LUXEMBOURG
LET'S MAKE IT HAPPEN

LUXEMBOURG AND KLEOS

COOPERATION WITHIN THE SPACERESOURCES.LU INITIATIVE

CONFÉRENCE DE PRESSE

24 juillet 2017

SPACE RESOURCES.LU

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Économie

Video Intro

- https://vimeo.com/212878439

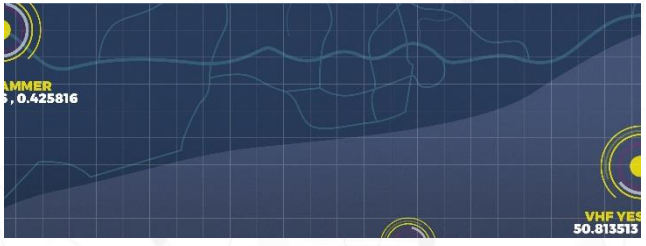
Introduction

MAGNAPARVA™

- UK based, Space engineering services for the Science, Exploration & EO sectors since 2005
- Developing In-Space Manufacturing technologies since 2008
- Developed key application: RF Interferometry (Geolocation Intelligence)

KLEOS

- Luxembourg based, new high growth company leveraging early historical R&D at MP
- Ground demonstration to flight readiness R&D
- Satellite (constellation) owner/operator
- Geolocation Intelligence Data as a Service sales

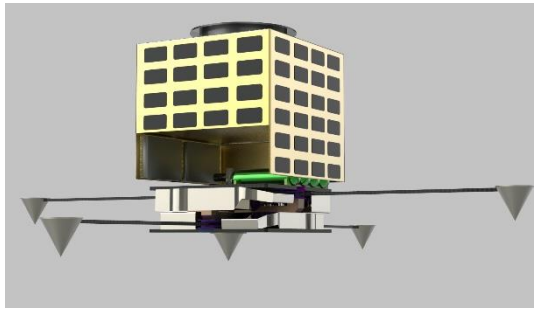


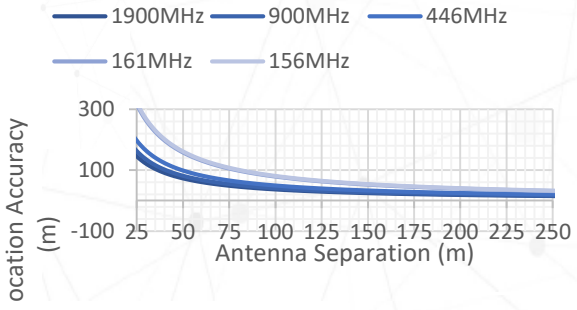
The Opportunity

- Increasing complex threats and emergencies driving need for geospatial intelligence (GEOINT) and signals intelligence (SIGINT)
- Current terrestrial solutions are:
  - expensive
  - technically limited by range, persistence and the weather
  - overt and subject to counter threats
- Land and sea 'activity based' intelligence applications: Maritime, Security, Regulatory, Defence, Search and Rescue
  - Geolocation of vessels – not transmitting AIS
  - Noise and interference monitoring
  - Geolocation of rogue transmitters, jammers and covert wireless infiltration/exfiltration devices
  - Global monitoring of unmanned borders, coastlines, harbours and large perimeters
  - Locating non-tracker based RF emissions
  - Management of deliberate and accidental interference
  - Spectrum usage and occupancy mapping over time trending and use patterns

The Kleos Solution

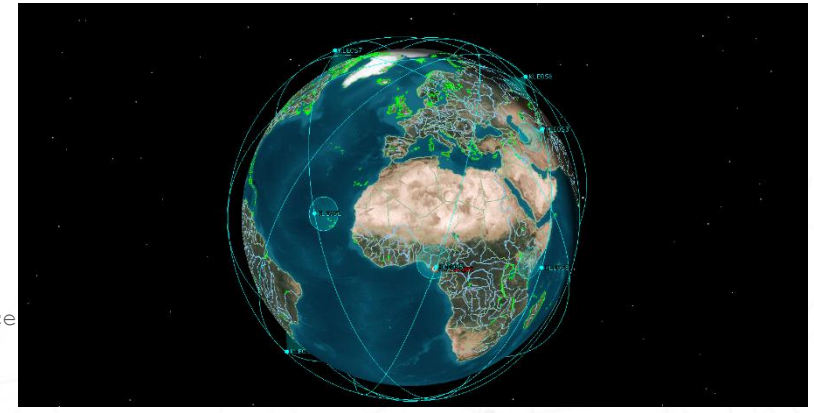
- We will deploy antenna from our micro-satellite(<100kg), fixed in position by large (~100m+) structures manufactured in Space
- The antenna using TDOA with *multilateration algorithms* deliver accurate geolocated radio frequency (RF) transmission information with global coverage
- Unique and cost effective solution when compared to conventional airborne ISR solutions due to the long flight endurance and global coverage
- Isolate and locate with high accuracy RF transmissions from surface emitters such as Maritime VHF & GPS jammers. RF spectrum use mapping capability also available
- Global coverage from a single satellite – as constellation grows, latency drops





