Aerospace Districts: Acceleration of the Strategic Transfer of Regional Advancements

Future regional developments and megatrends

D1.3 – Future regional developments and megatrends

Abstract:

Task 1.3 aims to outline which megatrends our regions are experiencing and how our collaboration between aerospace focused regions may prepare ourselves to anticipate, contribute, and benefit from these trends.

Firstly, we will proceed with the identification of future megatrends from a technological, social, economic, and political standpoint. Then, the preparedness level of each region with respect to megatrends management and a timely reaction to them needs to be evaluated. Lastly, a scenario analysis will be developed to assess and foreplan how synergies between the regions may help in dealing with future megatrends.

Megatrends can include topics like sustainability, clean-tech, Big Data, AI, (cyber-)security, water and food supply, inclusivity, innovative business models and geopolitics. Aerospace Sector focused megatrends include topics such as renewable materials, urban air mobility, in-orbit services, air traffic management, space tourism, etc…

Megatrends will forcefully induce EU aerospace districts not only to work together but also to investigate interactions and spill-overs in other industrial sectors (e.g., automotive, health, agri-food, etc…) to swiftly respond and benefit from current disruptive advancements occurring within the aerospace sector. These megatrends will be identified and the regional responses to them will be jointly developed into project's vision for the future of the aerospace sector, and innovation at large. Also, the identified regional reactions may inspire the adoption of similar policies from other regions, allowing for the formation of a wider European collaborative network.

Keywords:

Future regional developments, megatrends, innovation, aerospace, collaboration, disruptive advancements

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Acronyms and Terminology

Term	Definition
AD-ASTRA	Aerospace Districts: Acceleration of the Strategic Transfer of Regional Advancements
DTA	Distretto Tecnologico Aerospaziale
IQ	Innovation Quarter
UPM	Universidad Politecnica de Madrid
TM	Toulouse Métropole

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Disclaimer

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1 Introduction

Our aerospace ecosystems and the way our regions develop in the future depend to a very large extent on megatrends. Megatrends have important implications for our global society and will shape the future of industries and economies in our regions and countries.

This document (Deliverable 1.3 of Task 1.3) defines what megatrends are, which megatrends are relevant to our regions and which will have a significant effect on the aerospace domain.

Inter-regional crossovers will be identified using the most relevant megatrends. Experiences and potential for collaboration between our aerospace regions will be shared. Our mutual goal is to anticipate to, contribute to, and benefit from these megatrends.

The main goal of this task is the identification of future regional development megatrends from a technological, social, economic, and political standpoint, and scenario forecasting development (evolutionary and/or revolutionary). The assignment must result in the following 3 concrete deliverables:

- Identification of 10 key innovation curricula designed and developed in collaboration between government, academia, and industry defined in accordance with the new trends (new space economy, advanced materials, energy transitions, etc…).
- Identification of 2 inter-regional shared development priorities for each pair of regions (20 overall).
- Identification of 5 key regional development drivers, in alignment with S3s.

2 Definition and identification of future regional developments and megatrends

2.1 Definition of a megatrend

A megatrend is a long-term, large-scale shift in social, economic, political, technological, or environmental conditions that fundamentally alter the way people live, work, and interact with each other.

Megatrends have significant impacts on global society and can shape the future of multiple industries, economies, and countries. Megatrends are typically driven by a combination of factors, such as demographic changes, technological advancements, geopolitical shifts, and cultural and behavioral shifts. The most significant and longer term megatrend is climate change and the unknown effects for the medium and longer term.

Megatrends will determine for a large part the future regional development of European regions. Megatrends will also be the main driver for better and closer future cohesion and cooperation between European regions.

2.2 Definition of future regional development

Future regional development refers to the planned strategies, policies and actions aimed at promoting economic, social and territorial cohesion in different regions of Europe in the coming years. This includes efforts to support and strengthen regional economies, reduce disparities between regions, foster innovation and entrepreneurship, improve infrastructure and connectivity, and improve the quality of life of citizens across the continent. Such efforts are generally guided by the European Union's regional development policies and funding programmes, which aim to support the sustainable and inclusive development of all regions within the EU.

2.3 Most relevant megatrends for future regional development in Europe

The following megatrends are likely to determine future regional development in Europe:

- ***Climate change:*** Climate change is expected to have a profound impact on the economy, society, and environment of Europe. It is likely to affect the various regions of Europe in different ways, with some areas facing more severe consequences than others. Future regional development in Europe will involve efforts to mitigate the impact of climate change, such as transitioning to a low-

carbon economy, promoting sustainable energy sources, and adapting infrastructure and buildings to changing climate conditions.

- ***Demographic change***: Europe is facing an aging population and declining birth rates, which is expected to have significant social and economic implications. Future regional development in Europe will likely involve efforts to address these demographic changes, such as promoting immigration, better healthcare for the elderly, developing age-friendly cities, and providing more support for families and children.
- ***Digitalization:*** Digital technologies are transforming the economy and society of Europe, with profound implications for regional development. Future regional development in Europe will involve efforts to promote digitalization and innovation, such as developing digital infrastructure, promoting digital skills and literacy, and supporting the growth of digital industries.
- ***Urbanization:*** Europe is experiencing increasing levels of urbanization, with the majority of the population now living in urban areas. Future regional development in Europe will involve efforts to support sustainable and livable cities, such as promoting compact and connected urban development, enhancing public transport systems, and improving access to green spaces and amenities.

Overall, megatrends are expected to significantly shape the future of regional development in Europe, and policymakers will need to take these trends into account when developing strategies and policies to promote sustainable and inclusive development across the continent.

2.4 Identifying relevant megatrends for aerospace regions in Europe

Given the above, the topic of megatrends is vast and compelling. To keep this manageable for the aerospace domain, we will have to focus mainly on current and future trends in the aerospace sector and how they overlap with future regional development challenges. The trends include all fields related to aerospace, like aeronautics and aviation, airport development & technology, upstream and downstream space and drones & Advanced Air Mobility.

2.5 Longlist of megatrends in aerospace

The following list of trends (see also Appendix 1) is likely to have a significant impact on the aerospace industry in the coming years, driving innovation, improving efficiency, and shaping the future of for instance air travel and space exploration. The longlist of topics is divided into five main aerospace categories:

Enabling Technologies for Aerospace in General

- Increased automation and artificial intelligence

- Quantum computing and encryption
- Blockchain and distributed ledger technologies
- Advanced materials and manufacturing processes
- Additive manufacturing (3D printing)
- Health and safety monitoring and diagnostics systems
- Cybersecurity and digital security
- Augmented and virtual reality
- Innovative business models and financing mechanisms

Space

- Space tourism
- Space exploration and commercialization
- Lunar and Martian resource utilization technologies
- Earth observation and remote sensing technologies from space
- Advanced sensors and instruments for scientific exploration
- Advanced weather forecasting and prediction systems
- Next-generation (laser) communication and navigation systems
- Global positioning systems or satellite-based navigation systems
- Small and cube satellite technologies for research and commerce
- Electric propulsion systems for spacecraft
- In-space manufacturing and assembly technologies
- In-orbit servicing and repair technologies
- Space-based solar power technologies
- Space debris mitigation and removal technologies

