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EXPLORING NEW FRONTIERS

Luxembourg: a pioneer in space

BCFL meets Luxembourg Space Cluster

Luxembourg Embassy in Paris

21 June 2017

LUXEMBOURG
LET'S MAKE IT HAPPEN

Luxembourg space landscape

Luxembourg has been active in space for more than 30 years

- 1985: Creation of Société Européenne des Satellites (SES)
  - First launch in 1988 (ASTRA 1A)
  - 2001 acquisition of GE Americom
  - 2006 acquisition of NewSkies
  - Today, one of the largest geostationary satellites operators
- 2000: Cooperation agreement with ESA to participate in the ARTES programme (telecom)
- 2004: Signature of the adhesion agreement
- 2005: Luxembourg becomes the 17th Member State of ESA
- 2008: First National Action Plan for Space R&D
- 2012: ESA co-Presidency with Switzerland
- 2014: ESA Ministerial Council in Luxembourg
- 2015: Presidency of EU Council

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It has developed a solid industrial and research landscape …

- SES, wordwide leader in satcom and one of the largest geostationary satellites operators
- ~30 private companies active in the space, ground and downstream segments
- Several R&D laboratories within the Public Research Organisations LIST and Uni.lu
- Industry group for the aeronautic and space industry: GLAE
- Luxembourg Space Cluster

LUXEMBOURG SPACE CLUSTER

GLAE

SES your satellite company

LUXSPACE An OHB Company

GOVSAT

HTEC LUXEMBOURG

EURO-COMPOSITES®

EmTroniX electronics and software solutions

uni.lu UNIVERSITÉ DU LUXEMBOURG

SNT securityandtrust.lu

LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY LIST

GRADEL

INTOREL developer of advanced monitoring and control solutions

cybercultus

itrust consulting

space 4 environment

inverto

adwäisEO

stream ENGINEERING MSC Software Company

SATURNE Technology

DRONELAB UNMANNED AERIAL SYSTEMS

telindus belgacom ICT

meanswhat

DSI DEEP SPACE INDUSTRIES

PLANETARY RESOURCES

ispace

BLUE HORIZON

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… with competencies along the whole space value chain

Space Segment

Technology
- Structures (satellite, instrument)
- Support panels for solar arrays
- Heat exchanger / radiator panels
- Solar Sail Material
- Electric propulsion

Sub-systems
- AIS & ADSB receivers
- Telemetry, Telecommand & Ranging sub-systems

System level
- Micro-satellites (<100 kg)
- Satellite simulator

AIT means
- Mechanical and Electrical Ground Support Equipment

Ground Segment

Ground Stations
- Ground station elements (reflectors, drive system, Monitoring & Control, radome)
- Ground stations
- Telemetry Tracking & Control, In-Orbit Testing & Uplink Stations
- Fixed & Mobile / Limited & Full Motion
- Deployment & commissioning
- Maintenance services

Flight operation & payload data ground segment
- Mission Operation Center
- Security
- Data hubs

Services / Applications

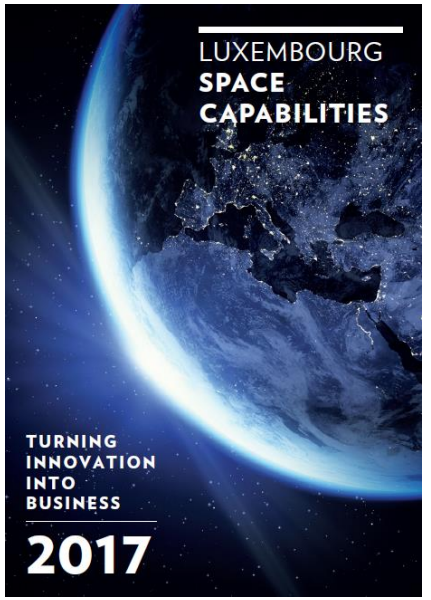
Satellite services
- Satellite engineering & Launcher procurement
- Flight Dynamics
- Transfer Orbit Services & In-Orbit Testing (IOT)
- Hosting & Teleport Services
- Satellite Broadband services

Applications
- Environmental monitoring & Management (Land & Forest; Atmosphere; Floods)
- Transport Management & surveillance
- Satcom for Crisis Management & Humanitarian Aid
- Location based services

Catalogue on space capabilities

Full information on:

www.spacecluster.lu



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The national space action plan defines strategic policy objectives and defines a few key thematic priorities