Kleos Operational Plan

- Initially launch single spacecraft at +2years
- Operational service, recurring sales and profitability
  - Sub-daily surveillance of whole globe
  - Demonstrate power of Kleos GI data
- Create low volume constellation
  - 2 launches per year
  - Directly funded from first satellite
  - Reduced lag between data and enhanced customer experience
- By 2022 revisit time max every three hours



	2019	2020	2021	2022	2023	2024	2025	2026	2027
Launch	1	2	2	2	2	2	2	2	2
Return	0	0	0	0	0	1	2	2	2
Operational	1	3	5	7	9	10	10	10	10
Global revisit time	5 to 24 hours	1.5 to 6.5 hours	1 to 4 hours	1 to 3 hours	0.6 to 2.5 hours	0.5 to 2 hours	0.5 to 2 hours	0.5 to 2 hours	0.5 to 2 hours

In-Space Manufacturing Technology

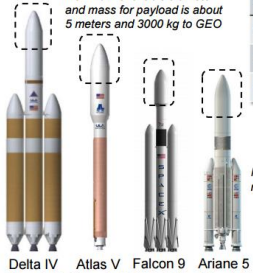
(credit of Airforce Research Lab)

- Magna Parva developed and patented an in-space manufacturing system that provides a method of producing indefinite carbon composite 3D structures in space.
- Current pre-manufactured structures (antenna, solar arrays, deployment booms) designed to go into space are high in mass and volume and have specific launch environment requirements. By manufacturing in space, many of these requirements are eliminated.
- Bigger is better – however launcher volume is limited: Our ISM technology offers at least an order of magnitude capability increase over current state of the art – for the GI application the packaging ratio = 1000:1.

Launch is violent!

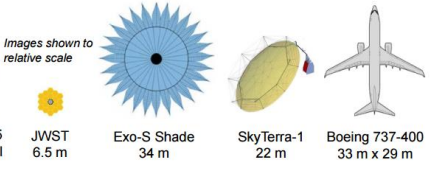
- **~50x Earth's gravitational accelerations (50 g's)**
- **0 to 7 km/s in 10 minutes**

Maximum available diameter and mass for payload is about 5 meters and 3000 kg to GEO

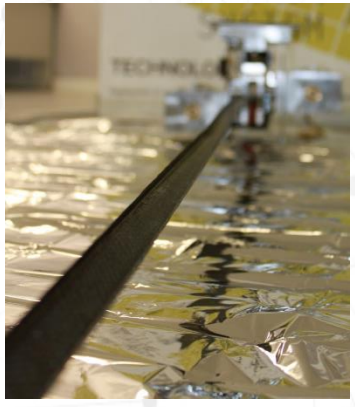


State of Practice (rank order for structural performance)	Deployed Size	Stowed Size	Packaging Ratio
JWST Primary	6.5 m	4.0 m	1.6:1
Exo-S Starshade	34 m	3.6 m	9:1
SkyTerra-1 mesh Reflector	22 m	2.4 m	9:1
NG Telescopic Tube	33 m	2.4 m	14:1
ATK Graphite Coilable Boom	40 m	0.4 m	100:1
Graphite STEM	17 m	0.3 m	57:1