Aeronautics and Aviation

- Electric and hybrid propulsion systems
- Hydrogen powered aviation
- Sustainable aviation fuels
- Supersonic and hypersonic flight
- Noise reduction technologies
- Advanced avionics and sensors for more efficient, reliable, safe aircraft operations
- Digital twins for aircraft design and optimization
- Advanced flight simulation and training technologies
- Personalized air travel and aircraft interiors
- Advanced cargo and logistics technologies for air transportation

Drones/Advanced Air Mobility

- Urban air mobility and eVTOL aircraft
- Hybrid fixed-wing/VTOL aircraft for longer-range air transportation
- Electric and hybrid propulsion systems for vertical take-off and landing (VTOL) aircraft
- Advanced drone and air taxi certification and regulatory frameworks
- Autonomous parcel delivery systems for last-mile logistics
- Advanced autonomous flight control systems for drones and air taxis
- Unmanned aerial systems (air traffic management systems and technologies)
- Sense and avoid technologies for drones and air taxis
- Advanced aerial imaging and mapping technologies for drones
- Drone-based inspection and maintenance services
- Drone swarm technologies for coordinated mission execution

Airport Technology

- Sustainable airport infrastructure and energy management systems
- Electrified ground infrastructure and smart airports
- Smart airports and digitization of airport operations
- Next-generation air traffic control and management systems
- Self-service passenger processing technologies
- Biometric identification and authentication systems for passengers
- Automated baggage handling and screening system

3 Top 10 most relevant megatrends for all five regions combined

Based on the above longlist of megatrends in aerospace the participating regions have identified (*Appendix 1*) which trends are most relevant for each region. Topics were rated zero (-) to maximum three times X (XXX). An X was given for the presence of a strong industry cluster (X), the availability of relevant knowledge & talent (X) or the active involvement of the government (X). Zero (-) was given if a topic was not relevant at all in a region. If a subject scores triple X (XXX), it is considered to have a complete ecosystem.

Based on online consultation with the AD-ASTRA team members during early 2023 and the Co-Creation workshop of May 22nd, 2023 in Delft, The Netherlands, the following 10 aerospace megatrends were shortlisted. These 10 megatrends were ranked highest in the 5 regions combined and are the furthest in designing and developing shared innovation curricula between the regions and in collaboration with governments, academia, and industry (See also Appendix 2)

- **Aerospace in General: Increased Automation and Artificial Intelligence.** This is a general aerospace enabling topic, relevant for aeronautics, space and AAM and a clear example of a topic where cross-contamination and spill-overs may happen. This topic is most advanced in all regions, having complete ecosystems available in all 5 of the AD-ASTRA regions, not only in the aerospace domain, but also involving automation and AI in industry 4.0, in automotive, packaging, etc. They can further stimulate regional innovation ecosystems by supporting research and development initiatives, promoting collaboration between academia and industry, and providing infrastructure and resources for testing and experimentation. As these ecosystems are developing rapidly in all regions there will be an ongoing need for talent. Regions can also facilitate skills development programs and attract new investment to support the growth of AI and automation in aerospace. By leveraging their unique strengths and capabilities, the AD-ASTRA regions can contribute to the advancement of the aerospace industry and position themselves as hubs for technological innovation and economic growth.
- **Aerospace in General: Advanced Materials and Manufacturing Processes (including biobased).** This is also a general aerospace enabling topic, relevant for aeronautics, space and AAM and also in this case other sectors are involved, with potentiality for cross-contamination and spill-overs. Complete ecosystems exist in all 5 regions. The AD-ASTRA regions can support research and development in the field of advanced materials, including biobased materials, by fostering collaborations between their regions' academia, industry, and research institutions. They can also provide infrastructure, facilities, and funding to enable testing, prototyping, and scale-up of innovative

materials and manufacturing technologies, including those technologies (i.e. 3D printing) that may be exploited for in-orbit applications.

- **Space: Earth Observation, Weather, Prediction, Remote Sensing Technologies.** Regions can collaborate to develop and deploy advanced satellite systems, enhance data collection and analysis techniques, and improve weather prediction models. By fostering research partnerships and knowledge exchange, they can advance remote sensing technologies and promote their application in climate monitoring, disaster management, and resource planning. Additionally, they can support the development of innovative data processing algorithms and promote the use of Earth observation data for informed decision-making (collaboration with policy makers), contributing to sustainable development and addressing global environmental challenges.
- **Space: Advanced Sensors and Instruments for Scientific Exploration**. Regions can stimulate this topic by providing research and development funding, establishing specialized infrastructure and testing facilities, fostering collaboration and partnerships, supporting skills development and training programs, offering investment incentives, and creating favorable policies and regulations. By creating a supportive ecosystem, regions can attract investments, promote innovation, and develop a skilled workforce, thereby driving economic growth in the field of advanced sensors and instruments for space exploration.
- **Space: Small and cube satellite technologies for research and commerce.** The AD-ASTRA regions can establish joint research projects, share technological expertise and best practices, and facilitate knowledge exchange and resource sharing. Collaborative initiatives can include joint funding programs, technology transfer agreements, and the establishment of shared testing and manufacturing facilities. Additionally, regular forums, workshops, and conferences can be organized to promote networking and collaboration among researchers, industry professionals, and government representatives. Such efforts will accelerate technological advancements, enhance competitiveness, and drive innovation in small and cube satellite technologies across European aerospace regions. Furthermore the advent and diffusion of cubesat technology has lowered the barriers to entry, allowing small companies to produce and launch their own cubesat. This makes this market more accessible and ready for a full commercial deployment.
- **Aeronautics & Aviation: Electric and Hybrid Propulsion Systems.** Future challenges for electric and hybrid propulsion systems in aircraft, space, and drones include developing high-energy-density batteries, optimizing power-to-weight ratios, improving charging infrastructure and battery management systems, ensuring safety and reliability, addressing regulatory and certification requirements, and mitigating range limitations. Additionally, the integration of electric propulsion systems into existing aircraft and the development of efficient electric power distribution networks pose technical and operational

challenges, in which the regions can play a crucial role, also bringing in competencies coming from neighbouring sectors, such as: automotive, motorsports, mobility, etc.

- **Aeronautics & Aviation: Hydrogen Powered Aviation.** Aerospace regions should create collaborative platforms to facilitate knowledge sharing and partnerships between academia, industry, and government entities. Where possible providing financial support and incentives to encourage innovation and investment in hydrogen-powered aviation. Developing necessary infrastructure, including hydrogen production facilities and refueling stations. Working closely with regulatory bodies to establish safety standards and certification processes. Promoting international cooperation and knowledge exchange to accelerate progress in hydrogen-powered aviation technologies, also with networks involved in the automotive and mobility sectors.
- **Drones/AAM: Urban Air Mobility and eVTOL Aircraft.** The regional aerospace clusters should create a supportive regulatory framework that enables the safe and efficient operation of eVTOL aircraft in urban environments. Providing funding and incentives to attract investments and stimulate research and development in the sector. Collaborating with industry stakeholders, research institutions, and local communities to make it possible to test, develop and demonstrate the various solutions and address infrastructure requirements.
- **Drones/AAM: Unmanned Aerial Systems (air traffic management systems and technologies)** The development of UAS can only take place when industry stakeholders, research institutions, and local communities closely collaborate to address infrastructure requirements and airspace management challenges. Regions can create a conducive environment for the safe and efficient operation of unmanned aerial systems, promoting innovation, economic growth, and the widespread adoption of UAS technologies. Most important interregional topics to address are regulatory frameworks, communication and navigation systems and detect-and-avoid systems.
- **Drones/AAM: Drone-based Inspection and Maintenance Services.** Besides the regulatory framework mentioned above, aerospace regions should focus on ensuring safety, privacy, and compliance with airspace regulations. Furthermore, advancements in automation and artificial intelligence (AI) will enable drones to conduct more sophisticated inspections and data analysis, improving efficiency and accuracy. Another topic of cooperation is payload capabilities and the development of specialized payloads such as high-resolution cameras, sensors, and robotic arms which will enhance the capabilities of drones for inspection and maintenance tasks. Finally, efficient data management systems and analytics tools plus the standardization and certification will be needed to make this subject an economic success.

