AMESC
AFRICA & MIDDLE EAST
SPACE CONFERENCE

AMESC 2025 CONFERENCE REPORT

Africa Middle East Space Conference

February 5-8, 2025 - University Mohammed VI Polytechnic, Rabat - Morocco

Published by
Moroccan Initiative for Space Industry

AMESC 2025 COMPREHENSIVE CONFERENCE REPORT

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Executive Summary

The Africa Middle East Space Conference (AMESC) 2025 brought together global space leaders, industry experts, academics, and policymakers over four intensive days focused on advancing space capabilities in Africa and the Middle East. Taking place at University Mohammed VI Polytechnic in Morocco, the conference demonstrated the region's growing ambitions and capabilities in the global space ecosystem.

The conference was structured around four thematic days:

- **Day 1: Partnerships & Vision** - Exploring international cooperation models and strategic frameworks
- **Day 2: Progress and New Opportunities** - Leveraging existing capabilities for space development
- **Day 3: Space Education, Capacity Building and Future Initiatives** - Building human capital and educational foundations
- **Day 4: Moving Forward: Innovation, Sustainability and Future Opportunities** - Focusing on emerging technologies and sustainable approaches

Key themes that emerged across the conference included:

1. **The critical importance of international collaboration** while balancing national sovereignty and strategic interests
2. **Human capital development** as the foundation for sustainable space capabilities
3. **Leveraging regional advantages** rather than attempting to replicate entire space programs
4. **The evolution from Low Earth Orbit activities to cislunar development**
5. **The application of space technologies to address pressing terrestrial challenges** in Africa and the Middle East
6. **The growing role of the private sector** in both space operations and educational initiatives
7. **The need for appropriate governance frameworks** spanning from national policies to international agreements
8. **Legal and regulatory framework development** to enable responsible space activities
9. **Strategic technology transfer** as a pathway to maximize socio-economic benefits from space investments

This report consolidates insights from all conference sessions, identifying cross-cutting themes, challenges, and strategic recommendations for different stakeholders. It serves as a roadmap for advancing space capabilities in Africa and the Middle East through collaborative, sustainable approaches that balance ambitious vision with practical implementation.

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Day 1: Partnerships & Vision

The first day of AMESC 2025 focused on "Partnerships & Vision," establishing a collaborative framework for space exploration and development. Beginning with a powerful opening ceremony, the day featured distinguished sessions with international space agencies, military leadership, astronauts, private companies, and emerging space nations, all emphasizing cooperation as the foundation for advancing humanity's presence in space.

Opening Ceremony

Speakers: H.E. Ryad Mezzour (Minister of Industry and Trade, Morocco), H.E. Salim Al Malik (Islamic World Educational, Scientific and Cultural Organization - ICESCO), Mrs. Aimee Cutrona (U.S. Embassy), Mr. Hicham Cherkaoui (University Mohammed VI Polytechnic - UM6P), Mrs. Fatima-Azzahra Driouach (Aerospace Moroccan Cluster - AMC), Mr. Naoufal Souitat (Moroccan Initiative for Space Industry - MISI), Mr. Zakaria Moudden (Royal Center for Space Studies and Research - CRERS), Mr. Aimad Ed Dermoun (Allianz), Mr. Mohssine Semmar (Moroccan Equipment and Development Company - MEDZ)

The opening ceremony highlighted Morocco's ambition to position itself as a regional leader in space, building on its success in the automotive and aeronautics sectors. Speakers emphasized the importance of youth empowerment, international cooperation, and infrastructure development to support sustainable space capabilities.

> *"When we started 10 years ago, they told us we couldn't build cars. Today we are the leading exporter of combustion vehicles to Europe. They tell us space is too far, too complex, not for us Africans, not for the Middle East. They say we don't have what it takes. This is wrong. One of you, one of your generation will be a man or woman from Africa and the Middle East in space very soon." — H.E. Ryad Mezzour, Minister of Industry and Trade, Morocco*

> *"Africa and Middle East are home to immense potential in space research and innovation. And this conference stands as a testament to our collective determination to harness this potential for the benefits of our nations and beyond." — H.E. Salim Al Malik, Director General, ICESCO*

The ceremony outlined several critical infrastructure elements being developed to support the space sector, including educational and research facilities at UM6P, industrial zones created by MEDZ, financial and insurance support from Allianz Morocco, and technical centers like the Royal Center for Remote Sensing (CRTS) and Royal Center for Space Studies and Research (CRERS).

International Cooperation and Sustainability of Space Activities

Panel Discussion with: Maria-Gabriella Sarah (European Space Agency - ESA), H.E. Tidiane Ouattara (African Space Agency), Hamza Hameed (Access Partnership), Vugar Bayramov (Azercosmos)

This panel explored how space activities must address local needs and priorities to gain political support. Speakers emphasized the importance of regional coordination, translating Earth observation data into actionable intelligence for policymakers, and developing sustainable financing models.

> *"Earth observation will not solve your problem. It will not help you achieve less poverty on Earth and better well-being and health for everyone on Earth. But it gives you… a diagnosis." — Maria-Gabriella Sarah (ESA)*

> *"The science is nothing if it is not addressing the citizens' needs." — H.E. Tidiane Ouattara (African Space Agency)*

The panel offered diverse regional perspectives. Vugar Bayramov shared Azerbaijan's methodical approach to establishing its space industry, beginning with a 2008 presidential decree and progressing to launching three satellites between 2013-2018. H.E. Tidiane Ouattara emphasized how space programs must be driven by African priorities rather than external agendas, noting that "Africa needs champions who understand both the technical and political dimensions of space." Hamza Hameed highlighted the importance of regulatory frameworks that enable rather than restrict innovation, presenting Access Partnership's work in helping emerging nations navigate complex policy landscapes. Maria-Gabriella Sarah shared ESA's catalog of over 900 space-based projects supporting SDGs and emphasized the complementary roles of public institutions and private sector innovation.

Key challenges identified included translating space data into policy action, human capital development and retention, balancing regional coordination with national priorities, and implementing Sustainable Development Goals (SDGs) through space applications.

The panel reached consensus on the critical importance of translating space capabilities into solutions for local challenges, the need for capacity building at all levels, the value of international cooperation while respecting national priorities, and the recognition that space is a tool for development rather than an end in itself.

Africa's Space Future - Strengthening National and Regional Programs

Speaker: H.E. Tidiane Ouattara, President of the Council of the African Space Agency

This keynote presented the African Space Agency's role as an organ of the African Union representing all 55 member states and guided by the Agenda 2063. Ouattara emphasized the need for a holistic approach to space programs encompassing governance, policy, law, science/technology, and investment.

> *"The 55 members of the African Union are members of the African Space Agency. And the seed money of the African Space Agency is coming from the contributions from the member state. Therefore, you can understand that we are guided by the priorities of the African Union."*

> *"The human capital is critical. This is where Africa will make a difference. Why? We do have 60% of young people, other continents, the birth rate is decreasing. We have to train our people not only to address our own problems, but also to be able to support others as labor without leaving the continent."*

Ouattara categorized African countries into three groups: pioneers (Egypt, Morocco, Nigeria, South Africa), newcomers (Ethiopia, Rwanda, Gabon, Ghana, Senegal, Kenya), and consumers of space products/services. He emphasized how space technologies can address critical African challenges including coastal erosion, natural resource management, cadastral mapping, and security.

Meeting an Astronaut

Speaker: Astronaut Dorothy Metcalf-Lindenburger, National Aeronautics and Space Administration (NASA)

Metcalf-Lindenburger shared her personal journey from classroom teacher to NASA astronaut, emphasizing the importance of role models like Sally Ride. She highlighted the remarkable achievement of international cooperation embodied by the International Space Station (ISS), which has hosted 279 astronauts from 22 countries over its 25-year history and facilitated over 4,000 scientific experiments.

> *"The little girl who dreamed about space because it looked possible, finally, because I saw a woman from the United States traveling and the little girl who also built the model of Discovery, well, I flew on Discovery almost 20 years to the day after attending that Space Camp."*

> *"Today's children only are living in a time when we've always had people working peacefully in space."*

She provided specific details about the ISS, which orbits approximately 380 km above Earth and has been continuously crewed since November 2, 2000. The first modules were launched in late 1998, and the station now serves as a multinational laboratory involving five partner agencies: NASA, Roscosmos, ESA, JAXA, and CSA.

Metcalf-Lindenburger highlighted scientific investigations conducted on the ISS, including immunity studies, optical fiber production, plant growth experiments, and research on muscle loss in microgravity. She also discussed the health challenges of space travel and the transition from ISS operations to future lunar missions under the Artemis program.

Global Space Leaders - Unity Beyond Borders

Panel Discussion with: Dorothy Metcalf-Lindenburger (NASA), Dr. Rodrigo Leonardi (Brazilian Space Agency), Colonel Galen Ojala (U.S. Space Forces Europe-Africa), Major General Pascal Legai (European Space Agency - ESA), Hugo Costa (Portuguese Space Agency)

This panel explored how the Artemis Accords provide a framework for international cooperation in lunar exploration, drawing parallels to how aviation standards enabled global air travel. Panelists discussed the complex balance between cooperation and competition in space activities, the importance of interoperability standards, and opportunities for emerging nations to contribute.

> *"One of the more important aspects of doing anything is being able to bring together multiple countries. But that takes standards… The Artemis Accords helps bring together countries of how do we address going to the moon." — Colonel Galen Ojala (U.S. Space Forces Europe-Africa)*

> *"When we signed the Accords, we had no previous experience in space exploration whatsoever. The priority of our space program has been historically Earth observation. But then as a space agency… we saw it as an opportunity to engage in space exploration, to open a new chapter." — Dr. Rodrigo Leonardi (Brazilian Space Agency)*

The panel offered diverse perspectives on international space collaboration. Colonel Galen Ojala emphasized how the Artemis Accords provide essential standardization: "One of the more important aspects of doing anything is being able to bring together multiple countries. But that takes standards." Dr. Rodrigo Leonardi described Brazil's strategic decision to join the Accords despite having no previous space exploration experience, seeing it as "an opportunity to engage in space exploration, to open a new chapter."

Dorothy Metcalf-Lindenburger shared insights from her experience aboard the International Space Station, highlighting how multinational crews demonstrate peaceful cooperation during geopolitical tensions. Hugo Costa emphasized Portugal's approach as a smaller space nation, noting "we must identify strategic niches where we can make meaningful contributions."

Major General Pascal Legai outlined ESA's extensive activities, noting their 23 Member States, 7.79 billion euro budget, and management of over 120 unique missions. He highlighted ESA's "Terrae Novae" exploration roadmap and their role as NASA's primary partner in the Artemis program, providing the European Service Module for Orion and key Gateway lunar station elements.

The panel identified key challenges including balancing cooperation and national interests, developing appropriate governance frameworks, establishing technical standards, and ensuring inclusive participation from emerging space nations. They reached consensus on the essential nature of international standards, the

importance of each nation identifying strategic niches, and the complementary roles of cooperation and competition.

Advancing Morocco's Space Capabilities: The Role of CRTS and CRERS

Speaker: Dr. Zakaria Moudden, Director, Royal Center for Space Studies and Research (CRERS)

Dr. Moudden presented Morocco's space strategy and the roles of two key institutions: the Royal Center for Remote Sensing (CRTS) established in 1989 and the Royal Center for Space Studies and Research (CRERS) established in 2004, highlighting their complementary missions in downstream applications and upstream technologies.

Morocco's space strategy focuses on four pillars: downstream space applications, upstream infrastructures, capacity building, and private sector development. CRTS focuses on downstream applications including water resources, forest management, urban planning, agriculture, coastal management, and oceanography, while CRERS focuses on upstream technologies including satellite development, research, and capacity building.

Morocco has successfully launched five satellites between 2001 and 2024. CRERS has developed significant infrastructure including facilities for vibration tests, thermal vacuum chambers, and PCB development. Both centers maintain extensive cooperation networks with national and foreign universities, research centers, and international space agencies.

The presentation demonstrated Morocco's methodical approach to developing space capabilities, beginning with applications (downstream) through CRTS and progressively building upstream technological capacity through CRERS.

