Symposium Proceedings

1st International Symposium on Space For Mauritius

Venue: Le Méridien Hôtel, Pointe-aux-Piments

18th -19th April 2024

Organised by : *Mauritius Research and Innovation Council*

In Collaboration with the Ministry of Information Technology, Communication, and Innovation

Acknowledgements

We extend our heartfelt gratitude to all who contributed to the success of the First Symposium on Space for Mauritius, organized by the Mauritius Research and Innovation Council (MRIC), which operates under the aegis of the Ministry of Information Technology, Communication and Innovation of the Government of the Republic of Mauritius.

We are grateful to our esteemed local and international speakers, panellists, and participants for their engaging discussions and contributions that sparked insightful discussions leading to new avenues for collaboration to consolidate the MRIC's initiatives in developing the space sector for the Republic of Mauritius.

A special thanks to the organizing committee and volunteers for their tireless efforts in bringing this symposium to fruition. Together, we have taken a significant step towards enhancing our national capabilities in space science and technology.

Thank you to our four generous sponsors – ***ArkEdge[1], Aeracces[2]s EMTEL[3],*** and ***GeoInt[4] -*** for believing in our vision and for their invaluable support to the symposium. Their commitment and partnership have played an important role in making this event a success.

We look forward to the continued collaboration and the positive impact of our collective efforts in the future to work together towards making Space Technology the next socioeconomic pillar for the Republic of Mauritius.

Thank you.

Mauritius Research and Innovation Council (MRIC)

[1] **ArkEdge** Space is a Japanese company specializing in nanosatellite development and space services, focusing on satellite communication, Earth observation, and maritime digitalization through innovative satellite technology. Their mission is to commercialize nanosatellite solutions and advance global space applications.

[2] **AerAccess Group** specializes in developing advanced unmanned aircraft systems (UAS) for defense, homeland security, and counter-UAS applications, providing innovative technology solutions for critical security missions.

[3] **Emtel** is a leading telecommunications provider in Mauritius, offering comprehensive mobile, broadband, and 5G services for both individuals and businesses. They are committed to enhancing connectivity through innovative solutions in voice, data, and digital services across the island.

[4] **GeoINT** is a South African company specializing in geospatial intelligence solutions that help organizations leverage location-based data for strategic insights. They offer tailored products and services to enhance decision-making and efficiency across various industries, integrating geospatial data to solve complex business and societal challenges.

Executive Summary

The 1st International Symposium on Space for Mauritius, hosted by the Mauritian Research and Innovation Council (MRIC) in collaboration with the Ministry of Information Technology, Communication and Innovation of the Republic of Mauritius, convened local and international experts, policymakers, and stakeholders from the space industry to outline Mauritius' potential and strategic vision within the global space sector. Given the country's strategic location in the Indian Ocean, Mauritius is well-positioned to harness space technologies for socioeconomic advancement, addressing challenges such as disaster management, agriculture, and sustainable resource management. The symposium highlighted collaborative efforts with various international partners, including the Indian Space Research Organisation (ISRO) and the United Nations Development Programme (UNDP), to explore applications in satellite technology, Earth observation, and geospatial intelligence.

A significant focus was placed on enhancing local expertise and capacity building. The MRIC's Space Unit has already made strides, launching the first Mauritian nanosatellite, MIR-SAT1, in 2021, and is now engaged in various collaborative projects to expand the country's technical knowledge and infrastructural capacity. Presentations emphasized the critical role of education and training, aiming to cultivate a skilled workforce to sustain long-term space sector growth in Mauritius.

The symposium addressed the challenges of limited human capital, awareness of Mauritius's space potential and the need for increased investment in space infrastructure. Discussions covered the regulatory and policy framework required to support space initiatives and create a supportive ecosystem for innovation and entrepreneurship. Various stakeholders explored the potential benefits of public-private partnerships and underscored the importance of alignment with international standards to foster growth in Mauritius' space sector.

The round table discussions promoted an inclusive and collaborative approach to the space industry. Participants acknowledged existing barriers such as fragmented efforts and limited cohesion across different space-related projects. The event concluded on an optimistic note, with a shared commitment to advancing Mauritius' position in the space industry. Key initiatives moving forward include enhancing the country's satellite capabilities, supporting startup ventures, and developing data-sharing platforms that facilitate collaborative research and innovation.

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FOREWORD

Dr Kaviraj Sharma Sukon,
PHEA, Chairperson of the MRIC

It is my great pleasure to present the proceedings of the First International Symposium on Space for Mauritius, an event that marks a pivotal moment in our nation's journey towards harnessing the potential of space technologies for sustainable development. This symposium has brought together experts, researchers, and innovators from around the world, united by a common goal: to explore how space-based technologies and research can contribute to addressing global challenges, while unlocking new opportunities for Mauritius.

As Chairman of the Mauritius Research and Innovation Council (MRIC), I am very proud of the strides our country is making in advancing science, technology, and innovation. The emerging field of space science presents immense possibilities, from satellite communications and earth observation to climate monitoring and disaster management. Mauritius, with its unique geographical position and commitment to innovation, is well-positioned to contribute significantly to global space initiatives.

This symposium not only showcases the research and innovations taking place in Mauritius but also augurs as a platform for collaboration with international partners. We are confident that the outcomes of this event will pave the way for groundbreaking projects, foster new partnerships, and inspire future generations of scientists and innovators.

I would like to express my heartfelt gratitude to all the esteemed speakers, participants, and organizers who have contributed to making this event a success. Let us continue to work together towards a future where space technologies are an integral part of Mauritius' development trajectory.

I hope you find the discussions in these proceedings insightful and that they inspire further exploration and collaboration in the exciting field of space science.

Thank You.

FOREWORD

Prof Theesan Bahorun,
PhD, G.O.S.K
Executive Director, MRIC

It is with great pride and anticipation that I introduce the proceedings of the First International Symposium on Space for Mauritius. This landmark event reflects Mauritius' growing commitment to leveraging space technologies for national and global development, fostering innovation, and enhancing our scientific capabilities.

At the Mauritius Research and Innovation Council (MRIC), we firmly believe that space research is no longer a distant frontier reserved for large nations but a vital and accessible field for small island states like Mauritius. The opportunities presented by space science and technology are vast and transformative, from satellite data applications in environmental management and agriculture to space-based innovations that contribute to disaster resilience and economic development. The insights shared during this event will not only shape our local space initiatives but also place Mauritius as a key player in the global space community.

I would like to express my deepest appreciation to all participants, speakers, and partners who have supported this endeavor. The symposium represents a first step towards creating a strong foundation for space-related innovation in Mauritius, and I am confident that it will ignite new ideas, collaborations, and breakthroughs in the years to come.

As you explore the content of these proceedings, I hope you are inspired to contribute further to consolidating the sustainable development of our space technology program– a new future and hope for development for the Republic of Mauritius

Thank You.

BACKGROUND

1. Contextualising The 1ST International Symposium On Space For Mauritius

The Republic of Mauritius is ideally located in the Indian ocean offering numerous advantages for space exploration, earth observation and remote sensing. This geostrategic position, coupled with other key factors such as its political stability, high connectivity, high literacy rate, and emerging economy among others offer a very good potential for future development in space and satellite technology for peaceful mission.

Leveraging the transformative opportunities for space exploration prevailing in this new space era, Mauritius, through the MRIC, made its historical entry into space in June 2021 by deploying its first ever nanosatellite (MIR-SAT1 – *www.spacemauritius.com*) This achievement marks the beginning of the island nation's aspirations to play an active role in space exploration and satellite technology.

MIR-SAT1 allowed Mauritius to make a huge leap in space technology initiation and inspired the MRIC to create the Mauritian Space Program which revolves around four major thrusts, namely: (i) Awareness, Capacity Building, and Training; (ii) R&D on downstream applications using satellite data for advising policy makers; (iii) leveraging on the space presence of friendly countries to push forward the Mauritius Space Agenda and (iv) incentivizing new startups in the Space/satellite field to set up in Mauritius.

In pursuit of our vision to making space technology our next Socioeconomic pillar, the MRIC in collaboration with the Ministry of Information Technology Communication and Innovation, sought to solicit inputs from the expertise of diverse local and international experts during the First International Symposium on New Space for Mauritius. This Symposium served as an open discussion platform to push the Mauritian Space Agenda forward by tapping into the expertise of internationally renowned space and satellite technology experts and thought leaders together with key Mauritian stakeholders from the public sector, private sector, academia, and the society.

The experts examined the following themes:

- Downstream applications of satellite data
- R&D and capacity building in space and satellite technologies
- Regulatory considerations for new space for Mauritius
- Space and Business for Mauritius

Through engaging discussions, insightful presentations, and collaborative workshops, the organizers leveraged collective expertise and resources to foster a deeper understanding of the possibilities and challenges associated with integrating space technologies into national development agenda of the Republic of Mauritius. Moreover, the Symposium on New Space for Mauritius provided a unique opportunity for networking and forging partnerships that can propel the participating local institutions into the forefront of the space domain to unlock the full potential of space-based applications.

The outcomes of the symposium will provide key insights for the MRIC to draft a roadmap for further development of the Space and Satellite Technology for Mauritius.

ABOUT US

The Mauritius Research and Innovation Council (MRIC) (www.mric.mu), operating under the aegis of the Ministry of Information Technology Communication and Innovation, is the apex body advising the Government of Mauritius in all matters pertaining to Science, Research, Technology and Innovation. The MRIC is committed to channeling Government investment in R&D towards impactful outcomes for the socioeconomic good of the People of Mauritius. Throughout the last three decades, the MRIC pioneered a number of key projects which have contributed to the socioeconomic development of the Republic of Mauritius. The MRIC's latest flagship achievement is the deployment of the first nanosatellite for the Republic of Mauritius in 2021 (www.spacemauritius.com). This historical milestone subsequently triggered a new wave of thinking and action geared towards a holistic vision of leveraging on Space and Satellite technology for the benefit of our nation.

2. Workshop Programme

DAY 1 – 18 April

Venue: Le Meridien Hotel, Pointe-aux-Piments

Time	Agenda
09:00 – 09:30	*Registration*
09:30 – 09:35	Welcome Address ***Prof T Bahorun**, Executive Director, Mauritius Research, and Innovation Council*
09:35 – 09:40	Address ***Dr K.S. Sukon**, Chairman, Mauritius Research, and Innovation Council*
09:40 – 10:05	Keynote Address ***Honourable D. Balgobin**, Minister of Information Technology, Communication, and Innovation, Republic of Mauritius*
10:05 – 10:30 - Tea Break	
Downstream Applications of Satellite Data	
10:35 – 10:45	**Mauritius in the New Space Era** – *Dr V. Bissonauth, Research Coordinator, MRIC*
10:45 – 10:55	**Bringing Space to Mauritius –** *Mr K. Ramsingh; Founder & CEO GeoINT, South Africa*
10:55 – 11:05	**Earth observation applications for sustainable development - Case studies in Urban development, Agriculture, Water Resources, Drought, Flood, Marine pollution, and Bathymetry -** *Dr M. Nowbuth, Lecturer, University of Mauritius*
11:05 – 11:15	**Remote Sensing & GIS application for Precise Sugarcane Farming in Mauritius –** *Mr S. Cadoo; Geographical Information System Officer, Land Drainage Authority*
11:15 -11:25	**Harnessing the Potential of Satellite Data in the South West Indian Ocean** – *Mr. E. Martial, Mauritius Oceanography Institute*
11:25 – 11:35	**Vessel Monitoring System (VMS)** – *Mrs D. Candassamy; Ministry of Blue Economy, Marine Resources, Fisheries and Shipping (Fisheries Division)*
11:35 – 11:45	**VDES Satellite constellation for Maritime Digitization** – *Mr M. Tsuji, Technical consultant ArkEdge Space Inc, Japan*
11:45 – 11:55	**Feeding the Future: Satellite Technology Transforming Agriculture -** *Veerraj-Karpoorkar Heerea; FAREI*
11:55 – 12:45	**Round Table Discussion – Consolidating Space Applications in Mauritius**
12:45 – 13:35 - Lunch	
R&D and capacity building in space and satellite technologies	
13:35 – 13:45	**Small satellite development and its transformative impact on non-spacefaring countries -** *Bonny Omara Special Presidential Assistant on Space Engineering under the State House, Uganda*.
13:45 – 13:55	**NEREUS: A Space-Based Maritime Surveillance System for Fisheries Monitoring and Anomaly Detection –** *Dr R. Guida, Associate Professor, Surrey Space Centre (SSC), University of Surrey, United Kingdom*
13:55 – 14:05	**Radioastronomy in Africa - Looking at the Invisible Universe in Radio Waves –** *Dr R. Somanah; Director General, Universite des Mascareignes*
14:05 – 14:15	**Radio Astronomy and Satellite Imagery work at the University of Mauritius -** *Dr. N. Heerallal-Issur; Associate Professor in Physics, University of Mauritius*
14:15 – 15:15	***Round Table discussion – Reflection on how Mauritius moves forward in its space Agenda***
15:20 -15:30	**Assessing Land Use of the G.R.N.W Catchment using Remote Sensing Techniques –** *Ms Y. Khoodeeram, University of Mauritius*
15:30 – 15:40	**Synthetic Aperture Radar (SAR) and/or Interferometric SAR (ISAR) Applications for Mauritius** - *Dr. Girish Kumar Beeharry, Associate Professor in Physics, University of Mauritius*
15:40 -15:50	**Research in Agriculture (sugarcane) using remote sensing (Satellite and drone imagery)-** *Preetee Mahadea Nemdharry, Mauritius Sugarcane Industry Research Institute-Mauritius - Cane Industry Authority (MSIRI-MCIA)*
Tea Break and Networking	

WORKSHOP PROGRAM

DAY 2 – 19 April

Venue: Le Meridien Hotel, Pointe-aux-Piments

Time	Agenda
09:00 – 09:30	*Registration*
Space and Business for Mauritius	
09:30 – 09:40	**Space Business – a booming industry –** *Mr T. Rudolph, Managing Director AZO Space, Germany*
09:50 – 10:00	**African Space Economy- Opportunities for Mauritius –** *Mr Temidayo Oniosun, Founder and Managing Director of Space in Africa*
10:00 -10:10	**Aerborne technological solutions in the New Space Era -** Mr *S. Kalachand, Founder & CEO Aeraccess Group*
10:10 – 10:20	**Business and Innovation Ecosystem in Mauritius** *–P.Sewpal, EDB representative*
10:20 – 10:30	**Role of a telco/tech company in supporting the space economy led business for Mauritius** *– Mr S. Nautiyal, Chief Strategy and Innovation Officer, Emtel Ltd*
10:30 – 10:50	Tea Break and Networking
10:50 – 11:00	**Mauritius International Financial Centre, Your Business Facilitation Hub in Africa** - *Mrs D.Pillay-Naiken, Ag Director, Financial Services Unit, Ministry of Financial Services and Good Governance*
11:00 –12:15	**Round Table Discussion – Space business In Mauritius – how far are we from implementation?**
12:15 – 13:15	Lunch
Regulatory considerations for new space for Mauritius	
13:30 – 13:40	**Mauritius as a new emerging spacefaring nation? Policy & Regulatory consideration** - *Mrs K. Gungaphul-Brocard, Scientific Advisor & Lawyer, Swiss Space Office of the State Secretariat for Education Research, and Innovation SERI of the Swiss Confederation, Switzerland*
13:40- 13:50	**Mauritius Satellite Space Sector Regulatory Considerations -** *Mr D. Pursunon, Engineer and Licensing Officer, Information and Communication Technologies Authority of Mauritius (ICTA)*
13:50 – 1430	***India-Mauritius Joint Satellite*** *– Mr. Avinash M*, Scientist / Engineer at U.R.Rao Satellite Centre, Bangalore – Indian Space Research Organisation (ISRO) – India
14:30 – 14:40	**African Space Economy- Opportunities for Mauritius –** *Mr Temidayo Oniosun, Founder and Managing Director of Space in Africa – VIA ZOOM*
14:40 – 14h50	**Space Business – a booming industry –** *Mr T. Rudolph, Managing Director AZO Space, Germany – VIA ZOOM*
14h50 – 15h00	**Challenges of the New Space Age and How to Overcome Them in Developing Countries -** *Mr. B. Waibi, Program Officer/Space Policy Analyst Aeronautics & Space Science Bureau, Uganda*
15h00 – 16h00	**Round table discussion – Regulatory considerations for Mauritius Space Initiative**
	Tea Break and Networking

DAY 1

Session 1

DOWNSTREAM APPLICATIONS OF SPACE DATA FOR THE REPUBLIC OF MAURITIUS

3. Envisioning the Mauritius Space Programme

Presentation given by: Dr Vickram. Bissonauth, Research Coordinator, MRIC

About the Speaker:

Dr Vickram Bissonauth is a highly skilled Research Coordinator and Molecular Biologist with over 15 years of experience, specializing in Fundamental Research, Innovation Management, and Space Development Programs. With a PhD in Molecular Biology and a proven track record in managing National Programs and fostering the ecosystem for startups in Mauritius, Vickram has successfully launched key initiatives such as the National SME Incubator Scheme and Mauritius' first nanosatellite. Currently He is focused on Space Development for Mauritius.

Background:

The Republic of Mauritius won the KiboCUBE Programme in 2018 organised the United Nations Office for Outer Space Affairs (UNOOSA) and the Japan Aerospace Exploration Agency (JAXA) . Through the KiboCUBE Programme, the Republic of Mauritius was offered the opportunity to launch and deploy a 1U Nanosatellite from the International Space Station (ISS) free of cost.

The First Mauritian Satellite, MIR-SAT1 (Mauritius Imagery Radiocommunication Satellite 1) designed by the MRIC's Space Unit constituting of team of Mauritian Engineers and scientists, was launched in June 2021 and re-entered into the earth's atmosphere in April 2022 after. The satellite spent 10 months in space before completely disintegrating in the earth's atmosphere[5, 6].

Despite the phasing out of the MIR-SAT1, the MRIC's Space Unit endeavoured to exploit all the facilities set in place through the MIR-SAT1 project. Consequently, the Ground Station infrastructure was used to track and telecommand one of India Space Research Organisation (ISRO) satellite INS2B. In this connection, the MRIC signed a Contract Agreement with ISRO in November 2022 for a period of 6 months and extendable for up to a maximum of 2 years.

Furthermore, to explore the research and development opportunities offered by the new space field, the MRIC's Space Unit secured a collaboration with the Surrey Space Centre (SSC) from the university of Surrey, UK to develop an algorism for Mauritius to detect Illegal, Unreported and Unregulated (IUU) fishing in the Mauritian Exclusive Economy Zone (EEZ)[7]. The project, which started in June 2022, is fully funded by the UNDP under the Ocean Innovation Challenge[8].

In January 2023, the MRIC has signed a Framework Agreement with the Mohammed Bin Rashid Space Centre (MBBRSC) to develop a payload in collaboration under the Payload Hosting Initiative where MRIC's Space Unit Engineer will developing a payload with the MBRSC which will fly on one of their satellites. Through this agreement, the MRIC in collaboration with the MBRSC organised a Live Event with their Emirati Astronaut who was onboard the International Space Station where 14 students had the opportunity to ask their questions. 400 students from the Republic of Mauritius participated for the event including Rodrigues and Agalega.

[5] www.spacemauritius.com

[6] https://www.unoosa.org/documents/pdf/psa/access2space4all/KiboCUBE/3rdRound/Interview_Article_MRIC_20210811_FINAL.pdf

[7] https://africanews.space/mric-partners-with-ssc-undp-and-university-of-surrey-to-launch-project-nereus/

[8] https://oceaninnovationchallenge.org/ocean-innovations/space-based-maritime-surveillance

The MRIC signed an MoU with ISRO on the 1st November 2023 for the implementation of the India Mauritius Joint Satellite (IMJS). In this Agreement ISRO will be working in close cooperation with MRIC engineers to design, build, launch and control the IJMS. The overall duration of the project, from signature of the MoU to the launching of the satellite in space, has been estimated to be around 15 months, should there be no technical/administrative issues. MRIC Engineers will get hands on training in India.

Way Forward:

The Republic of Mauritius is ideally located in the Indian ocean offering numerous advantages for space exploration, earth observation and remote sensing. This geostrategic position, coupled with other key factors such as its political stability, high connectivity, high literacy rate, and emerging economy among others offer a very good potential for future development in space and satellite technology for peaceful mission. We envisage making the space sector a new socio-economic pillar for the short and long-term benefits of the Republic of Mauritius.

Considering the above, the MRIC has initiated the development of the ***Mauritian Space Masterplan*** which will focus around six major actions, namely:

(i) Driving Innovation for the Republic of Mauritius in all matters pertaining to space and satellite projects to be developed in Mauritius e.g. Funding project/startups around space/satellite data and satellite technology
(ii) Acting as Focal point for Satellite data relevant to Mauritius. Such data will be made available for the Mauritian scientists and policy makers in view of consolidating their respective work and research.
(iii) Researching and implementing space-based solutions for the betterment of the lives and livelihood of the people of Mauritius.
(iv) Strengthening collaborative links with countries advanced in the space/satellite field.
(v) Making the agency a revenue generating entity.
(vi) Incentivising implementation startups operating in the space and satellite sector.

The outcomes of the discussions of the international workshop would prove to be of key importance for pursuing the above initiatives.

4. Bringing Space to Mauritius

Presentation given by: Kamal Ramsingh
Founder & CEO GeoINT, South Africa

About the Speaker:

Kamal has been entrenched in the African ICT sector for nearly three decades, with his career spanning executive roles in multinational consultancies, where he has guided CIOs and enterprises through Africa's varied tech landscapes. As an ICT entrepreneur, he is seizing the potential of the geospatial intelligence market. At the helm of GeoINT as Founder and CEO, and as chairman of digital mapping leader MapIT—previously TomTom SA—a pioneering enterprise in digital mapping solutions, which complements GeoINT's mission to deliver revolutionary geospatial products and solutions across various sectors. His expertise has been sought in the highest echelons of global brands, and he's played a key role in shaping South Africa's space industry through ZASPACE. Kamal's passion lies in transforming spatial data into innovations that drive better business and societal outcomes. His vision for GeoINT encapsulates his ambition—to manifest technological innovation on a global scale through strategic partnerships.