Overall, these megatrends are expected to drive significant innovation and growth in the aerospace industry, leading to a more sustainable, efficient, and interconnected global transportation system.

4 Paired regions: interregional shared development priorities

4.1 Aerospace initiatives and programs on a European level

The European aerospace industry is a major player in the global market, with companies such as Airbus, Safran, Leonardo, Arianegroup, Thales and OHB among the leading manufacturers. The European Union (EU) has identified aerospace as a key strategic sector for the continent's economic growth and competitiveness, and it has established various programs to support the industry's development.

Interregional cooperation in aerospace is accommodated by several European initiatives that either determine the standards for cooperation within Europe or enhance interregional interaction by dedicated programming and incentives. As part of task D1_2 former successful connections and case studies have been investigated and current and future European cooperation initiatives have been identified.

One such initiative is the European Union Aviation Safety Agency (EASA), which is responsible for ensuring the safety and regulatory compliance of aircraft, Urban Air Mobility and related products in Europe. EASA works closely with national aviation authorities and industry stakeholders to promote a high level of safety and standardization in the sector.

Another important initiative is the EU's Horizon Europe research and innovation program, which includes a specific focus on aerospace technologies. The program provides funding for research and development projects that aim to improve the efficiency, safety, and sustainability of aviation.

In addition to these programs, Europe's interregional shared development priorities in aerospace include promoting international cooperation and partnerships, supporting the development of small and medium-sized enterprises (SMEs) in the sector, and fostering innovation and technology transfer across industries.

Furthermore, there is a growing emphasis on sustainability and reducing the environmental impact of aerospace (in particular aviation), with initiatives aimed at promoting the use of alternative fuels or systems, reducing emissions, and improving the energy efficiency of aircraft.

4.2 Identifying the possibilities of interregional aerospace cooperation

Zooming in on the aerospace regions, there are plenty of European initiatives and programs to enhance interregional cooperation. In light of sustainable economic development & growth, strategic autonomy and maintaining or even creating global leadership in aerospace in Europe, stimulating the cooperation between two economically similar regions can lead to more economic prosperity and advantages.

When two regions with similar economic characteristics collaborate, they can benefit from economies of scale, increased trade, and knowledge sharing, which can lead to economic growth and development. For example, if two regions that produce similar goods collaborate, they may be able to specialize in different parts of the production process, which can increase efficiency and reduce costs. Similarly, by sharing knowledge and expertise, they may be able to develop new products and technologies that can create new markets and increase competitiveness.

However, it is important to note that the success of cooperation between two economically similar regions depends on several factors, including the political and institutional frameworks of the regions, the level of infrastructure and connectivity between the regions, and the cultural and linguistic differences between the regions. Additionally, cooperation may not always be the best strategy, as competition can also drive innovation and growth.

In summary, while the enhancement and stimulation of cooperation between two economically similar regions can lead to economic prosperity, it is important to consider the specific circumstances and factors that may impact the success of such cooperation.

5 Top 20 inter-regional shared development priorities

To identify 20 interregional shared development priorities the same longlist of megatrends in aerospace from Chapter 3 was used. After each region has carefully identified the most relevant topics, the highest scoring topics were paired with the most relevant regions (*See also Appendix 2)*. After careful consultation and research, the below regions were matched on the following topics.

Table 1. Description of the shared aerospace megatrends & priorities

REGIONS	SHARED AEROSPACE MEGATRENDS & PRIORITIES
ART-ER + DTA	**Additive manufacturing (3D printing)** Puglia, known for its strong aerospace sector, can contribute its expertise in aerospace engineering and manufacturing, while Emilia-Romagna, renowned for its advanced manufacturing capabilities, can provide its proficiency in additive manufacturing technologies. By combining these strengths, the regions can establish joint research and development initiatives, share knowledge and resources, and jointly attract investments to nurture innovation in 3D printing for the aerospace industry, ultimately enhancing their competitiveness and contributing to the growth of the sector.
ART-ER + DTA	**Urban air mobility and eVTOL aircraft** Puglia can contribute its knowledge in aircraft design, manufacturing, and certification processes; Emilia-Romagna is known for its automotive and motorsport industries and can provide its expertise in topics like electric propulsion systems and lightweight materials. Together, they can establish research and development centers, attract (foreign direct) investments, and deepen partnerships with universities and industry leaders to accelerate the development and deployment of eVTOL aircraft for urban air mobility, driving innovation and contributing to sustainable transportation solutions.

DTA + IQ	**Drone-based inspection and maintenance services** Puglia can contribute its expertise in drone technology, software development, and aviation regulations. Zuid-Holland, known for its innovative tech, maritime sector and port-related industries and logistics, can provide its knowledge in sensor technologies, data analytics, and onshore and offshore operations. By working together the regions can develop first-class applications in advanced drone-based inspection and maintenance services for industries such as energy, infrastructure, maritime and port-related industries, promoting efficiency, safety, and cost-effectiveness in operations and driving economic growth in the sector.
DTA + IQ	**Earth observation, weather, prediction, remote sensing technologies** Zuid-Holland has strong expertise in high-tech industries, satellite technology, data analysis and weather modeling. Puglia, with its favorable geographical location, can provide access to various ecosystems and environmental conditions for the validation and calibration of remote sensing technologies. By cooperating, the regions can improve weather forecasting capabilities, improve remote sensing techniques and contribute to the development of sustainable environmental monitoring.
IQ + TM	**Hydrogen powered aviation** Zuid-Holland, with its advanced aerospace and maritime industries, can contribute expertise in aircraft design, hydrogen infrastructure, and logistics. Toulouse Métropole, renowned as a global aerospace hub, can provide knowledge in aircraft manufacturing, propulsion systems, and testing facilities. More intense collaboration between the regions can accelerate the development of hydrogen-powered aviation technologies, drive innovation in decarbonizing the aerospace sector, and contribute to a sustainable and environmentally friendly future of aviation.
IQ + TM	**Increased automation and artificial intelligence** Toulouse Métropole can contribute its expertise in aircraft