Legal Frontiers: UNOOSA's Space Law Technical Advisory Mission for Morocco

Speaker: Dr. El Bachir Zantou, Royal Center for Space Studies and Research (CRERS)

Dr. Zantou presented on the importance of legal frameworks for space activities, highlighting Morocco's unique position as the only African country to have ratified

all five UN space treaties and UNOOSA's Technical Advisory Mission (TAM) to support Morocco in developing its national space law.

Space is becoming increasingly crowded, making legal frameworks essential for responsible behavior, space traffic management, and sustainability. UNOOSA established the "Space Law for New Space Actors" project in 2019 to assist emerging space nations, with Technical Advisory Missions providing tailored legal advisory services.

> *"We need to have a shared understanding among all stakeholders to preserve space as the common heritage of humanity, in line with the principles of the Outer Space Treaty."*

Morocco has ratified all five UN space treaties (the only nation in Africa to do so) and has been a COPUOS member since 1961. National Space Law is critical to implement international obligations, provide regulatory frameworks for private sector activities, and foster international cooperation.

Dr. Zantou identified several factors hindering African countries from developing national space laws, including limited private sector involvement, absence of dedicated space agencies, competing priorities for limited resources, limited technical and legal expertise, and lack of political will.

African Space Policy and Legal Frameworks

Panel Discussion with: Dr. Mohamed Said Riffi Tamsamani (CRTS), Dr. Matthias Creydt (CREYDT.LAW), Mr. Tomas Matraia (The Adwisers), Dr. Sherif Sedky (EgSA), H.E Tidiane Ouattara (African Space Agency)

This panel explored the critical role of appropriate policy and legal frameworks for space activities in Africa, with diverse perspectives on the challenges facing emerging space nations.

Dr. Mohamed Said Riffi Tamsamani highlighted Morocco's experience developing a comprehensive space policy that balances national sovereignty with international collaboration, noting that "effective space governance requires coordination across multiple government agencies." He emphasized that Earth observation applications

drove Morocco's initial policy development before expanding to broader space activities.

Dr. Sherif Sedky shared Egypt's approach to creating an enabling environment for private sector space activities through EgSA, describing their recent space law as "designed to balance security concerns with commercial opportunity." He emphasized the importance of harmonized regional frameworks across Africa.

H.E. Tidiane Ouattara presented the African Space Agency's role in supporting policy development across member states, noting that "we don't need 55 identical space laws, but rather complementary frameworks that leverage each nation's strengths."

Dr. Matthias Creydt provided focused insights on export control challenges, emphasizing that space technologies are "highly sensitive with risk of misuse" and outlining why NewSpace companies must develop compliance strategies early. The panel agreed on the importance of establishing appropriate legal frameworks at the beginning of space program development.

The Transformative Power of Space Technology Transfer

Speaker: Constance Bourouh, International Project Manager, EurA AG

Constance Bourouh presented on the critical role of technology transfer in accelerating socio-economic development across Africa and the Middle East, focusing on how space technologies can be adapted to solve terrestrial challenges through horizontal technology transfer.

EurA AG serves as an innovation partner with 25+ years of experience, supporting over 3,000 industry customers. The company specializes in horizontal technology transfer, which applies space technologies across various non-space industries, creating new solutions for terrestrial problems.

> *"When you apply space technology across various industries, you create solutions that address critical challenges on Earth while maximizing the return on space investments."*

The technology transfer approach involves needs evaluation, collection and offering of solutions, search, mediation, and support in technology management. Bourouh presented case studies demonstrating successful space technology transfer, including plasma technology adapted for water purification systems and wound healing, and satellite data analysis techniques applied to agricultural supply chain monitoring.

Bourouh's presentation highlighted how technology transfer creates multiple benefits: maximizing the return on space investments, solving pressing terrestrial problems, and developing new economic opportunities.

ispace's Blueprint for a Thriving Cislunar Economy

Speaker: Antonio Stark, Global Alliance Lead, ispace Inc.

Stark presented ispace's vision as a Japanese company providing lunar transportation services through entities in Japan, the United States, and Luxembourg. He discussed their lunar missions, including the recent M1 mission that completed 8 of 10 milestones but experienced a "hard landing," and the M2 mission launched in January 2025 carrying payloads including a rover, water electrolysis experiment, and radiation probe.

> *"We are here as silver sponsors because we really care about the African economy. We really do believe, as some of the previous speakers mentioned, that Africa and the Middle East has a very big vested interest in participating in the lunar economy."*

> *"The lunar economy is vast. You do not have to have your own rocket or lander to go to the moon. As long as you have an idea, even if it's a software analysis, imagery analysis, you can still come to the moon with us and identify your own value addition to the lunar economy."*

Stark emphasized ispace's international collaboration approach, highlighting MOUs with multiple countries including India, Uzbekistan, Thailand, South Korea, UK, and Brazil, and their development of both International Traffic in Arms Regulations (ITAR)-compliant and ITAR-free landers to serve different market segments.

Beyond Earth - Human Spaceflight and the Cislunar Economy

Panel Discussion with: Dorothy Metcalf-Lindenburger (NASA), Antonio Stark (ispace), Veronica La Regina (Inter-American Development Bank)

This panel explored opportunities in both Low Earth Orbit (LEO) and cislunar space, discussing the proven model of international cooperation established by the ISS alongside its limitations for commercial production. Panelists emphasized the democratization of space access enabling more countries to participate, with costs shifting to more predictable pricing models.

> *"Recently, through the Interamerica Development Bank, I'm supporting government of Colombia in establishing their national space agency. And when I joined this team... they told me 'Look, now we can do. Because we started 10 years ago, it was almost prohibitive to join the space arena... Nowadays we can keep shorter because it changed the way to do space. It's definitely more affordable.'" — Veronica La Regina (Inter-American Development Bank)*

The panel identified challenges including technical requirements for commercial space manufacturing, expanding access beyond traditional space powers, balancing human presence and automation, and creating sustainable business models. They reached consensus on space becoming more accessible, the complementary roles of human presence and autonomous systems, the need for specialized platforms beyond the ISS for commercial applications, and the significant opportunities for non-traditional space nations to participate.

Day 2: Progress and New Opportunities

Day 2 focused on "Progress and New Opportunities," exploring how to leverage existing capabilities and experiences to advance space development. The sessions examined Morocco's aerospace industry evolution, scientific research on the International Space Station, and space medicine applications.

Morocco's Aerospace Evolution - Building a Bridge to Space Industry

Panel Discussion with: Fatima-Azzahra Driouach (Aerospace Moroccan Cluster - AMC), Salim Rabbani (Eolat Morocco), Zuhair Mohammed El Oufir (Flying Tech), Badr Idrisi (Atlan Space), Bruno Igunenk (Experis Conseil)

This panel highlighted Morocco's two-decade journey in developing its aerospace industry and how this experience provides a blueprint for building a space sector. Speakers emphasized Morocco's remarkable growth to 150+ aerospace companies generating $2 billion in exports with a 42% local integration rate, enabled by strategic geographic location, political stability, extensive free trade agreements, modern infrastructure, a young workforce, competitive energy costs, and a diversified industrial ecosystem.

> *"Today no flight in the world flies without a part being made in Morocco, a part of Africa in it. And we are really proud about it." — Fatima-Azzahra Driouach*

> *"In Morocco or Africa, we don't build technology to build technology. We build it because it's the only way to do it." — Badr Idrisi*

Panelists identified challenges including the need for a clear space vision, financial constraints with space requiring longer-term investments, capability gaps in moving from "know-what" to "know-how," and the need for appropriate regulatory frameworks. They proposed a three-phase implementation approach: establishing strategic foundations (1-2 years), developing capabilities (3-5 years), and integrating value chains (5-10 years).

Earth's Space Links: The Art of Ground Segment Engineering

Speaker: Radim Badsi, CEO, Groundspace

Badsi presented on the growing challenges of radio spectrum management in the era of satellite mega-constellations. He highlighted how communications satellites share limited radio spectrum, with atmospheric opacity restricting the wavelengths available for space communications.

> *"More satellites have been launched in the past five years than in the previous fifty years."*

> *"Radio interference reduces the quality of service and creates business issues, while satellite networks have become a key strategic resource."*

Badsi explained how satellite communications have become essential for internet access in remote areas, rescue operations during natural disasters, and the global banking system, making any disruption potentially serious. He identified several types of interference affecting satellite operations and explained why traditional monitoring technologies using parabolic antennas are ineffective for monitoring today's complex satellite environment.

Groundspace has developed "Muskrat," the first radio monitoring system for LEO/MEO satellite constellations capable of monitoring the entire sky. The system uses electronically steerable antennas and proprietary signal analysis algorithms

to detect hostile transmissions, identify interferences between satellite networks, and locate sources of jamming.

The presentation highlighted how radio spectrum management has become a critical security and economic issue as space becomes increasingly congested, requiring sophisticated monitoring technologies to ensure reliable communications.

Navigating the Microgravity Lab - Conducting Experiments Aboard the ISS

Panel Discussion with: Najib Al Mokhtari (Moderator), Dorothy Metcalf-Lindenburger (NASA), Ted Tagami (Magnitude.io)

This session explored the scientific and educational dimensions of microgravity research aboard the International Space Station (ISS). Speakers discussed how the absence of gravity-driven convection allows fundamental properties to be studied that are masked on Earth, and how programs like ExoLab connect students worldwide with space research.

> *"Looking out into the deepness of space, it was very humbling… when you look back at Earth, you're like, but I really matter there. That's what I care about, that's who I care about, and that's where I'm tied to." — Dorothy Metcalf-Lindenburger*

> *"The gap between being inspired about space and actually having the opportunity with space was more than 40 years… We're powered by curiosity. Because I feel that in a way you stop living if you lose that flame, that fire." — Ted Tagami*

The panel identified educational challenges including accessibility barriers, engaging students effectively, knowledge transfer between research and education, and technology integration. They outlined a multi-level approach to

space education spanning from primary education (focusing on wonder and curiosity) through university level (enabling research-level participation in experiments).

Space for Earth - A New Frontier for Exploring Human Health

Speaker: Fay Ghani, Medical Scientist, Mayo Clinic

Dr. Ghani presented on the emerging field of space medicine and its potential to transform healthcare both in space and on Earth. She highlighted NASA's identification of five primary space health hazards: space radiation, altered gravity, isolation and confinement, closed environments, and distance from Earth.

> *"When I look at this image [of Earth from space], I think, first of all, how did humans go to the Moon? Physiologically, we know that space is a very hostile environment... And looking back at this photo, looking at Earth, it makes you realize that the advancements we make in space, whether it's technology, medicine, science, medical research advancements, we need to bring those advancements back to our home planet, Earth."*

> *"Astronauts lose 1% of bone mineral density every month they spend on the ISS. So it is an environment of accelerated aging."*

Ghani discussed current research including Mayo Clinic's work sending bone-forming stem cells to the ISS, addressing challenges like physiological knowledge gaps (particularly for women and diverse populations), translational research barriers in moving from space discoveries to Earth applications, autonomous healthcare capabilities for deep space missions, and resource optimization in space environments.

The Chinese Space Program: A Role Model for Space Emerging Nations

Speaker: Dr. Farid Gamgami, Vice Director of Key Laboratory for Satellite Digitization Technology, Chinese Academy of Sciences

Dr. Gamgami presented China's space program as a potential model for emerging space nations, highlighting its development from humble beginnings to a world leader. He emphasized how China's early space pioneers accomplished remarkable achievements despite severe economic limitations.

> *"In 1960, China launched its first suborbital rocket T-7M without Soviet support, using hand-cranked computers, a fuel tank pressurized using a bicycle pump, while working in hunger as China was in the midst of the Great Famine."*

> *"Next to the USA, China has the most dynamic and creative economy."*

Gamgami highlighted the contributions of China's "Four Elders of Aerospace" – Qian Xuesen, Ren Xinmin, Huang Weilu, and Tu Shou'e – all Western-educated scientists who returned to China to develop its space program. He particularly emphasized Qian Xuesen's story, a co-founder of NASA's Jet Propulsion Laboratory who returned to China in 1955 and led its space and ballistic missile programs.

