

WHERE TO PLAY:  
GAME-CHANGING  
TECHNOLOGIES  
FOR **AEROSPACE**



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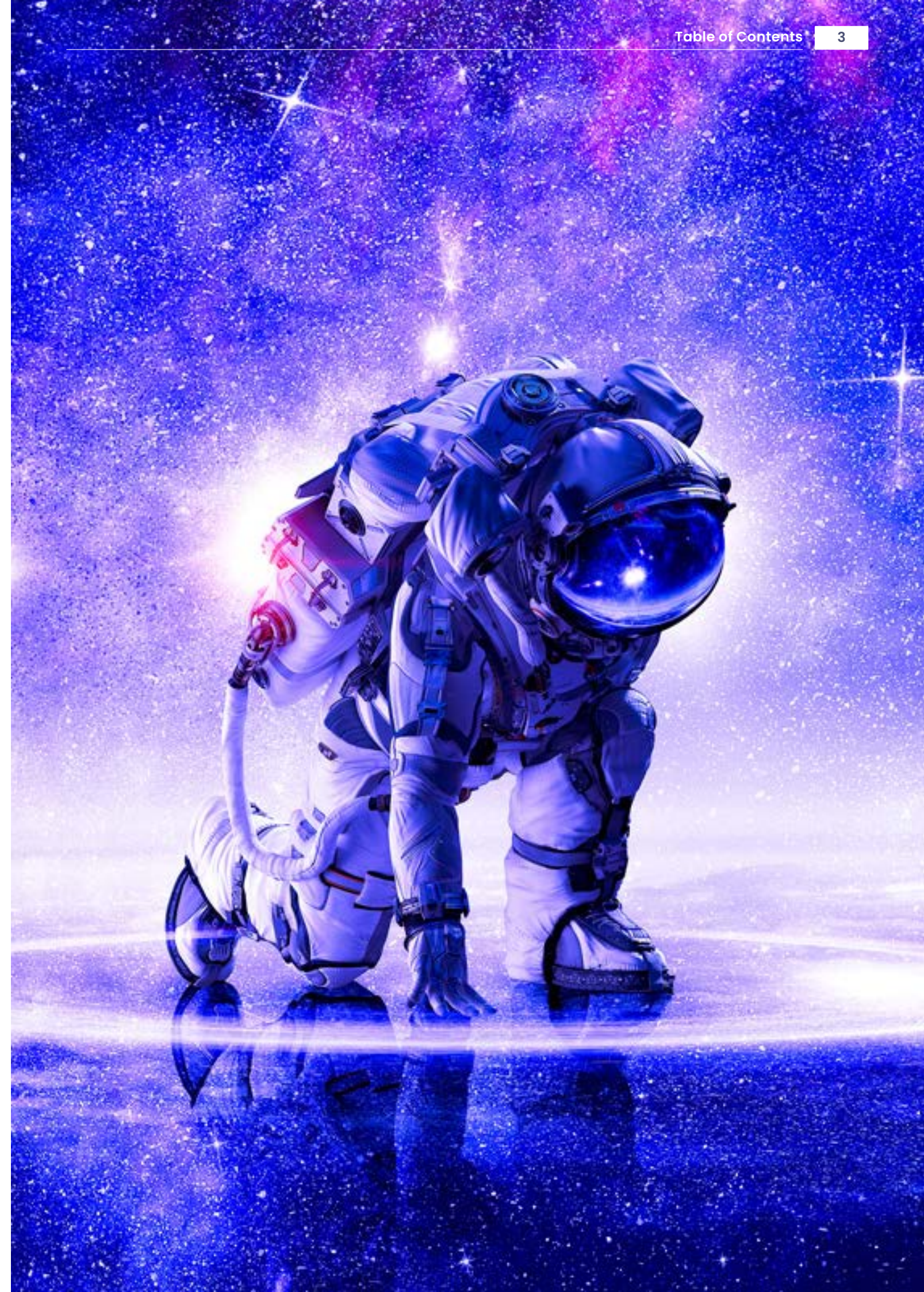
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# Introduction

## Foreword from Alexander Kruczek, Senior Sales Manager

The aerospace industry has historically been a paragon of innovation. Inventions from aviation and space agencies over the past 60 years have led the way for some of the most groundbreaking technologies we currently use on Earth. Space agencies have been at the forefront of breakthroughs across various sectors—from the development of Mylar technology that helps insulate electrical systems to digital signaling technology that led to the development of CAT scans and MRIs in the medical field to the prototyping of virtual reality. This trend is set to continue with aerospace undergoing several seismic changes in the coming decades.

The next aerospace era is being dubbed the “space economy,” a phase underpinned by two themes—sustainability and self-sufficiency. The space economy aims to develop technologies and processes whereby space activities do not rely on interventions from Earth. Creating a space economy will require a suite of technologies that operate independently while helping to mitigate

space pollution. A flourishing space economy could facilitate sustainable enterprises on the Moon and, eventually, Mars. This era will require key cross-industry collaborations, most notably new partnerships between space agencies and emerging startups offering products that enable scalable aerospace independence.



For organizations to see which opportunities they can leverage in the aerospace landscape, they will need to understand the forces shaping the future of the aerospace industry. Through this lens, organizations can identify the trends, technologies, and influential players driving change in the market. Organizations can use this intelligence to ascertain which developments are most promising to monitor, evaluate, or act upon.

This report aims to provide decision-makers in aerospace with a view of the technologies that hold the greatest potential for meaningful innovation. These game-changing technologies range from emerging to evolving and present several innovative use cases for enhancing resilience, relevance, and impact in the industry. The information contained within this report is interlinked with the ITONICS Innovation Platform to help you visualize the connections between various drivers of change and identify the technologies that align with and enable your strategic innovation goals.

## An Introduction to Technology Scouting

End2end innovation management begins by asking the fundamental question, **Where to Play**. Answering this question relies on several congruent activities and internal capabilities that primarily fall within the discipline of Foresight and Strategy, as advocated by our distinct **ITONICS COFIM** model. Organizations equipped with strong foresight capabilities can align their strategy with future scenarios and build resilience in an increasingly uncertain and competitive landscape.

Essential in **Foresight and Strategy** is an organization's capacity to scan its business environment comprehensively and continuously—environmental scanning. This is the capability to scan the horizon for weak signals that might indicate larger shifts and influence or disrupt the environment. It begins with the collection of vast amounts of data from which patterns are revealed through sensemaking analysis.

**Environmental scanning** focuses on control objectives that enhance innovation intelligence, thereby enabling the identification of new opportunities for growth, informing strategic priorities, and shaping future goals. These include capability supervision, competitor watch, trend scouting, and technology scouting.

As the focus of this industry report, **technology scouting** is the process of observing technological shifts and developments by collecting pertinent data, contextualizing change to uncover discernable patterns as weak signals, and identifying emerging technologies that hold both impact and relevance.

Actively screening for shifts in technology adoption, R&D, and patents serves as an early-warning system to help organizations anticipate and respond to changes while also minimizing risk.

Applying an industry lens to the process of technology scouting helps organizations direct their focus and resources more optimally.

And by gaining an understanding of the technological developments and adoption trends that may present future opportunities in their industry, they can equip themselves with the innovation intelligence needed to take decisive, strategic action and ultimately gain a competitive advantage.





## The Role of Technologies in Innovation

Emerging, evolving, and disruptive technologies serve as solution drivers, helping innovators connect the dots between their current and future states. These are the tools capable of meeting—and sometimes, creating—new needs, desires, and demands.

Technologies enable new business models, products, and services. They have the potential to meaningfully expand an organization's existing portfolio and transform an entire industry.