Introduction

I would like to extend my sincere appreciation to the MRIC and the organizers for inviting me to participate in this pivotal event. I firmly believe that this gathering will play a significant role in the future of the Mauritian space sector. In the coming years, we may celebrate Mauritius's first astronaut, and the event on the 18th of 2024 will undoubtedly be remembered as the foundation that made this milestone possible.

As someone who identifies as a "life servant of technology" and a self-proclaimed "immigrant to the space industry," I bring a unique perspective to the discourse surrounding the potential of the space sector in Mauritius. My experience as the founding chairperson of ZASpace, South Africa's space industry body, fuels my passion for the transformative impact of space technology on nations, businesses, and society.

The Geospatial Revolution

The focus of today's discussion centers on the remarkable potential of geospatial technologies. The industry's growth is projected to yield a direct economic impact of approximately USD 30 trillion. Within this dynamic landscape, Global Navigation Satellite Systems (GNSS) and positioning technologies are expected to lead, comprising nearly 45% of the market share. This is followed by Geographic Information Systems (GIS) and spatial analytics at approximately 25%, and Earth observation technologies at about 17%.

These vast potential underscores the importance of leveraging geospatial technologies to enhance business outcomes and foster societal benefits.

Addressing Existing Challenges

While the opportunities in the space sector are abundant, several challenges must be addressed to maximize growth:

1. Silos: Fragmentation within the industry can impede collaboration and innovation.

2. Capital Constraints: Financial limitations may restrict investment in critical technologies and infrastructure.
3. Technical Terminology: Complex jargon often alienates potential stakeholders and users.
4. Skill Shortages: There is a pressing need for a skilled workforce to meet the growing demands of the industry.

Key Pillars for Success in Mauritius

To effectively shape the future of space in Mauritius, we must concentrate on four fundamental pillars:

1. Consumer-Centric Approach:
    - Place the end-user at the core of every initiative. By adopting a use-case-driven approach, we can ensure that our programs are both relevant and impactful from the outset.
2. Community and Ecosystem Development:
    - Establish a collaborative ecosystem that integrates all stakeholders along the entire upstream and downstream value chain. This ecosystem should foster relationships among various players in the space sector, including government, industry, and academia.
3. Collaboration:
    - Align the strengths of state, industry, and research/academia to achieve sustainable success. By working in concert, these entities can optimize resources and expertise, leading to innovative solutions and enhanced capabilities.
4. Effective Communication:
    - It is essential to demystify the space sector for all stakeholders. By focusing on the tangible value that space technologies can deliver, particularly in developing the skills of the future, we can engage schools and universities meaningfully.

Practical Applications: GNSS Technology in Action

A notable example of how geospatial technologies can directly impact business and society is the demonstration of Mauritius's road traffic management product, which utilizes downstream GNSS technology. This application illustrates the tangible benefits of harnessing satellite-based positioning to improve urban mobility, reduce congestion, and enhance overall traffic management.

Conclusion

In summary, the Mauritian space industry stands at the brink of remarkable growth and innovation. By focusing on consumer needs, fostering a collaborative ecosystem, leveraging partnerships, and communicating effectively, Mauritius can unlock the vast potential of space technologies. The future is promising, and I look forward to contributing to this exciting journey as we shape the landscape of space in Mauritius.

As we move forward, let us remember that collective efforts will elevate us all, creating a thriving space sector that benefits not only Mauritius but also contributes to the broader global community. Thank you, and I wish everyone success in the ongoing discussions and initiatives at this conference.

5. Earth observation applications for sustainable development - Case studies in Urban development, Agriculture, Water Resources, Drought, Flood, Marine pollution, and Bathymetry

Presentation given by: Dr M. Nowbuth, Lecturer, University of Mauritius

Manta Nowbuth is an Associate Professor at the University of Mauritius, where she has developed significant expertise in the water sector, particularly in numerical modeling, following her training in Civil Engineering. With over 25 years of experience in academia, she has played a key role in designing programs and developing skills for both undergraduate and postgraduate students in Civil Engineering. Her research focuses on the sustainable development of water resources and the impacts of climate change. Professor Nowbuth is actively engaged in regional initiatives, including WaterNet, WARFSANEPAD, and the Global Water Partnership for Southern Africa, and she leads several multidisciplinary research projects at the national level. As a representative of the University of Mauritius on national and regional committees, she has made valuable contributions to addressing issues related to the water sector, environmental protection, coastal zone management, and disaster risk reduction.

Introduction:

Dr. Manta Nowbuth highlighted the crucial role that Earth observation and Geographic Information Systems (GIS) play in the sustainable development of small island developing states like Mauritius. Her discussion centered on the practical applications of these technologies in areas such as urban planning, agriculture, water resource management, drought and flood monitoring, marine pollution, and bathymetry. Dr. Nowbuth shared the University of Mauritius's (UOM) experiences in implementing these technologies over the years, along with the challenges faced and recommendations for broader adoption within Mauritius.

Earth Observation and GIS at the University of Mauritius:

Dr. Nowbuth began by outlining her role as a lead lecturer at UOM, where she teaches courses on the practical applications of GIS and remote sensing to address various developmental challenges in Mauritius. She emphasized the value of these technologies in supporting decision-making and described how they have advanced understanding and management of complex environmental issues in the country.

The University of Mauritius integrated Earth observation into its curriculum in the 1990s, despite initial challenges, such as limited access to high-resolution satellite imagery and software. Early GIS adoption involved low-resolution imagery with limited capabilities to meet the specific needs of a small island nation. Nevertheless, the university has steadily enhanced its capabilities. In 2017, UOM was recognized by the Environmental Systems Research Institute, Africa (ESRI-Africa), which monitors Earth observation activities in the region. ESRI provided the university with software and training resources, underscoring UOM's commitment to using GIS and remote sensing to address pressing issues in Mauritius.

Applications of Earth Observation Technology:

Dr. Nowbuth showcased numerous case studies that demonstrate the potential of Earth observation data for sustainable development in Mauritius, particularly its ability to offer valuable insights into

temporal and spatial changes across land and marine environments. These applications span climate change, pollution monitoring, coastal protection, and agricultural planning.

One compelling example involved multi-criteria analysis in agricultural planning. UoM Students, under her supervision, have created suitability maps for crops such as potatoes, using satellite imagery to assess factors like soil quality, water availability, and terrain. Such maps are invaluable for optimizing land use and enhancing agricultural productivity. Additionally, students have worked on shoreline analysis, crucial for coastal engineering and protection against erosion, and they analyzed the impacts of recent droughts on agriculture using satellite data to assess land use and water resource changes.

Another significant application lies in marine pollution monitoring, where Dr. Nowbuth highlighted student projects on algal blooms and oil spills. These projects compared satellite imagery with on-ground data to assess the extent and impact of pollution, enabling a clearer understanding of pollution patterns and their effects on marine ecosystems.

Dr. Nowbuth also stressed the importance of GIS and remote sensing in urban development. For instance, students have mapped land-use changes over time to track the expansion of built-up areas and assess its implications for flooding and other environmental impacts. The ability to monitor these changes is crucial for urban planning and sustainable city development, especially as Mauritius faces the challenges of rapid urbanization.

Challenges in Adopting Earth Observation Technologies

While Earth observation and GIS offer many benefits, Dr. Nowbuth outlined several challenges hindering their widespread adoption in Mauritius. One significant obstacle is the lack of technical support, particularly for remote sensing. Although GIS has gained broader acceptance and support, remote sensing faces accessibility and comprehension challenges. Many institutions in Mauritius remain unfamiliar with the potential applications of Earth observation data and thus do not fully utilize these technologies in decision-making.

Financial constraints also pose a significant challenge. Implementing Earth observation technologies requires considerable investment in specialized workstations, software, and human resources. High licensing costs for GIS software, such as ArcGIS, often deter institutions from adoption. Consequently, UOM promotes open-source alternatives, such as QGIS, to help bridge this gap; however, these options still require training and technical support for effective use.

Dr. Nowbuth noted that UOM has attempted to address these challenges by conducting training programs for professionals in various sectors, including the Land Drainage Authority. However, she emphasized that more institutional support and investment are necessary to ensure that these technologies can be sustainably integrated into the workflows of both public and private sector organizations.

Recommendations for Advancing Earth Observation in Mauritius

To foster the broader adoption of Earth observation technologies in Mauritius, Dr. Nowbuth proposed several recommendations. First, she stressed the importance of investing in human resources, especially through training professionals already employed in relevant sectors. While educating students is crucial, experienced professionals are best positioned to advocate for these technologies within their institutions.

She also recommended increasing access to satellite data and developing partnerships with international organizations. By leveraging networks like the Mauritius Oceanography Institute (MOI) and collaborating with global Earth observation initiatives, Mauritius could gain access to valuable data and technical resources to support its national development goals.

Finally, Dr. Nowbuth suggested that government and academic institutions organize national events like this First International Symposium on Space for Mauritius, to promote awareness and adoption of Earth observation technologies. These events would help build local expertise, showcase successful applications, and highlight the potential of Earth observation data for addressing the country's environmental and developmental challenges.

Conclusion

Dr. Nowbuth concluded by emphasizing the transformative potential of Earth observation and GIS technologies for sustainable development in Mauritius. While UOM has made significant strides in integrating these technologies into its curriculum and research, there remains a pressing need for increased institutional support, technical training, and funding to overcome existing barriers. By investing in these areas, Mauritius can harness the full potential of Earth observation data to address critical environmental and developmental challenges, from urban planning and agriculture to marine pollution and disaster management.

Her presentation underscored the importance of continued investment in Earth observation technologies to support Mauritius's journey toward sustainable development. Through education, collaboration, and innovation, Mauritius can position itself as a regional leader in utilizing space-based technology for societal and environmental betterment.

6. Remote Sensing & GIS application for Precise Sugarcane Farming in Mauritius

Presentation given by: Mr Mohammed Sulaiman Cadoo; Geographical Information System Officer, Land Drainage Authority

Mr. Mohammed Sulaiman Cadoo is a Geographical Information System (GIS) officer, with a background in geomatics and experience in various projects, including initiatives under the United Nations Convention to Combat Desertification (UNCCD), Mr. Cadoo has achieved notable success in the field. He recently placed second in an entrepreneurial challenge hosted by the Development Bank of Mauritius for a geospatial innovation project and participated in the "Map Morris" competition, funded by the Mauritius Research and Innovation Council. His work demonstrates a commitment to leveraging GIS and remote sensing to support sustainable agriculture in Mauritius, particularly within the vital sugarcane industry.

The Sugarcane Industry in Mauritius

Mr. Cadoo emphasized the historical and economic importance of sugarcane to Mauritius. Despite its significance, the industry faces several challenges, including reduced sugarcane land due to urban expansion, increased production costs, environmental concerns, changing climate conditions, and labor shortages. These issues threaten the long-term sustainability of sugarcane farming, making innovative approaches like GIS and remote sensing essential for improving farm management and enhancing productivity.

Aims and Objectives of the Project

The primary objective of Mr. Cadoo's project was to optimize field management in sugarcane farming through precise, data-driven practices. Specific goals included identifying key factors that influence crop yield, implementing near real-time crop assessments using remote sensing, analyzing data within a GIS framework, and delineating yield management zones to monitor field performance effectively. By combining remote sensing and GIS, the project aimed to offer cost-effective, objective tools for precision agriculture.

Methodology and Data Collection

The study was conducted on a nine-hectare sugarcane field in northern Mauritius, owned by Terragri Limited. Mr. Cadoo's methodology involved multiple stages: data acquisition, data processing, ground truthing, and yield management analysis. Data collection included a boundary and topographical survey to create a Digital Elevation Model (DEM), with additional data sourced from USGS Earth Explorer, including Sentinel-2 and Landsat-8 satellite imagery. Key thematic layers derived from this data included slope, aspect, soil texture, drainage density, and vegetation indices such as NDWI and NDVI.

Data Processing and Analysis

The data processing phase involved correcting geometric distortions and applying radiometric and atmospheric corrections to the satellite images. Within a GIS environment, Mr. Cadoo generated thematic layers showing the DEM, slope, rainfall distribution, solar radiation, and drainage density, revealing essential factors influencing sugarcane growth. For instance, areas with high slopes were prone to soil erosion, which could negatively impact crop yield. Additionally, solar radiation and drainage patterns were analyzed to identify areas with better growth potential.

Key Findings

Through remote sensing, Mr. Cadoo identified zones within the field with varying suitability for sugarcane cultivation. Results indicated that certain areas received higher sunlight exposure, making them ideal for sugarcane. The project also highlighted variations in soil moisture, which affects crop performance, and identified poorly drained areas where sugarcane is unlikely to thrive. By using indices such as NDVI and GCL, the study delineated zones with high, moderate, and low yield potential, enabling farmers to allocate resources more effectively.

Mr. Cadoo also utilized thermal infrared bands to monitor temperature impacts and shortwave infrared bands to assess pest infestation risks. Integrating these data layers enabled a detailed analysis of field conditions, resulting in a yield management map that categorized areas into high, moderate, and low performance. This map empowers farmers to optimize resource allocation by concentrating efforts on high-performance zones, ultimately maximizing profitability.

Recommendations and Conclusion

Mr. Cadoo recommended that farmers leverage geospatial technologies for vegetation analysis and yield management. By using remote sensing and GIS, farmers can transition away from traditional, labor-intensive practices and rely on precise, data-driven methods. The project demonstrated that yield management zones, validated through ground truthing, reflected field realities, and that weighted overlay analysis was effective in modelling the field's performance.

Moreover, Mr. Cadoo emphasized the transformative potential of integrating geospatial technologies with emerging tools such as AI, IoT, and fintech to advance precision agriculture. Adopting these technologies could enhance productivity and sustainability in the Mauritian sugarcane industry, positioning it to meet future challenges with resilience and innovation.

7. Harnessing the Potential of Satellite Data in the South West Indian Ocean

Presentation given by: Mr. Eric MARTIAL, Systems Administrator, Mauritius Oceanography Institute

Mr. Martial joined the Mauritius Oceanography Institute (MOI) in 2005 as a Project Officer in IT, now known as Systems Administrator. With extensive experience in Information Technology, he established the Institute's ICT infrastructure and developed several software for the MOI. For the past 15 years, Mr Martial has actively participated in different regional projects dealing with the use of satellite data for decision making. He was involved in the African Monitoring of the Environment for Sustainable Development (AMESD) project as systems administrator, developer and trainer. He then led the MOI-AMESD team from March 2011 to June 2013. He was the Project Leader of the Monitoring for Environment and Security in Africa (MESA) project for the Indian Ocean Commission region from March 2014 to September 2017. He headed the Global Monitoring for Environment and Security and Africa (GMES and Africa) Phase I for the East Africa region from July 2020 to December 2021.

Introduction

Mr. Eric Martial, an administrator at the Mauritius Oceanography Institute (MOI), presented on the effective use of satellite data for oceanographic applications in the Southwest Indian Ocean. His presentation covered the MOI's background, advancements in satellite data applications, and its impact on marine and coastal management across the region. Established in 2000, the MOI has developed significant oceanographic research capabilities, benefiting from partnerships with organizations like the European Union and the African Union Commission. Through collaboration with the Indian Ocean Commission, the MOI has extended its reach across island states and the East African coastline, enhancing regional cooperation in oceanographic research.

MOI's Mission and Regional Projects

The MOI's mission is to support decision-making in marine and coastal management using satellite data. Key projects—such as the Monitoring for Environment and Security in Africa (MESA) and Marine Spatial Data Infrastructure (MSDI)—have enabled the development of regional satellite capabilities. These projects have also bolstered infrastructure, establishing receiving stations in partner countries like Seychelles, Madagascar, Kenya, and Tanzania. By providing satellite data access to these countries, the MOI has facilitated valuable advancements in marine research and environmental monitoring.

Data Collection and Infrastructure

Mauritius is equipped with a high-capacity receiving antenna, enabling access to various satellite-derived datasets. These include chlorophyll-a measurements from MODIS Aqua and Sentinel-3, sea surface temperature (SST) and currents from Copernicus, and medium-resolution imagery from Sentinel-2, SPOT-5, and Landsat. High-resolution imagery from SPOT-5 (2.5m resolution) and Digital Elevation Models (DEMs) are also utilized for comprehensive coastal and marine analyses. This infrastructure allows the MOI to generate critical data that supports a range of oceanographic applications.

Applications of Satellite Data in Oceanography

The MOI extensively uses satellite data to monitor and forecast oceanographic variables, including SST, chlorophyll concentrations, and sea surface currents. These variables are essential for tracking algal blooms, supporting aquaculture, and managing coastal resources. Additionally, the MOI applies satellite data to assess coastal vulnerability, track oil spills, and monitor ship traffic. Working in collaboration with meteorological services, the MOI has developed a three-day marine forecast tool that uses satellite data to predict ocean conditions, thereby supporting various maritime and environmental stakeholders.

Success Stories in Satellite Data Applications

Mr. Martial highlighted two notable success stories where satellite data applications have yielded significant positive outcomes:

1. **Potential Fishing Zones in Tanzania**

In partnership with the Tanzania Fisheries Research Institute (TAFIRI), the MOI has developed tools to identify potential fishing zones (PFZs) using SST fronts and chlorophyll-a data. TAFIRI disseminates PFZ maps to artisanal fishers, who report increased accuracy and efficiency in locating productive fishing areas. These tools help reduce unnecessary fishing efforts and enable fishers to access more profitable areas, improving both sustainability and economic outcomes for Tanzanian communities.

2. **Harmful Algal Bloom Monitoring in Madagascar**

In collaboration with Madagascar's Institut Halieutique et des Sciences Marines (IHSM), the MOI monitors harmful algal blooms (HABs), which pose risks to human health. Using SST and chlorophyll data, IHSM can predict HABs up to 10 days in advance, allowing local authorities to warn fishers and prevent toxic catches. This early warning system has reduced incidences of seafood-related intoxications, thereby protecting public health and supporting the fishing industry in Madagascar.

Applications of Satellite Data in Mauritius

In Mauritius, the MOI utilizes satellite data to monitor tropical cyclones, providing meteorologists with critical information. Through Meteosat data, the MOI supports the Mauritius Meteorological Services in producing accurate cyclone forecasts, enhancing early warning systems. Mr. Martial also discussed the MOI's involvement in the MV Wakashio oil spill incident. During the crisis, the MOI used data from the Copernicus Marine Environment Monitoring Service to track sea surface currents and predict oil dispersal patterns. This information informed the placement of containment booms, mitigating the spill's environmental impact on the coast.

Coastal Vulnerability Index (CVI)

Mr. Martial described the development of a Coastal Vulnerability Index (CVI) map for Mauritius, which assesses risks to coastal areas from erosion, sea-level rise, and other factors. The CVI incorporates multiple data sources, such as shoreline change rates, coastal slope, geomorphology, sea-level change, and wave height. This index allows planners and policymakers to identify vulnerable areas and prioritize resilience measures for coastal infrastructure.

Ecosystem Mapping and Coastal Monitoring

In addition to vulnerability assessments, the MOI has conducted ecosystem mapping to analyze benthic habitats and coastal features. Using Sentinel data, the MOI has mapped habitats, including coral reefs and mangroves, which are essential for coastal protection. Ecosystem mapping provides a spatial basis for sustainable planning, helping to balance development needs with environmental conservation.

Conclusion and Future Directions

Mr. Martial emphasized the importance of satellite data in supporting sustainable ocean management practices. By leveraging Earth observation technologies, the MOI has developed tools that provide essential insights into marine ecosystems and coastal dynamics. He advocated for further investment in advanced geospatial technologies, such as Artificial Intelligence (AI) and the Internet of Things (IoT), to enhance the accuracy and effectiveness of satellite data applications. Mr. Martial also highlighted the value of continuous regional collaboration to expand the reach of these initiatives, contributing to sustainable ocean and coastal resource management across the Southwest Indian Ocean.

Through ongoing innovation and cooperation, the MOI has established itself as a regional leader in satellite data applications. By advancing its capabilities and fostering partnerships with other Indian Ocean states, the Institute is well-positioned to address the complex environmental challenges facing the region. Mr. Martial concluded by reaffirming the MOI's commitment to sustainable development, emphasizing that satellite data holds the key to informed, effective decision-making for the benefit of both Mauritius and its neighboring countries.

8. Fisheries Monitoring Centre

Presentation given by: Mrs D. Candassamy; Ministry of Agro- Industry, Food Security, Blue Economy and Fisheries

Mrs. D. Candassamy holds an MSc in Sustainable Environmental Management and is dedicated to promoting sustainable fisheries practices. With over nine years of experience at the Fisheries Monitoring Centre of Mauritius, Mrs. Candassamy focuses on the Vessel Monitoring System (VMS) for the monitoring of fishing vessels activities within the Mauritian Exclusive Economic Zone (EEZ) and areas beyond national jurisdiction. She has assisted and coordinated joint surveillance missions and received training in various VMS software and techniques. Mrs. Candassamy also spearheads the discussions with various Regional Fisheries Management Organisations for the planning and conceptualisation of joint surveillance missions in the Indian Ocean Region. During her career at the Ministry, she has also organized training sessions for local fishers.

Introduction

Mrs. Candassamy presented on the Fisheries Monitoring Centre(FMC) operational since 2005, focusing on the use of Vessel Monitoring Systems (VMS) and Automatic Identification System (AIS) for monitoring activities of licensed fishing vessels and movements of fishing vessels in Mauritius' maritime waters. The FMC plays a critical role in ensuring sustainable fishing practices and protecting marine resources.

Operational Framework

The Fisheries Monitoring Centre (FMC) currently consists of a team of 8 Fisheries Protection Officers and two technical staff. Secured logins to access the VMS was granted to relevant authorities such as the National Coast Guard and the Mauritius Revenue Authority Customs Anti-Narcotics Sections (CANS). The FMC is responsible for monitoring licensed and non-licensed fishing vessels' activities, cross verifying entry and exit notifications, and identifying any illegal unreported (IUU) fishing activities. The system captures route logs of vessels and identifies those scheduled to arrive at or depart from ports.