The presentation provided critical context for China's space development: when China launched its first satellite in 1970, its GDP per capita was just $113, compared to the US at $5,234. This demonstrated how determination and strategic focus can overcome economic limitations.

Gamgami discussed the psychological importance of sustainable high-tech development, noting four key factors: motivation, hope, confidence, and vision. He emphasized that "rocket science has the greatest psychological effect" on national confidence and that the scale of initial achievements is less important than them being true indigenous achievements.

From Opportunities to Ventures: Business and Entrepreneurship in Space

Panel Discussion with: Josué Barao (TEKEVER), Davis Cook (RIIS), Dr. Farid Gamgami (Chinese Academy of Sciences), Camila Erazo Gonzalez (SAVIAS), Constance Bourouh (EurA AG)

This panel explored diverse paths to business success in the rapidly growing space economy. Davis Cook presented RIIS's approach to supporting African space entrepreneurs, emphasizing the importance of locally-relevant applications: "Focus on solving real problems that matter to your region." He highlighted how the Africa Earth Observation Challenge has nurtured over 30 startups addressing agricultural, environmental, and urban challenges.

Dr. Farid Gamgami shared insights from China's space industrial development, noting how strategic government support created a fertile environment for commercial innovation. He emphasized that "emerging nations must balance international collaboration with developing indigenous capabilities."

Camila Erazo Gonzalez discussed legal and regulatory considerations for space ventures, highlighting how clear frameworks attract investment while protecting national interests. She noted that "legal certainty is the foundation for sustainable space business."

Constance Bourouh presented EurA AG's technology transfer methodology, demonstrating how space-derived innovations can create commercial opportunities in non-space sectors from healthcare to agriculture.

Josué Barao shared TEKEVER's evolution as a diversified technology company with dedicated space, unmanned aerial systems, and digital divisions. He detailed their product lines including GAMALINK (inter-satellite communications), GAMASAR (synthetic aperture radar), and GAMAX (software-defined radio systems). The panel agreed that miniaturization trends and falling costs have democratized space access, creating unprecedented opportunities for startups and emerging nations.

Shaping Africa's Future from Above: Exploring the Impact of the Africa Earth Observation

Challenge

Speaker: Davis Cook, Chairman, Research Institute for Innovation and Sustainability (RIIS)

Cook presented on the Africa Earth Observation Challenge (AEOC), an initiative supporting African space-tech startups to build a robust, entrepreneur-led innovation ecosystem. Since 2015, the challenge has grown from a South African program to a continental platform with partners from 17 African countries and numerous multinational organizations.

> *"We aim to identify and empower the creation and use of downstream technologies and increase public awareness around the potential applications of space technology."*

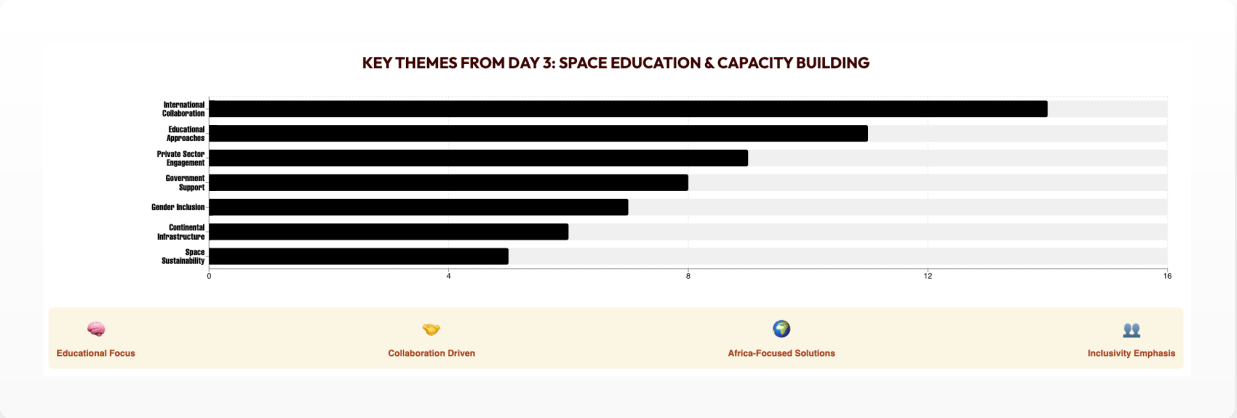
The AEOC selects promising startups annually, provides them with business development training, and connects them with the broader space ecosystem, investors, and technical resources. Winners receive funding and participate in a 3-4 month business incubation program. The challenge addresses structural barriers in the African space sector, including building human capital, increasing access to finance, supporting market development, influencing policies, fostering innovation culture, creating networking assets, encouraging equitable participation, and establishing pathways to scale.

Cook highlighted the 2023 cohort, which featured diverse applications including precision irrigation, air quality monitoring, sports terrain analysis, precision farming, photogrammetry services, carbon dioxide monitoring, geocoding solutions, and drone-based healthcare applications.

The 2024 challenge focused on seven thematic areas using five key space-based tools: optical data, synthetic aperture radar imagery, satellite navigation systems, Internet of Things, and artificial intelligence. Cook emphasized the opportunities for space agencies and regional institutions to take ownership of the concept, shape the challenge to reflect national priorities, and empower local entrepreneurs.

Day 3: Space Education, Capacity Building and Future Initiatives

Day 3 concentrated on space education, capacity building, and developing the next generation of space professionals across Africa and the Middle East. The day featured fourteen sessions spanning topics from educational models to planetary defense, space technology applications, and infrastructure development.



From Morocco to Space - Japan's Kyutech Model

Speaker: Fahd Moumni, Assistant Professor at Kyushu Institute of Technology (Kyutech)

Professor Moumni shared his personal journey from Morocco to becoming an assistant professor in Japan and presented Kyutech's model for space systems engineering education and capacity building. He highlighted the BIRDS (Joint Global Multi-Nation Birds) program, which has enabled 25 countries to launch their first satellites since 2017.

> *"Investing in human resource capacity building is definitely investing in the long-term value… When you invest in people, you know that you have capability that's able to replicate [success] many times."*

> *"The diversity environment enhances soft skills. This is something that we might underestimate but basically the diversity we had in our university allowed us to really have that kind of international dimension in handling such project. And you know the space field is the most international field."*

Moumni described how Kyutech hosts students from 29 countries, provides essential testing facilities through its Center for Nanosatellite Testing, and has enabled countries like Zimbabwe and Uganda to send their first satellites to space. He also shared his experience co-founding MicroOrbitra Inc. after graduation.

Space Technologies in Advancing the UN SDGs

Speaker: Maria-Gabriella Sarah, European Space Agency (ESA), Space Generation Advisory Council (SGAC)

Sarah presented ESA's approach to supporting the UN Sustainable Development Goals (SDGs) through space technologies and applications. She described ESA's SDG catalog (available at sdg.esa.int) containing over 900 projects and explained how space programs contribute to SDGs both as diagnostic tools (measuring and providing data) and as solutions (applications).

> *"Earth observation will not solve your problem. It will not help you achieve less poverty on Earth and better well-being and health for everyone on Earth. But it gives you… a diagnosis."*

Sarah highlighted ESA's collaboration with the EU and African partners on a €100 million initiative for space activities in Africa focused on digitalization and climate

resilience, and explained how ESA has developed water recycling technologies based on ISS systems to help with water management on Earth.

ATTARIK Foundation - Disseminating Science and Research

Speaker: Prof. Hasna Chennaoui, Founder of ATTARIK Foundation

Professor Chennaoui presented the work of the ATTARIK Foundation, a Moroccan NGO established in 2019 to promote planetary science and scientific education. The foundation focuses on promoting meteorites and planetary science research, valorizing Moroccan geoheritage, disseminating science to youth, and developing territories through geo-tourism.

> *"If we want to make space science, we have absolutely to know about our Earth and we have absolutely to know about our solar system. So we need to have people that are experts on the knowledge of Earth and planets and asteroids."*

> *"We have a geoheritage that is very well known worldwide, but not in Morocco. And if you want, I will tell you that we are one of the most important place in the world about meteorites, but I cannot bring you to a place to show you those meteorites."*

Chennaoui described the foundation's museum in Casablanca that has welcomed over 15,000 visitors, their educational materials including a meteorite storybook in multiple languages, workshops in villages, and educational videos explaining natural phenomena like earthquakes.

Apophis - International Efforts for Asteroid Science

Speaker: David Thomas, MILO Space Science Institute at Arizona State University

Thomas presented on planetary defense efforts focused on asteroid Apophis, which will pass extremely close to Earth in 2029. He outlined the Apophis Pathfinder mission and discussed how the MILO Institute provides opportunities for nations to participate in space missions with lower entry costs.

> *"Space is no longer out of reach, it is within your grasp. We have programs with other space agencies that allow you to explore. And it is that exploration that gives our lives some value."*

Thomas explained how understanding asteroid composition is critical for planetary defense, as different deflection strategies are needed for solid asteroids versus rubble piles. He described the mission's plan to use repurposed Janus spacecraft equipped with visible and IR imagers, and outlined MILO Institute's consortium-based approach to lowering costs and increasing participation.

Empowering Africa's Space Generation

Speaker: Prof. Teodoro Valente, Italian Space Agency (ASI)

Professor Valente discussed Italy's initiatives to support space education and development in Africa, highlighting bilateral agreements, educational programs, and strategic partnerships under the Mattei Plan for Africa.

> *"By 2050, Africa will be home to over 25% of the world population with a young and dynamic workforce... Africa's young generation must have the right tools, knowledge and opportunity to build the future. And Italy believes in this vision."*

> *"International cooperation is one key aspect for Africa to establish a competitive and sustainable space industry. History has shown that the great success in space exploration have been made through partnership, shared knowledge and mutual trust."*

Valente emphasized Italy's own space journey began through international collaboration, becoming the third nation to reach space in 1964. He described ASI's bilateral agreements with Egypt, Kenya, and South Africa and partnerships with 21 other African nations, as well as the Luigi Broglio Space Center in Malindi, Kenya serving as a hub for Italy-Africa space collaboration.

Expanding Space Accessibility

Panel Discussion with: Prof. Teodoro Valente (Italian Space Agency - ASI), Dr. Jawad El Kharraz (Environmental Change and Climate Challenges Organization - ECCO Climate), Prof. Bernard Foing (Space Renaissance International), Dr. Omar Emam (Expert in data handling)

This panel explored strategies to make space resources, technology, and data more accessible to emerging space nations. Discussions covered international collaboration models, climate applications of satellite data, cultural inclusivity in space, and data processing innovations.

> *"Collaboration between different agencies and private companies is a must. It gives the floor to innovative ideas, it enables the access to data for different kind of users." — Dr. El Kharraz*

> *"You can do a lot of the processing that we would traditionally do on the ground, we can do that in orbit. So you can potentially reduce this gigabyte of data to a few hundreds of megabytes." — Dr. Emam*

The panel identified challenges including the digital divide in space (with limited access to data and technologies), governance gaps (underrepresentation in international bodies), technical bottlenecks (like radio frequency congestion), and financial constraints. They proposed solutions for different timeframes: mapping capacities and developing training programs (short-term), establishing regional data centers and expanding governance participation (medium-term), and creating indigenous technologies and sustainable funding mechanisms (long-term).

Space Education in Africa and the Middle East

Panel Discussion with: Dr. Jawad El Kharraz (ECCO Climate), Dr. Awni Mohammed Al-Khasawneh (Arab Union for Astronomy and Space Sciences - AUASS), Olga Kornienko (SPUTNIX), Nadia Sanchez ("SHE IS" Astronaut Program), William Hosack (Open Cosmos)

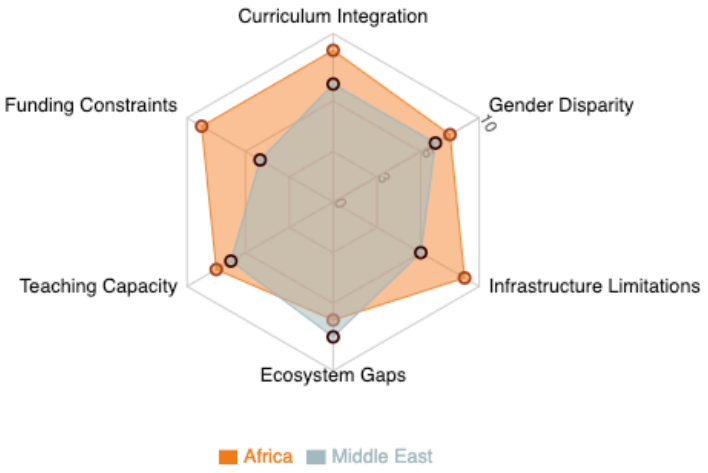
This panel discussed approaches to developing space education capacities across Africa and the Middle East, focusing on networks, role models, private sector engagement, and gender inclusion in STEM fields.