### The Interplay between Technologies and Trends

Technologies and trends are complementary elements that interact with and influence one another. Trends are expressions of new consumer attitudes, expectations, or behaviors—an indication of market pull; whereas technologies are designed either in response to these shifts or as precursors to nascent demands—representing a market push.

Together this push and pull exert force on the market, driving change forward. It is organizations' ability to pre-empt or respond to this change through innovation that determines their success.

### Determining Industry Relevance

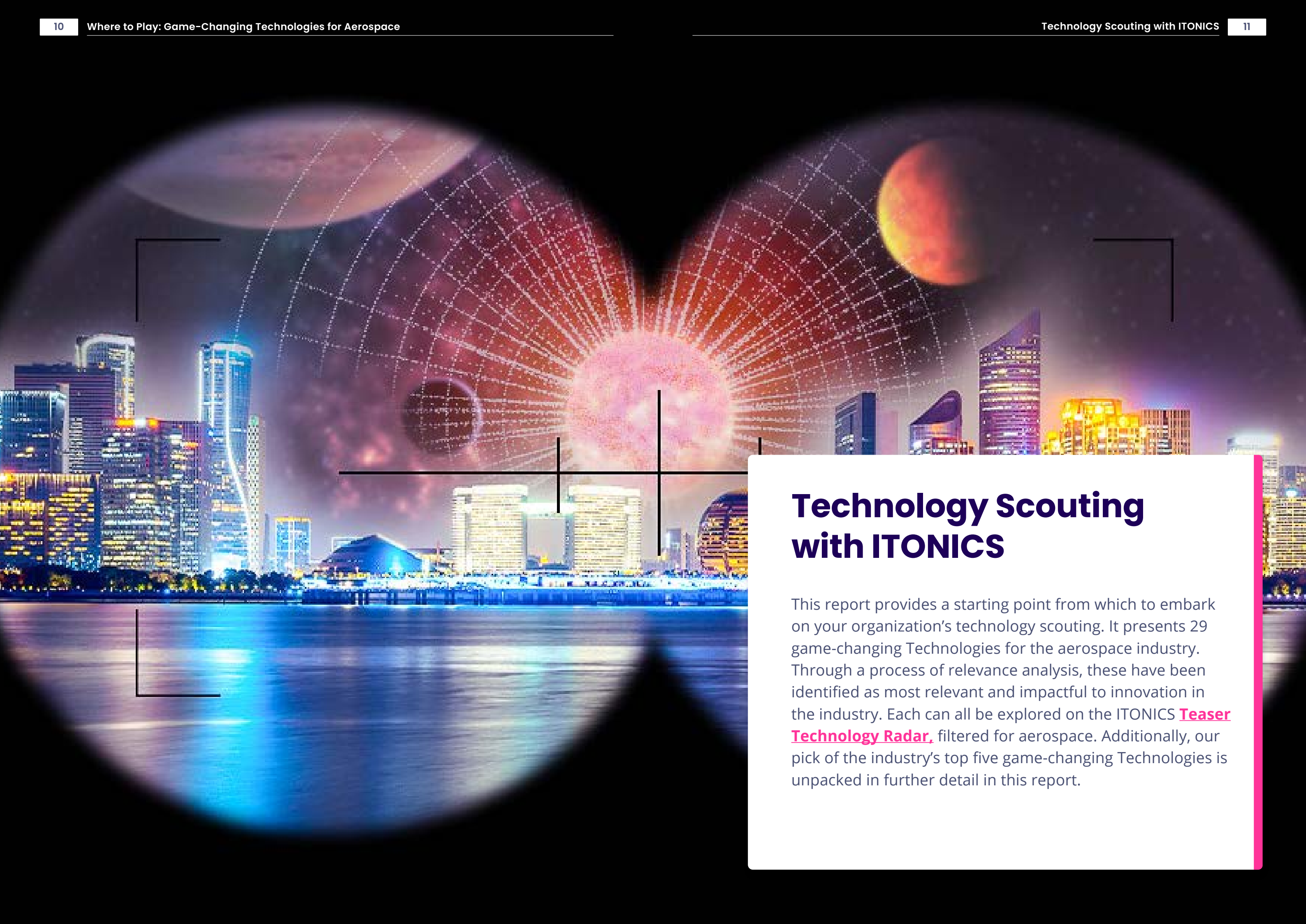
Environmental scanning is a divergent exercise; too narrow an approach and important opportunities can easily be missed. And while all elements in the ITONICS portfolio hold relevance—the degree of relevance differs depending on the industry in which your organization operates.

To help provide this industry lens, ITONICS analysts have performed relevance analysis to identify the Technologies and other elements that are most relevant and likely to be game changers in each respective industry.

Our team of analysts monitored the frequency with which each Technology appeared in a given industry. Instances of real-world applications, R&D, patents, and startup activities were tagged with relevant industries through a process combining manual and automated data classification.

This initial mapping of the ITONICS portfolio served as hypotheses of industry relevance. These hypotheses were further validated and enriched through additional quantitative and qualitative industry research to arrive at nine industry packages.

*Each industry package, available on the ITONICS Innovation Platform, displays the Technologies, Trends, and Inspirations that represent the most relevant—that is, impactful, disruptive, and transformative—areas in which to play.*



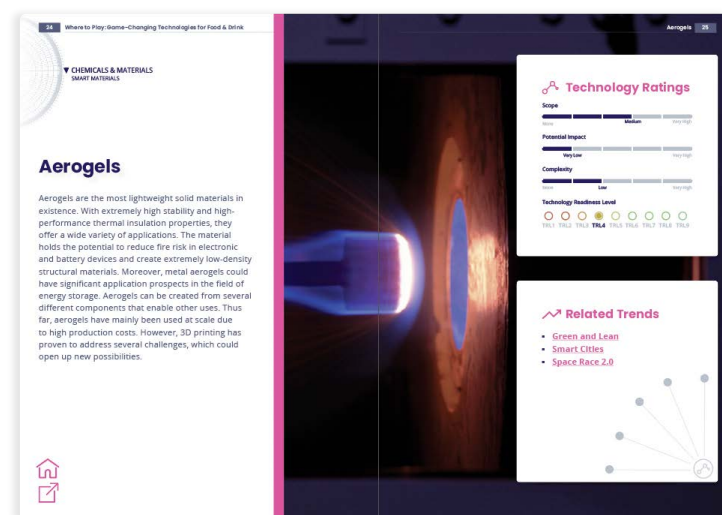
## Technology Scouting with ITONICS

This report provides a starting point from which to embark on your organization's technology scouting. It presents 29 game-changing Technologies for the aerospace industry. Through a process of relevance analysis, these have been identified as most relevant and impactful to innovation in the industry. Each can all be explored on the ITONICS [Teaser Technology Radar](#), filtered for aerospace. Additionally, our pick of the industry's top five game-changing Technologies is unpacked in further detail in this report.

## How to Read the Technologies

The **Synopsis** gives a brief overview of the Technology, explaining why it is important, what is required to enable it, how it has evolved, and any current limitations and opportunities.

The **Segmentation** of the Technology is indicated corresponding to the relevant categories that appear on the ITONICS Radar: Chemicals & Materials, Energy & Resources, Engineering, Healthcare & Life Sciences, ICT, and Mobility. Listed below, the **Sub-segmentation** provides a more narrow scope as to the area of technological development.