Fishing vessels are equipped with transponders that communicate with satellites through the Automatic Identification System (AIS) or the Vessel Monitoring System (VMS). The data collected from these sources is essential for generating alerts and reports, which facilitate comprehensive analysis of fishing activities within the Exclusive Economic Zone (EEZ) of Mauritius.

Data Verification and Analysis

The FMC conducts rigorous cross-verification of logbooks provided by fishing vessels to assess the accuracy of catch details. This scrutiny is crucial for identifying IUU fishing. Recently, the FMC detected suspicious activities involving Sri Lankan fishing vessels operating north of the Nassau Right Banker. Prompt action was initiated, leading to the interception of a Sri Lankan vessel by the National Coast Guard on October 17, which was found carrying a substantial illegal catch.

Detection Mechanism

Mrs. Candassamy illustrated the vessel detection process, using the VMS. Alerts regarding its movement into the EEZ were communicated to the National Coast

Guard for appropriate action. The detection system revealed that while these vessels often entered the EEZ during peak times, they frequently evaded capture by leaving the area before being apprehended.

Transshipment Monitoring

Another crucial aspect highlighted was the monitoring of transshipments occurring at sea. The FMC utilizes real-time data analysis to assess these activities, exemplified by the case of the vessel Harima,

which engaged in a transshipment operation. This capability is vital for verifying catch details and ensuring compliance with established licensing conditions.

Advanced tools enable the FMC to input specific dates and times to analyze activities effectively. They can also replay data for further scrutiny, enhancing situational awareness and oversight of fishing operations. For example, tracking the distance between fishing vessels helps confirm compliance with licensing regulations, as the ministry specifies when and where fishing can occur.

Conclusion

In conclusion, Mrs. Candassamy emphasized the vital role of advanced technology, such as VMS and AI, in effectively monitoring and managing the fishing industry in Mauritius. The FMC's efforts contribute to the sustainable use of marine resources and play an essential role in protecting the marine environment from illegal activities. Through ongoing improvements in surveillance technology and collaboration with national authorities, the FMC aims to ensure the long-term viability of Mauritius's fishing sector.

9. VDES Satellite constellation for Maritime Digitization

Presentation by: Mr Masanobu Tsuji, Technical consultant ArkEdge Space Inc, Japan

Mr Tsuji retired from the Japan Aerospace Exploration Agency (JAXA) in 2021 after 36 years of dedicated service. Throughout his tenure, he contributed significantly to satellite and ground station development, Earth observation research, and space education. As executive secretary of the Asia-Pacific Regional Space Agency Forum in the 2010s, he also played a key role in promoting international cooperation with emerging countries. In 2021, he became a technical consultant in the Satellite Solutions department at ArkEdge Space Inc. His interests encompass VDES for maritime DX and satellite IoT data collection. He is also an amateur radio operator and is a board member of the Japanese AMSAT organization.

Introduction:

Mr Tsuji provided an overview of ArkEdge Space VHF Data Exchange System (VDES) and its satellite constellation designed to enable maritime digitalization. VDES represents an evolution of the traditional Automatic Identification System (AIS) and aims to support communication, navigation, and operational management in the maritime sector. ArkEdge's approach to VDES satellite constellations is positioned as a critical step in enhancing maritime safety, enabling efficient logistics, and supporting environmental and fisheries management on a global scale.

Corporate Background: ArkEdge Space

ArkEdge Space, a Japanese nanosatellite developer established in 2018, specializes in creating small satellites and space services. With a headquarters in Tokyo, the company has successfully launched multiple CubeSats for various applications, including maritime communications and Earth observation. ArkEdge has notable partnerships, including an MoU with African and Brazilian space agencies, and contracts with the Taiwan Space Agency and University of Chile. ArkEdge's mission is to commercialize nanosatellite technologies and contribute to space services, with a specific focus on maritime digitalization through VDES technology.

What is VDES?

VDES is a cutting-edge maritime communication system that enhances AIS with three additional functions: Application-Specific Messaging (ASM), VDE-Terrestrial (VDE-TER), and VDE-Satellite (VDE-SAT). VDES is designed to provide two-way, high-throughput communication (up to 300 kbps, compared to AIS's 9.6 kbps) and extend the communication range beyond terrestrial limitations through satellite support. The technology, developed under guidelines from organizations like the International Maritime Organization (IMO), International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA), and International Telecommunication Union (ITU), offers improved resilience against environmental conditions and fraud.

Enhancements Over AIS

The primary issues with AIS include limited communication range (approximately 20-50 km), single-direction data transmission, and susceptibility to location spoofing. VDES addresses these challenges with the following advancements:

- Two-Way Communication: VDES enables two-way interaction through VDE-TER and VDE-SAT, allowing for more dynamic communication capabilities.
- Extended Range: By leveraging satellite support, VDES expands the communication range to around 2,000 km, supporting vessels in deep-sea areas far from shore-based stations.
- Higher Data Rate: With a maximum data rate of 300 kbps, VDES significantly improves data transmission speed, enhancing the exchange of information across maritime networks.

- Enhanced Security: VDES incorporates measures to counter spoofing and fraudulent manipulation, thereby securing vessel identification and positioning data.

Key VDES Applications

VDES satellite constellations provide numerous benefits, facilitating maritime safety, logistics management, and fisheries monitoring. Key applications include:

1. Maritime Safety

VDES can broadcast critical safety information, such as real-time updates on sea conditions, weather forecasts, and navigational aids. This capability is essential for search and rescue operations, enabling authorities to transmit instructions and locate vessels in distress. For example, during emergencies, VDES can send distress signals via satellite to nearby rescue teams, offering a quick response to incidents in remote areas.

2. Logistics and Port Management

The two-way communication offered by VDES allows for streamlined port entry and exit procedures. It provides data on vessel positions, expected arrival times, and port occupancy, allowing ports to optimize docking schedules and improve traffic flow. Additionally, it facilitates digitalized entry processes, thereby enhancing the efficiency of maritime logistics.

3. Fisheries and Environmental Monitoring

VDES supports fisheries management by tracking vessels' positions and monitoring their activities, enabling regulatory authorities to verify the origin of catches and deter illegal fishing. The system can also transmit environmental data, such as oceanographic information, to aid in resource management and ensure sustainable fishing practices.

4. Detection of 'Dark Ships'

With the ability to collect and analyze AIS data, VDES satellites can detect suspicious ships that disable their AIS to avoid tracking. This capability is particularly useful for preventing illegal activities, such as smuggling or unauthorized fishing. By identifying deviations from planned routes, VDES enhances maritime domain awareness and supports national security efforts.

ArkEdge Space's VDES Constellation

ArkEdge is advancing VDES technology through a satellite constellation designed to provide global maritime coverage. The company is collaborating with IHI Corporation and LocationMind Inc., funded by Japan's New Energy and Industrial Technology Development Organization (NEDO), to develop VDES satellites and supporting ground infrastructure.

The initial constellation, Generation Zero, is set for launch in 2024 and includes a deployable Cross Yagi antenna for enhanced signal reception. ArkEdge plans to launch subsequent generations (one, two, and three) by 2027, each iteration expanding functionality and coverage. These satellite constellations will facilitate inter-satellite communication and onboard data processing, ensuring robust, scalable communication channels across the maritime domain.

Satellite VDES Consortium

ArkEdge Space is part of the Satellite VDES Consortium in Japan, an initiative launched in collaboration with the Sasakawa Peace Foundation (SPF) and other companies. The consortium includes over 15 companies and several government ministries and agencies. Its purpose is to drive the development of VDES standards, expand the VDES satellite ecosystem, and foster collaboration on maritime digitalization initiatives. By pooling expertise from different sectors, the consortium aims to establish a comprehensive maritime communication network and set the stage for future advancements in maritime safety and logistics.

Ground Infrastructure

ArkEdge has established a ground station in Shizuoka, Japan, which supports S-band, X-band, and Ka-band communications for telemetry and data downlink. The ground station is vital for the operation of the VDES constellation, allowing ArkEdge to manage satellite communications and relay mission-critical data to maritime stakeholders.

Software Capabilities

ArkEdge has developed a suite of software tools to support satellite manufacturing and operations. Key features of their software platform include:

- Standardized Protocols: By standardizing communication protocols, ArkEdge reduces integration challenges and simplifies data exchange between satellites.
- Open Software: ArkEdge offers an open software platform, encouraging collaboration with developers from non-space fields to reduce costs and enhance functionality.
- Satellite Manufacturing Toolkit: The software toolkit facilitates efficient integration between ArkEdge's engineering teams and manufacturing partners, streamlining satellite production and minimizing coordination costs.

Strategic Implications and Future Outlook

The integration of VDES into maritime operations presents a transformative opportunity for the industry. With increased maritime traffic, especially in busy ports and territorial waters, VDES offers a scalable solution to support communication and navigation needs. VDES is positioned to become a foundational technology for maritime digitalization, enabling stakeholders to leverage data-driven insights and optimize their operations. By providing a reliable alternative to traditional AIS, VDES supports global maritime initiatives to enhance security, efficiency, and sustainability.

ArkEdge Space's continued development of VDES satellite constellations reflects the company's commitment to advancing maritime digitalization. Their efforts align with Japan's broader space policy objectives, leveraging space-based technology to address critical challenges in the maritime sector. With international collaboration and support from organizations like NEDO, ArkEdge is well-positioned to lead the next phase of maritime communication infrastructure, bringing about enhanced safety, streamlined logistics, and robust environmental monitoring.

Conclusion

ArkEdge Space is at the forefront of maritime digitalization through its VDES satellite constellation program. By addressing the limitations of AIS, VDES provides a comprehensive solution for maritime communication, safety, and operational management. The VDES satellite constellation promises to transform how maritime stakeholders interact, optimize logistics, and ensure sustainable resource management across oceans. ArkEdge's partnerships and consortium activities underscore the collaborative nature of this endeavor, paving the way for a global maritime communication network that meets the demands of a modern, digitalized maritime industry.

10. Feeding the Future - Satellite Technology Transforming Agriculture

Presentation by: Mr Veeraj K. Heerea, IT Officer and Systems Administrator, FAREI

Veerraj K. Heerea is an IT Officer and Systems Administrator at the Agricultural Research and Extension Institute (FAREI). In this role, he is responsible for managing and optimizing IT infrastructure to support FAREI's agricultural research and extension services. With a strong background in information technology and systems administration, Veerraj ensures the smooth operation of critical systems, enhances data security, and supports the institute's digital transformation initiatives. He is dedicated to leveraging technology to improve agricultural research and facilitate efficient knowledge exchange in the agricultural sector. **Expertise**: Systems administration, IT infrastructure, data security, agricultural technology solutions.

Introduction:

Mr Heerea discussed how satellite technology is revolutionizing agriculture. This initiative aligns with Government of Mauritius' policies focused on sustainable agricultural systems and aims to raise national food security and self-sufficiency. The presentation emphasized the Food and Agricultural Research and Extension Institute (FAREI)'s role in promoting agricultural resilience through technology, with a vision to build a sustainable agricultural sector that enhances national food security and empowers farmers.

Government Policy Alignment

FAREI's strategic plan, in line with Government's policies, sets a vision of fostering a vibrant non-sugar agriculture sector that sustainably uses natural resources and increases local production. This effort targets improved productivity, food safety, and the welfare of farming communities.

Satellite Technology in Agriculture

FAREI has been participating in the **Copwatch Innovative Cooperation Programme (ICP)** since 2021. This joint initiative, in collaboration with the United Nations Conference on Trade and Development (UNCTAD), the Aerospace Information Research Institute of the Chinese Academy of Science, and the Alliance of International Science Organisations, supports the United Nations Sustainable Development Goal for zero hunger. The ICP provides FAREI with access to cutting-edge satellite technology and data, which is instrumental in crop monitoring and prediction.

The GVG Mobile Application

A key tool FAREI employs is the **GVG App**, a mobile application developed by the CropWatch team. This app enables rapid collection of crop type data and land use classifications by integrating GPS, video, and GIS capabilities. The app facilitates real-time data gathering for crop monitoring, supporting resilience in agricultural practices. The GVG App is instrumental in marking land cover types on a digital map, capturing images, and supporting farmers by integrating data on drought, pests, and diseases.

Cosmic Ray Neutron Sensor for Soil Moisture Monitoring

FAREI utilizes the **Cosmic Ray Neutron Sensor (CRNS)**, a modern tool that measures soil moisture across areas up to 30 hectares. This technology fills a critical gap by measuring soil moisture at a landscape scale, providing essential data for optimizing water usage in agriculture. It operates by detecting cosmic ray neutrons that interact with hydrogen atoms, allowing accurate soil moisture measurements. This technology, which covers an area up to 600 meters in diameter, complements satellite data, allowing for precise irrigation scheduling, improved water efficiency, and enhanced crop yields.

Drone Technology and GIS Integration

FAREI has adopted **drone technology** for high-resolution aerial imaging, which, when integrated with Geographic Information Systems (GIS), becomes a powerful tool for the agricultural sector. Drones capture real-time, high-resolution images that are foundational for GIS mapping and resource optimization. These images help with precision agriculture by enabling detailed analysis of crop health and supporting data-driven decision-making for resource allocation, reducing waste, and enhancing climate resilience.

Information Systems for Decision-Making

To further support data-driven agricultural practices, FAREI has developed two major information systems:

- **Research and Extension Key Information Repository (ReKIA):** This system supports internal decision-making by storing comprehensive agricultural data.

- **Farmer Information Delivery System (FIDS):** This platform is designed to deliver critical insights to farmers, helping them with sustainable agricultural practices. It combines features from previous FAREI applications into one robust platform to provide actionable information on crop management.

Commitment to Sustainable Agriculture and Food Security

In summary, FAREI's initiatives underscore its commitment to farmer-centric, sustainable agricultural practices. By leveraging advanced satellite, drone, and soil moisture technologies, FAREI is transforming Mauritius' agricultural landscape. These technologies empower farmers, improve resource efficiency, and contribute to national food security, positioning FAREI as a key player in advancing resilient agricultural practices.

Heerea concluded by highlighting FAREI's collaborative efforts with international organizations, emphasizing the importance of a collective approach to addressing global food security challenges through innovative technological solutions.

DAY 1

Session 2

R&D AND CAPACITY BUILDING IN SPACE AND SATELLITE TECHNOLOGIES

11. Small satellite development and its transformative impact on non-spacefaring countries

Presentation given by: Mr Bonny Omara Special Presidential Assistant on Space Engineering under the State House, Uganda.

Eng. Bonny Omara is the Special Presidential Assistant on Space Engineering under the State House of Uganda and one of the three engineers who designed, built, and tested Uganda's first satellite. His research specializes in the use of multispectral cameras in small satellites.He holds a Master of Science in Space Engineering from Kyushu Institute of Technology, Japan, a Bachelor's degree in Computer Engineering from Busitema University, Uganda, a Postgraduate Diploma in Information Systems Management from the Uganda Management Institute, and an Advanced Certificate in Spatial Information Technology for Urban Planning and Management from Chennai, India. In recognition of his contributions, Eng. Omara received a medal from the President of Uganda, honoring him as one of the nation's heroes.

Introduction:

Eng. Bonny Omara presented a compelling discussion at the Mauritius Symposium on "Small Satellite Development and Its Transformative Impacts." He opened with a thought-provoking question: *"Is access to space truly free for everyone?"* and challenged attendees to reflect on why more countries, particularly in Africa, are not exploring this frontier. Reflecting on Uganda's achievements, such as the launch of its first satellite in 2022, he asked why African nations lag behind in the space industry despite increasing global accessibility.

The Transformative Potential of Small Satellites

Eng. Omara highlighted that his presentation would explore the transformative role of small satellites for African countries, specifically those yet to become significant space players. The talk outlined Africa's current standing in space, opportunities for non-spacefaring countries to engage in satellite development, and the challenges they face. By contextualizing the importance of space technology for Earth observation, climate research, and more, he aimed to underscore why space accessibility is crucial for sustainable development.

Africa's History in Space and the Rise of Small Satellites

He provided an overview of Africa's journey in space, noting that out of over 50 African countries, only 15 have successfully launched satellites. He explained that while Africa has launched approximately 59 satellites, only nine of these were developed on the continent, underscoring the need for more robust local infrastructure. Globally, small satellite technology has seen rapid adoption due to its cost-effectiveness and efficiency. In the early 2000s, fewer than 50 small satellites were launched, but by 2013, that number grew to 100, and today, over 1,800 are in orbit. This growth is largely due to commercial off-the-shelf components, which reduce costs and development time.

Opportunities for African Nations

He emphasized several key areas where small satellites offer significant opportunities for Africa:

1. **Earth Observation**: Small satellites enable monitoring of deforestation, urbanization, and agricultural changes, as well as natural disasters such as wildfires and pollution. This data is invaluable for sustainable resource management and disaster response.
2. **Climate Research**: Satellites can measure atmospheric parameters such as temperature, humidity, and greenhouse gases, providing critical insights into climate change and its impacts.
3. **Space Weather Monitoring**: By observing solar activity and geomagnetic storms, small satellites help to predict and manage space weather, which can affect communication and navigation systems.

4. **Biology and Biomedicine**: Small satellites enable research into the effects of microgravity on biological systems, which can have applications in agriculture, health, and space exploration.
5. **Astronomy and Astrophysics**: These satellites also contribute to the observation of celestial bodies and cosmic phenomena, opening up new avenues for scientific discovery.
6. **Technology Demonstration**: Small satellites are ideal for testing new technologies and techniques for space exploration. Their development is no longer a prohibitive expense, and many countries can now afford to invest in them, using them as platforms for innovation.

He pointed out that the lower costs, standardization, and availability of reusable rockets mean that African nations could leverage these opportunities to participate in the global space economy. He noted that small satellite missions are particularly accessible because they can be launched more frequently and with greater flexibility, making them ideal for countries seeking to enter the space industry on a limited budget.

Challenges and Considerations

However, the path to leveraging these opportunities is not without challenges. Eng. Omara discussed several key obstacles:

- **Regulatory Framework**: African nations must navigate international space law and develop legal frameworks that support sustainable space programs. He highlighted the importance of establishing clear policies to govern satellite development and launch activities.
- **Technical Constraints**: Building, designing, and testing satellites require specialized knowledge and infrastructure, which many African countries currently lack. Eng. Omara stressed the importance of technical capacity building to support these activities on the continent.
- **Funding and Resources**: Access to financial support remains a major barrier. Eng. Omara noted that while the cost of satellite development has decreased, initial investments are still significant, and securing sustainable funding sources is essential for long-term growth.
- **Capacity Building**: He advocated for education, training, and institutional support to foster a skilled workforce capable of sustaining space programs. He encouraged countries to invest in developing talent, retaining skilled individuals, and exposing them to international expertise. Sharing his own experience, he underscored the value of global exposure and collaboration in building a resilient space sector.

Transformative Impact of Small Satellites

Despite these challenges, the transformative impact of small satellites cannot be overstated. Eng. Omara highlighted several immediate benefits:

- **Space Weather and Climate Resilience**: Small satellites can monitor environmental changes and support climate resilience, a critical need for African countries facing climate challenges. They are useful in forecasting and managing resources to ensure food security and water availability.
- **Economic Growth and Job Creation**: Investment in satellite technology stimulates innovation, creates new industries, and provides employment opportunities. Eng. Omara noted that African countries can leverage these developments to diversify their economies and drive sustainable growth.
- **Advancement in Education and Technology**: The development of small satellites fosters a culture of innovation, encouraging students and researchers to engage in STEM fields. Eng. Omara views this as a foundational step towards building a technologically advanced society equipped to address global challenges.

Conclusion: A Call to Action

In concluding, Eng. Omara urged African nations to reconsider their approach to space and to seize the opportunities presented by small satellite technology. He emphasized that space is indeed free for

everyone, as affirmed by international regulations and conventions. However, taking advantage of this freedom requires proactive engagement, strategic investment, and a collective commitment to building a robust space infrastructure.

He called on policymakers, administrators, and the private sector to work together in creating a supportive environment for satellite development, stressing that the time to act is now. With strategic planning, African countries can play a meaningful role in space exploration and contribute to the global knowledge economy. Eng. Omara envisions a future where Africa is not merely a participant in the space industry but an innovator and leader, leveraging space technology to address local and global challenges.

Eng. Omara closed with a message of empowerment, reminding the audience that the future of space in Africa lies in their hands. By embracing the transformative potential of small satellites, African countries can shape a sustainable, resilient future for generations to come.

12. NEREUS: A Space-Based Maritime Surveillance System for Fisheries Monitoring and Anomaly Detection

Presentation given by: Dr Raffaella Guida, Associate Professor, Surrey Space Centre (SSC), University of Surrey, United Kingdom

Dr. Raffaella Guida is an Associate Professor and Head of the Remote Sensing Applications research group at the Surrey Space Centre (SSC), University of Surrey, where she also serves as Director of the Postgraduate Research Programme. She holds a Laurea degree in Telecommunications Engineering and a Ph.D. in Electronic and Telecommunications Engineering from the University of Naples Federico II. Her research focuses on electromagnetic and microwave remote sensing, particularly synthetic aperture radar (SAR) simulation, satellite data fusion, and new mission concepts. Dr. Guida has led national and international Earth Observation projects totaling over £2M and has delivered specialized SAR and Remote Sensing courses to various institutions, including the Mexican Space Agency and China Academy of Space Technology. She is a recipient of the IEEE J-STARS Best Paper Award (2013) and was recognized as an Ocean Innovator by the UNDP in 2022.

Introduction:

Dr. Raffaella Guida presented updates on a pioneering project spearheaded by her team at the Surrey Space Centre, University of Surrey in close collaboration with the Mauritius Research and Innovation Council (MRIC) Space Unit team led by Dr V.Bissonauth and team. This project was named NEREUS (a figure from Greek mythology, known as a sea god) leverages satellite technology to enhance maritime surveillance and combat illegal, unreported, and unregulated (IUU) fishing. Supported by the UNDP's Ocean Innovation Challenge in alignment with Sustainable Development Goal 14, the project showcases the transformative role space technology can play in marine conservation, especially within Mauritius's Exclusive Economic Zone (EEZ). This initiative not only addresses IUU fishing but also aims to restore fish stocks, contributing to long-term economic resilience for Mauritius.