National space policy objectives

- Contribute to the **diversification** and **sustainability** of economic activities in Luxembourg
- Consolidate and valorise the **existing competencies in the domain of media and telecommunications**
- Contribute to **reinforce the competitive position** of industry and public research organizations in the space sector
- **Expand competencies** in the sector
- Integrate Luxembourg entities in **international networks**

Key thematic priorities:

- Value added services using satellite data & infrastructures
- Ground equipment (Stations, MGSEs)
- Satellite equipment (Structures, Electric propulsion)
- Microsatellites (Platform and payloads)
- Utilization of space resources

Instruments:

- **National Programme LuxIMPULSE**
- **ESA programmes**
- **ESA Young Graduate Trainees**
- **EU space programmes**
- **EU Horizon 2020**
- **Bilateral and multilateral cooperation**

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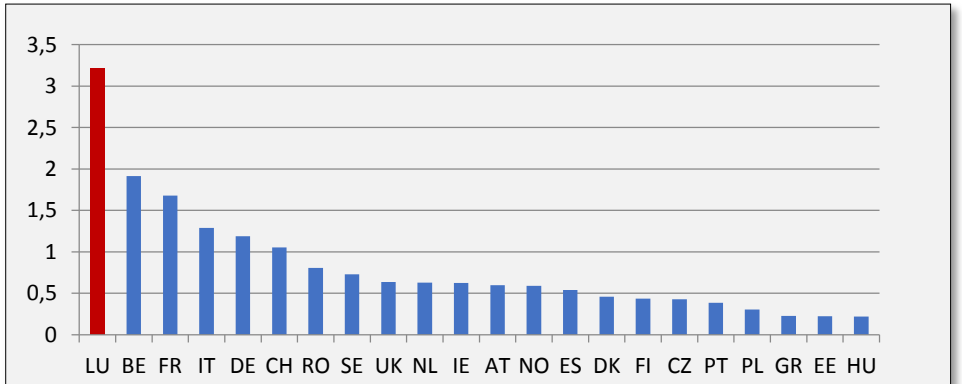
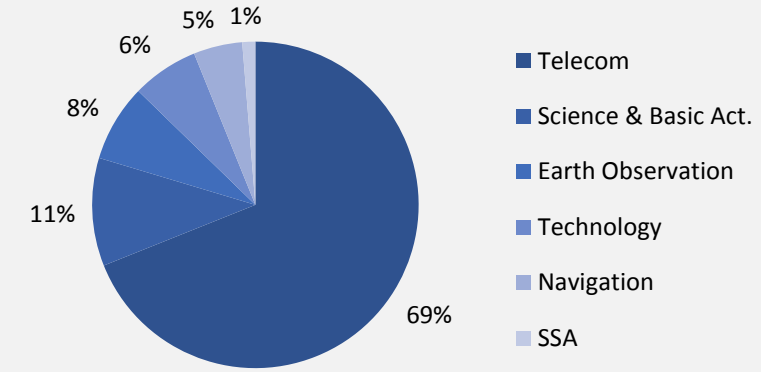
Luxembourg is an active member of ESA

- 6 May 2004: Signature of the adhesion agreement
- 30 June 2005: Luxembourg becomes the 17th Member State of ESA
- 20 Nov. 2012: ESA co-Presidency with Switzerland
- 2 Dec. 2014: ESA Ministerial Council in Luxembourg
- 1-2 Dec. 2016: ESA Ministerial Council in Lucerne



*2016 contribution to ESA relative to GDP**



Contributions to ESA between 2001 and 2016

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** Total contribution to ESA compared to the contribution to the mandatory programmes (based on GDP)*

2 Luxembourg Space Resources Initiative

In February 2016, Luxembourg announced its intention to study and promote the utilization of space resources

Space resources can be found on many celestial bodies...

- Abiotic materials that are present on asteroids, the moon or other celestial bodies, and that can be extracted (e.g. metals, gas, water, …)
- More generally, space resources can also include solar energy, radiations, gravitational waves, etc.

Images: NASA: RecentlySpotted Asteroid NoRiskforEarth| File:Full Moon Japan.jpg-Wikipedia

... and be used on Earth

Rare metals (e.g. Pt, Pd, ...), gases (He-3)

- To guarantee the continous access to rare materials once the resources on Earth will be exhausted
- Positive environmental impact on Earth

... as well as in space

Water, Fuel/propellant
Building materials

- To support the current space industry
- To support robotic and human exploration of space
- To enable a new economy in space

Images: Whole world -landandoceans.jpg-WikimediaCommons /media/images/Channel4/c4-news/2014/March/27/27_ solar_system _r_w.jpg

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Current space activities are limited by the launchers... Space resource utilisation will break this limit!