	manufacturing, avionics, and systems integration. Zuid-Holland, known for its advanced aerospace and manufacturing industries, can provide its knowledge in automation systems, robotics, and artificial intelligence applications.
TM + UPM	**Advanced materials and manufacturing processes (incl biobased)** Toulouse Métropole has expertise in aircraft manufacturing, design, and engineering. Madrid is known for its research and development capabilities, can provide knowledge in advanced materials, including biobased materials, and innovative manufacturing processes. By cooperating, the regions can drive innovation in materials science and manufacturing techniques, enhancing the performance, sustainability, and efficiency of aerospace products and contributing to the growth of the industry.
TM + UPM	**Global positioning systems or satellite-based navigation systems** Madrid, with its strong presence in the space sector, can contribute its expertise in satellite communication, ground stations, and space operations. Toulouse Métropole, known as a major aerospace hub, can provide its knowledge in satellite design, navigation algorithms, and system integration.
UPM + ART-ER	**Increased automation and artificial intelligence** Madrid, known for its research and technology institutions, can contribute expertise in artificial intelligence, machine learning, and data analytics. Emilia-Romagna, with its advanced manufacturing capabilities, can provide knowledge in automation systems, robotics, and process optimization.
UPM + ART-ER	**Small and cube satellite technologies for research and commerce** Madrid can contribute its expertise in satellite design, systems integration, and mission operations. Emilia-Romagna, known for its advanced manufacturing capabilities, can provide knowledge in miniaturized satellite components, propulsion

	systems, and testing facilities. Overall, the start-up ecosystem of both the regions can significantly benefit from this, leveraging on the reduced barriers to entry in the satellite market.
DTA - TM	**Health and safety monitoring and diagnostics systems** To ensure the well-being of aircraft occupants and the safe operation of aircraft systems, Puglia can bring its expertise in aerospace engineering, sensors and data analysis, whereas Toulouse-Métropole can provide knowledge in aircraft design, avionics and systems integration.
DTA - TM	**Electric and hybrid propulsion systems** The regions of Toulouse-Métropole and Puglia can collaborate on electric and hybrid propulsion systems for various aerospace applications, including space and drones, by leveraging their respective strengths. Toulouse-Métropole can contribute its expertise in aircraft and spacecraft propulsion systems, electric motor technologies, and battery systems. Puglia can provide knowledge in aerospace engineering, avionics, and manufacturing. By cooperating the regions can drive innovation in electric and hybrid propulsion systems, enhancing sustainability, efficiency, and performance in the aerospace industry and beyond.
ART-ER + IQ	**Advanced materials and manufacturing processes (incl biobased)** Emilia-Romagna can contribute its expertise in materials engineering, composite materials, and additive manufacturing. Zuid-Holland, with its strong focus on sustainability and innovation, can provide knowledge in biobased materials, recycling techniques, and eco-friendly manufacturing processes.
ART-ER + IQ	**Small and cube satellite technologies for research and commerce** Zuid-Holland can contribute its knowledge in satellite design, systems integration, and mission operations. Emilia-Romagna,

	with its advanced manufacturing capabilities, can provide expertise in miniaturized satellite components, propulsion systems, and testing facilities. Overall, the start-up ecosystem of both the regions can significantly benefit from this, leveraging on the reduced barriers to entry in the satellite market.
IQ + UPM	**Quantum computing and encryption** Zuid-Holland is known for its knowledge in quantum computing hardware, algorithms, and encryption techniques. Madrid, with its strong research and technology institutions, can provide expertise in quantum information theory, software development, and cybersecurity. By cooperating the regions can drive innovation in quantum computing and encryption applications, enhancing data security, communication, and computational capabilities in the aerospace industry.
IQ + UPM	**Next-generation (laser) communication and navigation systems** Madrid has thorough expertise in satellite communication, laser technology, and space operations. Zuid-Holland can provide knowledge in laser communication systems, navigation algorithms, and system integration. The cooperating regions can drive innovation in space-based communication and navigation systems, enabling faster and more secure data transmission and enhancing the efficiency and reliability of space missions.
TM + ART-ER	**Advanced weather forecasting and prediction systems (see Earth Observation)** Toulouse-Métropole can contribute its expertise in satellite technology, data analytics, and weather modeling. Emilia-Romagna, known for its advanced research and technology institutions, can provide knowledge in meteorology, climate science, and advanced prediction systems for downstream applications. Furthermore the area of Bologna is prominent in Europe in relation to data center capability for weather forecast (housing ECMWF). By cooperating the regions can enhance Earth observation capabilities, improve weather forecasting

	accuracy, and contribute to better preparedness and resilience against weather-related hazards.
TM + ART-ER	**Additive manufacturing (3D printing)** Emilia-Romagna contributes expertise in materials engineering, additive manufacturing technologies, and process optimization. Toulouse-Métropole provides knowledge in aircraft design, certification requirements, and industry standards. By working together the regions can drive innovation in additive manufacturing for aerospace, enabling faster prototyping, lighter components, in-orbit manufacturing and cost-effective production, while promoting sustainability and enhancing the competitiveness of the aerospace industry.
DTA - UPM	**Unmanned aerial systems** Madrid has expertise in UAS technologies, including autonomous flight systems and mission planning. Puglia, known for its advanced manufacturing capabilities, can provide knowledge in UAS design, production, and testing facilities. By cooperating, the regions can drive innovation in UAS applications, such as aerial surveys, infrastructure inspection, and emergency response.
DTA - UPM	**Electric propulsion systems for spacecraft** Puglia, with its advanced aerospace manufacturing capabilities, can contribute expertise in electric propulsion technology, thruster development, and power management systems. Madrid, known for its research and technology institutions, can provide knowledge in spacecraft design, propulsion system integration, and testing facilities. By collaboration the regions can drive innovation in electric propulsion systems, enhancing spacecraft maneuverability, reducing fuel consumption, and promoting sustainable space exploration and satellite missions.

6 Selecting key regional development drivers using S3s

This final chapter describes each region's Unique Selling Point that stands out from the others. Identifying these 5 key regional development drivers for our aerospace clusters should be in line with the basic principles of 'S3s'. These 'Smart Specialization Strategies' (S3s) are regional development strategies that aim to foster economic growth and innovation by focusing on the areas of specialization and competitive advantage within a region. They are a framework developed by the European Union to guide regional development policies and investments.

The concept behind S3s is to identify and leverage a region's unique strengths, assets, and knowledge to promote sustainable economic development. S3s encourage regions to concentrate their resources and efforts on a limited number of priority areas where they have a comparative advantage and can excel.

These strategies involve a thorough analysis of the region's potential, including its research and innovation capacities, industrial capabilities, and entrepreneurial ecosystem. By identifying specific areas of specialization, S3s enable regions to allocate resources efficiently, encourage innovation, attract investment, and foster collaboration between different stakeholders, including businesses, research institutions, and public authorities.

Smart Specialization Strategies are intended to be dynamic and adaptive, allowing regions to respond to changing economic and technological landscapes. They help regions develop and capitalize on their unique assets, ultimately driving economic growth, job creation, and competitiveness.

However, not every region has picked up on the principles of S3s. And even less regions have done so in respect to their aerospace clusters. Based on our joint exercise (*See again Appendix 2*) however we can determine what areas of specialization and competitive advantage a region has compared to other AD-ASTRA regions. This narrows it down to the following 5 key regional economic development drivers that make each region unique compared to the other members.

7. The 5 Key Regional Development Drivers

7.1 Emilia-Romagna: ART-ER

The region of Emilia-Romagna clearly scores highest in the category of Enabling Technologies for Aerospace in General. With a large high-tech mechanical engineering cluster in the area, the region can play a major role in the supply chain for all aerospace categories, although currently especially the space sector profits most from this.