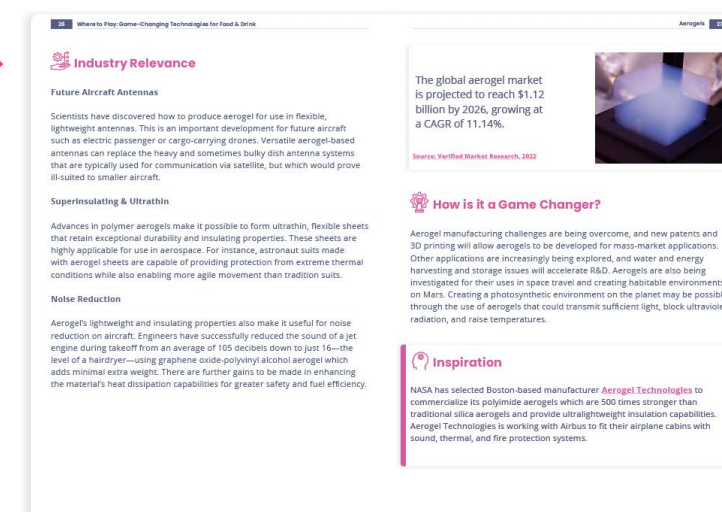
In the navigation bar, the icon will bring you back to the Table of Contents page. The button will open up the individual element in the ITONICS **Teaser Technology Radar**. Here you can deep dive into the Implications for Innovation associated with the Technology and view the interconnected elements that influence and impact it, including related Trends, Inspirations, and other Technologies.

The **Technology Ratings** look at the parameters of Scope, Potential Impact, Complexity, and Technology Readiness Level (TRL).

**Related Trends** show the elements that are influenced by and have an influence on the Technology, its development, and adoption. This network provides greater context as to the interplay between elements and points to possible opportunities.

The **Industry Relevance** unpacks the industry-specific applications and potential use-cases that are most prominent with regard to the Technology. Each point looks at the strategic advantage gained through adoption of the Technology and the considerations for its future development.

**How is this a Game Changer?** elaborates on how the Technology may contribute to or influence possible future scenarios. The relationship between the Technology and nascent demands is explored through a future-oriented lens.

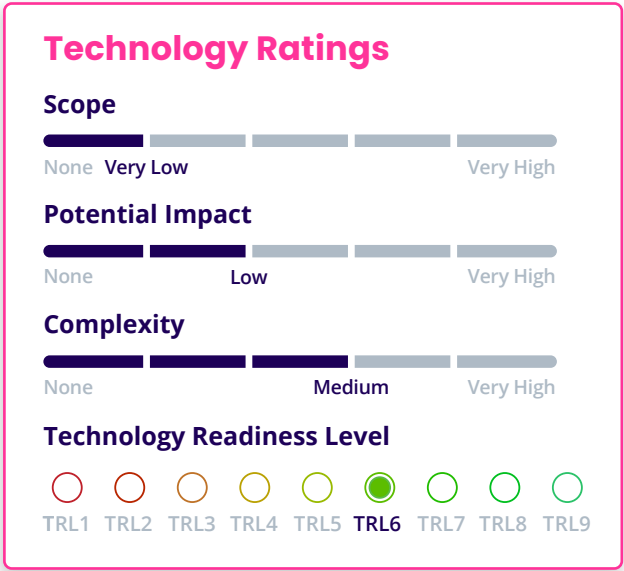


**Inspirations** provide evidence of how organizations are applying the Technology in the real world. They serve as springboards for ideation, helping innovators look beyond their category, connect information in new ways, and nurture fresh thinking.

# ITONICS Ratings

The evaluation of trends or technologies is one of the most important activities in innovation management. The goal is to predict future changes in your industry and whether they are relevant to your organization.

ITONICS Trends and Technologies are presented with ratings that help foresight teams focus their attention and identify relevance based on their unique set of strategic objectives.



**Scope:** How far-reaching is the potential influence of this element on this market?

ITONICS Insights tool uses keywords to retrieve data across three dimensions and derive an aggregated mean value to indicate the market reach of each Technology.

Signals generated (i.e., news, patents, publications, and other unstructured web reports) + Regions covered in World Map Visualization + Industries impacted = Market Reach

**Potential Impact:** How high is the potential impact of this element on the market?

Market growth data for each Technology is collected from a minimum of 5 verifiable sources, aggregated and extrapolated to 2025.

**Scale: Projected market value in 2025 (USD billion):**

- Very Low: >10 bil.
- Low: 10-50 bil.
- Medium: 50-500 bil.
- High: 500-1,000 bil.
- Very High: >1,000 bil.

Market Value 2021 → 2025

Our team of analysts uses advanced query and **ITONICS Insights** to garner the relevant information alongside our research and statistically derive the ratings from quantifiable historical and present data.

Each Technology is rated on Scope, Potential Impact, Complexity, and Technology Readiness Level (TRL) to provide targeted and tailored analysis at your fingertips.

**Complexity:** How high is the complexity of this element?

A complexity score is derived based on the number of connections each Technology forms with other elements.

The greater number of connections → the greater the complexity

**Technology Readiness Level (TRL):** How mature is this element in the market?

Each Technology is mapped by its Technology Readiness Level (TRL) to determine its relative maturity.

| PHASE       | TRL | DEFINITION                                               |
|-------------|-----|----------------------------------------------------------|
| RESEARCH    | 1   | Basic principles observed                                |
|             | 2   | Concept formulated                                       |
|             | 3   | Experimental proof of concept                            |
| DEVELOPMENT | 4   | Validated in lab                                         |
|             | 5   | Validated in relevant environment                        |
|             | 6   | Demonstrated in relevant environment                     |
| DEPLOYMENT  | 7   | System prototype demonstrated in operational environment |
|             | 8   | System complete and qualified                            |
|             | 9   | Actual system proven in operational environment          |

## Exploring the ITONICS Radar

Having the right tools to manage innovations, technologies, projects, and opportunities is vital to act on your organization's innovation strategy in an increasingly uncertain and dynamic world. After all, what you can't manage, you cannot change.

Get started by exploring the ITONICS [Teaser Technology Radar](#) and [Teaser Trend Radar](#), displaying the elements that are most relevant

to your industry. Here you will find a read-only overview of each Technology and Trend.

Beyond what's available in the Teaser, the full content on the ITONICS Innovation Platform provides deeper insight into each Technology. It allows users to interact with and configure different elements to derive greater meaning and prompt informed decision-making.

The ITONICS Innovation Platform provides access to:

- The full portfolio of **175+ Trends and Technologies**, each with detailed explanations of how they have developed, where they are currently having an impact, and how they could evolve into the future.

- **7,000+ Inspirations**, continually updated to illustrate how Trends and Technologies are being activated and brought to life by innovators, businesses, and consumers.

- Interactive **Network Graph** visualizations that display first- and second-level relations for a selected element. New relations that hold strategic relevance to your organization can also be added to any network graph.

Various **Tags** attributed to each element to help users focus their searches. A **Tag Filter** function allows advanced searching by tags and gives suggestions for related tags. To view the Trends, Technologies, and Inspirations that are most relevant to aerospace, use **Advanced Filtering** and select the **Saved Filter: Aerospace**

- The ability to set **Internal Ratings** such as Business Relevance, Strategic Fit, Internal Know-How, and Need for Action. Undertaken as a collaborative evaluation exercise within your organization, these ratings help build the consensus and commitment needed in the innovation journey.

*For full access to this content and functionality, register an account on ITONICS Cloud for free today.*

**REGISTER**

The screenshot displays the ITONICS Radar interface. On the left, a grid of 16 elements is shown, categorized into Trends, Technologies, and Inspirations. Each element card includes a title, a brief description, and a list of tags. For example, the 'Automating a Greener World' trend is tagged with 'cleantech', 'ir aerospace & defense', and 'ir auto'. The 'Advanced Filtering' sidebar on the right allows users to refine their search. It includes a 'Saved Filters' section with 'Aerospace' selected, a 'What element types do you want to show?' section with 'Trend', 'Technology', and 'Inspiration' selected, and a 'What do you want to filter by?' section with 'Tags' selected. The sidebar also shows filters for 'Trend', 'Technology', and 'Inspiration', each with a 'Tags' section and a search bar.