> *"We need champions of science to really inspire and push for the next generation who are qualified, who are motivated to push the boundaries of space sciences." — Dr. El Kharraz*

> *"Many times the girls say 'This is not for me, it's for boys.' So you need to try to create the new concept and breach the stereotypes." — Nadia Sanchez*

The panel identified educational challenges including curriculum integration barriers (with resistance to adding space science to crowded curricula), gender disparity (with limited female role models), infrastructure limitations (unequal access to digital tools), and ecosystem gaps (disconnect between education and industry). They proposed a multi-level implementation framework addressing primary/secondary education, university level, public education, and professional development, with specific metrics for success.

EDUCATIONAL CHALLENGES IN SPACE SCIENCE

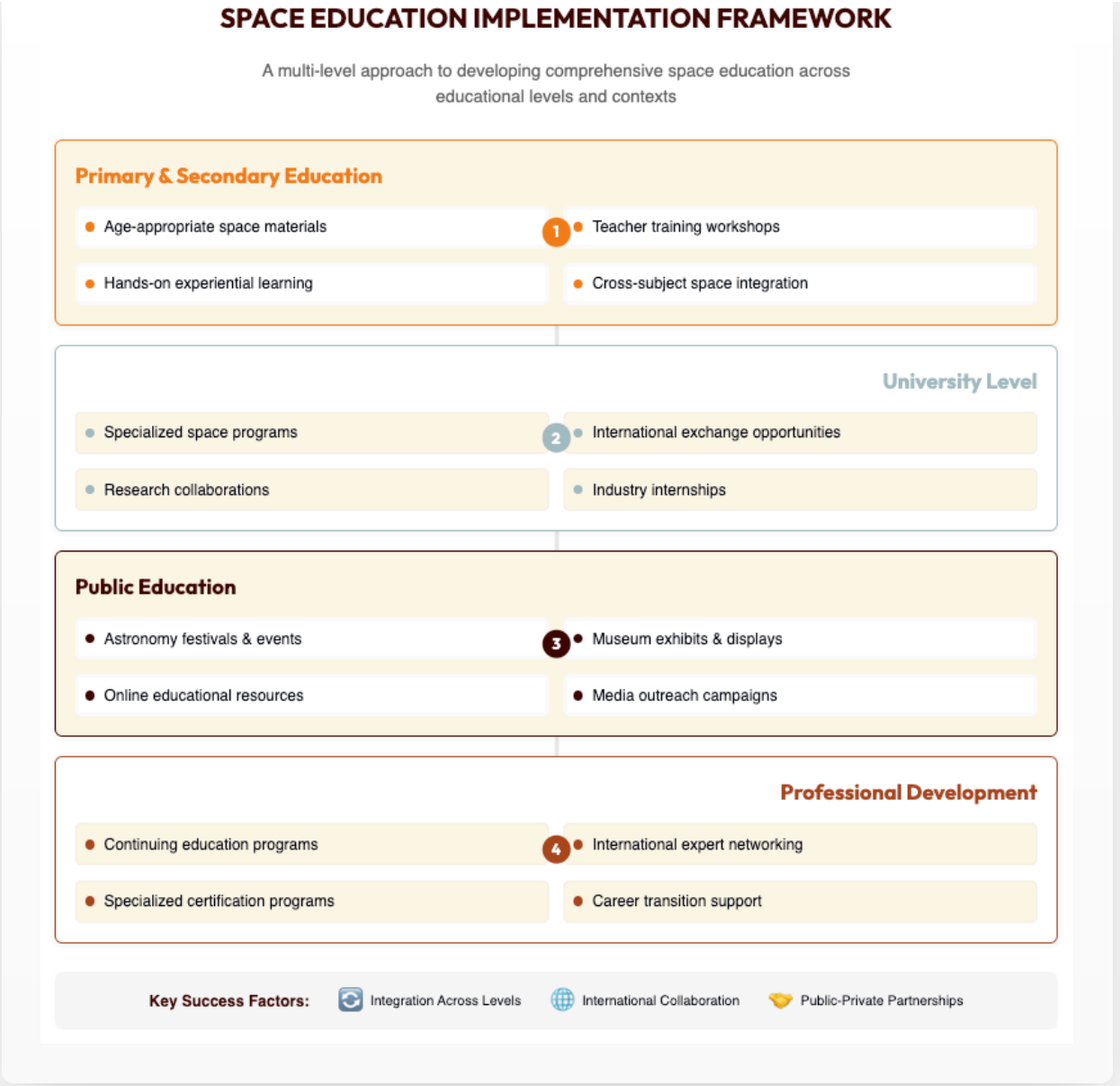


Key African Challenges

- Infrastructure limitations (9/10)
- Funding constraints (9/10)
- Curriculum integration barriers (9/10)

Key Middle East Challenges

- Ecosystem gaps (8/10)
- Gender disparity (7/10)
- Teaching capacity (7/10)



Planetary Defense - Involving Africa

Speaker: Dr. Youssef Moulane, University Mohammed VI Polytechnic (UM6P)

Dr. Moulane presented on the critical role Africa can play in planetary defense against asteroid threats, explaining the science behind near-Earth objects (NEOs) and how African nations can contribute to their detection and potential mitigation.

> *"When these asteroids are coming to hit the Earth, they are not going to choose where to impact. This is why it's a global challenge for all of us."*

> *"Africa is playing a really significant role in the collective ability to detect and monitor Near-Earth Objects by establishing telescopes that find these objects."*

Moulane emphasized how planetary defense requires international cooperation across search/detection, characterization, planning, mitigation, and assessment. He highlighted Morocco's Oukaïmeden Observatory's contribution to NEO discoveries, finding 4 comets and 11 near-Earth objects, and discussed how the Double Asteroid Redirection Test (DART) mission demonstrated successful asteroid deflection capabilities.

From YouTube to Telescopes - Bridging Space Science and Public Interest

Speaker: Najib El Mokhtari, Science Communicator

El Mokhtari presented on the importance of science communication and connecting the public with cosmic perspectives. As a former technology consultant turned science communicator, he focuses on using digital platforms to inspire interest in space science.

> *"Humans are the only animal species that are curious about familiar things... you will never see a cat or a dog wondering and looking at the moon and wondering who lifts the moon or how the moon is moving across the sky. But humans do that. And it's thanks to that that we have everything we see as technology, as achievements of human civilization."*

> *"The cosmic perspective is something that is universal. People can feel, have that feeling of awe looking at the stars, whatever their language is, whether their background, whatever their religion is, and so on."*

El Mokhtari discussed how his approach demonstrates scientific methods rather than merely teaching facts, the complex language choice in Morocco with multiple languages in use, and how Artificial Intelligence (AI) will transform science education through personalized tutors and auto-dubbing technology.

Aerospace Engineering Training in Morocco

Speaker: Dr. Mustapha Faqir, Dean of the School of Aerospace and Automotive Engineering at the International University of Rabat (UIR)

Dr. Faqir presented on UIR's approach to aerospace engineering education, highlighting a program that combines international partnerships with industry connections to develop qualified engineers for Morocco's growing aerospace sector.

> *"Aerospace engineering is known for this because it's the most multidisciplinary field... you are dealing with material science, with embedded systems, with computer science, we have also some machine learning, we have aerodynamics... so you have all what it takes to deal with many other fields."*

> *"This field, everybody is talking about huge investments, so nobody can do it alone. So this is why we need to come up with a national plan and collaborate with everybody. Try to not everybody working alone in his or her corner, but we need to join forces and try to develop this field."*

Faqir described how the program has CTI accreditation and the EUR-ACE label, recognizing equivalence to European master's degrees. He highlighted strategic partnerships with Georgia Tech and Mississippi State University allowing students to obtain dual degrees, a curriculum balancing fundamental courses with advanced aerospace topics, and an Industrial Advisory Board ensuring curriculum alignment with industry needs.

University Centre for Research in Space Technologies

Speaker: Dr. Zouhair GUENNOUN, University Centre for Research in Space Technologies (CURTS - Centre Universitaire de Recherche en Technologies Spatiales de l'Université Mohammed V de Rabat)

Dr. Guennoun presented on Morocco's University Centre for Research in Space Technologies (CURTS), a collaborative platform established in 2019 between the Royal Center for Space Studies and Research and Mohammed V University in Rabat.

> *"The University center for Research in Space Technologies is the fruit of the agreement that has been signed by 2019 between the National Administration for Defence, represented by the Royal center for Space Studies and Research and the Ministry of Higher Education in Morocco."*

> *"We are receiving a huge amount of data concerning telemetry data, concerning payload data and this data, they can be the materials that will be used in the future subjects in research."*

Guennoun highlighted CURTS' successful launch of two 3U CubeSats (UM5EOSAT and UM5SAT Rabat) on August 16, 2024. He described the center's organization into specialized teams, its scientific output of approximately 30 conference papers, 20 journal papers, and seven PhD theses, and its facilities including a clean room, concurrent engineering room, and ground station.

SBAS Flight Demo Trials

Speaker: Dr. Lasisi Lawal, Expert in Space Systems Engineering and Global Navigation Satellite System (GNSS) Technologies

Dr. Lawal presented on the economic and practical benefits of implementing a Satellite-Based Augmentation System (SBAS) across Africa, with an emphasis on

demonstration projects and cost-benefit analysis.

> *"Why would you want to drive just a nationwide system? If you go to ICG under UNOOSA, you just see that the nomenclature for NICOMSAT1 our satellite that holds the navigation overlay service is actually named Nigerian Satellite Augmentation system. But why would you want to do that when you have a Helix fired cavity antenna that covers the whole of the continent?"*

> *"SBAS adoption aligns with AU Agenda 2063 that talks about a single African Air Transport Market (SAATM) which seeks to advance the liberalization of civil aviation in Africa through a unified sky and acting as an impetus to the continent's economic integration agenda."*

Lawal explained how while countries like Nigeria and Morocco have rich Instrument Landing System (ILS) infrastructure, many runways across Africa lack navigation aids. He described successful flight demos conducted in Togo, Cameroon, and Congo using different aircraft types, and presented a cost-benefit analysis showing the estimated cost for continental SBAS infrastructure at $191-221 million with annual operating costs of $18.2-20.5 million, yielding a 545% return on investment in aviation and strong benefits in non-aviation sectors.

Oukaïmeden Observatory and Space Weather Monitoring

Speaker: Dr. Youssef Moulane, University Mohammed VI Polytechnic (UM6P) (presenting on behalf of Professor Zouhair Benkhaldoun)

This session highlighted the Oukaïmeden Observatory's work on space weather and satellite tracking, discussing its international partnerships and contributions to space debris monitoring.

> *"You guys, you make satellites, you are happy, you make money… but you leave this debris for us making some problem to access to the sky."*

> *"The problem in Morocco, our government does not care much about astronomy and space science. This is something we are pushing for… We are developing our infrastructure to be a little bit competitive with Chile because Chile, you are champions, but we are competitive with you to bring more collaborators to Morocco."*

Moulane described how the observatory hosts instruments from international partners including the South Korean Space Agency, has developed a satellite pass prediction app and uses machine learning for debris identification, and is located at 2,700 meters above sea level in the Atlas Mountains, providing excellent observing conditions. He explained how Oukaïmeden collaborates with telescopes in Chile to provide complementary coverage across hemispheres, and is promoting a Dark Sky Park to preserve astronomical viewing conditions.