Home to Motor Valley, the region is home to the headquarters of some of the most iconic automotive brands. To stay on top of their game, they need advanced technology to improve their products. No wonder the region scores highest on increased automation and artificial intelligence; advanced materials and manufacturing processes and additive manufacturing including 3D printing. With over a quarter of all employees in this region working for the manufacturing sector, this category is definitely a specialization with competitive advantages. Indeed, based on this strong regional heritage on advanced technology, the aerospace domain has been introduced in the last S3 regional strategy as one with the greater development potential, to underline how fastly this sector is growing in the region, starting from the hi-tech manufacturing excellences coupled with new assets such as the Data Valley Hub, with the most performing HPCs in Europe.

This proposition, being an enabler for the aerospace sector in general, makes Emilia-Romagna and ART-ER stand out with the key regional development driver being: **cutting-edge technologies encompassing automation, artificial intelligence, advanced materials and additive manufacturing.**

7.2 Occitania: Toulouse-Métropole

It may come as no surprise that Toulouse-Métropole scores highest in all three aerospace subsectors: space, aeronautics and drones. Toulouse Métropole is the heart of France's largest aerospace hub, where 1260 aerospace related establishments are located and 147.000 direct and indirect jobs are created in this area. With Airbus being active in aeronautics and space this is the only participating region where a large international OEM is present. This creates a competitive advantage that no other region has.

Considering that two-thirds of Airbus revenues comes from sales of aircraft, the aviation category should be the base for the region's key regional development driver. Uniquely, compared to other regions, in the overview, topics like: noise reduction technologies, advanced avionics and sensors for more efficient, reliable, safe aircraft operations, digital twins for aircraft design and optimization, advanced flight simulation and training technologies. Personalized air travel and aircraft interiors and advanced cargo and logistics technologies for air transportation, stand out compared to other regions.

Taking these unique characteristics into account, the key regional development driver for Toulouse-Métropole is: **Integrated technologies for enhanced aircraft performance, safety, and logistics in air transportation.**

7.3 Madrid: UPM

The Madrid region scores particularly high on topics related to space. However it also stands out uniquely in the aerospace & aviation category in respect to sustainable aviation. The only region scoring highest on both hydrogen powered aviation and sustainable aviation fuels. Combined with a high score on electric propulsion systems for spacecraft, the topic of future sustainable energy supplies and new sustainable power systems for aerospace is a specialization of the Madrid region.

While UPM performs research and develops extensive knowledge on this topic, serious competitive advantage arises from the collaboration of two major end-users: multinational energy company Repsol and the national airline Iberia, who have committed themselves longer term to an ambitious joint programs with activities in areas of research and production of sustainable aviation fuel (SAF) capable of reducing the carbon footprint of flights; development of processes for production and the supply of electricity and renewable hydrogen to decarbonize Iberia's fleet of land vehicles.

With this unique specialization and commitment from industry partners located in the area, the key regional development driver for UPM and the Madrid region is: **Advancements in sustainable aviation technologies, including hydrogen power, sustainable fuels, and electric propulsion for aerospace.**

7.4 Apulia: DTA

While Puglia ranks high in the Enabling Technologies, Space categories, and advanced materials and manufacturing processes and additive manufacturing including 3D printing; Puglia's unique selling point clearly lies in the Drones/Advance Air Mobility category, where five of the topics mentioned score a triple X. High-scoring topics are: urban air mobility; advanced drone and air taxi certification and regulatory frameworks; autonomous parcel delivery systems for last-mile logistics; advanced aerial imaging and mapping technologies for drones and drone-based inspection and maintenance services.

The regional program and annual event "Drones Beyond" aims to support and guide the industrial, scientific, economic and financial efforts of the aerospace community by linking them to the need to create solutions that can be integrated into the future of cities and communities. The initiatives carried out so far by DTA unfold on both the suburban (Grottaglie airport) and the urban (city of Bari) dimensions with the aim of presenting the two areas as an integrated offer for experimenting with new Advanced Air Mobility solutions. The goal of this initiative is to develop a framework of an integrated infrastructure between both locations and create an "experimental drone

highway". In particular, with the Grottaglie Airport Test Bed (GATB), the DTA and the Apulia Region are creating an infrastructure for research and testing of unmanned technologies, experimentation with U-space services and the development of drone services and advanced services (agriculture, intelligent multimodal mobility, environmental monitoring, etc.).

Taking these features and ambitions into account, the key regional development driver for DTA in Puglia is: **Enabling technologies for urban air mobility, autonomous parcel delivery, and advanced drone-based services and logistics.**

7.5 South Holland: IQ

Although performing well in the Aeronautics & Aviation and Drones/AAM categories, the unique selling point for Zuid-Holland is in the Space category. The region scores high on topics like: earth observation, weather, prediction and remote sensing technologies; advanced sensors and instruments for scientific exploration and small and cube satellite technologies for research and commerce.

Other regions also score quite high on those subjects, so while these may not be exclusive specialties for the Zuid-Holland region, the regional ecosystem is where the competitive advantage lies. Some 80% of all space activities in the Netherlands take place in this region. Being home to ESTEC, ESA's technical heart, with 2800 employees, this is the agency's largest facility in the world. Besides this 'Old Space' sector, new spin-off companies from TU Delft have started a so-called 'New Space'-sector, more focused on the private and commercial space industry.

Both the Old and New Space sectors are drivers for the competitive advantage of the Zuid-Holland and InnovationQuarter region, identifying the key regional development driver as: **Advanced technologies for small satellite research, commerce, and scientific exploration including earth observation and remote sensing**.

8 Conclusions

After describing our regional aerospace clusters under Deliverable 1.1 and identifying our European connections under Deliverable 1.2, it was now time in Deliverable 1.3 to focus on the future of our aerospace regions and determining subjects for long-term cooperation.

In the first segment, the concept of general megatrends was narrowed down to a more practical longlist of so-called 'aerospace megatrends'. The process of ranking them based on regional strengths has provided a practical and actionable framework. Each region was now able to identify its strengths per megatrend, resulting in a clear ranking of topics most relevant to our 5 regions.

Based on that list (Appendix1) we were able to select the top 10 most relevant megatrends for all 5 regions combined. The regions are active in all 4 main categories such as Enabling Technologies for Aerospace (2), Space (3), Aeronautics & Aviation (2) and Drones/AAM (3).

What stands out is that all 5 regions generally score highly in the Enabling Technologies for Aerospace category, justifying that all our regions are indeed home to strong aerospace clusters. Toulouse-Métropole ranks highest in 3 categories (Space, Aviation and Drones), confirming that this region is home to the most developed aerospace cluster of the five regions.

All regions score high in the space category; some score slightly higher than others in the aeronautics and aviation category, but it is clear that the drone/advanced air mobility clusters of the Emilia-Romagna and Madrid region are not as far developed as in other regions.

Based on the longlist (Appendix1) and the subsequent discussions during the Co-Creation Workshop of May 22, 2023 in Delft (Appendix2), it was also easier to determine common grounds for cooperation between two separate regions. An extensive list of 20 potential inter-regional projects was identified. It is noted that each of these inter-regional projects is also open to the participation of other regions if they are interested.