# Forces Shaping the Future of Aerospace

## Context of Change

Defining the objectives and scope of environmental scanning activities like technology scouting requires a clear understanding of the context of change in your industry. Context provides a foundation for identifying and assessing the driving forces shaping the future. It points to evidence of where we see change happening in social, technological, economic, environmental, and political spheres and where the change will expand to next. It is the landscape upon which trends and technologies play out; the ability to navigate this landscape is the ability to adequately prepare for possible futures.

## Forces Shaping the Future

There are several forces shaping the future of aerospace. The next era of aerospace will move from space activities anchored on Earth to fully-fledged, independent space operations—the emergence of the space economy. The space economy will create business opportunities for a variety of service providers in space, such as satellite servicing and collision prevention. Expect an increase in R&D taking place exclusively in space which aims to use the unique environment to help develop innovations in engineering, biology, and medicine. Attracting professionals from fields apart from STEM, keeping a watchful eye on sustainability, and mitigating the amount of debris and decommissioned satellites in space will all be imperative to a flourishing space economy.

*Here we'll discuss some of the forces shaping the future of the aerospace industry.*

## DE-ANCHORING FROM EARTH

*will help create a self-sufficient space economy.*

The future of aerospace may include a space economy in which transactions are aerospace-centric and do not require as much intervention from Earth as previously. Aerospace economists foresee in the coming years the normalization of initiatives such as spacecraft refueling in space, either in orbit or on the moon. A further untethering of operations from Earth will see the availability of materials in space or on the moon. Similarly, the ability to 3D print or produce vital technology in space may act as a critical innovation in creating a self-sufficient space value chain.

## FILLING THE AERO-SKILLS GAP

*will be key to the next era of the aerospace Industry.*

Expect a surge in the diversity of skills required in aerospace as the variety of space services expands in the coming decades. Projects such as the NASA Artemis Moon Mission or the various Mars colony missions will require professions not traditionally associated with STEM. These include biological researchers, contract lawyers, political scientists, and financial analysts. A barrier that the aerospace industry may have to overcome is luring away top talent from more sought-after tech companies with greater cultural capital amongst millennials and Generation Z.



## SPACE R&D

*will serve as the laboratory for developing future solutions.*

With new players entering aerospace, various opportunities exist for experimentation in developing scientific solutions not possible on Earth. SpaceX's 2021 Dragon mission to the International Space Station conducted experiments such as Targeting Improved Cotton Through On-orbit Cultivation (TICTOC) to develop tougher cotton varieties and microgravity's effect on microbes in the development of on-the-spot ultrasounds. These experiments could have groundbreaking effects on manufacturing, biological research, and medicine. The SpaceX Dragon mission and others like it are harbingers of future R&D space projects that have the potential to influence and alter several non-aerospace sectors significantly.



## LOW EARTH ORBIT TECHNOLOGY

*will be disruptive and usher in new product offerings.*

The historically dominant Geostationary Orbit (GEO) is under commercial threat due to innovations in Low Earth Orbit (LEO) and Middle Earth Orbit (MEO) technologies. Expect a steady rise in the number of new players raising venture capital in the billions and whose unique launch system product offerings will drive down the cost of orbit systems, in general, and LEOs, in particular. As much as unanchoring from Earth will be part of the space economy in the next two decades, services such as direct-to-consumer broadband internet mean there are still lucrative opportunities tethering space to Earth-specific needs.



## SUSTAINABILITY IN AVIATION

*will need to be top of mind for the sector.*

Organizations in the aerospace and aviation sector are not exempt from ESG and sustainability imperatives. Commercial aviation is expected to account for around 20% of global greenhouse emissions by 2050. Commercial aviation bodies such as the International Air Transport Association (IATA) and International Civil Aviation Organization (ICAO) will need to proactively accelerate ESG regulations to mitigate the industry's greenhouse emissions contribution and avoid imposed "regulation fiats" from governments. Forced regulations may be particularly precarious amid depressed commercial flight numbers due to the COVID-19 pandemic.



## COOPERATIVE AEROSPACE GOVERNANCE

*will be key to a flourishing space economy.*

Aerospace initiatives have been historically influenced by nation-states vying for supremacy. While innovations in aerospace can be good for humanity, they can also be sources of geopolitical tensions. Even though space agreements such as the Outer Space Treaty exist, new cooperative, legally binding agreements will be needed to account for emerging issues in aerospace. Satellite launches and servicing and space traffic control are vital issues, with overcrowding in space being one of the most pertinent. For instance, avoiding the Kessler Effect—a phenomenon whereby satellite and debris collisions create a chain reaction of infrastructure damage—will be critical on the space treaty agenda.



*Use this context to help better understand the strategic importance and innovation opportunities associated with the game-changing technologies identified for the aerospace industry.*

# Game-Changing Technologies for Aerospace

## Technology Navigation

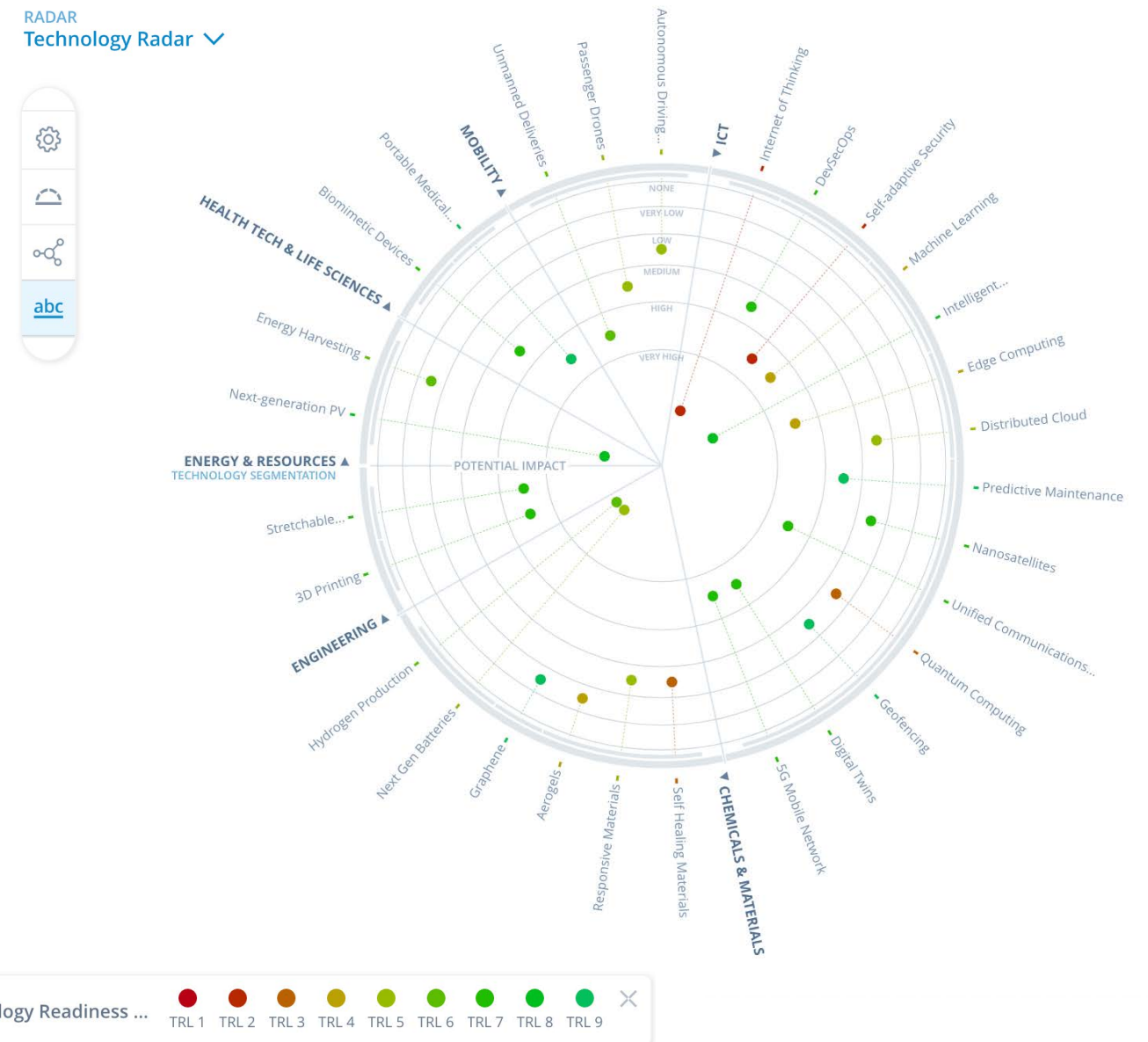
Through a process of qualitative and quantitative industry research, our team of analysts conducted relevance analysis in order to identify the Technologies within our portfolio that are **most relevant and influential in the aerospace industry**.