Core of the project:

NEREUS positions itself as an innovative **Maritime Domain Awareness** tool comprising three core components:

1. **Ship Trajectory Prediction (NRT)**: This near real-time feature enables authorities to forecast vessel trajectories, even when Automatic Identification System (AIS) signals are disabled, providing a proactive approach to monitoring suspicious activities.
2. **Heat Map (Offline)**: This component highlights areas within the EEZ at high risk of IUU fishing, optimizing the National Coast Guard's resource allocation by directing patrols to where illegal activity is most likely to occur.
3. **Maritime Situational Picture (NRT)**: This real-time overview of maritime activities empowers authorities with actionable intelligence, improving decision-making in response to potential threats.

NEREUS employs synthetic aperture radar (SAR) data and AIS transmissions to detect discrepancies or "dark spots" where vessel activity does not align with transmitted data. These anomalies can signal illegal or unreported activities, triggering further investigation. By utilizing SAR data from the UK Space

Agency's **NovaSAR** mission, NEREUS has compiled the most extensive radar dataset ever collected over Mauritius's EEZ, creating a robust historical record. This data enables Mauritius to establish patterns, identify high-risk areas, and locate frequent violations, particularly around the EEZ boundaries.

Dr. Guida emphasized NEREUS's economic potential, citing a conservative analysis over six months of observations in the **Saya de Malha Bank**. This analysis suggests that for every $1 invested, there could be a $31 return to the Mauritian community if the insights provided by NEREUS are acted upon. This highlights the tool's value, not only in conserving marine resources but also in contributing to economic recovery. Moreover, NEREUS enhances the National Coast Guard's operational efficiency with **tip-and-cue services**, which offer predictive analytics to support the prosecution of IUU fishing activities through robust evidence.

Way forward:

Looking forward, Dr. Guida stressed the importance of scaling the project regionally, positioning Mauritius as a leader in space-based maritime surveillance across the Indian Ocean and beyond. By utilizing these innovations, Mauritius can demonstrate how space technology protects marine resources and fosters sustainable development. The project also explores broader applications, including assisting artisanal fisheries by mitigating the effects of overfishing by industrial vessels, and providing evidence-based support for maritime insurance claims.

In conclusion, Dr. Guida called for sustained investment in space technology as a national priority for Mauritius. The success of NEREUS underscores the tangible benefits of space applications, from economic returns to enhanced enforcement capabilities. By committing to a **space agenda**, Mauritius can strengthen its role as a leader in maritime innovation, bolstering the region's collective ability to protect marine ecosystems and promote sustainable resource management.

13. Radioastronomy in Africa - Looking at the Invisible Universe in Radio Waves

Presentation by: Dr R. Somanah; Director General, Universite des Mascareignes

Dr. Radhakrishna Somanah is an accomplished astrophysicist specializing in radio astronomy, with significant contributions to the field in Africa. He holds a Ph.D. and has been instrumental in establishing the Mauritius Radio Telescope, where he has led numerous research projects. Dr. Somanah's work focuses on the study of cosmic phenomena and the development of innovative radio observational techniques. He actively collaborates with international research teams, contributing to major initiatives such as the Square Kilometer Array. His commitment to advancing scientific knowledge has positioned him as a key figure in the African space science community.

Introduction:

The objective of this discussion is to explore not only the current state of radio astronomy in Africa but also to appreciate the discipline's multidisciplinary essence and its significance within global space technology initiatives. As a branch of astronomy, radio astronomy encompasses a wide range of scientific and engineering fields, including physics, mathematics, and various engineering disciplines. This presentation provides a brief historical overview of radio astronomy's development, with a particular focus on milestones achieved in Africa.

Historical Context of Radio Astronomy

Radio astronomy began to take root in South Africa during the 1960s, specifically in Cape Town, where significant advancements were made in this field. The first major radio astronomy observatory, the **Hartrao Observatory**, was established in South Africa in 1961. This facility played a crucial role in conducting radio astronomy observations, including **Very Long Baseline Interferometry (VLBI)**, which synchronizes multiple radio telescopes to achieve higher-resolution imaging.

Globally, radio astronomy has a rich history marked by pioneering figures. **Karl Jansky**, often regarded as the father of radio astronomy, developed the first radio telescope in 1931, operating at a frequency of 20.5 MHz. His groundbreaking work laid the foundation for the field. Another significant contributor, **Grote Reber**, constructed the first dedicated radio telescope for astronomical observations in 1938, mapping the sky at 160 MHz between 1938 and 1941.

Several iconic radio telescopes have since emerged, including the **Green Bank Radio Telescope**, which is the world's largest steerable dish at 105 meters, and the **Arecibo Observatory**, which was the world's largest radio dish at 305 meters until its collapse in 2020. Other notable installations include the **Very Large Array** in New Mexico, USA, and the **Parkes Radio Telescope** in Australia. The **Hartbeesthoek Radio Telescope** in South Africa, with a 26-meter dish operating across frequencies from 12 GHz to 1500 GHz, has also made significant contributions to radio astronomy research.

The Need for Collaboration

The versatility of radio astronomy lies in its multidisciplinary nature. It draws upon mathematics, physics, and various branches of engineering, requiring collaboration among professionals from diverse fields. For example, during collaborative projects, researchers like Dr. Nalini Singh and I engaged in designing and processing data for radio images. This process required skills from mechanical and electronic engineering, as well as information technology. Transforming 100 gigabytes of data into coherent radio images took us nearly three years, exemplifying the complexity and dedication involved in this work.

In my view, any project involving space technology is inherently multidisciplinary. However, many African countries lack the critical mass of researchers across various fields necessary to excel internationally. Collaboration among scientists and engineers from different backgrounds is essential to achieve significant advancements in radio astronomy and related disciplines. Operating in isolation limits innovation and the ability to make impactful contributions on a global scale.

Pioneering Efforts in Mauritius

Following the establishment of the Hartrao Observatory, Mauritius emerged as a pioneer in radio astronomy in Africa with the launch of its own radio telescope. The **Mauritius Radio Telescope** is notable for being the first radio telescope in Africa built as an array, where multiple antennas are connected to enhance sensitivity and resolution. One of the significant achievements of the Mauritius Radio Telescope was the completion of the first-ever map of the southern sky at a frequency of 150 MHz, a project that required a decade of dedicated work and involved the efforts of twelve PhD students and over 50 published research papers.

The collaborative efforts of local astronomers, including Dr. Esouff and myself, played a vital role in utilizing the telescope to advance our understanding of radio astronomy. This work has positioned Mauritius as a key player in the field, contributing valuable data and insights that are recognized internationally.

The Square Kilometer Array

An ambitious next step in radio astronomy is the **Square Kilometer Array (SKA)**, which is poised to become the most powerful radio telescope in the world. This monumental project involves collaboration among nine African countries, including Mauritius, and aims to establish thousands of dishes capable of unprecedented sensitivity and resolution in radio observations. The SKA will enable researchers to explore fundamental questions about the universe, including the nature of dark matter, the formation of galaxies, and the origins of cosmic phenomena.

The scale and complexity of the SKA project highlight the collaborative spirit necessary for success in radio astronomy. By pooling resources and expertise, the participating countries can achieve remarkable advancements in scientific research and technology development.

The Evolution of Observational Techniques

Historically, human understanding of the universe was limited to observations made through visible light for nearly 5,000 years. However, the advent of radio astronomy opened new avenues for exploration. Early pioneers like Karl Jansky made groundbreaking discoveries using radio waves, laying the foundation for the field. The first significant radio telescope, the **Green Bank Telescope** in the United States, set a precedent for subsequent developments, demonstrating the potential of radio waves for astronomical observation.

Radio telescopes can range from single large antennas to arrays of smaller dishes interconnected to form a more sensitive instrument. The most powerful radio arrays, such as those found in Australia, have enhanced our ability to observe astrophysical objects that emit radio waves, including active galaxies, pulsars, supernova remnants, and H II regions. These celestial bodies often exhibit features not visible in optical observations, making radio astronomy essential for a comprehensive understanding of the universe.

Main Objects Found in Radio Astronomy

Radio telescopes enable the observation of a variety of astronomical phenomena, including:

1. **Active Galaxies**: These galaxies emit significant amounts of radiation, particularly in the radio spectrum, due to energetic processes near supermassive black holes.
2. **Pulsars**: Highly magnetized, rotating neutron stars that emit beams of electromagnetic radiation, which can be detected when they are aligned with Earth.
3. **H II Regions**: These are areas of ionized hydrogen gas where star formation occurs, emitting radio waves due to the presence of hot young stars.
4. **Supernova Remnants**: The remnants of exploded stars, which emit radio waves as they interact with surrounding interstellar matter.

Current Facilities and Developments

In Mauritius, the establishment of radio astronomy facilities, such as the Mauritius Radio Telescope, has facilitated extensive research and data collection. The telescope, located in the Bradu forest, features a unique design, incorporating approximately 2,000 antennas arranged in a specific layout. This configuration allows for the effective capture and analysis of radio signals from space, contributing to our understanding of various astrophysical phenomena.

The project faced delays due to the COVID-19 pandemic, which impacted the anticipated arrival of additional equipment and dishes that were to be integrated into the existing infrastructure. However, the team remains optimistic about the future of radio astronomy in Mauritius and is committed to advancing research efforts.

Integration of Instruments and Technologies

To enhance the capabilities of radio telescopes, the integration of various instruments is vital. These include:

1. **Central Computing Facilities**: High-Performance Computing (HPC) centers, such as those in Cape Town, facilitate the processing of large datasets generated by radio observations.
2. **Remote Sensing Instruments**: Optical, thermal infrared, and microwave sensors complement radio telescopes by providing multi-dimensional data for comprehensive analysis.
3. **Atmospheric Instruments**: Radiometers, spectrometers, and LIDAR systems measure atmospheric conditions, which can affect radio signal propagation.
4. **Geodetic Instruments**: These instruments ensure precise positioning of telescopes, crucial for accurate data collection.
5. **Oceanographic and Meteorological Instruments**: These tools provide context for radio observations, allowing scientists to understand environmental impacts on celestial phenomena.

By colocating these diverse instruments, radio astronomy can benefit from a holistic approach to data collection and analysis, facilitating richer insights into cosmic events.

Future Directions

In conclusion, radio astronomy in Africa has witnessed remarkable growth and development since its inception in South Africa. The establishment of the Mauritius Radio Telescope and participation in the Square Kilometer Array project highlight the continent's potential to contribute to cutting-edge research in this field. As we continue to foster collaboration among scientists and engineers across disciplines, we can build a stronger foundation for future advancements in radio astronomy.

By embracing the multidisciplinary nature of this field, African nations can enhance their scientific capabilities and engage in meaningful contributions to the global dialogue on space exploration and

understanding. The journey of radio astronomy in Africa is just beginning, and the prospects for the future are promising, driven by innovation, collaboration, and a shared commitment to uncovering the mysteries of the universe.

In summary, radio astronomy not only enriches our understanding of the cosmos but also serves as a catalyst for interdisciplinary collaboration and technological advancement. As we move forward, it is crucial to recognize the potential of radio astronomy to shape the future of scientific research in Africa and beyond.

14. Mauritius' Space Initiatives and Developments in Radio Astronomy and Earth Observation

Presentation by : Dr Nalini Heeralall-Issur,

Assoc. Prof. of Physics & Head, MRT Observatory, UoM

DARA Coordinator, Mauritius

Dr. Nalini Heeralall-Issur is an esteemed Associate Professor of Physics and the Head of the Mauritius Radio Telescope (MRT) Observatory at the University of Mauritius. With a passion for astrophysics and space science, she leads significant research and educational initiatives in Mauritius, focusing on astronomy and radio telescope technology. Dr. Heeralall-Issur also serves as the Mauritius Coordinator for the Development in Africa with Radio Astronomy (DARA) program, where she is instrumental in fostering local expertise and collaborations in radio astronomy. She is committed to advancing space science education and research in Mauritius and the African region.

Research Interests: Astrophysics, radio astronomy, space science, educational outreach in science and technology.

Introduction

The evolution of space technology in Mauritius, spearheaded by institutions like the University of Mauritius (UoM) and the Mauritius Radio Telescope (MRT) Observatory, signifies a pivotal step towards establishing the island nation as a key player in the global space sector. This development aligns with the broader goals of addressing national and regional challenges through advanced scientific research, training, and collaboration.

The Role of Radio Astronomy and Earth Observation

Mauritius is strategically positioned to benefit from advancements in both radio astronomy and Earth observation. Radio telescopes allow astronomers to peer into the cosmos, observing phenomena that date back to the early universe, while Earth-observing satellites offer real-time data about our planet's condition. Both fields, while distinct in their applications, share similar technological foundations and data processing techniques, thus presenting opportunities for synergies.

Mauritius Radio Telescope (MRT)

The MRT, built between 1988 and 1992, serves as a vital research facility equipped with an interferometric T-array that enables the survey of the southern sky at a frequency of 150 MHz. This facility consists of an extensive array of antennas configured to maximize data collection and has facilitated significant advancements in astronomical research, producing over 100 publications in the NASA Astrophysics Data System (ADS) and generating valuable training for students at various academic levels. Notably, research from the MRT has contributed to understanding cosmic phenomena, such as millisecond pulsars.

Collaboration in the Square Kilometer Array (SKA)

Mauritius's involvement in the proposed Square Kilometer Array (SKA) positions the nation within a larger international framework dedicated to radio astronomy. The SKA is set to be a groundbreaking project, featuring around 3,000 antennas distributed across several partner countries, including South Africa, Ghana, and Madagascar. This initiative not only enhances Mauritius's capabilities in radio astronomy but also promotes human capital development in the region, supporting educational and research programs.

DARA Project

The Development in Africa Through Radio Astronomy (DARA) project, initiated in collaboration with the University of Leeds, seeks to enhance research capabilities in Africa. Since its inception, DARA has trained numerous students across various African countries, emphasizing the multidisciplinary nature of radio astronomy and its potential to foster economic development through scientific collaboration.

Research Initiatives at UoM

Several innovative research projects are underway at UoM that leverage the MRT's infrastructure and expertise. Among these initiatives is the investigation of Earth's radio leakage as observed from different stellar systems. A notable study quantified the power emitted by mobile communication towers, revealing that peak power leakage could reach approximately 4GW. This research underscores the importance of understanding our planet's radio emissions and their implications for the Search for Extraterrestrial Intelligence (SETI).

Additionally, the study of fast radio bursts (FRBs) highlights the growing interest in transient cosmic phenomena. Researchers at UoM, particularly Ms. Divya Hurwanth, are examining the characteristics of FRBs, contributing to the broader understanding of these mysterious events.

Developing Ground Infrastructure for Satellite Communication

The construction of a low-cost CubeSat ground station at the MRT site is a significant step towards enhancing Mauritius's capacity in satellite communication. This facility will enable the nation to operate its first nanosatellite, MIR-SAT1, launched in 2020, and will facilitate future satellite missions. The ground station's capabilities will include telemetry, tracking, and command operations, which are crucial for effective satellite management.

Enhancing Maritime Domain Awareness (MDA)

Given Mauritius's extensive Exclusive Economic Zone (EEZ), improving Maritime Domain Awareness (MDA) is essential for monitoring maritime activities and addressing challenges such as illegal fishing and environmental protection. One research project focuses on using advanced machine learning algorithms for ship detection in satellite imagery, aiming to enhance maritime security. The findings indicate that simpler neural network models could achieve satisfactory performance for ship detection tasks, allowing for cost-effective solutions.

The 2020 MV Wakashio oil spill incident underscored the urgent need for effective surveillance systems to protect Mauritius's marine environment. By leveraging satellite technology and machine learning, future projects aim to develop a comprehensive framework for real-time maritime monitoring, thus enhancing the nation's capacity to respond to maritime incidents.

Conclusion

Mauritius's journey into space technology and radio astronomy exemplifies the potential for small island nations to contribute to global scientific endeavors. Through strategic initiatives, collaboration, and investment in education and infrastructure, Mauritius is positioned to address both local and global challenges. The integration of radio astronomy and Earth observation technologies not only enhances scientific research but also paves the way for economic development and increased resilience against environmental changes. Continued investment in these fields will ensure that Mauritius remains at the forefront of space science and technology, fostering a culture of innovation and discovery.

Outlook

The upcoming initiatives, such as the continued development of the MRT observatory and the expansion of the DARA program, will further bolster Mauritius's role in the international space community. As the country embraces its potential in space exploration and research, it also seeks to empower future generations through education and training in science, technology, engineering, and mathematics (STEM). With a commitment to fostering collaboration and innovation, Mauritius is poised to make meaningful contributions to the global scientific landscape while addressing the pressing challenges of the 21st century.

15. Assessing Land Use of the G.R.N.W Catchment using Remote Sensing Techniques

Presentation by: *Ms Y. Khoodeeram, University of Mauritius*

Education: BSc (Hons) Geomatics, University of Mauritius; MSc in Data Analytics and Project Management, UK

Ms. Yamuna Devi Khoodeeram is a geomatics specialist with expertise in remote sensing, GIS, and environmental analysis. She holds a BSc (Hons) in Geomatics from the University of Mauritius and an MSc in Data Analytics and Project Management from the UK. Ms. Khoodeeram has conducted significant research on land use assessment and watershed management, focusing on the impact of urbanization on environmental sustainability. Her work incorporates advanced techniques such as digital elevation modelling and satellite imagery analysis, providing valuable insights for land planning and decision-making.

Research Interests: Remote sensing, digital elevation models, watershed management, GIS, and environmental monitoring.

Introduction:

Ms. Khoodeeram addressed the environmental challenges associated with rapid urbanization in the Grand River Nord West (GRNW) catchment area of Mauritius. The project focuses on the impacts of population growth, land conversion, and infrastructural development on watershed management, particularly in light of the unplanned construction activities that have made the area vulnerable to climate change and flooding.

Problem Statement and Research Significance

The GRNW catchment area, one of the largest in Mauritius, is heavily industrialized and urbanized. Major developments, including the Metro Express project, have altered natural landscapes and watercourses, causing pressure on both the environment and watershed management systems. Ms. Khoodeeram's research aims to assess these impacts by analyzing land use changes and creating a watershed delineation using digital elevation models (DEMs) and remote sensing techniques. The findings will support local authorities by providing data-driven insights to expedite decision-making processes and manage land use sustainably.

Objectives

The primary objectives of the study include:

1. Investigating land use within the GRNW catchment area using remote sensing techniques.
2. Delineating watersheds based on DEMs to understand the topography and water flow in the catchment.
3. Conducting a topographical survey to assess DEM accuracy using various interpolation methods and selecting the most effective one.
4. Generating a land use map and validating its accuracy by comparing it with ground truth data, specifically through spectral signature analysis.

Methodology

Ms. Khoodeeram used a comprehensive approach combining DEMs, satellite imagery, and various interpolation techniques. The specific methodology included:

- **Data Collection**: Spot satellite imagery was obtained from the Ministry of Agro, providing the base for land classification and mapping. Additionally, DEMs with a 10-meter resolution were generated, supplemented by topographic data from the Ministry of Housing.

- **Interpolation Techniques**: Ms. Khoodeeram evaluated multiple interpolation methods—such as Triangulated Irregular Network (TIN), Kriging, Inverse Distance Weighting (IDW), and Spline—to find the most accurate surface representation for the DEMs. Kriging was ultimately found to be the most effective.
- **Supervised Classification**: Using the Maximum Likelihood Classification method, land use within the catchment was mapped and categorized into various land cover types, including built-up areas, agricultural lands, forests, and water bodies.
- **Sampling and Accuracy Assessment**: A stratified random sampling method was employed, with a sample size of 100 points. The overall accuracy of the classification was determined to be 73.6%, with a Kappa coefficient of 0.7, indicating good agreement between the classified map and ground truth data.

Key Findings

The study revealed significant changes in land use within the GRNW catchment. Over a period of 20 years, built-up areas have increased substantially, leading to a reduction in forest cover and agricultural land. Key findings include:

- A notable expansion in urban areas, reaching approximately 30% of the catchment's land area.
- A decrease in forest cover to 16%, with agricultural land experiencing similar reductions.
- Industrial developments encroaching upon buffer zones along the river, increasing vulnerability to flood risks and exacerbating the effects of unplanned construction.

The analysis also highlighted the value of remote sensing for detecting and classifying land cover changes, particularly as they relate to environmental management and policy-making.

Hydrological Assessment

To further understand the impact on watershed management, Ms. Khoodeeram assessed the longest flow path within the GRNW catchment and established a buffer zone of 100 meters at the river's outlet. This assessment revealed that industrial and urban encroachment within the buffer zones has disrupted natural watercourses, increased flood risks, and amplified the effects of unplanned urban development. This spatial analysis underscores the need for more robust flood risk management strategies that account for both topographical and land use factors.

Limitations and Challenges

Ms. Khoodeeram identified several challenges in her study:

1. **Data Limitations**: The high-resolution classification of satellite images required powerful processing capabilities and rigorous topographical surveys, which were resource-intensive.
2. **Flood Risk Mapping**: The flood risk map generated in this study was based solely on topographic parameters and lacked integration with real-time hydrological data, limiting its predictive accuracy for flood events.
3. **Interpolation Accuracy**: While Kriging proved to be the most accurate method for DEM interpolation, the study acknowledges that a combination of traditional and machine learning-based methods may enhance future analyses.

Recommendations and Future Work

Ms. Khoodeeram made several recommendations for improving land use planning and environmental monitoring in Mauritius:

1. **Adoption of High-Resolution Imagery**: Future assessments should utilize higher-resolution satellite imagery and aerial photographs to better detect land use changes at finer scales.
2. **Integration of Machine Learning Techniques**: Advanced machine learning algorithms, such as Random Forest and Support Vector Machines, should be used for digital image classification to enhance accuracy.