Day 4: Moving Forward - Innovation, Sustainability and Future Opportunities

The fourth and final day focused on “Moving Forward” with innovations in space technology, sustainable solutions, and future opportunities for emerging space nations. The day covered strategic financing models, green propulsion technologies, exploration of extreme environments, advanced materials, spaceport development, Earth observation applications, food security, artificial intelligence, and systems engineering approaches.

Strategic Financing for a Sustainable Space Economy

Speaker: Fanny Kalyanu De Jong, Climate Strategy Team, European Bank for Reconstruction and Development (EBRD)

De Jong presented on EBRD’s expansion into Sub-Saharan African countries including Benin, Cote d’Ivoire, Ghana, Kenya, Nigeria, and Senegal, creating new financing opportunities for space ventures. She explained how the bank operates on principles of sound banking, transition impact, and additionality, and is fully Paris Agreement-aligned since January 2023.

Space-related financing products she highlighted included Green Economy Financing Facilities, the Telecommunication, Media and Technology (TMT) team that can finance satellite projects (€5-200 million investments), the Venture Capital Investment program, and the Star Venture technical assistance program. De Jong emphasized how space applications can act as enablers for addressing climate change challenges and supporting UN Sustainable Development Goals.

Recent Advancements in Green Propulsion

Speaker: Professor Rashid Amrousse, University of Chouaib Doukkali, Morocco

Professor Amrousse presented on how conventional propellants like ammonium perchlorate (solid) and hydrazine (liquid) are being replaced by greener alternatives due to toxicity and handling challenges. He highlighted promising green propellant alternatives including Hydroxyl Ammonium Nitrate (HAN)-based solutions with 10-12% higher specific impulse than hydrazine, Ammonium Dinitramide (ADN)-based propellants, nitrous oxide propellants with hydrocarbon additives, and water propulsion systems.

Amrousse explained how beyond propellant chemistry, catalyst design is critical for performance, with research focusing on alternatives to the expensive Shell 405 iridium-based catalyst. He also noted potential synergies between Morocco's green hydrogen initiatives and space propulsion development.

High Latitude Areas in Technological Advancements

Speakers: Isabel Gimenez (Antarctic Institute of Chile), Victoria Valdivia (Ministry of Defense, Chile), Pablo Dueñas (Spacely, Chile)

This session explored how Antarctica serves as a natural laboratory for testing space technologies due to extreme conditions similar to space environments. The speakers highlighted Chile's 67 years of Antarctic operations, developing expertise in extreme environment operations that translates to space applications.

They described key technology areas being tested, including renewable energy systems in extreme cold, ground station operations in remote locations, and communications technologies. The presentation emphasized how the Magallanes region in southern Chile serves as a strategic gateway to Antarctica, offering logistical support and infrastructure for technology deployment, and how the Antarctic Treaty System served as a model for the Outer Space Treaty, with both emphasizing peaceful use and international cooperation.

High-Purity Germanium in Space Applications

Speaker: Henrik Pan, China Germanium Co., Ltd.

Pan presented on germanium's unique properties that make it ideal for space applications. He explained that germanium (Ge) is a semiconductor material with

atomic number 32 belonging to the carbon group in the periodic table, with a high refractive index and low thermal conductivity.

> *"Germanium is a semiconductor material with high refractive index and low thermal conductivity."*

Pan outlined four key reasons why germanium is particularly valuable for space applications:

1. **Superior Conductivity:** Germanium substrate solar cells can achieve efficiency up to 34%, significantly higher than conventional materials
2. **Exceptional Optical Properties:** Ge has excellent permeability to infrared light, making it ideal for optical systems
3. **Thermal Stability:** Germanium maintains performance even at high temperatures encountered in space
4. **Radiation Performance:** Ge performs well in high radiation environments, showing resistance to degradation

The presentation detailed two primary space applications:

1. **Solar Cells:**
    - Acts as a medium for photoelectric conversion
    - Offers high electron mobility and conversion efficiency
    - Provides a wide spectral range, capturing more solar energy
2. **Infrared Optical Systems:**
    - Demonstrates high transmittance, especially in the mid-infrared band (8-12 micron)
    - Ideal for thermal imaging applications
    - Different transmittance properties across wavelengths allow for specialized applications

While germanium is more expensive than silicon for terrestrial applications, its superior performance in space environments makes it cost-effective for satellite systems where reliability and efficiency are paramount.

Feasibility Analysis of a Spaceport in Morocco

Speaker: Dr. Nabil Souhair, Al Qamar Space

Dr. Souhair delivered a comprehensive analysis of Morocco's potential as a spaceport location, beginning with an overview of the NewSpace economy and its rapid growth. He defined the NewSpace economy as "a global trend encompassing an emerging investment philosophy and a series of technological advancements leading to the development of a private space industry largely driven by commercial motivations."

He provided market data showing the global space economy grew to $423.8 billion in 2019, with projections for 2019-2028 indicating approximately 10,000 satellites to be launched with revenue in the hundreds of billions.

> *"This amount of satellites will increase the demands of space launchers and the need of new launch windows, achievable through new spaceports."*

Dr. Souhair explained the technical criteria for launch site selection:

1. **Launch Physics Requirements:** Need for high altitude and horizontal velocity (>7 km/s)
2. **Earth Rotation Benefits:** Local Earth rotational speed provides energy advantages
3. **Drop Zone Considerations:** Need for safe areas for rocket stage returns and potential mission aborts

Morocco has unique advantages as a spaceport location:

- The Moroccan Sahara's latitude range (20-35°) provides up to 96% of Earth's maximum rotational speed benefit
- The lunar orbital plane at 28° latitude passes near Laayoune, saving expensive orbital plane change maneuvers
- The Sahara desert provides safe areas for eastward launches
- Proximity to the Atlantic Ocean enables polar or highly inclined orbit launches
- Well-connected logistics with commercial ports, highways, and railways

For implementation, he presented two approaches:

1. Building a brand-new spaceport in the desert near 28° latitude
    - Pros: Site selection flexibility
    - Cons: Higher cost
2. Extending/refurbishing an existing airport
    - Pros: Lower cost
    - Cons: Less flexibility in site selection

Dr. Souhair emphasized a scalable development scenario and detailed socioeconomic benefits including accelerating a Morocco-based space ecosystem, attracting investments, encouraging manufacturing facilities near the spaceport, and creating opportunities to support promising small-satellite operators.

Upstream Innovations - Advanced Launch and Propulsion Technologies

Panel Discussion with: Dr. William Hosack (Open Cosmos), Valeria Barashkova (Aerospace Capital), Antonio Stark (ispace), James Benouda (Al Qamar Space), Prof. Rashid Amrousse (University of Chouaib Doukkali)

This panel explored diverse upstream innovations enabling emerging nations to enter the space sector. Dr. William Hosack highlighted Open Cosmos's approach to rapid satellite development and deployment, explaining how modular platforms reduce both cost and development time. He emphasized that "specialized capabilities rather than end-to-end systems offer the most accessible entry point for new space nations."

Antonio Stark discussed ispace's lunar transportation services and their successful commercial model that doesn't require customers to develop their own landers. He noted that "emerging nations can participate in lunar exploration through targeted instruments and experiments rather than complete missions."

James Benouda shared Al Qamar Space's analysis of Morocco's potential as a launch site, highlighting how geographic advantages at specific latitudes create natural opportunities for specialized launch services. He noted that the "lunar

orbital plane at 28° latitude passes near Laayoune, saving expensive orbital plane change maneuvers."

Prof. Rashid Amrousse presented advances in green propulsion technologies, emphasizing both environmental and handling safety advantages, particularly for emerging nations with limited hazardous materials infrastructure.

Valeriya Barashkova detailed Aerospace Capital's satellite deployment technologies, noting their experience deploying 120 CubeSats since 2021. She highlighted their customers across Africa and the Middle East, including the Mohammed Bin Rashid Space Centre (UAE), Telnet (Tunisia), and universities in Kenya and Saudi Arabia. Barashkova also described their educational Space-π project connecting students with real space experiments.

The panel discussed how environmental and resource challenges are driving innovation, particularly around noble gas limitations for electric propulsion, with iodine propellants offering a promising alternative with solid-state storage advantages. Panelists also addressed the trade-offs between different integration strategies: vertical integration providing control but requiring broader capabilities, versus horizontal integration offering flexibility but increasing dependency.

The panel reached consensus on several points: international collaboration is essential even while pursuing national capabilities, environmental sustainability is becoming a competitive advantage in propulsion, specialized niches offer better opportunities than competing in mature segments, and education and ecosystem development are prerequisites for sustainable space capabilities.

Modern Earth Observation in Decision-Making

Speaker: Dr. Hassan Arid, Royal Center for Remote Sensing (CRTS), Morocco

Dr. Arid presented on how Earth observation technologies have evolved to support decision-making processes across numerous sectors. He emphasized that gathering useful information is critical for decision-making, and this information must be precise, timely, comprehensive, recurring, multi-thematic, and easily processed.

He outlined the advantages of satellite and geospatial information:

- Multi-scale and multi-dated observations
- Synoptic and multi-directional views
- Access to diverse satellites and international archives
- Advanced data processing capabilities
- Increasingly accessible technology

Dr. Arid provided background on CRTS, a Moroccan government institution created in 1988 to develop remote sensing applications. CRTS supports various national strategies including the Digital Economy plan, National Strategy for Sustainable Development, Morocco Green Plan, and Water Strategy 2030.

He presented detailed case studies of Earth observation applications across multiple sectors:

1. **Agriculture:** Creating dynamic land use maps, monitoring irrigated lands, and developing crop indicators
2. **Forestry:** Conducting forest inventories, managing forest activities, and assessing fire impact
3. **Urban Planning:** Monitoring urban development and territorial evolution
4. **Fisheries:** Assessing potential aquaculture locations and mapping coastal ecosystems
5. **Water Resources:** Monitoring surface waters and optimizing agricultural water use
6. **Disaster Management:** Mapping floods, assessing tsunami risks, and supporting emergency response

Dr. Arid described CRTS's involvement in international disaster response initiatives, including activating the International Charter "Space and Major Disasters" during 2024 floods. He highlighted CRTS's commitment to capacity building through training programs, awareness workshops, and research activities.

Dr. Arid concluded by highlighting emerging technologies transforming Earth observation: satellite constellations providing global coverage, nanosatellites offering lower costs, machine learning optimizing processing, and Big Data enabling better analysis and forecasting.

Space-Driven Solutions for Food Security

Panel Discussion with: Dr. Lasisi Lawal, Specialist in satellite applications for food security, Camila Eraso Gonzalez, Savias, Legal and Business consultant on space economy and trade

This panel discussed how the European Union Deforestation-Free Products Agreement (EUDR) is transforming global agricultural supply chains by requiring geolocalization of crop origins, evidence of zero deforestation since December 2020, and due diligence throughout the supply chain. The speakers noted that EUDR enforcement was delayed from January 2025 to January 2026 due to implementation challenges, highlighting the knowledge gap between regulatory requirements and technology capabilities.

The panel outlined a multi-level approach to enhancing food security through space technologies:

1. **Technology Adaptation** - developing localized applications adapted to regional agricultural practices, ensuring technologies function despite connectivity challenges, and creating simplified interfaces
2. **Knowledge Transfer** - using familiar communication channels (e.g., WhatsApp) to deliver insights to farmers, working through trusted intermediaries, and developing pilot projects with visible results
3. **Financing and Support** - leveraging regulatory requirements to secure investment, engaging development banks for project funding, and creating collaborative models involving multiple stakeholders

Generative AI - Falcon Open Source Model for Space

Speaker: Dr. Chaouki Kasmi, Chief Innovation Officer, Technology Innovation Institute (TII), United Arab Emirates (UAE)

Dr. Kasmi presented on TII, established in 2020 to make Abu Dhabi a central hub for innovation, with 1,000+ researchers across 10 research centers. He explained how open-source technologies like the Falcon Large Language Model (LLM) series can empower emerging countries by enabling access to critical technologies without massive initial investment.

Kasmi detailed the Falcon 3 series including models of various sizes (1B, 3B, 7B, and 10B parameters) with both Transformer and Mamba (state space architecture) variants, support for English, French, Spanish, and Portuguese, and extreme quantization capabilities for edge deployment (down to 1.5-bit precision). He outlined space applications for LLMs including spacecraft guidance and control, satellite tracking, orbit adjustment assistance, and mission planning support.