Images shown to relative scale

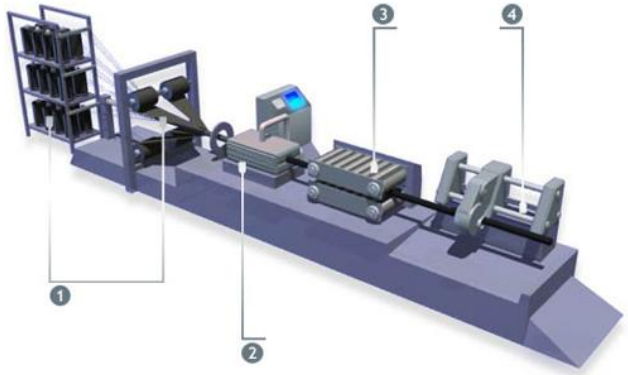


	Largest Available Today		Future Size	Benefits of Going Bigger
Telescopes	JWST primary	6.5 m	3x	***Better Resolution***
Sun Shields	JWST sun shield	22 m	n/a	***Cooler Optics***
Star Shades	Exo-S Starshade	34 m	10x	***Directly Image More Planets***
Solar Sails	Sunjammer	20 m	50x	***Higher Propulsion Thrust***
Antennas	SkyTerra-1 reflector	22 m	9x	***Smaller Ground Antennas***
Radar	RadarSat-II	15 m	30x	***Track more Objects***
Photovoltaic Arrays	Rigid panel array	47 m²	30x	***Higher Power***



How our In-Space Manufacturing works

- The new precision robotic technology manufactures using a continuous process called pultrusion. L: Industrial Machine. R: Our ISM Engineering Model to scale



- Why is it difficult? Space Requirements: Autonomy, Reliability, Fluid handling, Radiation, Power, Size, Mass

In-Space Manufacturing & Space Resources

Current ISM tech uses materials from earth and in-situ energy sources – to be Space qualified with Geolocation Intelligence mission

Current ISM tech further exploited in applications where bigger = better

(resupplyable factory in Space, telescope deployment, solar sailing, solar array deployment, comms etc.)

ISM tech further developed to use non-earth materials as well as in-situ energy sources e.g. regolith

Why Luxembourg?

- Luxembourg has a clear, defined and commercially focussed Space strategy.
- Luxembourg has demonstrated forward thinking proactivity and thought leadership in the Space sector with the Space Resources initiative.
- Luxembourg has a shallow bureaucracy – enabling responsiveness.
- Luxembourg evidentially understands the funding gap faced by high-growth ventures and has a competitive mechanism to fill it.
- Luxembourg is geographically ideal, central, in the EU, with appropriate local facilities/capabilities/supply chain.
- Luxembourg, the people, the companies and the Government bodies we have worked with so far over the last 6 months have been welcoming, helpful, insightful and proactive.

Contact

Our goal is to launch and operate Space based infrastructure that will generate unique commercial geolocated Signals Intelligence and to sell the Data as a Service internationally via application subscription to government agencies, the intelligence community, end users and/or businesses interested in locating threats, assets or targets

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electronics and software solutions

EmTroniX

SPACE ACHIEVEMENTS

2017

About Us

EmTroniX was founded in 2001 by engineers having a passion for electronics and software. The market was in the first years concentrated on Automotive Electronics, but business has since grown into the Military, Aeronautic and Space Industry after Luxembourg became member of the European Space Agency in 2005.

EmTroniX has over the years realized a wide range of technical projects by which it has gained significant experience and competences in the following fields :

- **Space** electronics, RF and advanced signal processing
- **Aerospace** controls development
- **Military** equipment redesign
- **Automotive** electronics, software and controls engineering
- **General consumer**'s products design

Realization Examples (Space)

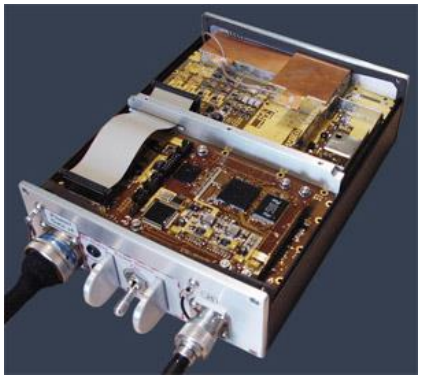
PATHFINDER 2

PATHFINDER 2 (LuxSpace/OHB) - 2008

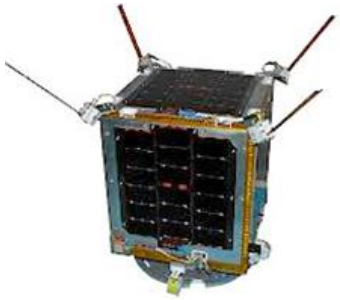
- AIS demonstration satellite
- Contribution : AIS receiver, downlink modulator, solar panel power tracker, battery management and protection, embedded software