3. **Use of Remotely-Sensed Data for Policy-Making**: Authorities are encouraged to use remote sensing data for informed decision-making on land development, supporting models that forecast development trends.
4. **Water Quality and Resource Management**: Remote sensing and digital tools should be leveraged to monitor water quality and manage water resources, especially in areas affected by industrial activities.
5. **Drone Technology for Aerial Surveys**: The deployment of drones can facilitate faster topographic surveys, enabling efficient ground truthing and the acquisition of high-resolution data for ongoing land use assessments.

Conclusion

Ms. Khoodeeram's research underscores the role of digital elevation models and remote sensing in monitoring land use and watershed management. Her findings reveal how rapid urbanization in the GRNW catchment area has placed considerable strain on the environment, emphasizing the need for sustainable land development practices. By leveraging remote sensing technology, the study provides a baseline for local authorities to develop data-driven strategies for environmental management and flood risk mitigation.

This project also serves as a foundation for future studies, which could benefit from integrating more advanced technologies like synthetic aperture radar and machine learning algorithms for enhanced predictive capabilities. Ms. Khoodeeram's work highlights the importance of using modern geomatic tools to address complex environmental challenges and supports the use of digital data in proactive land use planning in Mauritius.

16. Synthetic Aperture Radar (SAR) and Interferometric SAR (InSAR) Applications for Mauritius

Presentation given by: Dr Girish Kumar Beeharry, Assoc. Professor of Physics, University of Mauritius.

Dr. Girish Kumar Beeharry is an Associate Professor of Physics at the University of Mauritius. With a robust academic background in radar technology and remote sensing, he specializes in Synthetic Aperture Radar (SAR) and Interferometric Synthetic Aperture Radar (InSAR) applications. Dr. Beeharry's research focuses on the innovative use of radar technologies for environmental monitoring, disaster management, and agricultural applications. He has presented his work at various scientific symposiums and has contributed significantly to the understanding of radar systems in both academic and practical contexts.

Introduction:

Dr. Girish Kumar Beeharry, an Associate Professor of Physics at the University of Mauritius, presented an in-depth lecture on Synthetic Aperture Radar (SAR) and Interferometric Synthetic Aperture Radar (InSAR). He highlighted the fundamental principles of radar technology and explored its applications in fields such as meteorology, disaster management, and agricultural monitoring. His presentation, conducted during the MRIC Space Symposium, was designed to show how SAR and InSAR provide high-resolution, real-time data that can significantly benefit various scientific and industrial sectors.

Overview of Radar Technology

Radar (Radio Detection and Ranging) technology has evolved considerably since its initial military applications during World War II. Radar functions by emitting radio waves from a transmitter, which then reflect off objects and return to a receiver. By analyzing these reflections, radar systems can determine the distance, speed, and characteristics of objects. This technology has applications across several domains, including aviation, marine navigation, automotive safety, meteorology, law enforcement, and military defense. Radar’s capabilities have expanded over time, becoming a crucial tool for detecting and tracking objects in multiple industries.

Dr. Beeharry discussed the Doppler radar, commonly used in meteorology to track weather patterns. Doppler radar measures the frequency shift of returning waves, allowing for the observation of moving objects, such as storm systems. Additionally, radar waves are polarized, meaning they can be oriented in various directions, which is useful for distinguishing between different surface types, such as water, vegetation, or metallic surfaces.

Introduction to Synthetic Aperture Radar (SAR)

Synthetic Aperture Radar (SAR) is an advanced radar technique that uses a moving radar platform, such as a satellite or aircraft, to synthesize a large antenna aperture. SAR transmits a series of radar pulses over time as the platform moves. This process captures high-resolution images of the Earth's surface, which can be used to analyze both natural and man-made features.

SAR differs from traditional radar in that it combines multiple returns from moving antennas to create a “synthetic” aperture. By leveraging the movement of the radar platform, SAR achieves spatial resolutions that would be impossible with a stationary antenna of the same size. This technique allows for detailed two-dimensional images, and even three-dimensional reconstructions, of landscapes, infrastructure, and vegetation.

Technical Aspects of SAR

The resolution of SAR images depends on the wavelength of the radar signals and the size of the synthetic aperture. The relationship is described by the equation R≈λ/DR \approx \lambda / DR≈λ/D, where λ\lambdaλ represents the wavelength and DDD is the aperture diameter. Shorter wavelengths yield higher resolutions, making SAR ideal for applications that require precise detail.

SAR systems operate using various frequency bands, with each band suited for specific applications:

- **L-Band** (1-2 GHz): Penetrates vegetation and soil, useful for environmental monitoring.

- **C-Band** (4-8 GHz): Provides higher resolution, commonly used in maritime and urban mapping.

Dr. Beeharry also explained the concept of **beam scanning**, where a single SAR beam "illuminates" a target, and the reflections are received back at varying positions. These echo recordings are then combined to produce a higher-resolution image than would be possible with a physical antenna of the same size. This technique is essential for generating images that reveal intricate details of both large and small-scale features.

Interferometric SAR (InSAR)

Interferometric SAR (InSAR) is a specific application of SAR that measures the phase difference between two SAR images taken at different times. This phase difference results from slight changes in the target's position, which can be caused by natural movements, such as tectonic shifts or volcanic activity. InSAR can detect changes at the millimeter level, allowing for precise monitoring of ground deformation.

InSAR is invaluable for monitoring hazards, including:

- **Flooding**: By mapping water levels and changes in water bodies, InSAR provides data on flood extents and helps authorities plan for disaster response.
- **Landslides**: InSAR detects ground movement associated with landslides, allowing for early warning and risk assessment.
- **Volcanic Activity**: InSAR can measure the inflation and deflation of volcanic domes, offering insights into volcanic processes and potential eruption risks.

Applications of SAR and InSAR

1. Digital Elevation Mapping

SAR is widely used in creating Digital Elevation Models (DEMs), which represent the Earth's surface in three dimensions. DEMs are essential for topographic mapping, infrastructure planning, and environmental management. Dr. Beeharry referenced studies that used SAR data to generate DEMs, providing accurate elevation data over large areas.

2. Flood Monitoring

SAR's ability to capture high-resolution images regardless of weather conditions makes it ideal for flood monitoring. Dr. Beeharry presented an example of SAR data used during Hurricane Harvey in 2017, where SAR imagery helped track floodwater spread in real-time, supporting disaster response teams. Since radar waves penetrate cloud cover, SAR can monitor floods effectively under adverse weather conditions, offering valuable information for emergency response and infrastructure protection.

3. Volcanic and Seismic Activity Monitoring

InSAR is particularly valuable in regions prone to volcanic and seismic activity. Dr. Beeharry discussed how InSAR imagery from the Etna volcano was used to observe deformation patterns, indicating potential eruption risks. InSAR can detect ground displacement associated with tectonic movements, providing early warnings for earthquakes and aiding in understanding seismic processes.

4. Agricultural Applications

SAR is increasingly being used in agriculture to monitor crop growth, assess soil moisture, and classify land use. By using different frequency bands, SAR can distinguish between various crop types and track changes in vegetation health. Dr. Beeharry referenced research where SAR data helped classify crops in small agricultural plots, demonstrating SAR's potential for precision agriculture. This technology aids farmers and policymakers in monitoring agricultural productivity and making informed decisions.

5. Urban and Coastal Surveillance

In urban environments, SAR can monitor infrastructure development and detect unauthorized construction. In coastal areas, SAR assists in tracking maritime traffic and identifying vessel types. SAR's high-resolution capabilities make it effective for detecting illegal fishing, smuggling, and environmental hazards, supporting law enforcement and coastal management.

Advanced SAR Techniques: Beam Scanning and Time Domain Addition

Dr. Beeharry highlighted **beam scanning** as a method where SAR transmits radar waves in targeted directions. This technique, combined with time-domain processing, enables the capture of high-resolution images over large areas. SAR platforms collect multiple snapshots and combine them to create a single, detailed image, effectively enhancing resolution.

This process is similar to a camera taking multiple low-quality images and combining them to produce a higher-quality composite. Time domain addition allows SAR to achieve centimeter-level accuracy, making it ideal for monitoring fine-scale changes in the environment. This capability is crucial in applications such as flood monitoring, where high resolution is needed to differentiate between flooded areas and unaffected zones.

Challenges and Future Directions

While SAR and InSAR offer numerous advantages, Dr. Beeharry noted some challenges, including:

- **Data Processing Requirements**: SAR data processing is computationally intensive, requiring specialized software and hardware.
- **Resolution Limitations**: Although SAR provides high resolution, achieving finer details requires more advanced techniques and higher-frequency bands.
- **Data Interpretation**: SAR imagery is not intuitive and often requires expert analysis to interpret accurately.

Looking forward, Dr. Beeharry discussed the potential for integrating SAR data with machine learning algorithms to enhance classification accuracy and automate data processing. He also mentioned the importance of expanding SAR applications to new areas, such as climate change studies and ecosystem monitoring.

Conclusion

Dr. Beeharry's presentation underscored the importance of SAR and InSAR as versatile tools for environmental monitoring, disaster response, and agricultural management. SAR's ability to operate in all weather conditions and capture high-resolution images from great distances makes it an indispensable technology for modern science and industry. InSAR, with its sensitivity to minute ground movements, provides crucial data for hazard assessment and land deformation studies.

The potential applications of SAR and InSAR are vast, and as technology advances, these tools will become increasingly accessible and applicable to a broader range of scientific and practical challenges. Dr. Beeharry emphasized the need for continued research and investment in radar technology, as it holds the promise of transforming fields ranging from geology to agriculture to urban planning.

In summary, Dr. Beeharry's lecture provided a comprehensive overview of SAR and InSAR, highlighting their technical foundations and illustrating their real-world benefits. His insights encourage the use of radar technology for addressing pressing global issues, from disaster resilience to sustainable agriculture, making SAR and InSAR essential components of future environmental and infrastructural management strategies.

17. GIS and Remote Sensing at MCIA-MSIRI

Presentation given by : Mrs R. Mahadea Nemdharry

Mrs. R. Mahadea Nemdharry is a dedicated researcher at the Mauritius Sugarcane Research Institute (MSIRI), where she focuses on the application of remote sensing technologies in agriculture. With a strong background in agronomic research, she employs advanced methods such as drone mapping and satellite imagery analysis to enhance sugarcane production and management. Mrs. Nemdharry is actively involved in innovative projects that integrate artificial intelligence for yield forecasting and precision agriculture. Her work contributes significantly to sustainable agricultural practices in Mauritius.

Introduction:

Mrs. Nemdharry, representing the Mauritius Sugarcane Research Institute (MSIRI), delivered a comprehensive presentation on the institute's research initiatives in remote sensing, particularly focusing on the applications of drones and data analysis in sugarcane agriculture. Her talk provided insights into thematic mapping, agronomic applications, and the utilization of artificial intelligence (AI) in yield forecasting, highlighting MSIRI's commitment to innovative agricultural practices.

Introduction to Remote Sensing at MSIRI

The remote sensing unit at MSIRI plays a pivotal role in advancing agricultural research by leveraging technology to enhance crop management and production efficiency. Remote sensing involves the use of aerial and satellite imagery to gather data about the Earth's surface without direct contact. This technology enables researchers to create thematic maps that provide critical insights into various agricultural parameters.

Mrs. Nemdharry emphasized the importance of continuous innovation and adaptation in the agricultural sector, particularly in response to challenges such as pest management and crop health monitoring. By incorporating advanced remote sensing techniques, MSIRI aims to optimize sugarcane production and ensure sustainability in the agricultural landscape of Mauritius.

Thematic Mapping and Agronomic Applications

One of the key focuses of Mrs. Nemdharry's presentation was the institute's thematic mapping efforts. MSIRI has developed various thematic maps that aid in understanding crop distribution, health, and the prevalence of weeds. These maps are essential tools for researchers and farmers alike, facilitating informed decision-making regarding land management and resource allocation.

Mrs. Nemdharry highlighted the introduction of drone technology into their research processes. Drones equipped with high-resolution cameras and sensors allow for detailed mapping of sugarcane fields. MSIRI has been utilizing drones to conduct assessments of:

- **Weed Mapping**: Drones can identify and map different weed species, providing critical data to agronomists for targeted herbicide application. This technology allows for precision agriculture, where interventions are tailored to specific areas, improving efficiency and reducing chemical use.
- **Cane Growth and Health Assessment**: By monitoring sugarcane growth over time, researchers can analyze the health of crops and determine optimal harvesting times.

Time Series Analysis and Data Integration

MSIRI is engaged in time series analysis, which involves collecting and analyzing data over specific periods to observe changes and trends in sugarcane growth. This ongoing research enables the team to track the evolution of cane height and health throughout the growing season.

In addition to drone data, Mrs. Nemdharry mentioned the integration of satellite data into their research. The institute utilizes imagery from various satellite sources, including Sentinel, to supplement their analyses. This multi-source approach allows for a more comprehensive understanding of the factors affecting sugarcane production, including climate conditions and soil health.

AI Applications for Yield Forecasting

Last year, MSIRI embarked on an ambitious project that integrated artificial intelligence for yield forecasting. This initiative aims to predict sugarcane yields based on various parameters collected through remote sensing and traditional methods. The initial results showed promise, with an accuracy of 76% in yield predictions.

The project is in its second phase, which is expected to provide further insights by the end of September or October. This ongoing research aims to refine the algorithms used for predictions, enhancing their accuracy and reliability in forecasting yields based on historical and current data.

Detailed Methodology and Technology Utilization

Mrs. Nemdharry provided an overview of the technological tools and methodologies employed at MSIRI for remote sensing and data analysis. The following key components were highlighted:

1. **Drone Technology**: The use of drones has revolutionized the way data is collected at MSIRI. Equipped with multiple sensors, drones capture high-resolution imagery of sugarcane fields, enabling detailed assessments of crop conditions and weed infestations.
2. **Software and Analysis Tools**: The research team utilizes advanced software such as ArcGIS for spatial analysis and MapView for visualizing data. These tools allow for the manipulation and analysis of geographic information, enabling the creation of accurate thematic maps.
3. **Data Processing**: The processing of drone imagery involves several steps, including pre-processing to enhance image quality and object-based image analysis techniques to classify various features within the imagery. The team employs programming languages like Python and SQL for geocomputation and data manipulation.
4. **Collaboration and Knowledge Sharing**: Mrs. Nemdharry emphasized the importance of collaboration among different research teams at MSIRI. The data collected through remote sensing is shared with agronomists and other specialists who develop targeted interventions based on the findings.

Weed Mapping and Herbicide Application

One significant aspect of MSIRI's research is the mapping of weed populations within sugarcane fields. Using drones, the institute can assess the extent and distribution of various weed species, which is crucial for effective pest management strategies. Mrs. Nemdharry explained that the information gathered is used to prepare specific herbicide mixtures tailored to combat different types of weeds, ensuring that the right chemicals are applied to the appropriate areas.

This targeted approach minimizes herbicide use and enhances the effectiveness of weed control measures, ultimately contributing to better crop yields and sustainable practices.

Satellite Data Utilization and Predictions

The integration of satellite data into MSIRI's research has significantly enhanced their ability to monitor sugarcane growth and yield potential. By downloading and cleaning satellite images, researchers can analyze historical trends and correlate them with current conditions to make informed predictions.

Mrs. Nemdharry reported that MSIRI has achieved an accuracy of 85% in certain assessments related to sugarcane growth, which is a testament to the effectiveness of combining drone and satellite data. The team continuously works to improve their methodologies and seeks to obtain higher-resolution imagery, aiming for resolutions less than five meters.

Future Directions and Expectations

Looking ahead, Mrs. Nemdharry expressed high expectations for the continued development of remote sensing technologies at MSIRI. The ongoing use of drones is anticipated to provide images at higher frequencies, allowing for timely assessments of sugarcane fields. Additionally, the possibility of integrating more advanced satellite data will further enhance their research capabilities.

The research team's commitment to innovation is evident as they explore the potential for using additional sensor bands on drones, which could provide more detailed insights into crop health and environmental conditions.

Conclusion

Mrs. Nemdharry's presentation on remote sensing applications at the Mauritius Sugarcane Research Institute highlighted the significant advancements made in agricultural research through the use of modern technology. The integration of drones and satellite imagery has enabled more precise monitoring and management of sugarcane crops, ultimately leading to improved agricultural practices and productivity.

By employing innovative approaches such as AI for yield forecasting and targeted weed management strategies, MSIRI is positioned to contribute significantly to the sustainability of sugarcane production in Mauritius. The commitment to ongoing research and collaboration within the institute underscores the vital role of remote sensing in addressing contemporary challenges in agriculture.

In summary, the research initiatives presented by Mrs. Nemdharry exemplify how technological advancements in remote sensing can drive progress in agriculture, enhancing efficiency and promoting sustainable practices. As MSIRI continues to refine its methods and expand its capabilities, it stands to make a lasting impact on the agricultural landscape of Mauritius and beyond.

DAY 2

Session 3

SPACE AND BUSINESS FOR MAURITIUS

18. Space Business – a booming industry

Presentation given by: Mr T. Rudolph, Managing Director AZO Space, Germany

Thorsten Rudolph is CEO of the Anwendungszentrum GmbH Oberpfaffenhofen (Application Centre for Satellite Navigation). Under the leadership of Mr. Rudolph, the AZO has gained a reputation throughout Europe as an expert and leader in innovation management, technology transfer, business development, and international project management. He has a lifetime of experience in the Satellite industry at both organizational and technical levels. Mr Rudolph is in control of a satellite navigation network with 24 participating high-tech regions throughout and beyond Europe. He has awarded dozens of SMEs for their work and encouraged application development for Galileo and GMES while enlisting the support of high-profile corporate sponsors. He has overseen the creation and incubation of more than 65 start-up companies in the ESA BIC Bavaria.

Introduction

Thorsten Rudolph delivered an insightful presentation on innovative strategies employed in Europe to foster the development of a new space ecosystem. Although unable to attend the event in person, he emphasized his commitment to enhancing collaboration between Mauritius and European entities in the field of space research and technology. The presentation outlined several key initiatives, partnerships, and programs designed to stimulate entrepreneurship and innovation within the space sector.

Mr. Rudolph began his presentation by expressing gratitude for the invitation and acknowledging the importance of discussing the burgeoning space economy. He stated that the European experience could provide valuable lessons and frameworks for Mauritius to adopt in its quest to develop a sustainable space ecosystem. With over 20 years of experience in space entrepreneurship, Mr. Rudolph shared insights from his work with various European organizations, particularly focusing on fostering startups and innovation networks.

20 Years of Space Entrepreneurship

Mr. Rudolph emphasized the significant strides made in space entrepreneurship over the past two decades, particularly in Germany and across Europe. He highlighted the role of various initiatives designed to empower the new space economy, which includes innovation, incubation, networking, competition, and policy advisory. As a leading initiator and organizer of innovation networks in Germany and the EU, his organization has been pivotal in developing a robust ecosystem for startups in the space sector.

Key Initiatives and Programs

Several noteworthy initiatives were discussed during the presentation, showcasing the collaborative efforts to foster innovation in the space industry:

1. **Galileo Masters (2004–2021)**: This initiative promotes the use of Galileo satellite navigation technologies, encouraging entrepreneurs to develop innovative applications.
2. **INNOspace Masters (2015–2023)**: Focused on supporting space-related startups, this program encourages the development of ideas into market-ready products.
3. **Copernicus Masters (2011–2022)**: This competition promotes the use of Earth observation data from the Copernicus program, inspiring startups to create solutions based on this data.
4. **Copernicus Hackathons (2017–2019)**: These events foster collaboration among developers and entrepreneurs to create innovative applications using Earth observation data.
5. **Space App Camps (2011–2021)**: Aimed at engaging students and young professionals in space-related projects, fostering creativity and innovation in the sector.
6. **European Space Week (2012–2019)**: This event brings together stakeholders from across the space industry to share knowledge and promote collaboration.

7. **Various Accelerators and Support Programs**: Mr. Rudolph mentioned multiple acceleration programs, including the ESA Business Incubation Centers (ESA BIC) established in Bavaria, NRW, and Northern Germany. These centers provide critical support for startups, helping them navigate the challenges of entering the space market.

Networking and Policy Advisory

In addition to entrepreneurship support, Mr. Rudolph emphasized the importance of networking and policy advisory roles. By connecting startup networks with investors and corporate partners, the European Union aims to strengthen the capacity of its space sector. One of the key initiatives discussed was the **International Space Initiative**, designed to support the internationalization of the European space sector across more than 90 countries.

This program provides services to European companies and their partners outside Europe through various means, including online events, live conferences, and market reports that highlight business opportunities in targeted countries. Through these initiatives, Mr. Rudolph stated that approximately 200 European space companies have been engaged, fostering collaboration and knowledge sharing across borders.

Partnership Agreements and Collaboration with Mauritius

One of the significant outcomes of these activities is the initiation of 72 partnership agreements between European stakeholders and non-European entities. Mr. Rudolph highlighted three partnership agreements established between his organization, the Mauritius Research and Innovation Council (MRIC), and various European companies. He expressed confidence that these partnerships would enhance cooperation between Mauritius and Europe, facilitating the development of Mauritius's new space economy.

Leveraging European Expertise for Mauritius

Mr. Rudolph believes that European expertise can significantly aid Mauritius in developing its space economy. He emphasized the potential for collaborative projects that could be co-financed by the European Commission and other European entities. By fostering networks between European space pioneers, corporates, and investors, Mauritius could leverage external expertise to strengthen its own space initiatives.

Matchmaking Programs and Fundraising Support

The presentation also covered the matchmaking programs organized to connect startups with investors and industry leaders. These events facilitate the establishment of relationships that can lead to successful partnerships and funding opportunities. By building a network of more than 100 corporates and investors, the aim is to provide space business pioneers with the resources needed for fundraising and market access.

Mr. Rudolph underscored the importance of awareness-raising initiatives, such as innovation networks and competitions, in promoting the European space sector. By organizing events that highlight the achievements and opportunities in the space industry, these programs aim to attract attention and investment into emerging companies.