And finally the rankings were utilized to establish the Unique Selling Points of each region. These 5 key regional development drivers serve as distinctive features that set one region apart from another. They represent specific areas where a region possesses a particular expertise or holds a competitive advantage, either currently or with the potential for future development. By identifying these key regional development drivers, we gained insights into the specific niches that differentiate each region and can contribute to its success. And by understanding the unique strengths and advantages of each region, we can determine the areas where cooperation and collaboration between regions can thrive.

In summary, this work package has been instrumental in clarifying the future strategic priorities for each aerospace region. It has shed light on the specific areas of

expertise and competitive advantage that set them apart, allowing stakeholders to focus their efforts and resources accordingly.

By identifying these key drivers and themes, we have provided a roadmap for successful cooperation and collaboration, ensuring that regions can leverage their unique strengths to drive innovation, growth, and overall success in the aerospace industry.

APPENDIX 1: Longlist of megatrends in aerospace

Trends/Regions	IQ	ART-ER	TM	UPM	DTA	Total
Enabling Technologies for Aerospace in General						0
Increased automation and artificial intelligence	XXX	XXX	XXX	XXX	XXX	15
Quantum computing and encryption	XXX	X		XX		6
Blockchain and distributed ledger technologies						0
Advanced materials and manufacturing processes (including biobased)	XXX	XXX	XX	XXX	XXX	14
Additive manufacturing (3D printing)	X	XXX	XXX	XX	XXX	12
Health and safety monitoring and diagnostics systems		XX	XX		XXX	7
Cybersecurity and digital security	XX	XXX	XX	X	X	9
Augmented and virtual reality	X	XX	X	X	X	6
Innovative business models and financing mechanisms	X		X		X	3
Space						
Space tourism			X		X	2
Space exploration and commercialization	X	XX	X		XX	6
Lunar and Martian resource utilization technologies			X			1
Earth observation and remote sensing technologies from space	XXX	XX	XX	X	XXX	10
Advanced sensors and instruments for scientific exploration	XX	XX	XX	X	XX	9
Advanced weather forecasting and prediction systems	X	XXX	XX	X	XX	9
Next-generation (laser) communication and navigation systems	XX	X	X	XXX		8
Global positioning systems or satellite-based navigation systems	X		XXX	XXX		7
Small and cube satellite technologies for research and commerce	XXX	XXX	XXX	XX	XX	13
Electric propulsion systems for spacecraft	XX		X	XX	XXX	8
In-space manufacturing and assembly technologies			X			1
In-orbit servicing and repair technologies	X	X	X			3
Space-based solar power technologies	XX		X			3
Space debris mitigation and removal technologies			XX	X		3
Aeronautics and Aviation:						
Electric and hybrid propulsion systems	XX	X	XX	X	XX	8
Hydrogen powered aviation	XXX	X	XX	XXX	XX	11
Sustainable aviation fuels	XX	X	XX	XXX		8
Supersonic and hypersonic flight			X			1
Noise reduction technologies	XX		XX			4
Advanced avionics and sensors for more efficient, reliable, safe aircraft operations	X	X	XX			4
Digital twins for aircraft design and optimization	X	X	XX	XX	X	7
Advanced flight simulation and training technologies	X	X	XX			4
Personalized air travel and aircraft interiors	X		XX			3
Advanced cargo and logistics technologies for air transportation			XX		X	3
Drones/AAM						
Urban air mobility and eVTOL aircraft	X	XX	XX	X	XXX	10
Hybrid fixed-wing/VTOL aircraft for longer-range air transportation	XX		XX			2
Electric and hybrid propulsion systems for vertical take-off and landing (VTOL) aircraft	XX		XX			3
Advanced drone and air taxi certification and regulatory frameworks	X		X		XXX	5
Autonomous parcel delivery systems for last-mile logistics	X		X		XXX	5

Advanced autonomous flight control systems for drones and air taxis	XX		XX			4
Unmanned aerial systems (air traffic management systems and technologies)	XX	X	XX	XX	XX	9
Sense and avoid technologies for drones and air taxis	X		XX			3
Advanced aerial imaging and mapping technologies for drones	XX	X	X		XXX	7
Drone-based inspection and maintenance services	XXX	X	XXX		XXX	10
Drone swarm technologies for coordinated mission execution	X		X			2
Airport Technology						
Sustainable airport infrastructure and energy management systems	X	X	XX	X		5
Electrified ground infrastructure and smart airports	X		X	X		3
Smart airports and digitization of airport operations	XX	X	XX	X		6
Next-generation air traffic control and management systems	XX		XX	XX		6
Self-service passenger processing technologies	X		X			2
Biometric identification and authentication systems for passengers	X					1
Automated baggage handling and screening system	X					1

APPENDIX 2 Co-Creation Workshop on megatrends

22/05/2023

AD-ASTRA
Co-Creation Workshop
Megatrends

Date: May 22nd 2023

Time: 12:30 – 15:00

Location: NEXTDelft at TU Delft Campus

Participants Workshop

AD-ASTRA Participants:
Alina Bisag - ART-ER (Attractiveness Research Territory Emilia-Romagna)
Lorenzo Calabri - ART-ER (Attractiveness Research Territory Emilia-Romagna)
Céline Bizieau - Toulouse Metropole (Aerospace Valley)
Michele Giannuzzi - DTA (Distretto Tecnologico Aerospaziale in Apulia)
Gustavo Alonso Rodrigo– UPM (Universidad Politécnica de Madrid)
Jose Miguel Alvarez Romero – UPM (Universidad Politécnica de Madrid)
Jan Terlingen – InnovationQuarter/Aerospace Delta (Zuid-Holland)
Niels Krol – InnovationQuarter/Aerospace Delta (Zuid-Holland)

Aerospace Delta Participants:
Renate Beausoleil – Province of South Holland
Bas Smit - Province of South Holland
Femke Verdegaal – Aerospace Innovation Hub
Jos van den Boom - TU Delft
Niklaas van Hylckama Vlieg – Enterprise Europe Network IQ
Dietmar Lander – Unmanned Valley
Bert Klarus – Technology Park Ypenburg

Program in Delft:
12:00 travel to NEXTDelft
12:30 Lunch
13:00 Start Workshop
15:00 End of Workshop
15:30 Break
16:00 Presentation Agenda
17:00 End & Drinks

Outline Workshop

13:00 **Word of Welcome**
- background AD-ASTRA
- Set up for the co-creation workshop

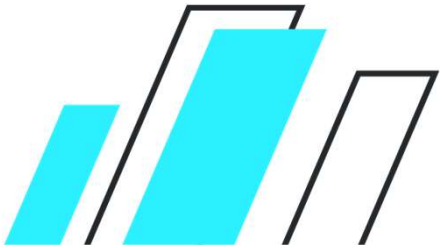
13:05 **Introduction of Participants:**
- maximum 3 slides per AD ASTRA region
- introduction ecosystem participants

13:30 **Start Part 1:**
- Introducing aerospace megatrends longlist
- Present Top 10 best match with Zuid-Holland region

13:50 **Start Part 2:**
- What role can this region play in each megatrend?
- plenary discussion per topic (max 5 min each)

14:50 **Select top 3 best match** and identify joint future action

15:00 **End**



Program in Delft:

12:00 travel to NEXTDelft
12:30 Lunch
13:00 Start Workshop
15:00 End of Workshop
15:30 Break
16:00 Presentation Agenda
17:00 End & Drinks

Megatrends

Our aerospace clusters and the way our regions develop in the future depend to a very large extent on megatrends. Megatrends have important implications for our global society and will shape the future of industries and economies in our regions and countries.