Launcher-related limitations to activities in space	... and how utilization of space resources might help

• Current satellites / spacecrafts have to fit into the fairing of rockets
  • Limits the size to a diameter of around 5 m
  • Need of mechanically complex deployment mechanisms (e.g. for solar panels)
• Current launch costs are extremely high
  • Launch costs, typically ~10 000 $/kg
  • Heavy launcher: ~100 M$
• This is also true for propellant (for living, for propulsion)
	• No need to launch everything from Earth
	• Manufacturing of structures in space
	  • Size becomes quasi unlimited
	  • No need for complex mechanisms
	  • Micro-gravity allows structures that are not possible on ground
	• Water can be sourced from asteroids or the Moon, and used for life support and as propellant (O2 & H2)

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Newly developed technologies can bring short-term business opportunities in the current space and terrestrial markets

Space applications

- Higher performance
- Lower costs
- Miniaturization
- Mass / Power optimization
- More autonomy & flexibility
- In-orbit servicing
- ...

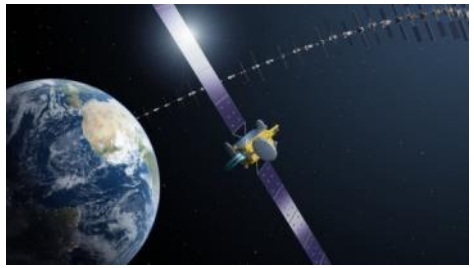

Image : ESA

Technologies needed for space resources exploration and utilization

- Robotics, autonomous systems
- Artificial intelligence
- Failsafe systems
- Telecommunications (Optical, data relay)
- High-performance computing / Data analysis
- Remote sensing
- In-situ sensing
- Propulsion systems
- Innovative energy systems
- Innovative Materials
- 3D printing/ Additive manufacturing
- ...

Terrestrial applications

- Mobility
- Transport
- Agriculture
- Manufacturing
- Insurance
- Security
- Energy
- Oil&Gas, Mining
- Infrastructure
- ...

Image: Whole world -landandoceans.jpg- WikimediaCommons

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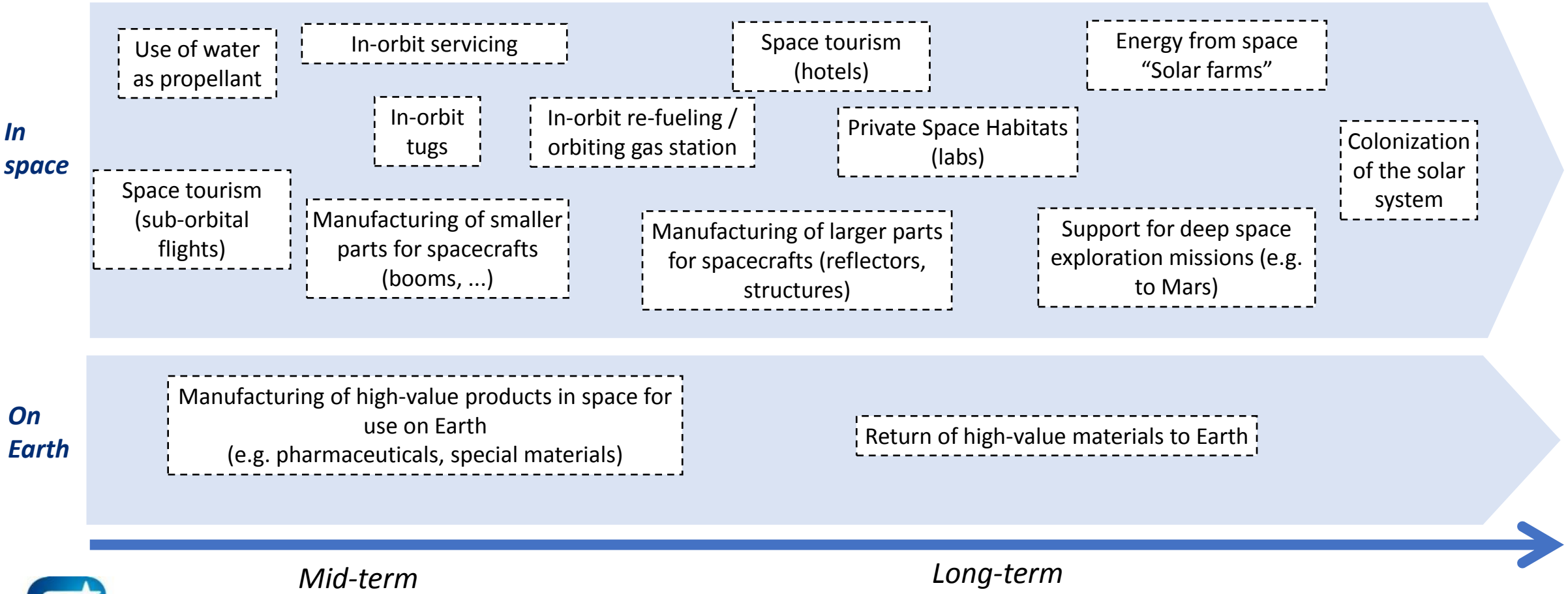
In the mid- and long-term, completely new business models and applications will develop in space and on Earth