LUXAIS (LuxSpace/ESA Project) – 2009/2010

- Dual channel AIS receiver operated in the International Space Station
- Contribution : AIS RF front-end electronics, analog and digital signal processing chains, power supply, modem interface, FPGA code, embedded software, mechanics



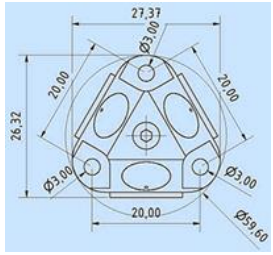
LUXAIS Receiver



VesselSat

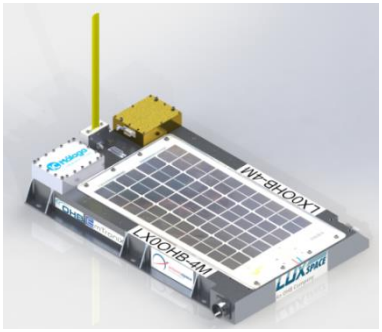
VESSELSAT 1 & 2 (LuxSpace/Orbcomm) – 2010/2011

- Two commercial four channels AIS satellites
- Contribution : AIS Payload receivers, tele-command receivers, OBC bus interface electronic board, tri-axis sun sensor, GPS module and RF couplers



Tri-Axis Sun Sensor

Realization Examples (Space)



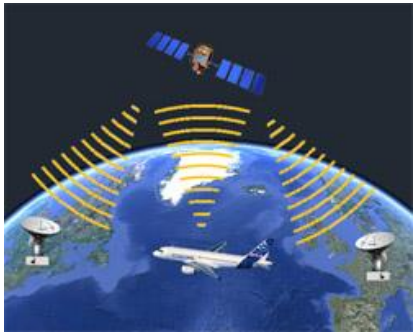
Lunar Pathfinder

Lunar Pathfinder (OHB) - 2014

- First commercial demonstration satellite orbiting the Moon.
- Contribution: RF front-end electronics, on-board computer interface, battery management, satellite integration

Space-based ADS-B Receiver FPGA IP (Thales) – 2013/2015

- Optimized high-sensitivity, flexible and multi-channels non-coherent SDR ADS-B receiver
- Contribution: DSP algorithms designed from scratch, FPGA code, performances test bench

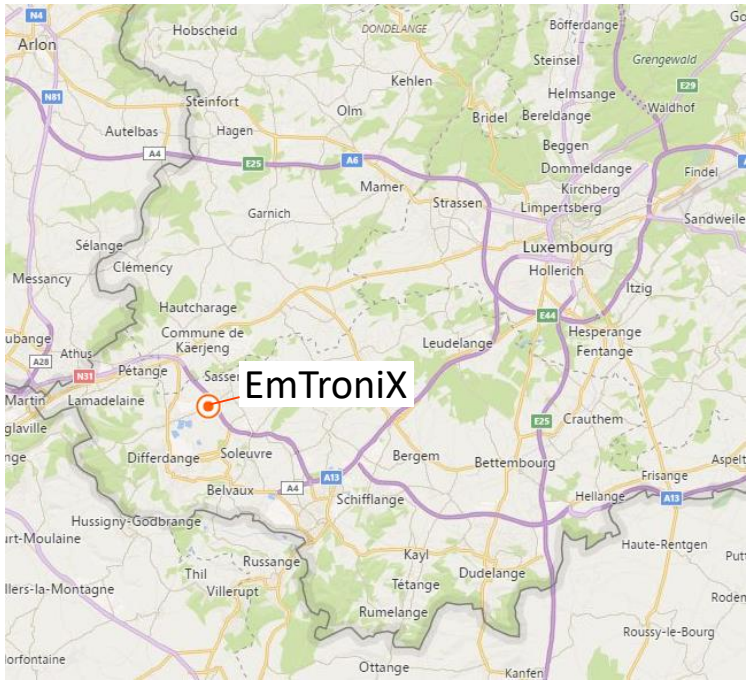


Space-based ADS-B concept

Proximity 1 SDR Autonomous Receiver (ESA/QinetiQ) – 2016/2017

- Mars-Orbiter autonomous telecommunication HUB (automatic detection of signal modulation, frequency, baud-rate and demodulation) SDR receiver
- Contribution: Architecture definition, DSP algorithms design, simulation and FPGA implementation, hardware prototype, test bench

References



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