As part of Work Package 1.3 we have defined what megatrends are, which megatrends are relevant to our regions, and which will have a significant effect on the aerospace domain.

Inter-regional crossovers have been identified using the most relevant megatrends. Experiences, future regional trends & ambitions, and potential for collaboration between our aerospace regions will be shared. Our mutual goal is to anticipate to, contribute to, and benefit from these megatrends.

Chapter 3:
Methodology to Identify Top 10

A longlist of aerospace megatrends was generated, in which each region has arranged per topic whether:

- there is no activity at all
- some activity by placing an X if there is:
  - industry available: either manufacturers, supply chain, end users (X)
  - knowledge & talent available: institutions, universities, schools (X)
  - government involved: local or regional, incentives or commitment (X)
- if a subject is awarded with XXX, we assume that there is a (reasonably) complete ecosystem present, which is of national and European importance

We will now determine per sector and topic:

1) if the IQ ecosystem agrees on the classification
2) identify per highlight the possibilities of cooperation between regions

Enabling Technologies for Aerospace in General

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Enabling Technologies for Aerospace in General					
Increased automation and artificial intelligence	XXX	XXX	XXX	XXX	XXX
Quantum computing and encryption	XXX	X		XX	
Blockchain and distributed ledger technologies					
Advanced materials and manufacturing processes (incl biobased)	XXX	XXX	XX	XXX	XXX
Additive manufacturing (3D printing)	X	XXX	XXX	XX	XXX
Health and safety monitoring and diagnostics systems		XX	XX		XXX
Cybersecurity and digital security	XX	XXX	XX	X	X
Augmented and virtual reality	X	XX	X	X	X
Innovative business models and financing mechanisms	X		X		X

Space

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Space					
Space tourism			X		X
Space exploration and commercialization	X	XX	X		XX
Lunar and Martian resource utilization technologies			X		
Earth observation, weather, prediction, remote sensing technologies	XXX	XX	XX	X	XXX
Advanced sensors and instruments for scientific exploration	XX	XX	XX	X	XX
Advanced weather forecasting and prediction systems (see Earth Obs)	X	XXX	XX	X	XX
Next-generation (laser) communication and navigation systems	XX	X	X	XXX	
Global positioning systems or satellite-based navigation systems	X		XXX	XXX	
Small and cube satellite technologies for research and commerce	XXX	XXX	XXX	XX	XX
Electric propulsion systems for spacecraft (see Aeronautics)	XX		X	XX	XXX
In-space manufacturing and assembly technologies			X		
In-orbit servicing and repair technologies	X	X	X		
Space-based solar power technologies	XX		X		
Space debris mitigation and removal technologies			XX	X	

Aeronautics and Aviation

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Aeronautics and Aviation:					
Electric and hybrid propulsion systems (incl space and drones)	XX	X	XX	X	XX
Hydrogen powered aviation	XXX	X	XX	XXX	XX
Sustainable aviation fuels	XX	X	XX	XXX	
Supersonic and hypersonic flight			X		
Noise reduction technologies	XX		XX		
Advanced avionics and sensors for more efficient, reliable, safe aircraft operations	X	X	XX		
Digital twins for aircraft design and optimization	X	X	XX	XX	X
Advanced flight simulation and training technologies	X	X	XX		
Personalized air travel and aircraft interiors	X		XX		
Advanced cargo and logistics technologies for air transportation			XX		X

Drones/Advanced Air Mobility

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Drones/AAM					
Urban air mobility and eVTOL aircraft	X	XX	XX	X	XXX
Hybrid fixed-wing/VTOL aircraft for longer-range air transportation	XX		XX		
Electric and hybrid propulsion systems for vertical take-off and landing (VTOL) aircraft	XX		XX		
Advanced drone and air taxi certification and regulatory frameworks	X		X		XXX
Autonomous parcel delivery systems for last-mile logistics	X		X		XXX
Advanced autonomous flight control systems for drones and air taxis	XX		XX		
Unmanned aerial systems (air traffic management systems and technologies)	X	X	XX	XX	XX
Sense and avoid technologies for drones and air taxis	X		XX		
Advanced aerial imaging and mapping technologies for drones	XX	X	X		XXX
Drone-based inspection and maintenance services	XXX	X	XXX		XXX
Drone swarm technologies for coordinated mission execution	X		X		

Airport Technology

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Airport Technology					
Sustainable airport infrastructure and energy management systems	X	X	XX	X	
Electrified ground infrastructure and smart airports	X		X	X	
Smart airports and digitization of airport operations	XX	X	XX	X	
Next-generation air traffic control and management systems	XX		XX	XX	
Self-service passenger processing technologies	X		X		
Biometric identification and authentication systems for passengers	X				
Automated baggage handling and screening system	X				

During the Co-Creation workshop it was decided that Airport Technology trends are already part of the 4 topics mentioned above

Summary

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Enabling Technologies					
Increased automation and artificial intelligence	XXX	XXX	XXX	XXX	XXX
Advanced materials and manufacturing processes (incl biobased)	XXX	XXX	XX	XXX	XXX
Additive manufacturing (3D printing)	X	XXX	XXX	XX	XXX
Cybersecurity and digital security	XX	XXX	XX	X	X
Electric and hybrid propulsion systems	XX	X	XX	X	XX
Space					
Advanced sensors and instruments for scientific exploration	XX	XX	XX	X	XX
Earth observation, weather, prediction, remote sensing technologies	XXX	XX	XX	X	XXX
Small and cube satellite technologies for research and commerce	XXX	XXX	XXX	XX	XX
Aeronautics and Aviation:					
Electric and hybrid propulsion systems	XX	X	XX	X	XX
Hydrogen powered aviation (incl infra)	XXX	X	XX	XXX	XX
Sustainable aviation fuels (incl infra)	XX	X	XX	XXX	
Drones/AAM					
Urban air mobility and eVTOL aircraft (incl infra)	X	XX	XX	X	XXX
Unmanned aerial systems (air traffic man. systems and technologies)	X	X	XX	XX	XX
Drone-based inspection and maintenance services	XXX	X	XXX		XXX

Chapter 5:
Methodology to Pairing the Regions

The same longlist which was used for identifying the 10 key innovation curricula, is also used to identify 2 inter-regional shared development priorities for each pair of regions (20 in total).

They 2 highest ranking topics per two regions are matched and suggestions for cooperations are identified:

- if a subject is awarded with XXX, we assume that there is a (reasonably) complete ecosystem present, which is of national and European importance. In that case the both ecosystems are mature enough to work together
- If a subject is awarded with XX in either one or two regions, these ecosystems are well underway but have the potential to grow by learning from each other.