In-Orbit Demonstration and Validation Opportunities

An exciting aspect of the European space ecosystem is the provision of access to in-orbit demonstration and validation opportunities. Mr. Rudolph detailed an initiative led by the European Space Agency to offer access to space for experimental projects. An open call was made for proposals, and two were selected for demonstration aboard a reusable spacecraft scheduled for launch in October 2024.

This initiative presents a unique opportunity for universities, researchers, and scientists to conduct experiments in space, further enhancing the collaborative nature of the space sector. By enabling such projects, Europe aims to develop an ecosystem that encourages innovation and research in the field of space.

Technical Integration and Pilot Projects

Mr. Rudolph discussed additional programs aimed at integrating small to medium-sized enterprises (SMEs) into the space industry. An open call was launched to select pilot projects that address

promising areas of innovation identified by large system integrators. Seven SMEs were selected to collaborate with major players in the space sector, fostering a collaborative environment that encourages the development of innovative solutions.

These projects are financed by the European Space Agency, underscoring the commitment to advancing technological integration and efficiency within the space industry. By supporting these collaborations, Europe aims to enhance the capabilities of both small startups and larger system integrators, facilitating a more robust space ecosystem.

Successful Entrepreneurship Programs in Germany

Mr. Rudolph highlighted a particularly successful entrepreneurship program in Germany, recognized as the most successful space entrepreneurship initiative in Europe. Operating across twelve locations and six federal states, this program has supported more than 420 companies to date. The program exemplifies the importance of a strong network of partners, including public agencies, the European Space Agency, and industrial partners.

Through this initiative, participating companies gain access to various resources, including technical support, funding opportunities, and access to laboratories. These resources are crucial for startups as they develop their first prototypes and navigate the challenges of entering the market.

Market Opportunities and Innovations

The presentation also addressed the diverse market opportunities available within the space sector. Mr. Rudolph explained that companies supported through these initiatives often focus on providing services based on Earth observation and satellite navigation, catering to various markets. The ability to develop both hardware and software solutions allows these companies to bring innovative products and services to the market.

Moreover, the push to develop small satellite launchers and establish satellite constellations is expected to create additional opportunities within the lunar economy and beyond. This expansion aligns with the growing interest in utilizing space resources for a variety of applications, including telecommunications, environmental monitoring, and disaster management.

Building an Investor Network in Mauritius

Recognizing the importance of financial backing for the development of the space sector, Mr. Rudolph emphasized the need to build a robust investor network in Mauritius. He outlined the significance of establishing relationships with venture capital firms, corporate investors, and business angels to secure funding for emerging space companies.

By creating a diverse mix of financial partners, Mauritius can enhance its investment landscape, providing startups with the capital necessary to grow and innovate. As an example, he noted that Bavaria has developed a network of over twelve investors who have collectively invested approximately 2.5 billion euros in about 70 companies. Such a model could be adapted for Mauritius to attract similar levels of investment.

Conclusion

In his concluding remarks, Mr. Rudolph expressed optimism about the potential for collaboration between Mauritius and Europe in the space sector. He reiterated the importance of leveraging European expertise to support the growth of Mauritius's space economy and emphasized the role of networking, innovation, and funding in achieving this goal.

By fostering partnerships and engaging in collaborative projects, Mauritius can develop a sustainable space ecosystem that benefits from the resources and knowledge of established players in the European space industry. Mr. Rudolph’s presentation underscored the valuable opportunities available through international cooperation, paving the way for a thriving space economy in Mauritius.

Through strategic initiatives, innovation networks, and robust funding mechanisms, the path toward a vibrant space sector in Mauritius is not only feasible but promising. The collaborative efforts outlined in his presentation serve as a framework for future growth and development in the space industry, benefiting both Mauritius and its European partners.

19. African Space Economy- Opportunities for Mauritius

Presentation by: Mr Temidayo Oniosun, Founder and Managing Director of Space in Africa

Temidayo is the Founder and Managing Director of Space in Africa, the leading analytics and consulting company shaping the future of the African space and satellite industry. With several years of experience in the industry, Temidayo advises governments and commercial space players in the industry value chain. Temidayo has led several strategy and policy consulting projects for government and commercial stakeholders. This includes the African Union Commission baseline studies on the four space segments and the socio-economic benefits of establishing and operationalising the African Space Agency, and the commercialisation strategy for AngoSat-2 for the Angolan National Space Management Office (GGPEN). Temidayo is a 2020 Karman Fellow, a 2021 Forbes Africa 30 under 30 award recipient and before founding Space in Africa, was the African Regional Coordinator for the Space Generation Advisory Council of the United Nations. Temidayo regularly appears on various media commenting on the African space and satellite programs including BBC, CNN, CNBC, Forbes Africa, Voice of America, among others. Temidayo has a Master's degree in satellite applications from the University of Strathclyde, UK and is currently a PhD candidate at the University of Delaware, USA.

Introduction

Temidayo Oniosun, Managing Director at Space in Africa, shared insights into the African space economy, including the organization's role, the current state of the sector, and the opportunities that lie ahead for the Republic of Mauritius.

Company Overview

Space in Africa is an analytics and consulting firm dedicated to the African space satellite industry. We collaborate with government institutions across the continent, including space ministries, to formulate strategies for national space programs. Our work extends to engaging with commercial enterprises outside Africa, identifying various business opportunities within the industry ecosystem.

The Current State of the African Space Economy

As of 2023, the African satellite industry generates approximately $19 billion in revenue. This revenue stream spans various sectors, including:

- Global Navigation Satellite Systems (GNSS)
- Satellite TV services
- Fixed and mobile satellite manufacturing
- Remote sensing and networks
- The rapidly growing segment of satellite applications

It is projected that by 2026, the industry's revenue will exceed $22 billion, highlighting a robust growth trajectory. However, as we consider the expanding market, it is vital to address the financial commitments of African governments toward their national space programs. Over the past seven years, African nations have allocated more than $3.1 billion to space budgets, reflecting a Compound Annual Growth Rate (CAGR) of 5.31%. Notably, the budget allocation peaked at $645 million last year, but in 2024, a significant decline of 23.87% was observed due to currency fluctuations, with this year's budget estimated at around $500 million.

Country Contributions and Budget Allocations

Budget cuts have been reported across various nations, with South Africa, Egypt, and Nigeria being the highest contributors to space funding. In contrast, countries such as Ethiopia, Zimbabwe, and Angola are in the nascent stages of developing their national space programs.

The New Space Ecosystem in Africa

The African new Space ecosystem is evolving rapidly, with approximately 300 companies currently operating across the industry's value chain, both upstream and downstream. These companies are primarily situated in Egypt, Kenya, South Africa, Rwanda, and Nigeria.

Since 2015, African space startups have collectively raised over $184 million in funding, with approximately 97% of this total coming from investors located outside the continent. While venture capital, private equity, and angel investments provide significant funding, bootstrapping remains a prevalent strategy for many African companies striving for sustainability.

Challenges and Opportunities for Mauritius

In this context, we must consider Mauritius' standing within the African space landscape. Currently, fewer than ten space companies operate in Mauritius, with two established in 2015. These companies primarily target the global market, offering products and services related to spatial applications and maritime solutions.

One notable business trend is the integration of high-tech applications and the development of custom analytics frameworks for various industries.

Strategic Approach for Developing Mauritius' Space Program

To enhance Mauritius' space program and align it with economic relevance, we propose a three-stage approach focusing on:

1. **Immediate Economic Relevance**: Ensuring that the national space program contributes positively to the economy.
2. **Talent and Innovation Development**: Nurturing local talent and fostering innovation in the sector.
3. **Thriving Commercial Ecosystem**: Driving the development of a robust commercial ecosystem.

To achieve these objectives, we propose the establishment of a Space Bureau that integrates all government space initiatives and consolidates space services procurement. This bureau will focus on:

- Building research labs in universities.
- Sponsoring university research and exchange programs.
- Developing open-access research and development (R&D) infrastructure.
- Encouraging the local presence of foreign subsidiaries while ensuring compliance with local content requirements to cultivate a thriving commercial ecosystem.

Sustainable National Space Program Strategy

The establishment of a lean space bureau will enable the integration of government space needs and the aggregation of space services procurement. By developing a startup ecosystem, Mauritius can capitalize on its potential to attract global talent and companies, thus establishing research labs and universities that foster innovation.

Key initiatives include:

- **Partnerships**: Collaborating with research labs and universities to sponsor university research programs.
- **Infrastructure Development**: Implementing strategies to strengthen a sustainable national space strategy.
- **Funding Diversification**: Securing private capital and promoting local investments to ensure financial sustainability for the space program.

As we look ahead, addressing the following questions is vital:

- How can space agencies achieve a return on investment (ROI)?

- What will be the outlook on demand for satellites?
- Where will the funding for next-generation satellites come from?

The landscape indicates that most African satellites are funded through government initiatives, with a pressing need for private capital to drive next-level growth in satellite infrastructure.

Globalization of Satellite Services and Regional Operator Response

The emergence of global satellite communication networks, such as Starlink, poses challenges and opportunities for regional operators. Integrated global satellite operators with superior cost structures are entering the African market, prompting regional operators to remain competitive. Key strategies for these operators include:

- Securing long-term commitments from anchor clients, typically government entities.
- Developing localized ground infrastructure for secure communications.
- Forming strategic partnerships with equipment manufacturers and service providers.

Growth of the Earth Observation Segment in Africa

There is a burgeoning demand for Earth Observation (EO) solutions within Africa, spurred by low entry barriers and local market needs. Increasing numbers of African startups are emerging to provide EO-based services, focusing on application services and custom analytics for non-defence use cases. International operators are providing the upstream layer while local partners address downstream applications.

Collaboration and International Partnerships

Inter-African collaborations constitute only 11% of all announced space agreements involving African countries. The African Space Agency is expected to play a significant role in facilitating local collaborations, strengthening Africa's position in the global space landscape. Notably, 19 African countries have signed 76 space bilateral agreements with European entities between 2006 and 2024.

Conclusion

In conclusion, the African space economy presents a wealth of opportunities for innovation and collaboration. As we move forward, it is essential for African nations to enhance their space programs, leverage international partnerships, and promote sustainable strategies to ensure growth.

Thank you for your attention, and I look forward to engaging further in discussions about advancing our collective goals in space exploration and technology development.

20. Aerborne technological solutions in the New Space Era

Presentation given by: Mr S. Kalachand, Founder & CEO Aeraccess Group

Shehzaad Callachand, who currently lives in Courcouronnes, Île-de-France, France, is the Founder and CEO of AERACCESS Group. He brings extensive experience from his previous roles at Université Evry Val d'Essonne, where he earned a Diplôme de Recherche Technologique from 2008 to 2011. With a strong skill set encompassing startups, Microsoft Excel, management, strategy, and project management, Shehzaad Callachand provides valuable insights and contributions to the industry.

Introduction

AERBORNE is a pioneering company that has established itself over 18 years in the fields of robotics, artificial intelligence (AI), and aerospace. With a commitment to cutting-edge and sovereign technology, both hardware and software, AERBORNE has made significant strides in developing innovative solutions tailored to meet the unique needs of clients across various sectors. This summary provides an overview of AERBORNE's mission, team, expertise, global presence, and vision for the future.

Company Overview

AERBORNE's extensive research and development (R&D) efforts have culminated in over 50 world-class references that validate the quality of its solutions. The company operates in more than 15 countries, providing technology transfer (ToT), knowledge sharing, and factory setups that empower local industries. This includes the supply of off-the-shelf products as well as the development of customized turnkey solutions to address specific client requirements.

International Recognition

AERBORNE has garnered significant acclaim for its innovative contributions to the fields of robotics and AI. The company has received several awards in Europe, including the Unmanned Systems Innovation Awards in Riyadh (2018) and recognition at the World AI Show in Mauritius. Furthermore, AERBORNE's participation in the Startup World Cup in Silicon Valley has highlighted its potential on a global scale. The company has successfully secured over €5 million in grants from the European Union's Horizon 2020 and the European Innovation Council (EIC) over the past eight years, reflecting its strong commitment to research and innovation.

Fields of Expertise

AERBORNE operates at the intersection of several key areas, which include:

- **Robotics**: The company designs and develops autonomous systems capable of performing complex tasks in various environments. Their robotics solutions are adaptable and scalable, addressing both commercial and governmental needs.
- **Artificial Intelligence**: AERBORNE harnesses AI to enhance its robotics solutions, enabling smarter decision-making and operational efficiencies. This integration helps clients optimize their processes and achieve better outcomes.
- **New Space**: AERBORNE is committed to advancing space technologies, contributing to the emerging New Space sector through innovative aerospace solutions that support various missions.
- **Industry 4.0**: AERBORNE embraces the principles of Industry 4.0 by integrating advanced technologies such as IoT, big data analytics, and cloud computing into its offerings. This commitment ensures that its solutions are at the forefront of modern manufacturing and operational practices.

Sovereign Solutions

AERBORNE emphasizes the importance of sovereign solutions, which are tailored to the specific needs of its clients while maintaining data security and integrity. Key offerings include:

- **Ground Control Systems**: AERBORNE's ground control stations are designed with security in mind, featuring no backdoor access and employing AES 256-bit encryption for data transmission. These systems can be customized to fit the specific needs of each client, ensuring seamless integration with their operations.
- **Payloads and Flight Control Software**: The company develops advanced payloads for various applications, alongside robust flight control and telemetry software that supports autonomous operations.
- **User-Friendly Interfaces**: AERBORNE provides rugged tablets equipped with touchscreen capabilities and one-hand control systems, allowing for easy operation in diverse environments.

Global Presence and Partnerships

AERBORNE's commitment to technology transfer extends beyond its home country, impacting various regions around the world. The company actively drives national strategies for AI and robotics in several countries, collaborating with local governments to set up factories that facilitate Industry 4.0 initiatives. This includes establishing 3D printing facilities, mobile clinics, lithium polymer factories, and PCB/SMD soldering assembly lines.

In Africa, AERBORNE has formed strategic partnerships with governments, positioning itself as an AI expert for robotics in Morocco through its collaboration with 'AI DOME – UPM6 Rabat.' Additionally, the company is contributing to the development of the AI Village for Nigeria, showcasing its dedication to advancing technology across the continent.

Vision 2030: A Path to Success

AERBORNE operates with a forward-thinking approach, encapsulated in its Vision 2030. This vision emphasizes the importance of collaboration, innovation, and sustainability as critical factors for success in the rapidly evolving technological landscape.

The guiding mantra of AERBORNE can be summed up in three key principles:

1. **Think Big**: AERBORNE encourages ambitious thinking and long-term planning, pushing the boundaries of what is possible in robotics and AI.
2. **Start Small**: While ambitious in vision, AERBORNE believes in starting with manageable projects that can scale over time. This approach allows for gradual implementation and refinement of ideas.
3. **Act Now**: AERBORNE emphasizes the importance of taking immediate action to seize opportunities in the market. By staying agile and responsive to technological advancements, the company positions itself as a leader in the industry.

Conclusion

AERBORNE’s commitment to innovation in robotics, AI, and aerospace has established it as a key player in the global technology landscape. With a strong foundation built on R&D, a highly skilled team, and a focus on sovereign solutions, the company is well-equipped to address the challenges of the future. Its extensive international presence and strategic partnerships further enhance its capability to drive technological advancements and support local economies.

In conclusion, AERBORNE is poised to go beyond traditional limits, ensuring that it not only meets the needs of its clients today but also prepares for the technological landscape of tomorrow. With a commitment to excellence and a vision for growth, AERBORNE is ready to redefine what is possible in the fields of robotics and artificial intelligence.

21. Business Facilitation and Innovation Ecosystem in Mauritius

Presentation given by: Mrs P. Sewpal, Senior Manager, ICT Digital services cluster, Economic Development Board.

Mrs. Pratima Sewpal is the Senior Manager in the ICT Digital Services Cluster at the Economic Development Board (EDB) Mauritius, the National Investment Promotion Agency of the Government of Mauritius. She joined the agency in 2004, where she has played a crucial role in positioning Mauritius as a competitive global services delivery destination in the ICT and BPO sectors. With extensive experience, Mrs. Sewpal oversees a diverse portfolio of projects and is well-regarded within both the local and international ICT business communities. Before her current role, she worked at Mauritius Telecom and the Sugar Investment Trust, further enhancing her industry knowledge. Mrs. Sewpal holds a master's degree in E-Business and a Bachelor of Science (Honours) in Economics from the University of Mauritius. Her expertise and dedication contribute significantly to promoting and facilitating investment in Mauritius, driving the nation's economic development

Introduction:

The Republic of Mauritius is a strategic island located in the Indian Ocean, approximately 2,000 kilometers off the southeastern coast of Africa. Covering an area of 2,040 square kilometers, it boasts an Exclusive Economic Zone (EEZ) of 2.3 million square kilometers. Mauritius is today globally recognized as an established location for global services delivery thanks to its quality, multilingual workforce, flexible business environment, diversity in connections and sustainable financial attractiveness. Multinational companies and organizations benefit from leveraging on the country not only as a hub for their global services delivery but also as an ideal location to access Africa, Asia and Europe.

The presentation of Mrs Sewpal focussed on some of the key milestones in the evolution of the ICT industry and support being provided by Economic Development Board in facilitating the various innovative projects through panoply of schemes and incentives**.** She also provided an overview of the current economic landscape, population statistics, key sectors contributing to GDP, and institutional support for innovation and business facilitation in Mauritius.

Demographics and Economic Indicators

As of 2021, the population of Mauritius is approximately 1.3 million, with an active population of 532,800. The country is bilingual, with English and French as the primary languages. The literacy rate stands at 91.3%. In 2022, Mauritius recorded a real GDP growth rate of 8.7%, with a GDP per capita of USD 10,256. The local currency is the Mauritian Rupee (MUR), with an exchange rate of roughly 46 MUR to 1 USD.

The country has established various bilateral agreements, including 54 Double Taxation Avoidance Agreements (DTAAs) and 45 Investment Promotion and Protection Agreements (IPPAs). Mauritius operates under a hybrid legal system that combines elements of both common and civil law.

Economic Transition and Growth

Mauritius has undergone significant economic transitions over the past decades. The per capita income has increased steadily across various sectors:

- **Agriculture**: USD 400
- **Export-Oriented Manufacturing (EPZ)**: USD 1,180
- **Tourism**: USD 2,500
- **Financial Services**: USD 3,860
- **Business Facilitation**: USD 7,770

- **Innovation**: USD 10,400

The government aims to elevate the per capita income above USD 20,000 by 2030, with strategic focus areas including manufacturing (13.6%), construction and real estate (10.7%), tourism and ocean economy (10.3%), and financial services (13.5%).

Key Sectors and Milestones

The economic structure of Mauritius has diversified, and key sectors contributing to GDP include:

- **Manufacturing**: 13.6%
- **Financial Services**: 13.5%
- **Tourism**: 10.3%
- **ICT**: 5.7%
- **Healthcare**: 5.0%
- **Creative Industries**: 2.7%

Several milestones have marked Mauritius' progress in becoming a digital economy:

- **2002**: Establishment of fiber optic connections (SAFE/SAT3).
- **2015**: Launch of the Cyber Tower and promulgation of the Data Protection Act.
- **2021**: Deployment of the first Mauritian nanosatellite, MIR-SAT1, and the introduction of new submarine cable connections.

Transition to a Digital Economy

Mauritius has been transitioning towards becoming a digital island, focusing on various smart technologies. Initiatives include:

- **Smart Education**: Implementation of gamification and interactive whiteboards.
- **Smart Health**: Adoption of wearable devices.
- **Smart Utilities**: Integration of smart metering systems.
- **Smart Agriculture**: Utilization of sensors for flood detection and light measurement.

Emerging sectors that present opportunities for growth include data analytics, fintech/blockchain, Internet of Things (IoT), artificial intelligence (AI), machine learning, cybersecurity, robotics, and creative outsourcing.

Role of the Economic Development Board (EDB)

The Economic Development Board (EDB) operates under the Ministry of Finance, Economic Planning, and Development, focusing on strategic economic planning, business facilitation, country branding, and trade and investment promotion. The EDB's strategy is built around three core principles:

- **Accelerate**: Focus on established sectors such as sugar, textiles, fishing, hospitality, and real estate.
- **Diversify**: Promote investments in high-growth sectors like biotechnology, fintech, and renewable energy.
- **Innovate**: Encourage innovation in high-tech fields and emerging industries.

Innovator Occupation Permit

Introduced in 2017, the Innovator Occupation Permit has no capital outlay requirement. Applicants can submit innovative projects for evaluation or register with an accredited incubator under the Mauritius Research and Innovation Council (MRIC). The R&D expenditure must constitute at least 20% of total operational expenses during the research phase. The permit is valid for ten years and is renewable.

E-Commerce and Incentives

The E-Commerce Scheme introduced in 2020 offers a five-year tax holiday for qualifying businesses that invest at least 20 million rupees in Mauritius and hire at least 20 qualified resident personnel. The scheme aims to boost e-commerce activities in priority sectors.

In 2021, an incentives framework was established, including benefits such as:

- **Investment Certificate**: Provides an eight-year tax holiday and exemptions on land transfer tax and VAT for machinery and equipment.
- **Premium Investor Certificate**: Offers negotiable incentives, including tax rebates and exemptions for projects in pharmaceutical manufacturing, medical devices, renewable energy, and innovative technologies.

Eligibility criteria include creating a minimum of 20 jobs, a minimum investment of MUR 5 million, and alignment with global rankings recognized by the EDB.

Conclusion

Mauritius is positioned as an emerging hub for business facilitation and innovation in the region. With its strategic geographic location, supportive government policies, and a robust legal framework, the country presents numerous opportunities for local and international businesses. The ongoing initiatives to transition towards a digital economy, coupled with the establishment of key sectors and an effective EDB, make Mauritius an attractive destination for investment and research and development activities.

As Mauritius continues its journey towards becoming a high-income economy, the focus on innovation and diversification will play a crucial role in sustaining economic growth and development.

22. Role of a telco/tech company in supporting the space economy led business for Mauritius

Presented by Shivendra Nautiyal, Chief Strategy and Innovation Officer, Emtel Ltd.

