurance	Qualification testing

These space competences are missing in house. Building them means hiring specialists, changing R&D structures and carrying the cost for a few units per decade: few niche manufacturers would accept that.

SINEQUANET: a shared pool of space specialists



- **A common pool** of experienced specialists, available when needed and for the time needed.
- **Owned and managed as a consortium** by the companies that use it, open to new members.
- **Sells competence, not products,** so competitors can share the pool without affecting their position.
- **First conceived for SMEs and New Space;** the same model fits niche manufacturers that must lunarize their products.

How SINEQUANET supports the manufacturer

A Integrated support

Specialist resident at the manufacturer

Typically not less than six months, working as a member of the R&D team on tasks agreed between the SEQC Director and the user company.

B Functional support

Task oriented work managed by the centre

Defined tasks carried out and managed directly by SINEQUANET, under annual planning agreed with the users.

MODELLED ON THE SUPPORT ESA TECHNICAL DIRECTORATE GIVES TO ESA PROJECTS. ADVANTAGES FOR THE MANUFACTURER:

Top level engineers

at salaries competitive with large space industry

No HR disruption

internal policies and R&D structure untouched

Paid only when needed

resources used for the lunarization project only

Know how stays in house

specialists train staff on the job

Way forward

The two elements depend on each other. A standard without support is a requirement manufacturers cannot afford; support without a standard has no stable target. Together they give a bounded, predictable path to a qualified lunar variant.

1

Lunarization standard

An ECSS standard defining lunarization levels in the MIL-STD-810 style, as the seed for an ASTM, SAE or ISO work item.

2

SINEQUANET as a ten year project

Established with intermediate decision points that sanction objectives before each next phase.

3

EU funded conceptual phase

Defines technical objectives, facilities and tools, the cost envelope and a legal form owned by members yet open to new ones.