### Game-Changing Technologies for Aerospace

Explore the selection of Technologies at play in the aerospace industry. Click on the Technology below to view it in the ITONICS [Teaser Technology Radar](#):

- [3D Printing](#)
- [5G Mobile Network](#)
- [Aerogels\\*](#)
- [Autonomous Driving Technologies](#)
- [Biomimetic Devices\\*](#)
- [DevSecOps](#)
- [Digital Twins](#)
- [Distributed Cloud](#)
- [Edge Computing](#)
- [Energy Harvesting](#)
- [Geofencing](#)
- [Graphene](#)
- [Hydrogen Production](#)
- [Intelligent Manufacturing](#)
- [Internet of Thinking](#)
- [Machine Learning](#)
- [Nanosatellites\\*](#)
- [Next-gen Batteries](#)
- [Next-gen PV](#)
- [Passenger Drones\\*](#)
- [Portable Medical Devices](#)
- [Predictive Maintenance](#)
- [Quantum Computing](#)
- [Responsive Materials](#)
- [Self-healing Materials\\*](#)
- [Self-adaptive Security](#)
- [Stretchable Electronics](#)
- [Unified Communications Services](#)
- [Unmanned Deliveries](#)

\*These Technologies make up ITONICS' pick of the aerospace industry's top 5 game-changing Technologies. These are unpacked in further detail in this report.



### ITONICS Top 5 Game-Changing Technologies for Aerospace

**Click below** to read more about the industry potential of these Technologies and examples of how organizations are applying them as solutions:

1. [Aerogels](#)
2. [Biomimetic Devices](#)
3. [Nanosatellites](#)
4. [Passenger Drones](#)
5. [Self-healing Materials](#)

▼ CHEMICALS & MATERIALS  
SMART MATERIALS

# Aerogels

Aerogels are the most lightweight solid materials in existence. With extremely high stability and high-performance thermal insulation properties, they offer a wide variety of applications. The material holds the potential to reduce fire risk in electronic and battery devices and create extremely low-density structural materials. Moreover, metal aerogels could have significant application prospects in the field of energy storage. Aerogels can be created from several different components that enable other uses. Thus far, aerogels have mainly been used at scale due to high production costs. However, 3D printing has proven to address several challenges, which could open up new possibilities.



## Technology Ratings

### Scope



### Potential Impact



### Complexity

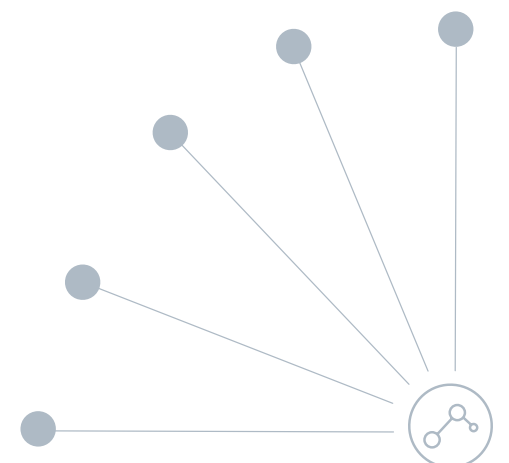


### Technology Readiness Level



## Related Trends

- [Green and Lean](#)
- [Smart Cities](#)
- [Space Race 2.0](#)





## Industry Relevance

### Future Aircraft Antennas

Scientists have discovered how to produce aerogel for use in flexible, lightweight antennas. This is an important development for future aircraft such as electric passenger or cargo-carrying drones. Versatile aerogel-based antennas can replace the heavy and sometimes bulky dish antenna systems that are typically used for communication via satellite, but which would prove ill-suited to smaller aircraft.

### Superinsulating & Ultrathin

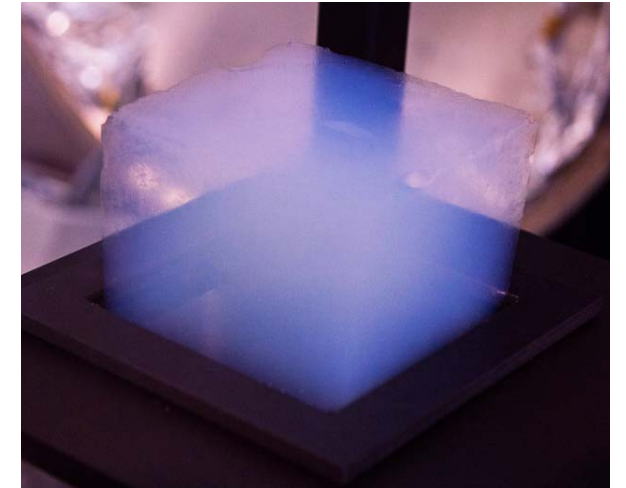
Advances in polymer aerogels make it possible to form ultrathin, flexible sheets that retain exceptional durability and insulating properties. These sheets are highly applicable for use in aerospace. For instance, astronaut suits made with aerogel sheets are capable of providing protection from extreme thermal conditions while also enabling more agile movement than traditional suits.

### Noise Reduction

Aerogel's lightweight and insulating properties also make it useful for noise reduction on aircraft. Engineers have successfully reduced the sound of a jet engine during takeoff from an average of 105 decibels down to just 16—the level of a hairdryer—using graphene oxide-polyvinyl alcohol aerogel which adds minimal extra weight. There are further gains to be made in enhancing the material's heat dissipation capabilities for greater safety and fuel efficiency.

The global aerogel market is projected to reach \$1.12 billion by 2026, growing at a CAGR of 11.14%.

Source: [Verified Market Research, 2022](#)



## How is it a Game Changer?

Aerogel manufacturing challenges are being overcome, and new patents and 3D printing will allow aerogels to be developed for mass-market applications. Other applications are increasingly being explored, and water and energy harvesting and storage issues will accelerate R&D. Aerogels are also being investigated for their uses in space travel and creating habitable environments on Mars. Creating a photosynthetic environment on the planet may be possible through the use of aerogels that could transmit sufficient light, block ultraviolet radiation, and raise temperatures.



## Inspiration

NASA has selected Boston-based manufacturer [Aerogel Technologies](#) to commercialize its polyimide aerogels which are 500 times stronger than traditional silica aerogels and provide ultralightweight insulation capabilities. Aerogel Technologies is working with Airbus to fit their airplane cabins with sound, thermal, and fire protection systems.