Concurrent Design and Systems Engineering

Speaker: Dr. Anton Ivanov, Technology Innovation Institute (TII), United Arab Emirates (UAE)

Dr. Ivanov presented on Morocco's significant potential in space, explaining that strategic planning and sustained investment are essential. He noted that advanced space nations typically spend 0.05-0.1% of GDP on space (equivalent to ~7 billion dirhams annually for Morocco) and emphasized that long-term commitment (10+ years) is essential for sustainable development.

Ivanov highlighted how clear governance and strategic direction are critical for space development, citing the UAE's Supreme Space Council as an example of setting national space direction. He explained how concurrent design facilities bring together 20-30 specialists in a single room for collaborative spacecraft development, noting that University Mohammed V has already established such a center, and emphasized the importance of face-to-face collaboration for effective systems engineering.

Accelerating Space Systems Development

Panel Discussion with: Dr. Chaouki Kasmi (Technology Innovation Institute - TII), Dr. Anton Ivanov (Technology Innovation Institute - TII), Dr. Adnane Addaim (University Centre for Research in Space Technologies - CURTS), Radim Badsi (Ground Space)

This panel explored how AI applications in space require balancing innovation with reliability requirements, noting that 80-95% accuracy is insufficient for critical functions like guidance and navigation, though non-critical applications (data analysis, maintenance prediction) offer safer implementation paths. Participants

highlighted the unique challenges of radiation effects and computational constraints for space-based AI.

The panel emphasized how cybersecurity must be integrated from the earliest design stages, with software-defined radios and reprogrammable satellites increasing potential risks, and even small university satellites potentially vulnerable to repurposing by attackers. They discussed how systems engineering education requires balancing theory and practice, distinguishing between "know-what" (theoretical knowledge) and "know-how" (practical skills), and explaining how students need domain specialization before systems engineering education.

The panel reached consensus on several points: human factors remain central to successful space systems development, long-term vision and commitment are essential for sustainable progress, international collaboration complements rather than contradicts national capability development, and emerging space nations should focus resources on strategic specializations.

CROSS-CUTTING THEMES AND CHALLENGES

International Collaboration Models

A central theme across all conference days was the critical importance of international collaboration in space development. From the ISS's 25-year history highlighted by Metcalf-Lindenburger to Kyutech's BIRDS program presented by Moumni, successful space initiatives leverage international expertise and resources. However, collaboration models must evolve beyond dependency relationships to create genuine partnerships where all participants contribute meaningful value.

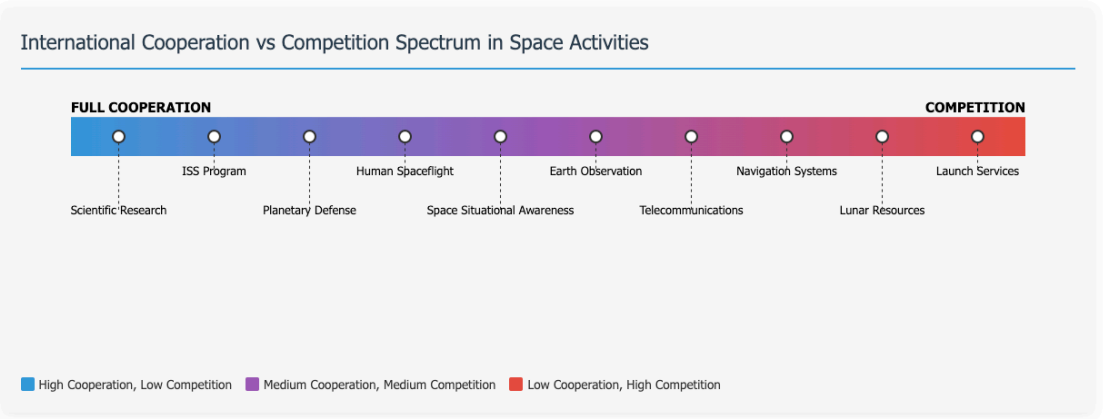
FINANCIAL CHALLENGES & SOLUTIONS

CHALLENGES	SOLUTIONS
High launch costs	Consortium-based approaches
Limited investment pathways	Regional investment mechanisms
Insufficient R&D funding	Industry-academia partnerships
Insurance & risk barriers	Specialized insurance products

POLICY CHALLENGES & SOLUTIONS

CHALLENGES	SOLUTIONS
Regulatory frameworks gaps	National space legislation
Limited governance participation	Increased COPUOS membership
Export control restrictions	Indigenous technology development
Sovereignty concerns	Regional policy coordination

Addressing these interconnected challenges requires coordinated action across multiple stakeholders



Different models emerged across sessions:

- **Educational Exchanges** - Programs like Kyutech's space engineering courses build human capital across multiple countries
- **Consortium Approaches** - MILO Institute's model for inclusive participation in space missions
- **Technical Assistance** - ESA and ASI programs supporting African space development
- **Regional Coordination** - African Space Agency's approach to maximizing limited resources
- **Public-Private Partnerships** - Morocco's aerospace industry development through strategic international partnerships
- **South-South Cooperation** - Expanding networks between emerging space nations sharing similar challenges

The tension between collaboration and sovereignty was addressed by multiple speakers. As Major General Pascal Legai noted, some domains are better suited to collaboration (science, exploration) while others involve legitimate competition (commercial applications). The Artemis Accords were presented as a framework balancing common principles with national interests.

Human Capital Development

Speakers across all days emphasized human capital as the foundation for sustainable space capabilities. H.E. Tidiane Ouattara highlighted Africa's youthful population as the continent's greatest potential contribution to global space activities. Educational approaches ranged from Nadia Sanchez's targeted initiatives for girls to Dr. Faqir's aerospace engineering program with international partnerships.

Key challenges in human capital development include:

- **Brain Drain** - Vugar Bayramov highlighted the need to retain talent while allowing for international experience
- **Educational Pipeline** - Multiple speakers noted the need for space education from primary through university levels
- **Interdisciplinary Skills** - Dr. Ivanov emphasized that systems engineering requires both specialized knowledge and integrative thinking
- **Cultural Factors** - Dr. Faqir discussed Morocco's cultural risk aversion affecting entrepreneurship
- **Gender Inclusion** - Sanchez demonstrated how targeted initiatives can address stereotypes and expand participation

The most successful approaches integrated theoretical knowledge with practical experience. UIR's "senior design projects" connect students with industry problems, while Kyutech's hands-on satellite building program provides end-to-end mission experience. Ted Tagami's ExoLab demonstrates how even young students can engage in meaningful space research through parallel Earth-space experiments.

Sustainable Financing Approaches

Financing emerged as a critical challenge across multiple sessions. Traditional government funding models remain dominant, especially in early-stage space development, but new approaches are emerging to create more sustainable ecosystems.

Different financing models discussed included:

- **International Financial Institutions** - EBRD's expanding role in supporting space projects linked to development goals
- **Consortium-Based Approaches** - MILO Institute's model distributing mission costs across multiple participants
- **Blended Finance** - Combining public, philanthropic, and commercial funding sources
- **Service-Based Models** - ispace's approach allowing countries to participate in lunar activities without owning infrastructure
- **Regional Pooling** - African Space Agency's approach to maximizing limited resources

A key insight from multiple sessions was linking space investments to terrestrial priorities. Fanny Kalyanu De Jong emphasized how space applications supporting climate adaptation can access climate finance mechanisms. Dr. Arid demonstrated Morocco's success in applying Earth observation to multiple sectors, creating clear value propositions for continued investment.

Applying Space Technologies to Regional Challenges

Speakers consistently emphasized the importance of connecting space capabilities to addressing pressing regional challenges. As H.E. Tidiane Ouattara stated, "The science is nothing if it is not addressing the citizens' needs."

Specific applications highlighted included:

- **Agricultural Monitoring** - Earth observation for crop health, water management, and precision farming
- **Natural Resource Management** - Satellite data for monitoring forests, water resources, and land use
- **Disaster Response** - Morocco's activation of the Space and Major Disasters Charter during floods
- **Urban Planning** - Identifying irregular settlements and monitoring urban growth
- **Maritime Resources** - Identifying potential fishing zones through sea surface temperature analysis
- **Transportation Safety** - SBAS systems improving aviation safety across Africa

Dr. Lawal's presentation on SBAS demonstrated the economic case for space investments, showing a 545% return on investment through improved aviation safety and efficiency alone. Similarly, the panel on food security highlighted how space technologies can support compliance with regulations like the EU Deforestation-Free Products Agreement while improving agricultural productivity.

From Capacity Building to Indigenous Capabilities

A recurring theme was the journey from dependency on external space capabilities to developing indigenous capacity. This progression was described in different ways across sessions:

Dr. Addaim distinguished between "know-what" (theoretical knowledge) and "know-how" (practical skills), emphasizing that practical skills are harder to transfer but essential for sovereignty. Professor Moumni's presentation on Kyutech's model showed how countries progress from participating in international programs to developing independent capabilities. Morocco's aerospace industry evolution demonstrated how manufacturing expertise can develop incrementally, eventually achieving a 42% local integration rate.

Dr. Souhair's analysis of Morocco's spaceport potential represents a prime example of leveraging geographic advantages to develop strategic capabilities. Rather than attempting to replicate the full spectrum of space capabilities, Morocco can utilize its unique position to provide launch services that benefit both national objectives and international partners.

Similarly, Barashkova's presentation on CubeSat deployment technologies highlighted how standardized interfaces and deployment systems have democratized access to space. By utilizing these standardized approaches, emerging space nations can focus on payload development while leveraging established launch infrastructure, creating a pragmatic pathway to building indigenous capabilities incrementally.

Key milestones in this progression include:

1. **Data Utilization** - Using existing satellite data for local applications
2. **Ground Infrastructure** - Developing receiving stations and processing capabilities
3. **Educational Programs** - Building specialized human capital
4. **Cubesat Development** - CURTS' success launching two 3U CubeSats
5. **Specialized Capabilities** - Dr. Amrousse's work on green propulsion technologies
6. **Integration into Value Chains** - Morocco's aerospace industry supplying global manufacturers

Governance and Regulatory Frameworks

Governance frameworks spanning from national policies to international agreements were discussed across multiple sessions. At the national level, Dr. Ivanov emphasized the importance of clear vision and governance structures, citing the UAE's Supreme Space Council as an example of coherent strategic direction.

Regionally, H.E. Tidiane Ouattara described the African Space Agency's role in coordinating activities across 55 member states, guided by the African Union's Agenda 2063. The panel on SBAS highlighted how continental-scale infrastructure requires harmonized regulatory approaches.

Internationally, the Artemis Accords were presented as an evolving framework for lunar activities, with the panel on Global Space Leaders discussing both the opportunities and challenges they present. Major General Pascal Legai raised specific concerns about "security zones" on the Moon, while Dr. Rodrigo Leonardi described the Accords as Brazil's entry point to international space exploration despite having no previous experience in this domain.

A key insight across sessions was the need for emerging space nations to participate in governance discussions from the outset rather than attempting to join frameworks designed without their input. As Hugo Costa noted, "If we all sit together at the table, we can also all bring contributions to the decisions that are being taken."

Legal and Regulatory Framework Development

Dr. Zantou's presentation highlighted the critical importance of legal frameworks for space activities, particularly for emerging space nations. This cross-cutting challenge affects national space program development, international cooperation, and private sector participation.

Dr. Creydt emphasized why export control is a crucial consideration for space players. Space technologies and items are highly sensitive with risk of misuse, of military interest as dual-use items, critical for national security, and enable strategic infrastructure. A wide range of items fall under export control regulations, including satellites, launch vehicles, propulsion systems, materials, software, and technical know-how.

The tension between technology acquisition and regulatory compliance represents a significant challenge for African space programs. While international collaboration offers pathways to capability development, export control regimes can limit the depth of technology transfer, creating a strategic imperative for emerging space nations to develop clear understanding of these regulations early in their space program development.