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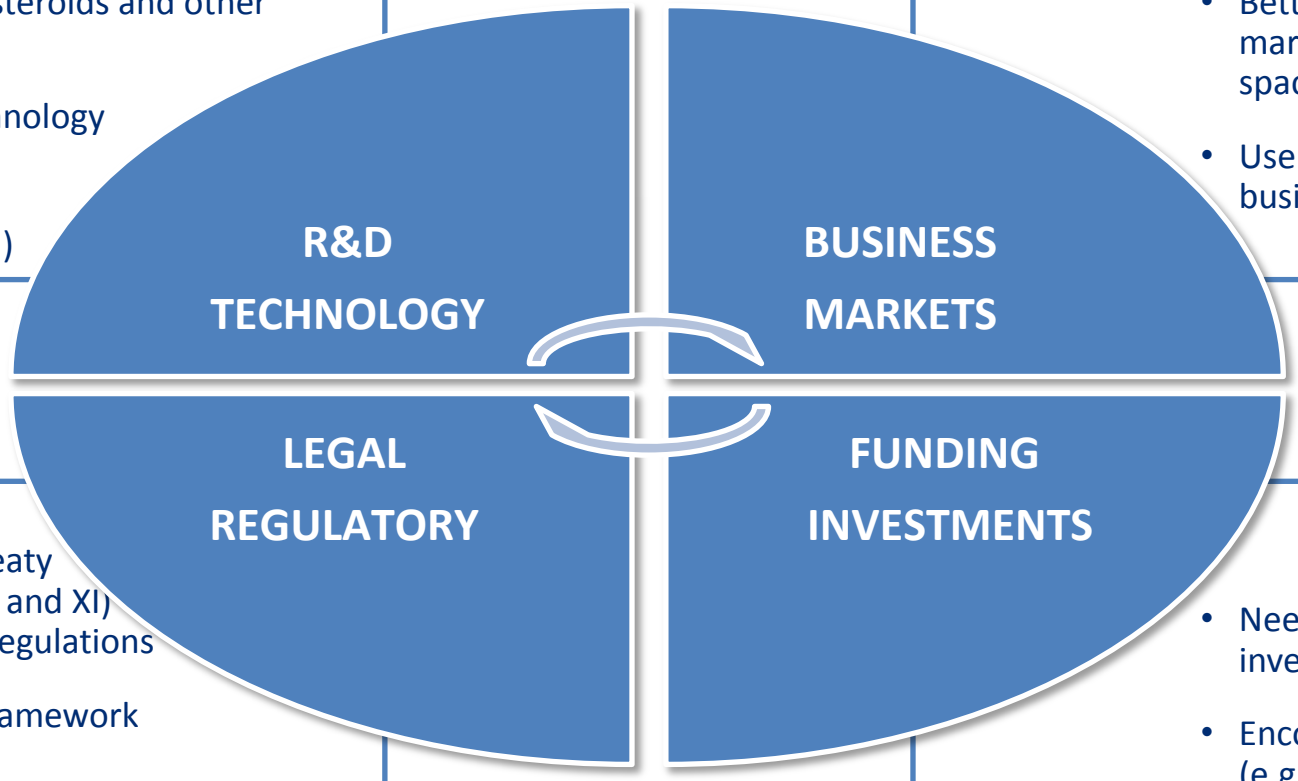
Many challenges need to be tackled for an operational use of space resources at an industrial and commercial scale

- Increase knowledge of asteroids and other celestial bodies
- Increase maturity of technology along the value chain (prospection, extraction, processing & distribution)