▼ HEALTH TECH & LIFE SCIENCES  
BIOTECHNOLOGY

# Biomimetic Devices

Biomimetic devices use biomimicry as inspiration to engineer devices whose functions imitate biological processes. These devices mimic biological efficiency and are engineered to overcome natural biology's limitations through nanotechnology, artificial intelligence, robotics, or sensors. Creating efficient biomimetic materials that display similar reaction times and specificity to their natural counterparts remains challenging in some instances. Using nature as a model, systems and design thinking are present at multiple stages in the development pipeline. This, in turn, benefits the medical, scientific, and engineering fields. Additionally, biomimetic developments also provide advanced solutions for agriculture, military, environmental, and commercial product design.



## Technology Ratings

### Scope



### Potential Impact



### Complexity



### Technology Readiness Level



## Related Trends

- [Alternative Energy Transition](#)
- [Automating a Greener World](#)
- [Biophilic Design](#)





## Industry Relevance

### Reducing Energy Consumption

The aerospace industry is looking to nature for more efficient methods of energy consumption. Technological and structural advancements have been made based on the morphology and movement of manta rays, humpback whales, and perhaps most notably, albatrosses—which uses their large wingspan and air currents to be one of the most energy-efficient animal travelers. The patterns of geese flying in a V-shaped formation have also been imitated to significantly reduce energy consumption without structural adaptations.

### Avian-inspired Wing Design

Biomimicry is applied for manufacturing efficient aerial vehicles with lightweight and shape optimization features. Inspired by owl and other bird feathers, these lightweight crafts enhance maneuverability, reduce drag, and suppress aerodynamic noise. Moreover, bio-inspired wings consume less energy compared to conventional wings. However, availability and precision remain challenges.

### 3D Printed Mechanical Efficiency

Scientists are developing novel biomimetic cell-like structures using 3D printing technology. These structures—modeled after the morphology of cuttlefish and, in at least one study, sea urchin—exhibit unique energy absorption capabilities and are ultra-resistant to compression. This allows engineers to develop new rigid yet flexible, lightweight materials for use in mechanically efficient aircraft.

“As the aviation industry faces the colossal challenge of how to make aviation more sustainable, nature is increasingly proving to have some invaluable insight on how to make aircraft lighter, faster, and more fuel-efficient.”

Source: Airbus, 2020



## How is it a Game Changer?

The imitation of natural processes will significantly advance regenerative medicine by creating technically useful applications. Many of these developments use nanomanufacturing technologies to develop “nano-biohybrids” like microstructured surfaces that can respond to external environments with augmented properties beyond their innate capabilities. Multi-functional surfaces and systems could accomplish multiple actions, and this will be a crucial area of focus for sustainable design and development. 3D and 4D printing developments in soft robotics will continue to create innovative solutions.



## Inspiration

Airbus has launched a project to flight test an **extra-performing wing**. As part of the company’s aim to decarbonize the aviation sector, the wing is inspired by the ability of eagles to alter the shape, span, and area of their wings. This ability allows eagles to optimize their aerodynamic performance continuously. Airbus’ extra-performing wing integrates technologies that enable active control, which, if realized, will increase flight efficiency and reduce carbon emissions.

# Nanosatellites

Nanosatellites are miniature satellites weighing between 1 and 10 kilograms. Despite their size, nanosatellites can perform most typical satellite functions. They have a shorter development cycle, fewer operational challenges, and can be launched at a fraction of the cost of conventional satellites, making them accessible even to small organizations. Nanosatellites are being used in remote sensing and communication systems, space exploration, earth observation, the Internet of Things (IoT), and low-latency communications. As there are strict restrictions on factors like propulsion, payload, and other considerations, nanosatellite applications in the execution of complex missions are currently limited.



## Technology Ratings

### Scope



### Potential Impact



### Complexity

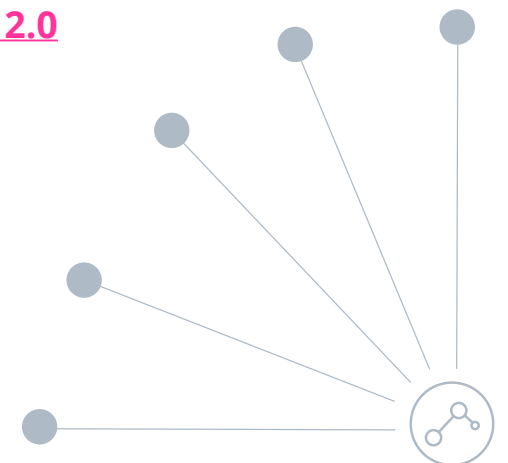


### Technology Readiness Level



## Related Trends

- [Data Ethics](#)
- [Digital Equality](#)
- [Prosperous Partnerships](#)
- [Space Race 2.0](#)





## Industry Relevance

### Bridging the Digital Divide

The deployment of nanosatellites can provide reliable internet access to remote and underserved locations. Due to their low mass and high capabilities, nanosatellites are a viable alternative to costly ICT infrastructure on the ground or conventional satellites. By delivering affordable telecommunications services and helping to bridge the digital divide, nanosatellites can create new economic opportunities and lasting social impact where there is the greatest need.

### Enhancing Space Observation

CubeSats, a form of nanosatellites, have broad scientific applications for space observation and interplanetary missions. When deployed as space-based telescopes, these miniature satellites augment astronomical research and enable experiments not possible with large, expensive space missions and telescopes. CubeSats can focus the scope and precision of research to close existing data gaps and provide a more holistic picture of astrophysics.

### Modular Design

A host of new opportunities have emerged with the advancement of CubeSats. Built with off-the-shelf components, CubeSats are significantly more cost-effective and accessible to smaller organizations and research and academic institutes. Their modular design speeds up the time to launch and allows for the combination of subsystems that perform different functions according to the needs of the mission. CubeSat constellations can therefore provide extremely comprehensive coverage.

As of 1 January 2022:

**1,802** nanosats launched

**102** nanosats destroyed on launch

**76** countries with nanosats

**2,500** nanosats forecast to launch in next 6 years



Source: Nanosats Database, 2022



## How is it a Game Changer?

Nanosatellites solve the cost and operational challenges of conventional satellites and shorten the launch time, making them more feasible for smaller organizations. Nanosatellite constellations enable developments in edge computing, weather forecasting, and internet-based communications. Developments in the field are focused on mitigating launch restrictions and ensuring that maintenance and upgrades performed in situ produce minimal space debris.



## Inspiration

A team of young Kazakh, Kyrgyz, and Uzbek women designed, developed, and launched three nanosatellites into the stratosphere to analyze air pollution. This launch, which took place on 27 March 2022, is a part of the **UniSat Program** that aims to encourage girls in science, technology, engineering, and mathematics (STEM) disciplines, equipping them with knowledge and competencies related to nanosatellite construction.

▼ **MOBILITY**  
AUTONOMOUS VEHICLE SYSTEMS

## Passenger Drones

Passenger drones are autonomous aerial vehicles that may offer an effective alternative mobility solution to congested land-based transportation methods. With advances in technologies like LiDAR, sensors, 5G, and AI and ML, passenger drones are taking flight. This technology could quickly emerge as the urban mobility solution of choice due to its ability to reduce travel time, avoid traffic congestion, and reduce noise pollution and emissions compared to traditional forms of land-based transport. However, safety and affordability concerns will determine adoption, and there is a need for lighter, more energy-dense battery technologies for electric passenger drones to become viable.