Key aspects include:

- The gap between international treaty ratification and national implementation
- The particular challenges facing African nations in developing space legislation
- The role of UNOOSA's technical advisory services in supporting legal framework development
- The sequential relationship between space policy development and legal frameworks
- The tension between adopting established models and creating context-appropriate regulations

While Morocco demonstrates leadership as the only African nation to ratify all five UN space treaties, Dr. Zantou noted that many African countries have not ratified any space treaties, creating potential governance gaps as space activities increase. The development of harmonized regional approaches could address capacity limitations while ensuring context-appropriate regulations.

Technology Transfer as Development Strategy

Constance Bourouh's presentation illuminated how technology transfer can serve as a strategic approach for emerging space nations to maximize returns on space investments. This approach connects directly to the challenge of demonstrating the value of space investments in regions with pressing terrestrial needs.

Key considerations include:

- The structured process required for effective technology transfer
- The dual benefits of addressing immediate societal challenges while building space capabilities
- The need for intermediary organizations that can bridge space and non-space sectors
- The potential for emerging nations to create innovative applications of space technologies
- The opportunity to develop context-specific solutions for regional challenges

Technology transfer offers a pathway to justify space investments based on tangible terrestrial benefits while gradually building indigenous capabilities. The examples presented by Bourouh demonstrated how space-developed technologies like plasma systems could address critical challenges in water purification, healthcare, and agricultural monitoring.

Spectrum Management and Space Traffic Challenges

Radim Badsi's presentation highlighted the growing challenges of radio spectrum management and space traffic as orbital congestion increases. This theme connects to several other sessions, including the panel on "Space Security and Safety" and discussions about satellite constellations.

Key aspects of this challenge include:

- The limited nature of radio spectrum as a resource for space communications
- Increasing potential for interference as satellite numbers grow exponentially
- The strategic importance of satellite communications infrastructure
- The need for sophisticated monitoring technologies
- The governance challenges in managing orbital slots and frequency allocations
- The security implications of potential deliberate interference

As noted by Badsi, "More satellites have been launched in the past five years than in the previous fifty years," creating unprecedented congestion in both physical space and the electromagnetic spectrum. This challenge particularly affects emerging space nations, which may struggle to secure orbital slots and frequency allocations as established players expand their presence.

The development of technologies like Groundspace's "Muskrat" system represents an opportunity for specialized monitoring capabilities that could potentially benefit multiple nations through shared services. This connects to broader themes of international collaboration while highlighting an area where emerging nations could develop specialized expertise.

STRATEGIC RECOMMENDATIONS

For Government Agencies

1. **Develop Comprehensive Space Policies**

   - Establish clear national space visions and strategies aligned with development priorities
   - Create or enhance space agencies with appropriate mandates
   - Develop regulatory frameworks that enable private space activities
   - Commit sustainable funding at appropriate levels (targeting 0.05-0.1% of GDP as suggested by Dr. Ivanov)
   - Establish robust export control compliance frameworks from the outset of space program development
   - Create specialized units within space agencies to navigate international export control regimes
   - Develop bilateral agreements addressing technology transfer with key partner nations

2. **Invest Strategically in Human Capital**

   - Develop educational curricula integrating space applications
   - Create international exchange programs for specialized training
   - Implement mechanisms to retain talent while enabling global experience
   - Establish centers of excellence in strategic domains

3. **Prioritize Regional Collaboration**

- Develop complementary capabilities rather than duplicating efforts across neighboring countries
- Create shared infrastructure where appropriate (e.g., ground station networks, testing facilities)
- Harmonize regulatory frameworks to facilitate cross-border space activities
- Support continental initiatives like SBAS that provide economies of scale

4. **Establish Clear Governance Frameworks**

- Create institutional mechanisms (e.g., space councils) to maintain continuity across political cycles
- Develop strategic roadmaps with 10-15 year horizons
- Join relevant international frameworks like the Artemis Accords
- Participate actively in international forums to ensure regional interests are represented

5. **Develop Legal and Regulatory Frameworks**

- Engage with UNOOSA's Technical Advisory Missions for specialized support
- Develop comprehensive national space policies before implementing legal frameworks
- Address key regulatory elements including authorization, supervision, liability, and registration
- Consider regional harmonization to address capacity limitations
- Ensure frameworks support both public and private space activities

6. **Prioritize Spectrum Management and Monitoring**

- Develop national capabilities for monitoring satellite signals and potential interference
- Participate actively in international frequency allocation processes
- Establish strategic partnerships for spectrum monitoring
- Invest in technologies to detect and mitigate interference
- Develop expertise in spectrum management and regulation

For Academic Institutions

1. **Bridge Theory and Practice**
    - Establish concurrent design facilities for hands-on systems engineering education
    - Develop project-based learning approaches like UIR's senior design projects
    - Create mechanisms to document and preserve "know-how" beyond individual student projects
    - Build laboratory facilities supporting practical skills development

2. **Build International Networks**
    - Establish partnerships with global space technology leaders
    - Participate in international small satellite development programs like BIRDS
    - Leverage open-source technologies and educational resources
    - Create exchange opportunities with established space institutions

3. **Focus on Interdisciplinary Education**
    - Integrate technical specializations with systems engineering approaches
    - Incorporate business and entrepreneurship modules in technical programs
    - Develop programs connecting Earth observation with domain applications
    - Create multi-level educational pathways from primary through professional development

4. **Enhance Educational Outreach**

- Develop programs like “Astronaut for a Day” to inspire young people
- Create content explaining space benefits in accessible language
- Establish astronomy clubs and observation opportunities
- Utilize social media and digital platforms to reach broader audiences

5. **Incorporate Space Law and Policy Education**

- Develop interdisciplinary programs connecting technical and legal aspects of space activities
- Create specialized tracks for space law and policy within existing programs
- Collaborate with international institutions on space law curriculum development
- Train legal professionals on space-specific frameworks and agreements
- Partner with government agencies to support policy and regulatory development

For Industry and Private Sector

1. **Identify Strategic Niches**

   - Focus on specialized applications rather than competing across all space segments
   - Leverage regional geographic advantages (e.g., Morocco's position for spaceports)
   - Develop solutions addressing regional priorities (food security, water management, etc.)
   - Build upon existing industrial capabilities (e.g., aerospace manufacturing)

2. **Adopt Appropriate Technologies**

   - Implement model-based systems engineering to accelerate development
   - Leverage open-source tools like the Falcon AI models for space applications
   - Develop rigorous cybersecurity practices from early developmental stages
   - Focus on technologies aligned with regional strengths

3. **Build Sustainable Business Models**

   - Develop services and applications that generate near-term value while building toward long-term capabilities
   - Form consortia to share infrastructure costs
   - Engage with international financial institutions and development banks for innovative financing
   - Create service-based offerings reducing upfront investment requirements

4. **Support Educational Initiatives**

- Partner with educational institutions to provide internships and real-world projects
- Contribute expertise and equipment to strengthen educational programs
- Develop corporate social responsibility initiatives supporting STEM education
- Create mentorship programs for emerging space professionals

5. **Prioritize Technology Transfer Initiatives**

- Identify space technologies with potential terrestrial applications
- Develop adaptation strategies for space technologies to address regional challenges
- Create partnerships with non-space sectors to accelerate technology adoption
- Document and share technology transfer case studies to demonstrate value
- Advocate for dedicated funding mechanisms supporting technology transfer

6. **Standardize and Modularize Technology Approaches**

- Adopt internationally recognized standards for satellite systems and interfaces
- Utilize modular approaches allowing incremental capability development
- Leverage existing launch and deployment infrastructure while developing specialized payloads
- Create standardized testing protocols aligned with international requirements
- Develop compliance processes for export control regulations from early development stages

For International Organizations

1. **Facilitate Technology Transfer**

   - Create frameworks for space technology sharing that respect security concerns
   - Develop capacity-building programs tailored to emerging space nations
   - Establish common data standards and sharing protocols
   - Support open-source technology initiatives like TII's Falcon models

2. **Provide Financial Support Mechanisms**

   - Create blended finance models for space infrastructure development
   - Support pilot projects demonstrating space applications for sustainable development
   - Fund programs connecting upstream space capabilities with downstream applications
   - Develop risk mitigation mechanisms for early-stage investments

3. **Promote Inclusive Governance**

   - Ensure emerging space nations have meaningful representation in governance bodies
   - Develop frameworks addressing space sustainability and resource utilization
   - Create mechanisms for equitable sharing of space benefits
   - Balance established and emerging interests in policy development

4. **Support Regional Integration**

- Facilitate regional coordination in policy development
- Fund infrastructure benefiting multiple countries
- Provide technical assistance for harmonizing regulations
- Support knowledge sharing across regions

5. **Address Spectrum and Orbital Resource Allocation**

- Develop more equitable frameworks for allocating limited orbital and spectrum resources
- Create mechanisms to ensure emerging space nations can access necessary frequencies
- Support the development of shared monitoring infrastructure
- Develop international standards for interference mitigation
- Establish dispute resolution mechanisms for spectrum conflicts

For Regional Coordination Bodies

1. **Map Existing Capabilities**

   - Conduct comprehensive mapping of space capabilities across regions
   - Identify gaps and opportunities for complementary development
   - Create databases of specialized expertise and facilities
   - Develop regional asset utilization strategies

2. **Facilitate Knowledge Sharing**

   - Create platforms for researchers, educators, and industry to share experiences
   - Establish regional conferences and workshops on space technologies
   - Develop regional networks of space professionals and researchers
   - Create mechanisms for translating research into applications

3. **Coordinate Education Standards**

   - Develop regional standards for space education ensuring compatibility
   - Create joint degree programs across regional institutions
   - Establish regional scholarships and exchange programs
   - Develop certification programs for specialized space skills

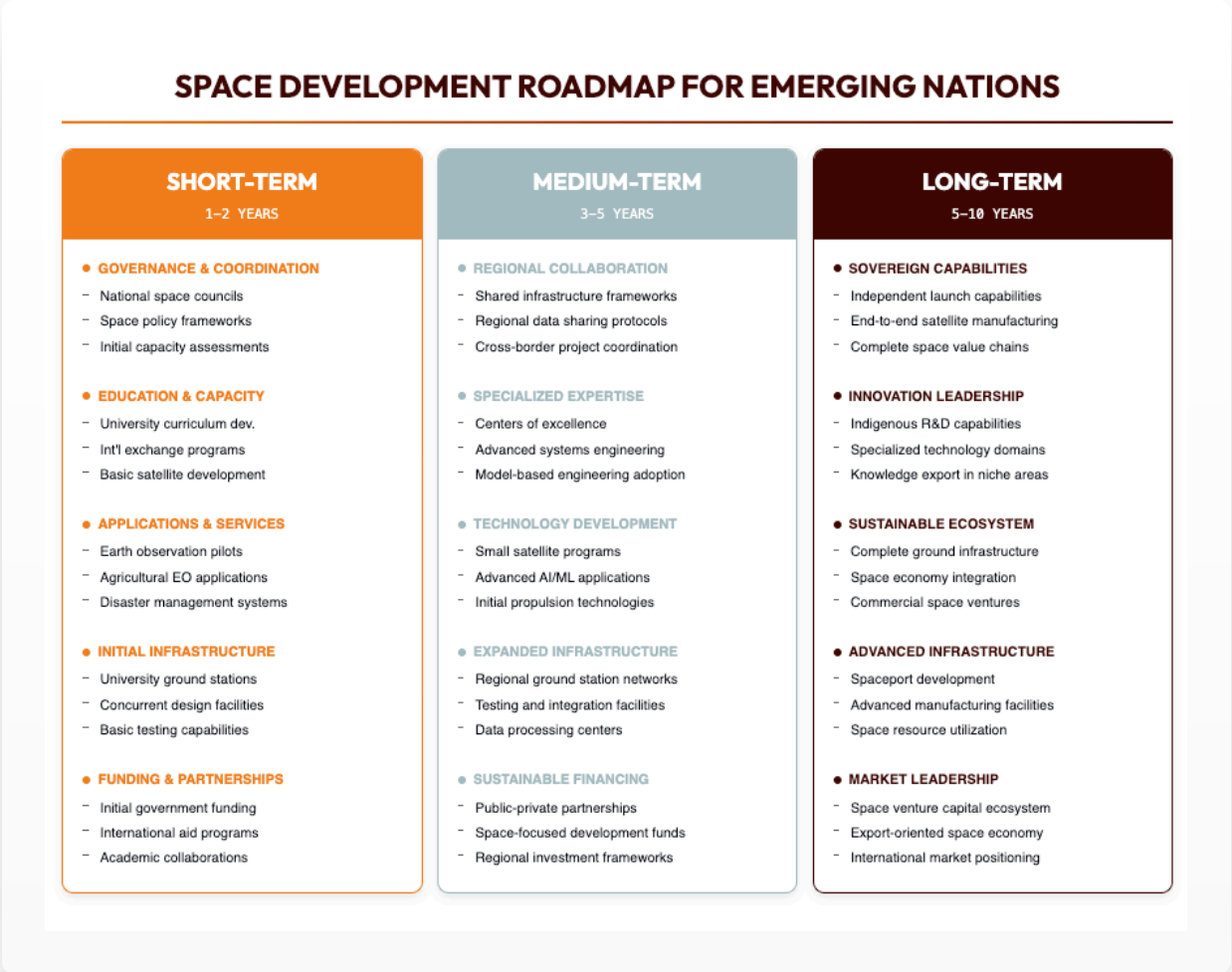
4. **Promote Space Sustainability Frameworks**