- Better estimate Long-term markets (both on earth and in space)
- Use short- and medium term business opportunities

- Consider Outer Space Treaty of 1967 (especially Art. II and XI) and other international regulations
- Agree on international framework

- Need huge long-term investments
- Encourage private investment (e.g. High-net-worth individuals)

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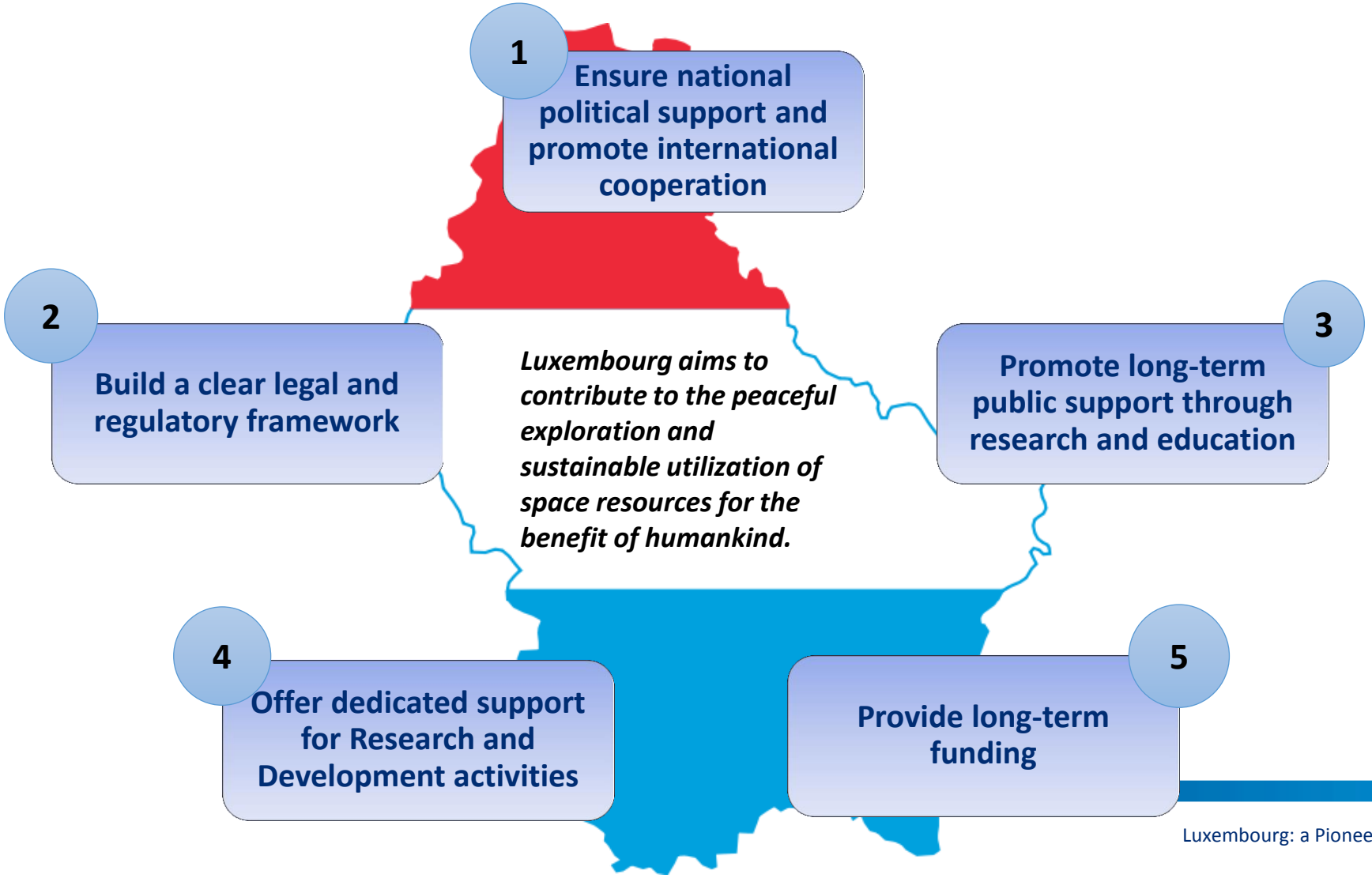
Luxembourg aims to position itself as a European hub for the utilization of space resources, working along 5 main pillars



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Space resource utilization: let's make it happen!

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Thank you
for your attention

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