### Technology Ratings

#### Scope



#### Potential Impact



#### Complexity

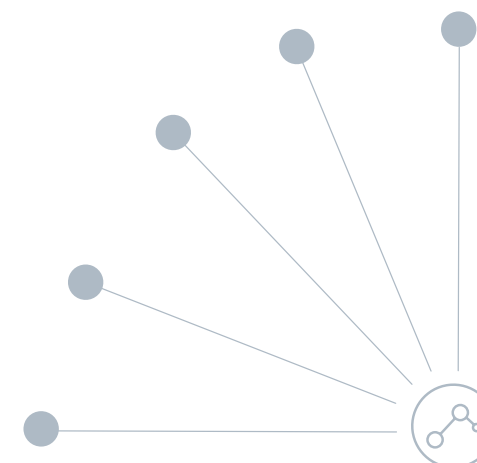


#### Technology Readiness Level



### Related Trends

- [Electromobility](#)
- [Road to Autonomy](#)
- [Smart Cities](#)



## Industry Relevance

### Urban Air Mobility

The urban air mobility market will see gradual adoption of drones as air taxis. These commercialized passenger drones can rapidly transport passengers throughout a city without contributing to traffic congestion or air and noise pollution. Passenger drones fitted with internal rotors are also safer than helicopters in dense urban areas. However, their rollout is currently limited by regulation and costly infrastructure like landing ports—or vertiports—which can be prohibitive for many cities.

### Emergency Rescue Operations

Passenger drones can be an effective medium for search and rescue operations for disaster emergencies or military purposes. These compact, autonomous crafts can serve as surveillance guides, helping to locate individuals and deliver assistance in difficult or dangerous conditions that are inaccessible to conventional helicopters or ground support. At the same time, they provide real-time imagery of a situation to help rescuers make better decisions and save crucial time.

### Supporting Net-Zero

Electric passenger drones will benefit from the development of new battery technologies being spearheaded by the automotive industry. As the energy and power density of next-generation batteries improves, electric propulsion systems on drones will be capable of greater range and speed. With increased capacity and sustainability, these electric crafts will support net-zero carbon emissions targets set by mobility providers and governments.

The global passenger drone market is projected to reach \$1.4 billion by 2026. While this is still a relatively small portion of the total UAV (unmanned aerial vehicle) market—projected to reach \$58.4 billion in the same period—passenger drones are expected to see a higher growth rate of 29.5% compared to 16.4% for all UAV.



Sources: [Market Watch, 2022](#); [Markets and Markets, 2021](#)



## How is it a Game Changer?

Passenger drones are steadily making their way toward commercialization, with the potential to disrupt the mobility sector and revolutionize the way we travel. Increased urbanization fuels this technology with possibilities like rapid rooftop-to-rooftop transportation. Once electric passenger drones become viable, these aircraft—both manned and unmanned—will provide a sustainable solution for smart cities of the future. Advancements in AI, ML, and battery technology, along with organizational collaboration, will further enhance drone capabilities, improve scalability, and reduce costs.



## Inspiration

UK startup [Urban-Air Port](#) joins forces with Hyundai to build 65 mini airports around the world. These airports are specially designed for the new generation of electric vertical take-off and landing (eVTOL) aircraft that will operate as taxis. According to the company, the lack of infrastructure needed to support eVTOLs has been a significant hindrance to its growth.

▼ CHEMICALS & MATERIALS  
SMART MATERIALS

# Self-healing Materials

Self-healing materials refer to synthetic or artificial substances that repair themselves without direct intervention from humans. They function almost like the human body, by automatically sensing failure or breakdown, halting or preventing the process from worsening, then repairing the damage as soon as possible. These materials support sustainability by prolonging the life of products and reducing the need for replacement and waste over time. Experts believe that industries such as aerospace, oil, gas, automotive, shipping, and construction will first see strong growth of self-healing products for surfaces and buildings that are exposed to heavy weathering.



## Technology Ratings

### Scope



### Potential Impact



### Complexity

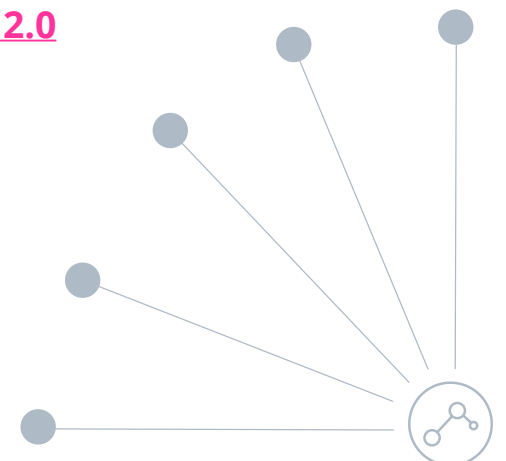


### Technology Readiness Level



## Related Trends

- [Biophilic Design](#)
- [Circular Economy](#)
- [Low Touch Living](#)
- [Space Race 2.0](#)





## Industry Relevance

### Self-sufficient Space Economy

Building a self-sufficient space economy will require in situ resource utilization (ISRU) and the infrastructure—energy, transportation, and communications systems and services—to execute ISRU. Self-healing materials will therefore play an important role in helping to maintain this infrastructure in space and at scale. Self-healing materials, together with other intelligent technologies like self-adaptive security, deep learning, and 3D printing, will pave the way for increasingly autonomous space operations.

### Aerospace's Outer Limits

The ability of self-healing materials to proactively detect and repair problems will allow the aerospace industry to reach new levels of potential. This technology will be essential in building spacecraft capable of deep space missions, during which microcracks, if left untreated, can grow and leave material critically weakened. In the commercial aviation sector, self-healing materials will also be important in realizing supersonic flight, which calls for enhanced structural integrity.

### Reducing Space Debris

Self-healing materials, capable of autonomously correcting defects or damage on satellites, rockets, and other spacecraft, will help keep equipment in operation for longer, reducing the amount of space debris entering orbit. Moreover, scientists are investigating self-destructing material that would enable a spacecraft to be eliminated once its lifetime is over, preventing both waste-dropping into seas and space debris.



The global self-healing materials market is projected to reach \$62.66 billion by 2028, exhibiting a notable CAGR of 62.5%.

Source: [Fortune Business Insights, 2021](#)



## How is it a Game Changer?

Premature product and infrastructure corrosion and high repair and replacement costs will drive the development of self-healing technologies. These technologies hold significant potential to aid efforts to combat sustainability issues, and biotechnologies, AI, and machine learning will increase the potential and usefulness of these technologies. Materials that can extract the necessary propellant to self-repair from their immediate environment are being explored, and these “animate materials” may pave the way for additional environmental benefits.



## Inspiration

Researchers at the University of Alabama are exploring [self-repair mechanisms](#) for materials that are often used in the aerospace industry. Their solution includes sensors that predict, detect, and evaluate structural issues, activating heat-induced repair as needed and without human intervention. Their work has garnered attention from NASA due to its potential for improving the durability of spacecraft materials.

# Conclusion

## Closing Remarks

The future of the aerospace industry will hinge, in part, on the ability to establish a self-sufficient space economy. Variables such as addressing a skills gap, diplomatic collaboration, and harnessing nascent startup resources to build space infrastructure will be key to this endeavor.

Private companies will continue to enter aerospace, not only capitalizing on opportunities but also creating new ones through novel partnerships and cutting-edge technologies. As more players enter the industry, technologies that reduce costs and increase accessibility, such as **Nanosatellites**, will be vital to initiating and diversifying various space activities.

For the next era of the space economy to be fully realized, sustainability and self-sufficiency will be key priorities. Solution drivers such as **Self-healing Materials** can address both of these needs by providing in situ resource utilization (ISRU) and helping develop dynamic infrastructure that requires little-to-no intervention from Earth. Used in conjunction with other technologies such as **Aerogels**, these technologies will be critical to ushering in resilient, autonomous space operations.