Enabling Technologies for Aerospace in General

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Enabling Technologies for Aerospace in General					
Increased automation and artificial intelligence	XXX	XXX	XXX	XXX	XXX
Quantum computing and encryption	XXX	X		XX	
Blockchain and distributed ledger technologies					
Advanced materials and manufacturing processes (incl biobased)	XXX	XXX	XX	XXX	XXX
Additive manufacturing (3D printing)	X	XXX	XXX	XX	XXX
Health and safety monitoring and diagnostics systems		XX	XX		XXX
Cybersecurity and digital security	XX	XXX	XX	X	X
Augmented and virtual reality	X	XX	X	X	X
Innovative business models and financing mechanisms	X		X		X

Space

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Space					
Space tourism			X		X
Space exploration and commercialization	X	XX	X		XX
Lunar and Martian resource utilization technologies			X		
Earth observation, weather, prediction, remote sensing technologies	XXX	XX	XX	X	XXX
Advanced sensors and instruments for scientific exploration	XX	XX	XX	X	XX
Advanced weather forecasting and prediction systems (*see Earth Obs*)	X	XXX	XX	X	XX
Next-generation (laser) communication and navigation systems	XX	X	X	XXX	
Global positioning systems or satellite-based navigation systems	X		XXX	XXX	
Small and cube satellite technologies for research and commerce	XXX	XXX	XXX	XX	XX
Electric propulsion systems for spacecraft (*see also Aeronautics*)	XX		X	XX	XXX
In-space manufacturing and assembly technologies			X		
In-orbit servicing and repair technologies	X	X	X		
Space-based solar power technologies	XX		X		
Space debris mitigation and removal technologies			XX	X	

Aeronautics and Aviation

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Aeronautics and Aviation:					
Electric and hybrid propulsion systems (incl space and drones)	XX	X	XX	X	XX
Hydrogen powered aviation	XXX	X	XX	XXX	XX
Sustainable aviation fuels	XX	X	XX	XXX	
Supersonic and hypersonic flight			X		
Noise reduction technologies	XX		XX		
Advanced avionics and sensors for more efficient, reliable, safe aircraft operations	X	X	XX		
Digital twins for aircraft design and optimization	X	X	XX	XX	X
Advanced flight simulation and training technologies	X	X	XX		
Personalized air travel and aircraft interiors	X		XX		
Advanced cargo and logistics technologies for air transportation			XX		X

Drones/Advanced Air Mobility

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Drones/AAM					
Urban air mobility and eVTOL aircraft	X	XX	XX	X	XXX
Hybrid fixed-wing/VTOL aircraft for longer-range air transportation	XX		XX		
Electric and hybrid propulsion systems for vertical take-off and landing (VTOL) aircraft	XX		XX		
Advanced drone and air taxi certification and regulatory frameworks	X		X		XXX
Autonomous parcel delivery systems for last-mile logistics	X		X		XXX
Advanced autonomous flight control systems for drones and air taxis	XX		XX		
Unmanned aerial systems (air traffic management systems and technologies)	X	X	XX	XX	XX
Sense and avoid technologies for drones and air taxis	X		XX		
Advanced aerial imaging and mapping technologies for drones	XX	X	X		XXX
Drone-based inspection and maintenance services	XXX	X	XXX		XXX
Drone swarm technologies for coordinated mission execution	X		X		

Chapter 7
Methodology to Identify 5 Key Regional Development Drivers

Again the Excel list Appendix 1 is used. This time to identify
per region what the areas of specialization and competitive advantage are.

This is done by:
- adding up all X's per category and per region.
- this will generate low and high scores
- besides these facts the regions ambitions are also taken into consideration

This exercise has some interesting outcomes:
- all regions score relatively high in the Enabling Technologies category.
- TM scores high in all 3 subsectors aeronautics, space and drones.

Enabling Technologies for Aerospace in General

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Enabling Technologies for Aerospace in General					
Increased automation and artificial intelligence	XXX	XXX	XXX	XXX	XXX
Quantum computing and encryption	XXX	X		XX	
Blockchain and distributed ledger technologies					
Advanced materials and manufacturing processes (incl biobased)	XXX	XXX	XX	XXX	XXX
Additive manufacturing (3D printing)	X	XXX	XXX	XX	XXX
Health and safety monitoring and diagnostics systems		XX	XX		XXX
Cybersecurity and digital security	XX	XXX	XX	X	X
Augmented and virtual reality	X	XX	X	X	X
Innovative business models and financing mechanisms	X		X		X
Total X:	14	17	14	12	15

Space

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Space					
Space tourism			X		X
Space exploration and commercialization	X	XX	X		XX
Lunar and Martian resource utilization technologies			X		
Earth observation, weather, prediction, remote sensing technologies	XXX	XX	XX	X	XXX
Advanced sensors and instruments for scientific exploration	XX	XX	XX	X	XX
Advanced weather forecasting and prediction systems (see Earth Obs)	X	XXX	XX	X	XX
Next-generation (laser) communication and navigation systems	XX	X	X	XXX	
Global positioning systems or satellite-based navigation systems	X		XXX	XXX	
Small and cube satellite technologies for research and commerce	XXX	XXX	XXX	XX	XX
Electric propulsion systems for spacecraft (see Aeronautics)	XX		X	XX	XXX
In-space manufacturing and assembly technologies			X		
In-orbit servicing and repair technologies	X	X	X		
Space-based solar power technologies	XX		X		
Space debris mitigation and removal technologies			XX	X	
Total X:	18	14	22	14	15

Aeronautics and Aviation

Trends/Regions	IQ	ART-ER	TM	JPM	DTA
Aeronautics and Aviation:					
Electric and hybrid propulsion systems (incl space and drones)	XX	X	XX	X	XX
Hydrogen powered aviation	XXX	X	XX	XXX	XX
Sustainable aviation fuels	XX	X	XX	XXX	
Supersonic and hypersonic flight			X		
Noise reduction technologies	XX		XX		
Advanced avionics and sensors for more efficient, reliable, safe aircraft operations	X	X	XX		
Digital twins for aircraft design and optimization	X	X	XX	XX	X
Advanced flight simulation and training technologies	X	X	XX		
Personalized air travel and aircraft interiors	X		XX		
Advanced cargo and logistics technologies for air transportation			XX		X
Total X:	13	6	19	9	6

Drones/Advanced Air Mobility

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Drones/AAM					
Urban air mobility and eVTOL aircraft	X	XX	XX	X	XXX
Hybrid fixed-wing/VTOL aircraft for longer-range air transportation	XX		XX		
Electric and hybrid propulsion systems for vertical take-off and landing (VTOL) aircraft	XX		XX		
Advanced drone and air taxi certification and regulatory frameworks	X		X		XXX
Autonomous parcel delivery systems for last-mile logistics	X		X		XXX
Advanced autonomous flight control systems for drones and air taxis	XX		XX		
Unmanned aerial systems (air traffic management systems and technologies)	X	X	XX	XX	XX
Sense and avoid technologies for drones and air taxis	X		XX		
Advanced aerial imaging and mapping technologies for drones	XX	X	X		XXX
Drone-based inspection and maintenance services	XXX	X	XXX		XXX
Drone swarm technologies for coordinated mission execution	X		X		
	17	5	19	3	17

Airport Technology

Trends/Regions	IQ	ART-ER	TM	UPM	DTA
Airport Technology					
Sustainable airport infrastructure and energy management systems	X	X	XX	X	
Electrified ground infrastructure and smart airports	X		X	X	
Smart airports and digitization of airport operations	XX	X	XX	X	
Next-generation air traffic control and management systems	XX		XX	XX	
Self-service passenger processing technologies	X		X		
Biometric identification and authentication systems for passengers	X				
Automated baggage handling and screening system	X				
Total X:	9	2	8	5	-