Shivendra Nautiyal Chief Strategy and Innovation Officer Emtel Ltd. He has a comprehensive work experience in the telecommunications industry. Shivendra began their career at Ericsson India, working as a Senior Engineer- Support and later as a Specialist Core Network. In 2005, they joined Digicel Group Jamaica as a Manager Core Network, responsible for overseeing the company's core network operations. Shivendra then moved to Digicel Suriname in 2007 as the CTO, where they played a crucial role in the roll-out and operations of GSM services. In 2013, Shivendra worked as the Deputy CTO at Digicel Myanmar before joining OOREDOO as the Director - Planning and Engineering in 2014, where they supervised the green-field rollout of UMTS network in Myanmar. Shivendra returned to Digicel Suriname in 2014 as the CTO before eventually joining Emtel in 2016 as the CTO. In 2023, Shivendra assumed the position of Chief Strategy and Innovation Officer at Emtel.

Introduction

Emtel Ltd. has been a pioneer in innovation for 35 years, facilitating connectivity across Mauritius and beyond. With a robust network infrastructure, Emtel is committed to driving advancements in various sectors, including entertainment, finance, education, healthcare, and e-commerce.

Emtel Technopolis

Role of a Terrestrial TechCo

Emtel's role as a terrestrial technology company (TechCo) encompasses several key responsibilities:

- **Infrastructure Acquisition and Development:** Emtel focuses on acquiring and developing the necessary infrastructure to support technological advancements.
- **Local Regulatory Knowledge:** The company possesses an in-depth understanding of the local regulatory framework, which is essential for successful project execution.
- **Licensing:** Emtel holds the required licenses to operate and execute technological initiatives.
- **Collaboration with Local Agencies:** The ability to collaborate with local agencies and government bodies allows for quicker project deployment.
- **Satellite Ground Station Experience:** Emtel has years of experience operating satellite ground stations, further solidifying its role in the tech landscape.
- **Trained Workforce:** The company boasts a skilled workforce that is well-equipped to manage technological initiatives.
- **Strong Financial Position:** Emtel maintains a robust financial standing, enabling it to execute and partner in various programs.
- **Reliable Connectivity:** Emtel ensures both domestic and international connectivity, working alongside other Internet Service Providers (ISPs) to enhance redundancy.
- **Partnerships with International Vendors:** Emtel has established strong relationships with trusted international vendors, which facilitates efficient technology deployment.

Eutelsat Group OneWeb Project

Emtel is a key player in the Eutelsat Group's OneWeb project, being one of 43 global ground station locations. Mauritius was chosen as a strategic site following a rigorous Request for Proposal (RFP) process that considered competing countries in the Indian Ocean. The location is crucial for covering vast areas of the Indian Ocean and the Proud Indian Africa region.

Economic Benefits

The establishment of a ground satellite station in Mauritius presents several potential economic benefits:

- **Job Creation:** The project is expected to generate employment opportunities within the region.
- **Attracting Foreign Investment:** By enhancing technological capabilities, Mauritius can attract foreign investment, boosting the local economy.
- **Access to Remote Areas:** The ground station will improve connectivity in remote regions such as Rodrigues, Agalega, and St Brandon.
- **Redundant Connectivity:** The project will provide a backup solution for increased capacity during high-demand periods.
- **Global Connectivity Mission:** Partnering with OneWeb aligns with the mission to provide connectivity to unconnected areas, including airlines and maritime sectors.

Significance of the Ground Satellite Station

The establishment of the first ground satellite station in Mauritius is a milestone that enhances connectivity and reliability. Key aspects include:

- **Technical Capabilities:** The ground station features advanced technical capabilities that improve overall connectivity.
- **International Connectivity:** Mauritius will benefit from diverse international connectivity through three different cable systems.

Project Delivery Team

Emtel's experienced project delivery team is responsible for the deployment and operation of the Eutelsat ground station project. As the only operator with a diverse and experienced team managing satellite ground stations, Emtel stands out in its capability to deliver and operate these essential facilities effectively.

Future Plans

Emtel Technopolis is poised for further development with several upcoming projects:

- **Showcasing Technological Prowess:** Emtel aims to position itself and Mauritius as pioneers in technology, attracting foreign investments and fostering an innovative ecosystem.
- **New Initiatives:** Future projects include a new data center, innovation labs, a solar park, a cable landing station, and additional ground stations for space economy initiatives.
- **Technological Advancement Goal:** The ultimate goal is to position Mauritius at the forefront of technological advancements, particularly in the field of space technology and emerging technologies.

Conclusion

Emtel Ltd. continues to play a critical role in driving innovation and connectivity in Mauritius and the wider region. With its strategic initiatives and partnerships, the company is well-positioned to lead in the development of space technology and enhance the nation’s technological landscape.

23. Mauritius International Financial Centre, Your Business Facilitation Hub in Africa

Presentation given by Mrs Dovina PILLAY-NAIKEN, Acting Director, Ministry of Financial Services and Good Governance

Dovina is the Acting Director of the Financial Services Unit at the Ministry of Financial Services and Good Governance, a position she has held since joining the Ministry in June 2018. In this role, she is responsible for leading strategic initiatives aimed at advancing the financial services sector. She oversees a team of analysts, ensuring the development and implementation of innovative strategies for sectoral growth. Dovina's career began at the State Bank of Mauritius, where she served as a Legal Officer before being appointed as the Company Secretary of SBM Holdings Ltd in 2014. Her extensive experience within the banking sector has included collaborations with various departments, where she contributed to corporate governance and strategic advisory functions. In 2016, Dovina expanded her expertise by joining the transaction advisory team at Ernst & Young (EY Mauritius). She holds a *Maîtrise en Droit des Affaires* from the University of Reunion and a Postgraduate qualification in Cybercrime from the Asian School of Cyberlaw in Pune, India. In addition to her role at the Ministry, Dovina serves as a Board Member of the Financial Services Institute Ltd.

Introduction

The Mauritius International Financial Centre (IFC) has a foundational role in the nation's economic development and serves as a key player in attracting foreign investment. Since its inception in 1992, the IFC has evolved into a strategic hub, driven by a strong regulatory framework, favorable tax policies, and an enabling business environment. The IFC operates with a mission to provide a robust platform for businesses across sectors, including emerging industries such as space and technology. Today, the IFC is integral to the Mauritian economy, supporting over 17,000 jobs and serving as a gateway to Africa and beyond.

Historical Context and Economic Impact

Mauritius's role as a financial center can be traced back to the 1800s, positioning itself as a strategic node for trade between Asia and Africa. The formal establishment of the IFC in 1992 signaled a new chapter, marking the island nation's entry into global finance. With a regulatory framework that complies with international standards set by the OECD, FATF, and IOSCO, Mauritius has garnered trust and credibility as a financial jurisdiction. Currently, the IFC is the second pillar of the Mauritian economy, attracting investment through a blend of favorable legislation and a diverse array of financial services.

Mauritius's Global Reach

Mauritius has built an extensive network of Double Taxation Avoidance Agreements (DTAAs) with over 47 countries, including 17 in Africa. These agreements minimize tax liabilities, providing businesses with an attractive fiscal environment. Mauritius also holds Free Trade Agreements (FTAs) with major economies, including China and India, further enhancing its appeal as a regional financial hub. Compliance with global anti-money laundering (AML) and counter-terrorism financing (CFT) standards, alongside its multilingual workforce, underscores Mauritius's commitment to international best practices.

Structures Available for Businesses

The IFC offers a range of corporate structures that cater to various business needs, especially those looking to establish or expand in emerging sectors like space technology. These include:

1. **Domestic Companies** - Ideal for businesses operating primarily within Mauritius, with requirements such as appointing a local director.

2. **Global Business Companies (GBCs)** - These entities benefit from fiscal advantages when conducting business outside Mauritius. GBCs are regulated by the Financial Services Commission (FSC) and require the assistance of a licensed management company for incorporation.
3. **Authorized Companies** - Designed for businesses whose activities are conducted outside Mauritius, Authorized Companies provide a high degree of flexibility in structuring operations to suit international transactions.

Mauritius also offers structures that promote investor confidence, such as the Variable Capital Company (VCC), which enables companies to attract and retain investors through features like sub-funds, crowdfunding capabilities, and other innovative financial products.

Investor-Friendly Policies

The Mauritius IFC emphasizes ease of doing business, as reflected in its ranking on the World Bank's Ease of Doing Business Index. The IFC offers a one-stop-shop regulatory framework that simplifies the incorporation and licensing processes, reducing administrative burden on new businesses. Investors also benefit from policies like free repatriation of profits, acceptance of digital signatures, and no foreign exchange controls.

The Mauritian legal framework, which is based on a hybrid system with the Privy Council as the highest court of appeal, reinforces investor confidence through investment protection agreements. Mauritius's two arbitration centers—MIAC and MARC—further bolster its dispute resolution capabilities, making it an attractive destination for international arbitration.

Support for Emerging Sectors

With the rapid development of the space sector, the IFC has positioned itself as a financial enabler. Mauritius is a signatory to the Cape Town Convention, which facilitates asset-based financing for space assets, aircraft, and other high-value mobile equipment. This legal framework provides creditors with enforceable rights on these assets, thereby encouraging investment in the space industry.

The Space Protocol, a key component of the Cape Town Convention, outlines protections for space assets, offering clarity to creditors and enhancing financial security for space-related ventures. The anticipated ratification of this protocol will enable Mauritius to provide a stable legal environment for space asset financing, paving the way for Mauritius to become a key player in the global space economy.

Strategic Advantages and the Way Forward

Mauritius is uniquely positioned to serve as a bridge between Africa and the rest of the world. Through strategic partnerships and trade agreements, businesses operating from Mauritius can access up to 70% of the global market. The Africa Continental Free Trade Agreement (AfCFTA) exemplifies this, enabling Mauritius-based entities to leverage preferential trade terms with over 54 African nations.

The IFC's future lies in its ability to support sectors such as fintech, blockchain, and space technology. By enhancing its regulatory framework, Mauritius can attract innovators and entrepreneurs looking for a cost-effective and compliant environment to test and launch new technologies. The FSC's Regulatory Sandbox License (RSL) provides a controlled environment for startups to pilot their innovations, potentially leading to new business models that contribute to Mauritius's economic growth.

Conclusion

The Mauritius International Financial Centre stands as a testament to the island's forward-thinking approach to economic diversification. With over three decades of experience, the IFC has established itself as a competitive, compliant, and innovative hub for financial services. Its comprehensive regulatory environment, investor-friendly policies, and strategic position between Africa and Asia make it a compelling choice for businesses in traditional and emerging industries. The ongoing support for sectors like space technology underscores Mauritius's commitment to staying at the forefront of global economic developments, ensuring a prosperous future for the IFC and the Mauritian economy.

24. Mauritius as a new emerging spacefaring nation? Policy & Regulatory consideration

Presentation by: Mrs K. Gungaphul-Brocard - Scientific Advisor & Lawyer, Swiss Space Office of the State Secretariat for Education Research and Innovation SERI of the Swiss Confederation, Switzerland

Kamlesh Gungaphul-Brocard is a Scientific Advisor and Lawyer at the Swiss Space Office within Switzerland's State Secretariat for Education, Research, and Innovation (SERI). She contributes to space policy, law, communication, and interdepartmental coordination, and serves on the Swiss Delegation to the European Space Agency (ESA). Currently, she chairs the ESA Advisory Communication Committee and is an expert on the ESA Advisory Committee for Education. Born in Mauritius, Kamlesh holds law degrees from the UK, Germany, and Université Paris XI, specializing in space law. She is a member of the IISL and ECSL, with experience across both public and private sectors.

Introduction to Mauritius as a New Spacefaring Nation

Mauritius is positioning itself as a burgeoning spacefaring nation with an emphasis on policy and regulatory development to support space activities. Kamlesh Gungaphul-Brocard, a Scientific Advisor and Lawyer at the Swiss Space Office, shared insights into the framework necessary for Mauritius to expand its presence in space. She detailed her journey in space law, spanning two decades, and highlighted the importance of legal and policy infrastructure to foster a space program on a national scale.

Understanding Space and Its Utilization

Space is seen as an infinite realm, rich with opportunities for discovery and a catalyst for innovative solutions across international and national dimensions. Space utilization, particularly for socio-economic benefits and peaceful purposes, is a key objective. According to the United Nations Office for Outer Space Affairs (UNOOSA), space sustainability must be prioritized to ensure that all of humanity can continue to benefit from space.

Policy and Governance Framework

Space policy is shaped by a robust international governance framework built on treaties and conventions that aim to facilitate peaceful exploration. These treaties, dating back to the Cold War era, outline principles like the freedom of exploration, non-appropriation of space, peaceful usage, and the responsibility of states for their activities in space. The five primary space treaties—the Outer Space Treaty (1967), the Rescue and Return Agreement (1968), the Liability Convention (1972), the Registration Convention (1975), and the Moon Agreement (1979)—are fundamental to space law. Mauritius has ratified the Outer Space Treaty and the Rescue and Return Agreement, affirming its commitment to international norms.

For countries engaged in space activities, establishing a legal framework for authorizing and supervising space activities is essential. Such frameworks typically include offices or designated entities to register space objects and ensure adherence to international obligations. For Mauritius, signing and adhering to additional treaties like the Liability Convention could further solidify its commitment to responsible space exploration and mitigate risks associated with potential damages from space activities.

Benefits of Space Activities

Space applications on Earth are numerous, extending from satellite-based services in Earth observation, navigation, and communication to fields like climate monitoring, agriculture, and disaster management. These applications demonstrate the tangible benefits that space activities bring to everyday life, including real-time weather updates, efficient navigation, and connectivity for remote areas. Space technologies also play an increasingly important role in health, an area where Mauritius could see significant benefits through satellite-assisted telemedicine and health monitoring systems.

Space activities provide a unique opportunity for Mauritius to bolster its disaster response capabilities, leveraging satellite data for early warning systems, which is particularly pertinent for climate-vulnerable island nations. Satellite imagery can be instrumental in assessing storm impacts, guiding disaster relief efforts, and helping to build resilience to climate change.

Emergence of NewSpace and Private Sector Involvement

The "NewSpace" movement represents a shift from traditional, government-dominated space activities to a more dynamic, commercially driven approach. Reduced costs in satellite manufacturing and launch services have democratized access to space, enabling private companies to play an increasingly prominent role. This trend opens new avenues for Mauritius to attract foreign investment and participate in global space endeavors by creating an investor-friendly regulatory environment. Private investment in space can foster economic growth, job creation, and innovation, benefiting sectors beyond aerospace.

The Swiss Space Office highlights that collaboration with spacefaring nations and entities like the European Space Agency (ESA) provides Mauritius with the resources and knowledge needed to succeed in NewSpace. Kamlesh emphasized that space endeavors are not limited to scientists and engineers; there is a demand for diverse skill sets, including lawyers, project managers, and business professionals. This interdisciplinary approach can help Mauritius build a sustainable space sector by integrating expertise from various fields.

Considerations for Mauritius's Space Sector

1. **Establishing Clear Objectives:**
    - Mauritius must first define its space ambitions and priorities, considering the country's unique needs and resources. A targeted approach could involve a focus on Earth observation for environmental management, agriculture, and disaster mitigation.
2. **Creating a Regulatory Framework:**
    - Mauritius needs a structured legal foundation to authorize, supervise, and register space activities. This could include establishing a dedicated space agency or office within an existing governmental body, tasked with overseeing compliance with international agreements and fostering innovation through licensing and regulatory support.
    - Drawing from the Swiss model, Mauritius could develop policies that incentivize local and international businesses to participate in its space sector, positioning itself as a regional hub for space-related activities.
3. **Leveraging International Collaborations:**
    - Mauritius can strengthen its space capabilities by forming partnerships with established space agencies and institutions, such as the European Space Agency (ESA). These collaborations can provide access to technical expertise, funding, and training opportunities, which are crucial for a nascent space program.

- As an island nation, Mauritius can also explore alliances with other developing spacefaring nations, sharing knowledge and best practices to overcome common challenges.

4. **Utilizing Space for Socioeconomic Benefits:**
    - Space technology can have profound effects on sectors such as agriculture, fisheries, and health. Mauritius could utilize satellite data to improve crop yield predictions, monitor ocean health, and enhance public health initiatives.
    - The space sector can serve as a source of employment, with potential job opportunities in fields like data analysis, satellite operations, and space law. Developing local expertise in these areas can contribute to Mauritius's economic diversification.
5. **Promoting Space Education and Public Engagement:**
    - To sustain its space ambitions, Mauritius needs to invest in space-related education and inspire future generations to pursue careers in science, technology, engineering, and mathematics (STEM). Public outreach programs can help demystify space activities and garner support from the community, ensuring that space remains a priority for the government and citizens alike.
    - Encouraging curiosity about space through educational programs can foster a culture of innovation and experimentation, laying the groundwork for a vibrant space sector.

Implementing Space Activities on the Ground

Space activities have practical applications on Earth that extend beyond exploration. In disaster management, satellites offer unparalleled vantage points to monitor and respond to natural disasters, providing real-time data that can save lives. Additionally, space technology supports advancements in global navigation, positioning, and telecommunications, which are crucial for sectors like transportation and logistics.

Mauritius can apply satellite-derived data to areas such as land management, infrastructure development, and environmental monitoring, supporting sustainable development goals. By leveraging space-based solutions, Mauritius can address pressing issues, including climate resilience and resource management, while positioning itself as a leader in space technology applications within the region.

Conclusion: A Strategic Path Forward for Mauritius

As Mauritius embarks on its journey as a new spacefaring nation, it must establish a solid foundation through comprehensive policy and regulatory frameworks. This approach will enable Mauritius to harness space technology for national development, economic growth, and international collaboration. The country has already demonstrated a commitment to space through its ratification of key treaties and participation in global forums, which bodes well for future advancements.

With strategic planning, investment in capacity-building, and international partnerships, Mauritius can emerge as a significant player in the space sector, not only benefiting its own citizens but also contributing to global space exploration efforts. Mauritius has the potential to transform its economy through the opportunities presented by space, fostering innovation and setting a course toward sustainable development in the years to come.

25. Mauritius Satellite Space Sector Regulatory Considerations

Presentation by: Mr D. Pursunon, Engineer and Licensing Officer, Information and Communication Technologies Authority of Mauritius (ICTA)

Mr. Dorendra Pursunon is an experienced ICT professional and a key representative at the Information and Communication Technologies Authority (ICTA) of Mauritius. With extensive experience in telecommunications regulation, he oversees spectrum management, licensing, and compliance for satellite and ICT services, ensuring alignment with international standards. A registered engineer with the Council of Registered Professional Engineers, Mr. Pursunon also holds an MBA in Business Administration and Management. He is dedicated to advancing Mauritius's technological landscape through strategic regulatory frameworks and collaborative initiatives on both regional and global levels, fostering growth in the nation's satellite and ICT sectors.

Introduction to ICTA and Its Role in Satellite Regulation

The Information and Communication Technologies Authority (ICTA) of Mauritius, established in 2001 and operational since 2003, is responsible for managing and regulating the ICT sector, with a particular focus on radio communications and spectrum management. As Mauritius positions itself as an emerging spacefaring nation, ICTA has a crucial role in overseeing the regulatory framework that supports satellite activities. ICTA issues licenses for satellite ground stations, manages frequency allocations, and ensures compliance with both local and international telecommunication regulations.

Importance of Spectrum Management

The backbone of satellite operations is the radio spectrum—a scarce and valuable natural resource. Effective spectrum management is essential to ensure that satellite communications are reliable and interference-free. Each country manages its own spectrum, but due to the global nature of satellite communications, international consistency is vital. For this purpose, Mauritius collaborates with the International Telecommunication Union (ITU), which sets global regulations for spectrum use through the Radio Regulations framework. Mauritius, as a member state of the ITU, abides by these rules to maintain harmony and avoid interference in satellite communications.

ICTA's Responsibilities in Satellite Operations

As the national regulator, ICTA provides authorization and licensing for satellite ground stations, telemetry, and tracking systems. ICTA also ensures that all satellite communications infrastructure adheres to the necessary technical standards, protecting the nation's telecommunication resources. It plays a key role in satellite filings—an essential process for any entity in Mauritius wishing to launch a satellite. ICTA collaborates closely with other Mauritian institutions, such as the Mauritius Research and Innovation Council (MRIC), to facilitate these filings and secure frequency assignments.

For entities to operate satellite communications equipment in Mauritius, ICTA issues various licenses, including General Mobile and Personal Communications earth station licenses, station licenses, and telemetry, command and ranging satellite earth station licenses and VSAT/USAT (C, Ku, Ka band operation). ICTA also regulates the import of ICT equipment, enforcing standards to prevent interference from non-compliant devices.

International and Regional Regulatory Frameworks

Mauritius adheres to multiple international regulatory frameworks in addition to ITU guidelines, such as the United Nations Office for Outer Space Affairs (UNOOSA), which coordinates global governance of space activities. ICTA also participates in regional bodies like the African Telecommunication Union (ATU) and the Southern African Development Community (SADC). Through these affiliations, Mauritius collaborates on initiatives that expand the reach and impact of satellite services across the African continent.

ITU and Frequency Allocation for Mauritius

The ITU is responsible for allocating orbital slots and frequency bands for member countries. For Mauritius, the ITU has assigned two specific orbital slots: one for fixed satellite services and another for broadcasting satellite services. These slots provide Mauritius with opportunities to leverage space resources for satellite communications, broadcasting, and other applications. Obtaining these slots required a rigorous four-year process involving simulations, international coordination, and extensive negotiations with over 200 satellites.

Mauritius's assigned slots are at 92.2 degrees for fixed satellite services and a newly secured slot for broadcasting services at 68.4 degrees. These positions allow Mauritius to develop its satellite capabilities further, potentially attracting new industry players and promoting economic growth through satellite communications.

SADC Satellite Initiative

ICTA supports the SADC's regional shared satellite system, which aims to provide satellite coverage across member states, improving communication and connectivity in Southern Africa. This collaborative effort is expected to enhance regional integration and bolster satellite-based services in sectors such as telecommunications, broadcasting, and internet access. SADC's shared satellite initiative represents a significant step in optimizing satellite resources within the region, allowing member countries to benefit from shared infrastructure and reduced costs.