The impact of aerospace R&D is considerable due to the potential for addressing current and future needs of the planet. **Passenger Drones** are one such solution for urban air mobility that also helps advance technologies like LiDAR, sensors, 5G, and AI and ML. These foundational technologies, together with new approaches such as **Biomimetic Devices** that mirror nature will play an essential role in spotting new opportunities for innovation in this new frontier.

Within this context of change, we provide a set of questions for organizations in aerospace to consider in the hope of nurturing fresh thinking about the future they wish to be a part of and play an active role in helping to create.

- What if the end of the nation-based 'Space Race' leads to a flourishing space economy?
- What if new companies start providing the needed in situ resource utilization (ISRU) infrastructure to create a self-sufficient space economy?
- What if technological innovations are spurred by increased collaboration between space agencies and tech unicorns providing aerospace-specific products?
- What if the aviation sector fails to increase its sustainability profile and is subjected to harsher government regulations?
- What if the aerospace industry becomes an attractive destination for a variety of professionals to usher in the next era of the space economy?
- What if Low Earth Orbit technology creates much-needed services on Earth?

There are countless questions to be asked about what the future holds for aerospace. Finding possible answers to these questions requires a systematic approach and a structured innovation strategy.

## The Way Forward

*Create a future competitive advantage tomorrow by defining your strategic direction today.*

Making better decisions for tomorrow relies on an organization's ability to collect, understand, and act on innovation intelligence—the multitude of building blocks that make up an organization's innovation process.

Scouting the trends, technologies, startups, and other forces of change that are shaping your industry is a crucial first step in this process. But turning this information into innovation intelligence, and subsequently into action, requires additional steps and capabilities that fall within Foresight and Strategy.

## Taking Trends & Technologies to Opportunities



1. Discover ITONICS Trends



2. Build Internal Consensus



3. Develop Pictures of the Future

### 1. Discover ITONICS Trends

Supplement the insights gained in this industry-relevant technology report with an immersion into the trend landscape.

Get started by exploring the ITONICS [Teaser Trend Radar](#) displaying the elements that are most relevant to your industry.

For a full view of the trend landscape, our [Where to Play 2021+ Trend Report](#) contains the complete ITONICS Trend portfolio, presenting 90+ Trends with real-life inspirations and rich analysis.



**DOWNLOAD NOW**

## 2. Build Internal Consensus

In establishing **Where to Play**, it is essential to gain consensus and raise alignment within your organization. This can be achieved through a process of collaborative evaluation. Invite internal stakeholders and experts to participate in rating elements—trends, technologies, scenarios, opportunities, etc.—based on unique industry- and company-specific parameters.

When undertaken in the environmental scanning stage, an internal rating exercise helps empower teams with the consensus needed to ensure strategic relevance, strengthen buy-in, and act decisively.

**ITONICS has provided the following internal rating criteria for organizations to consider for trends and technologies:**

### Technologies

- Technology Attractiveness: How high is the potential value of the technology?
- Internal Know-How: How much internal know-how does your business possess with regard to this element?
- Need for Action: How important is it that your organization take action with regard to this element?

### Trends

- Business Relevance: How relevant is this element to your business?
- Strategic Fit: How well does this element fit into your organization's overall strategy?
- Need for Action: How important is it that your organization take action with regard to this element?

The ratings above are pre-set in the ITONICS Showroom. However, organizations can tailor rating criteria to align with their own set of needs and workflows.

## 3. Develop Pictures of the Future

It's not enough to identify the trends, technologies, disruptive startups, and other drivers of change that are relevant to your industry and organization. To develop an innovation strategy that remains effective beyond the time horizon of key drivers, organizations need to develop realistic and plausible pictures of the future in which these various drivers will unfold. This is done through a process of **scenario planning** and is the basis for discovering future opportunities upon which to act.

Scenario planning is a strategic tool commonly used by key decision-makers, innovation leads, and strategists to find focused foresight, grounded in dependable analysis. This equips them to anticipate exposures appropriately, evaluate innovation opportunities, and inform proactive responses.

### What is a scenario?

In the context of business planning and strategy, a scenario is a postulated sequence or combination of events projected to take place that could hold relevance to an organization's future state.

Developing plausible, actionable scenarios requires a systematic approach and organizational participation. It builds on the internal rating exercise, which serves to identify those trends and technologies that hold the greatest strategic relevance and potential. From here, your organization must derive the underlying drivers that are influencing its business environment and extrapolate the different trajectories each driver could take.

Plotting these trajectories against one another and engaging your team's collective and creative input reveals multiple scenario narratives. While each narrative represents a possible future for which your organization may need to prepare, internal consistency and strategic objectives point to those scenarios that should be prioritized.

Your team should prioritize the scenarios they feel hold the most strategic relevance by asking the following two questions:

- Is this a future we hope to play an integral role in creating and shaping?
- Is this a future we hope to mitigate and avoid through thoughtful tactics?

The selected scenarios form a foundational springboard from which your organization can best derive and define clear opportunities—i.e., possible solutions or responses to the various scenario narratives. Use the **ITONICS Roadmap** to plot critical scenario events and develop a timeline of innovation activities required to explore the various opportunities ahead of the horizon in which they are set to occur.

In this way, scenario planning provides organizations with the information required to act on opportunities timeously—as well as the evidence needed to develop appropriate capabilities and assets, actively shape our world, and influence outcomes as they steer towards the future.

To further your innovation journey, all the Trends, Technologies, and Inspirations selected as most relevant to aerospace can be found on the ITONICS Innovation Platform using the saved filter: [Aerospace](#).

The ITONICS solution supports end2end innovation management, from environmental scanning and trend and technology management to building internal consensus and roadmapping.

**REGISTER**



## About ITONICS

### We build AI-powered SaaS to innovate, grow, and disrupt.

Our data-driven software platform helps organizations around the globe to identify emerging technologies, trends, and market potentials and translate them into powerful growth strategies.

Supported by artificial intelligence, companies can manage their entire innovation process in a modular software suite to efficiently achieve their business goals and remain future-proof.

Working with global teams to innovate new products, services, and business models, ITONICS professional services inspire, guide, and accompany organizations on their innovation journey. With more than 115 experts on four continents, we support innovation leaders such as adidas, AUDI, CISCO, Intel, Johnson & Johnson, and SAP.

*As a strategic partner to key market players across all industries, we systematically advance the topics of innovation, strategy, and digitalization.*



*As a strategic partner to key market players across all industries, we systematically advance the topics of innovation, strategy, and digitization.*

# What's Next

## Turn Innovation Intelligence into Action

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| <p><b>Your digital toolbox for game-changing innovation</b></p> <ul style="list-style-type: none"><li>▪ Industry-specific Trend and Emerging Technology Radars</li><li>▪ Strategic Roadmaps that guide you into the future</li><li>▪ Lean Portfolios to manage ideas, technologies, projects, and opportunities</li></ul> | <p><b>Free access to inspiring insights &amp; content updates</b></p> <ul style="list-style-type: none"><li>▪ Access to 6 million+ signals to uncover insights at large scale</li><li>▪ 90+ Trends, 85+ Emerging Technologies updated annually</li><li>▪ 7,000+ freshly curated inspirations maintained</li></ul> | <p><b>Dependable thought leadership &amp; advisory services</b></p> <ul style="list-style-type: none"><li>▪ Free innovation maturity assessment</li><li>▪ Exclusive access to COFIM Masterclass content</li><li>▪ Access to our international innovation community</li></ul> |
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**EMPOWER EVERYBODY TO INNOVATE**



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