   - Lead development of regional approaches to space sustainability
   - Create frameworks for responsible space conduct
   - Develop approaches to space debris mitigation
   - Align space activities with regional development goals

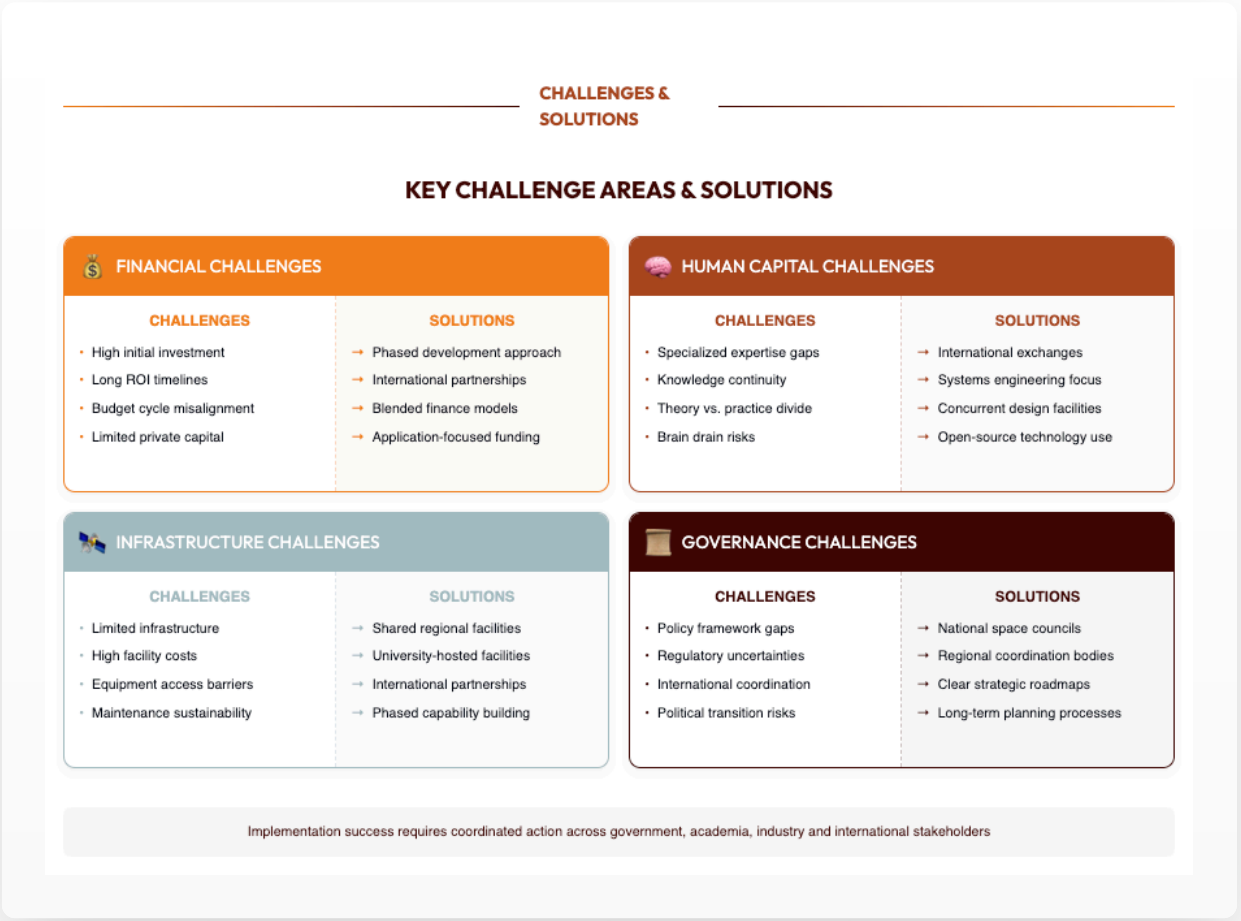
IMPLEMENTATION FRAMEWORKS

Stakeholder Responsibility Matrix

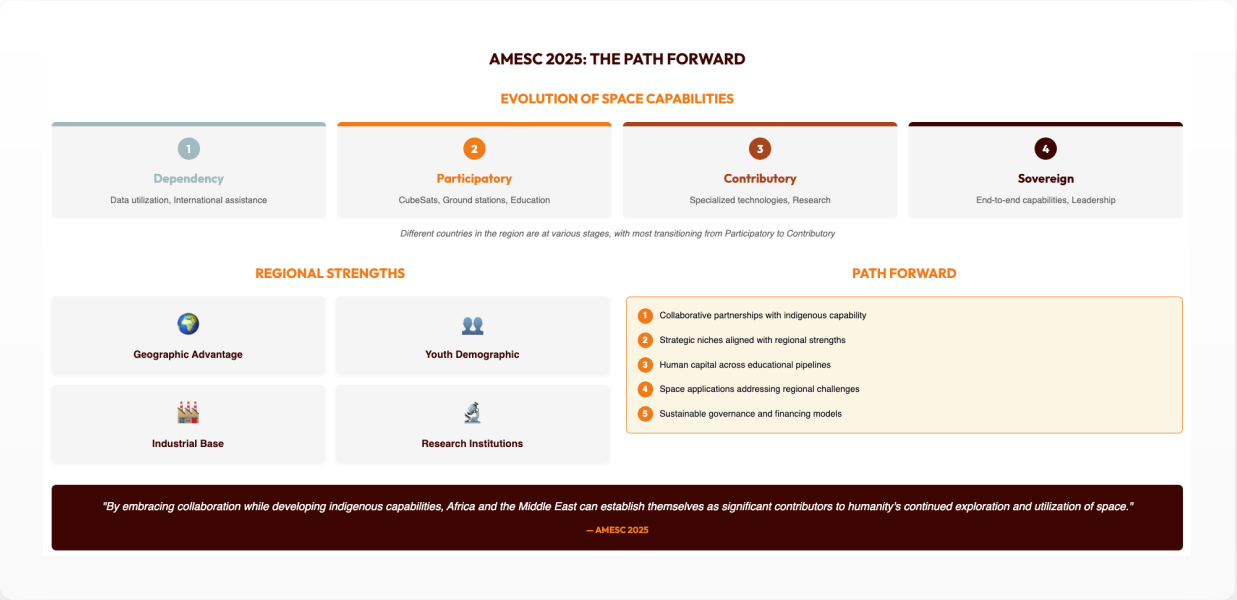
The matrix below outlines primary and supporting responsibilities for implementing the strategic recommendations across different stakeholder groups:



Challenges and Solutions Framework



CONCLUSION



The Africa Middle East Space Conference (AMESC) 2025 demonstrated the region's growing ambitions and capabilities in the global space ecosystem. Across four days of intensive discussions, a clear vision emerged for how Africa and the Middle East can contribute meaningfully to space exploration and development while addressing pressing terrestrial challenges.

Several key conclusions can be drawn from the conference:

First, international collaboration remains essential for emerging space nations, but the nature of collaboration is evolving from dependency relationships to more equitable partnerships. Programs like Kyutech's BIRDS initiative, MILO Institute's consortium approach, and Italy's Mattei Plan demonstrate how thoughtful collaboration models can accelerate capability development while respecting national sovereignty.

Second, human capital development stands as the foundation for sustainable space capabilities. From primary education initiatives like ExoLab to specialized university programs at UIR and professional development through international exchanges, building a skilled workforce requires coordinated investment across the educational pipeline. As H.E. Tidiane Ouattara emphasized, Africa's young population represents its greatest potential contribution to global space activities.

Third, emerging space nations can participate meaningfully by focusing on strategic niches aligned with their capabilities and priorities rather than attempting to replicate entire space programs. Morocco's success in aerospace manufacturing, CURTS' development of small satellites, and specialized research in areas like green propulsion demonstrate how targeted investments can create valuable capabilities. As Dr. Rodrigo Leonardi noted regarding Brazil's approach, "Look to yourself, see where you can add value."

Fourth, space technologies offer powerful tools for addressing regional challenges from food security to disaster response. Dr. Arid's presentation on Morocco's Earth observation applications across multiple sectors demonstrates the practical benefits of space investments, while the panel on food security highlighted how space technologies can support regulatory compliance while improving agricultural productivity.

The conference also highlighted significant challenges and opportunities in the rapidly evolving satellite landscape. Dr. Gamgami's presentation on China's space program demonstrated how determination and strategic focus can overcome economic limitations, providing inspiration for emerging space nations. Radim Badsi's insights into radio spectrum challenges emphasized the growing congestion in both physical space and the electromagnetic spectrum, requiring sophisticated monitoring and management approaches.

The presentations by Dr. Creydt on export control challenges, Henrik Pan on specialized materials like germanium, Dr. Souhair on Morocco's spaceport potential, Valeriya Barashkova on standardized deployment systems, and Dr. Arid on Earth observation applications collectively reinforced a crucial insight: emerging space nations can make meaningful contributions by focusing on strategic niches aligned with their unique advantages. Whether through specialized materials production, launch services leveraging geographic position, standardized deployment technologies, or Earth observation applications addressing regional challenges, the most successful approaches build incrementally on existing strengths rather than attempting to replicate entire space programs. As a panelist noted, "You don't have to have your own rocket or lander to go to the moon" – what matters is identifying where you can add unique value to the broader space ecosystem.

Additionally, the conference highlighted two critical enablers for sustainable space development in the region. First, as emphasized by Dr. Zantou, appropriate legal and regulatory frameworks are essential foundations for responsible space

activities. Morocco's leadership in ratifying all five UN space treaties demonstrates commitment to international norms, but the development of national space legislation remains a challenge across the region. Second, as illustrated by Constance Bourouh, strategic technology transfer can accelerate socio-economic benefits from space investments, creating a virtuous cycle of innovation and development. By adapting space technologies to address pressing terrestrial challenges, emerging space nations can demonstrate immediate value while building long-term capabilities.

Finally, successful space initiatives require an integrated approach spanning policy, education, infrastructure, financing, and applications. The most promising examples featured in the conference demonstrated coherence across these dimensions, creating sustainable ecosystems rather than isolated capabilities.

As Africa and the Middle East continue building their space capabilities, AMESC 2025 provided both inspiration and practical guidance. By embracing collaboration while developing indigenous capabilities, focusing on applications that address local priorities, and investing strategically in human capital, the region can establish itself as a significant contributor to humanity's continued exploration and utilization of space.

> *"The human capital is critical. This is where Africa will make a difference. Why? We do have 60% of young people, other continents, the birth rate is decreasing. We have to train our people not only to address our own problems, but also to be able to support others as labor without leaving the continent." — H.E. Tidiane Ouattara, President of the African Space Agency*

This report was compiled by the Moroccan Initiative for Space Industry (MISI) based on proceedings of the Africa Middle East Space Conference (AMESC) 2025. For more information about MISI and its activities, please visit www.misi.ma.