Satellite Filings and International Recognition

ICTA facilitates satellite filings on behalf of Mauritian entities, securing international recognition for Mauritius's space activities. Satellite filings are an essential part of global satellite operations, as they ensure that satellites are registered and compliant with ITU's radio regulations. Through filings, Mauritius gains international acknowledgment of its satellite projects, strengthening its position in the global space industry. This process also involves coordination with the ITU and UNOOSA to ensure that all frequency assignments are recorded in the international frequency register.

Embracing Non-Geostationary Satellite Orbits

The growing popularity of non-geostationary satellite orbits (NGSOs) is reshaping the landscape of satellite communications. NGSOs offer new possibilities for satellite-based services, such as broadband internet, due to their lower latency and faster data transmission capabilities. Mauritius has already licensed a few projects involving NGSOs, showcasing its commitment to adopting flexible and modern regulatory frameworks that can accommodate these emerging technologies. ICTA is working closely with policymakers and industry stakeholders to develop licensing frameworks that support both traditional geostationary and innovative non-geostationary satellite systems.

Addressing Challenges in Satellite Regulation

The satellite industry is fast-evolving, and ICTA faces the challenge of keeping pace with technological advancements. To foster a competitive environment, ICTA aims to create a level playing field for both newcomers and established players. The Authority recognizes the need for adaptable legislation that can evolve alongside industry developments. A flexible regulatory approach is essential to maximize the efficient use of the radio spectrum, a finite resource. ICTA continues to engage with stakeholders to ensure that Mauritius's regulatory framework remains relevant and supportive of the space sector's needs.

Mauritius's Commitment to Space Development

Mauritius is positioning itself as a space-friendly nation by proactively engaging in international satellite regulatory frameworks and securing orbital slots. Through ICTA's efforts, Mauritius has already established a solid foundation for its satellite industry, addressing licensing, spectrum allocation, and compliance with international standards. The country's commitment to developing its space capabilities is evident in its participation in ITU conferences, such as the World Radiocommunication Conference, where it advocated for amendments to frequency allocations that align with its goals.

Opportunities for Mauritius in the Satellite Industry

Mauritius's involvement in the satellite industry presents multiple opportunities. With its strategic location in the Indian Ocean, Mauritius can capitalize on its orbital slots and frequency assignments to support satellite communications in the region. By fostering partnerships with global and regional entities, Mauritius can expand its role in the space economy, attracting investment in satellite technology, research, and development.

Mauritius's position as a spacefaring nation is further supported by initiatives like the SADC shared satellite system, which enhances regional connectivity. This positions Mauritius as a leader in providing satellite services across Africa, creating economic opportunities and promoting technological advancements. ICTA's continued engagement with ITU and other international bodies ensures that Mauritius is well-placed to leverage these opportunities for national and regional benefit.

Strategic Vision for the Future

Looking ahead, ICTA is committed to supporting Mauritius's growing space ambitions by providing a supportive regulatory environment. The Authority has submitted frameworks to policymakers to address the evolving needs of the satellite industry. It plans to work closely with stakeholders to explore new areas of growth within the space sector, including satellite-based internet services, Earth observation, and space research.

ICTA aims to align its regulatory framework with global best practices, positioning Mauritius as a hub for satellite and space-related activities in the Indian Ocean region. By embracing innovative technologies and fostering partnerships, Mauritius is laying the groundwork for a vibrant and sustainable space industry that can drive economic growth and scientific progress.

Conclusion

The Information and Communication Technologies Authority (ICTA) of Mauritius is playing a vital role in shaping the country's satellite regulatory landscape. By managing spectrum allocation, issuing licenses, and collaborating with international bodies, ICTA ensures that Mauritius remains compliant with global standards while advancing its space ambitions. The country's involvement in regional initiatives, like the SADC shared satellite system, demonstrates its commitment to enhancing connectivity and promoting economic development through satellite technology.

As Mauritius continues to develop its satellite industry, ICTA will be a key facilitator, providing regulatory support and fostering a business-friendly environment for satellite operators. With a forward-looking approach to regulation, Mauritius is well-positioned to capitalize on the opportunities presented by the satellite industry, supporting both national development and regional integration in the years to come.

26. India-Mauritius Joint Satellite

Presentation by: Mr Avinash M. Project Director, India Space Research Organisation,Bangalore, India

Mr. Avinash M. is a distinguished Project Director at the Indian Space Research Organization (ISRO) with extensive experience in satellite development and launch operations. He has played a key role in overseeing various missions, including the successful deployment of the EOS-08 satellite, which involved the demonstration of advanced technologies. Mr. Avinash is instrumental in facilitating international collaborations and capacity-building initiatives, particularly in the context of joint satellite projects with Mauritius. His technical expertise and leadership contribute significantly to India's advancements in space technology and exploration.

Overview of ISRO's Achievements and International Collaborations

Mr. Avinash M., an engineer at the Urao Satellite Center in Bangalore under the Indian Space Research Organization (ISRO), introduced the Indo-Mauritius satellite initiative as part of a Memorandum of Understanding (MoU) signed between ISRO and the Mauritius Research and Innovation Council (MRIC). He began by sharing ISRO's impressive track record of over five decades in space exploration, with 125 spacecraft missions and 96 rocket launches, including collaborations with various countries. ISRO has facilitated the launch of 32 international spacecraft and successfully executed re-entry and experimental missions like Gaganyaan, India's human spaceflight project.

International collaborations have been central to ISRO's work, demonstrated by joint missions such as the 2011 Megha-Tropiques, a climatic study with France, and the recent India-Bhutan SAT project. The upcoming NASA-ISRO Synthetic Aperture Radar (NISAR) mission further highlights ISRO's commitment to global partnerships. ISRO has also hosted payloads for international agencies on Indian spacecraft, such as Chandrayaan-1 and Astrosat, a scientific satellite developed with international collaboration. ISRO has established ground stations in various countries and expanded its influence through capacity-building programs, training South Asian students in satellite technology, and participating in global policy-making through its technical liaison offices in Washington and Moscow.

Future Directions for ISRO

Looking forward, ISRO is focused on developing next-generation launch vehicles, human spaceflight capabilities, and long-term space exploration missions. The organization is working on human-rating the LVM-3 launch vehicle for the Gaganyaan mission, developing semi-cryogenic engines, and designing modular launch vehicles for future space missions. Plans are underway to establish an Indian space station by 2035, with the first module expected by 2028. ISRO is also preparing for upcoming Chandrayaan missions, including sample return missions, lunar surface exploration, and longer-duration lunar missions targeting the moon's south pole.

ISRO's vision includes expanding beyond Earth's orbit and achieving a human moon landing by 2040. These ambitious goals reflect the organization's dedication to advancing space exploration and utilizing space resources for India's scientific and economic benefit.

The Indo-Mauritius Joint Satellite Initiative

The Indo-Mauritius joint satellite project, formalized through an MoU with MRIC, aims to develop a small satellite for Mauritius to enhance the nation's capacity in space technology. ISRO's role includes satellite design and development, training MRIC engineers, and providing a platform for knowledge transfer. ISRO and MRIC will work together on all stages of satellite realization, from design and testing to launch and operations.

The project encompasses a series of capacity-building activities for MRIC engineers, including classroom and hands-on training at ISRO's facilities. Mauritian engineers will participate in satellite development activities, focusing on configuration, interface finalization, and mission planning. They will also be involved in ground station requirements and spacecraft assembly, gaining valuable experience in integration and testing. By directly engaging in these processes, MRIC engineers will develop the skills needed to independently manage future space projects for Mauritius.

Technical Specifications and Training Programs

The satellite will be a 20-kg, sun-synchronous satellite positioned at an altitude of 475 kilometers. It will feature an aluminum structure, passive thermal control, deployable solar panels, and lithium-ion batteries. Equipped with VHF, UHF, and S-band communication capabilities, the satellite will support telemetry, telecommand, and data downlink functionalities. The payload includes a multi-spectral camera capable of capturing images in four bands (B1, B2, B3, B4), with a spatial resolution of approximately 15 meters and a swath width of 140 kilometers. This configuration will allow the satellite to capture high-quality images with a data rate of 140 megabits per second.

ISRO will conduct training sessions for MRIC engineers on various technical aspects of satellite development. These sessions will cover topics such as configuration design, mission planning, and ground segment requirements. Practical training will include assembly, integration, and testing of satellite hardware, exposing engineers to crucial stages like thermal vacuum testing, vibration testing, and final assembly. Mauritian engineers will also participate in the launch operations from ISRO's launch site in Sriharikota, enabling them to gain hands-on experience in satellite deployment and mission control.

Key Outcomes of the Joint Project

The project has three primary objectives: capacity building, ground station upgrades, and enhanced data access for Mauritius.

1. **Capacity Building:** The collaboration will empower MRIC engineers with the skills needed to develop and operate satellites independently. Through direct involvement in the project, Mauritian engineers will learn about satellite design, integration, and testing, as well as the operational aspects of satellite missions.
2. **Ground Station Upgrades:** The project includes upgrading Mauritius's ground station capabilities to enable direct communication with the satellite. These enhancements will allow MRIC to receive payload data, supporting real-time data processing and applications tailored to Mauritius's needs. Improved ground station infrastructure will enable Mauritius to communicate with and control the satellite, facilitating the local processing of satellite data.
3. **Enhanced Data Access:** The satellite will support applications in agriculture, forestry, environmental monitoring, and water resource management. Its multi-spectral capabilities will provide data for applications like chlorophyll absorption monitoring, coastal water quality analysis, and biomass assessment. These data products will assist Mauritius in making informed decisions regarding natural resource management and environmental protection. ISRO will also assist MRIC in utilizing image processing tools and deriving actionable insights from the satellite's data, ensuring that Mauritius can fully leverage the satellite's capabilities.

Operational and Launch Details

The satellite will be equipped with two deployable appendages—a solar panel and a communication antenna. Its sensors will include gyros, magnetometers, and reaction wheels, enabling precise attitude control. The satellite will be launched into a sun-synchronous orbit with a local time of around 9:30 to 12:30, providing consistent lighting conditions for imaging. Designed for multi-spectral imaging, the satellite will capture data across four spectral bands with high spatial resolution, enabling detailed analysis of Mauritius's land and water resources.

ISRO will oversee the satellite's launch on a Polar Satellite Launch Vehicle (PSLV), which is well-suited for small satellites and commonly used for sun-synchronous missions. MRIC engineers will participate in the launch operations at Sriharikota, contributing to the satellite's deployment and early mission activities. After launch, ISRO will support MRIC in stabilizing the satellite, calibrating its systems, and establishing communication. Once the satellite achieves operational stability, ISRO will transfer data reception and processing responsibilities to MRIC, allowing Mauritius to manage the satellite's data outputs.

Applications of Satellite Data for Mauritius

The satellite's primary mission will involve Earth observation, with applications spanning agriculture, forestry, environmental monitoring, and water resource management. Each spectral band on the satellite is optimized for different applications, such as:

- **B1:** Sensitive to chlorophyll absorption, aiding in agricultural and coastal water studies.
- **B2 and B3:** Useful for biomass assessment, vegetation monitoring, and land use analysis.
- **B4:** Supports high-contrast imaging for water body analysis and environmental assessments.

These data products will help Mauritius monitor coastal areas, assess forest health, and manage natural resources more effectively. Satellite imagery can also assist in disaster management, enabling quick assessments of impacted areas after natural events. By utilizing the satellite's capabilities, Mauritius can enhance its decision-making processes in environmental management and sustainable development.

Project Timeline and Next Steps

The Indo-Mauritius satellite project is on track for launch within the next 16 to 18 months. The timeline includes several phases of development, training, and integration, with regular milestones to monitor progress. The training programs for MRIC engineers will be scheduled in stages, encompassing classroom learning, hands-on activities, and participation in key project milestones. ISRO will continue to provide technical support and guidance throughout the project, ensuring a seamless transition of operational responsibilities to MRIC upon launch.

As the satellite reaches its operational phase, MRIC will be responsible for processing the data, deriving actionable insights, and disseminating information to relevant stakeholders in Mauritius. The satellite is expected to deliver significant benefits in environmental monitoring, natural resource management, and disaster response, positioning Mauritius as a capable player in the space sector.

Conclusion

The Indo-Mauritius joint satellite project signifies a milestone in Mauritius's space journey, providing MRIC engineers with practical experience in satellite technology and enhancing the country's capacity for space-based applications. Through collaboration with ISRO, Mauritius gains access to cutting-edge satellite technology, valuable data for sustainable development, and a foundation for future space initiatives. The partnership reflects the shared commitment of India and Mauritius to advancing scientific knowledge and leveraging space technology for socio-economic progress. As Mauritius embarks on this venture, it is well-equipped to build a robust space program and contribute to regional space endeavors.

27. Challenges of the New Space Age and How to Overcome Them in Developing Countries

Presentation by: Eng. B. Waibi, Program Officer/Space Policy Analyst Aeronautics & Space Science Bureau, Uganda

Eng. Brian Waibi is a dedicated Space Policy Analyst and Program Officer at the Aeronautics & Space Science Bureau. He plays a key role in advancing Uganda's space science initiatives by coordinating research, facilitating technology transfer, and fostering a supportive ecosystem for space exploration. He is involved in projects such as AfDevSat and PEARL-AFRICASAT1, aimed at enhancing regional satellite capabilities. With a strong commitment to building a national space agency, Waibi contributes significantly to promoting aeronautics and space innovation in Uganda.

Introduction:

Eng. Brian Waibi provides a comprehensive overview of the obstacles and proposed solutions for developing nations entering the new space age. He addressed critical challenges such as policy gaps, space debris, cybersecurity risks, and limited human capacity.

Key Challenges of the New Space Age in Developing Countries

1. **Unfavorable Space Ecosystem for New Startups** Developing countries face an unsupportive environment for new startups and other stakeholders in the space sector. This issue stems largely from inadequate policy, legal frameworks, and regulatory structures, making it difficult for emerging entities to thrive in the industry. The absence of a supportive ecosystem affects innovation, investment, and long-term sustainability in the sector.
2. **Space Debris** Space debris presents a growing concern, especially as the number of satellites and other man-made objects in Earth's orbit continues to increase. This debris consists of defunct satellites, fragments, and elements that have become non-functional due to various factors, including collisions and aging infrastructure. This issue poses a significant risk for both operational satellites and future space missions, as it can lead to collisions and increased space traffic.
3. **Increased Cyber Attacks** With the increasing reliance on satellite technologies, space assets have become more vulnerable to cyber attacks. These attacks can include Denial-of-Service (DoS), malware, and jamming, which could render space segments unresponsive or entirely shut them down. Cybersecurity is, therefore, a crucial element in protecting the integrity and functionality of space technologies.
4. **Limited Human Capacity** Developing countries often lack the critical mass of skilled professionals necessary to drive the space sector forward. This shortage is due to inadequate training opportunities, limited access to advanced technologies, and an overall scarcity of resources to cultivate a skilled workforce. Human capital development is thus essential for sustainable progress in the space sector.

Proposed Remedies for the New Space Age Challenges

To address these challenges, Eng. Waibi suggests a range of strategies that focus on both national and international cooperation, technological advancement, and capacity building.

1. **Policy and Legal Framework Development** Developing countries should adopt robust and operational legal frameworks to facilitate and accelerate national space agendas. These frameworks need to be adaptable to address evolving threats and opportunities, ensuring a stable regulatory environment for new startups and established players alike. An effective legal framework will support innovation, encourage investment, and help align national space activities with international standards.
2. **Space Debris Mitigation and Removal** Effective space debris mitigation strategies are essential for safeguarding current and future space missions. Eng. Waibi emphasizes the need for both national and international cooperation in this area, as existing mitigation measures are often voluntary and lack legally binding commitments. Establishing legally enforceable agreements on debris mitigation can promote shared responsibility and foster a cleaner, safer orbital environment.
3. **Cybersecurity Framework Development** Developing a comprehensive cybersecurity framework is necessary to protect space assets from cyber threats. Such a framework should outline best practices for engineering, building, and operating satellite systems in a way that allows for rapid response to incidents, quick recovery from disruptions, and proactive management of emerging threats. Investing in cybersecurity will enhance the resilience and reliability of space infrastructure.
4. **Human Capital Development** Building a skilled workforce requires specialized training programs, technology transfer initiatives, and the domestication of advanced technologies. Countries need to prioritize education and training in fields related to space science and engineering, such as telecommunications, satellite technology, and cybersecurity. Partnering with more experienced space-faring nations for knowledge-sharing and capacity-building initiatives can also help to accelerate human capital development.

Conclusion

The presentation highlights that developing countries have the potential to leverage space technology for significant socio-economic benefits. However, overcoming challenges such as regulatory limitations, space debris, cybersecurity risks, and human capacity constraints is critical to achieving this potential. By implementing effective policies, investing in technology and cybersecurity, and fostering workforce development, developing nations can establish a more secure and prosperous presence in the new space age.

SUMMARY OF ROUND TABLE DISCUSSIONS

28. Round Table Discussion Summary: Advancing the Mauritian Space Sector

Introduction

The Republic of Mauritius stands at a pivotal moment in its journey toward becoming a key player in the global space sector. Nestled in the Indian Ocean, Mauritius benefits from a unique geostrategic position that facilitates opportunities for space exploration, earth observation, and remote sensing. This advantageous location, coupled with political stability, high connectivity, a well-educated populace, and a growing economy, positions the nation favorably for advancements in space and satellite technology.

In June 2021, Mauritius made its historic entry into space by deploying its first nanosatellite, MIR-SAT1, marking a significant milestone in the country's aspirations for active participation in space exploration. This initiative has inspired the Mauritian Research and Innovation Council (MRIC) to develop the Mauritian Space Program, focusing on four key areas: awareness and capacity building, research and development (R&D) of downstream applications, leveraging relationships with space-friendly nations, and fostering new startups in the space sector.

To further its vision of making space technology a crucial component of socioeconomic development, the MRIC, in collaboration with the Ministry of Information Technology, Communication, and Innovation, hosted the **1st International Symposium on Space for Mauritius**. This symposium aimed to bring together local and international experts to provide insights that would advance the Mauritian Space Agenda. The round table discussions that followed served as an important platform for stakeholders from various sectors to collaborate, share knowledge, and explore innovative solutions for harnessing space technology.

Data Collaboration and Sharing

Collaborative Approach to Data Management

A significant theme of the round table discussion was the importance of collaborative data management among various stakeholders in the Mauritian space sector. Participants recognized the need for comprehensive sharing of data sets and findings, which would enhance decision-making and resource management. This collaborative spirit encourages entities to identify common objectives and maximize synergies while minimizing redundancy in efforts. Kamal, a key participant, emphasized the importance of sourcing data that could be made available free of charge to increase accessibility for all involved parties.

The Role of Educational Institutions

The contributions of universities and educational institutions in data collection and analysis were underscored, with calls for academia to engage more deeply with industry practitioners. Educational institutions were urged to initiate innovative projects that would not only support the space sector but also enhance the skill sets of their students. The symposium highlighted the necessity for a partnership between academic entities and industry professionals, ensuring that future leaders are equipped with practical knowledge and experience.

Leveraging Advanced Technologies

Discussions also revolved around utilizing advanced technologies, such as drones and satellite imagery, particularly for agricultural applications and other sectors. Shezade highlighted the importance of partnering with international research bodies to harness existing technologies for the benefit of Mauritius. This alignment with international expertise would enhance the capacity of local institutions and maximize the potential of advanced technologies in addressing local challenges.

Community Involvement

Engaging Local Communities

The need to involve local communities, particularly farmers and fishermen, in the development and application of space technology was emphasized. Asha Puneet from the UNDP shared insights into using satellite technology to support fisheries and agriculture, stressing the importance of creating demand within these communities. Engaging with local stakeholders is essential for raising awareness

about available technologies and fostering adoption, ensuring that the benefits of space technology reach those who need it most.

Building a Collaborative Platform

The round table participants discussed the potential creation of a collaborative platform to streamline data sharing and software development efforts. The idea of establishing a federating entity was proposed to manage collaboration among stakeholders, ensuring that shared interests are recognized and addressed effectively. Such a platform would serve as a crucial hub for coordinating efforts and fostering partnerships across the space sector.

Challenges and Opportunities

Fragmentation and Cohesion

The discussions acknowledged existing challenges, such as the fragmentation of efforts among various players in the space sector. Participants stressed the need for more cohesive action and the importance of adapting to new technologies. A modular approach to software and hardware development was advocated to allow for flexibility and innovation in addressing the unique challenges faced by Mauritius.

Optimism for Future Leadership

Despite these challenges, participants expressed optimism about Mauritius's potential to lead in the space industry, citing the nation’s geographical advantages and available resources. There is a collective belief that with the right collaborative frameworks in place, Mauritius can position itself at the forefront of the global space narrative.

Engaging Younger Generations

The engagement of younger professionals and students in the discussions was viewed as a positive indicator for the future of the Mauritian space industry. Encouraging young talent to participate in projects, internships, and hands-on experiences is vital for cultivating a new generation of experts in the field. The round table highlighted the importance of mentorship and guidance from experienced professionals to help students navigate their careers in the space sector.

Closing Remarks

As the round table ended, participants were called to action to collaborate more closely and share insights and resources. A commitment was made to continue discussions and develop concrete plans for joint initiatives in the space sector. Feedback from participants was encouraged to refine future collaborations and ensure that efforts align with the overarching goals of the Mauritian Space Program.

Next Steps

Plans for follow-up meetings and discussions were established to maintain momentum in the development of the space sector. Stakeholders were urged to keep the dialogue open and engage with the MRIC as a central hub for coordination and information sharing.

Conclusion

The round table discussion successfully identified key areas for collaboration, community engagement, and capacity building within the Mauritian space sector. Participants shared a collective vision for advancing Mauritius's role in the space era, emphasizing the importance of leveraging technology for local development while fostering an inclusive environment for all stakeholders. The insights and commitments from this gathering serve as foundational steps toward realizing the full potential of space exploration and satellite technology for the benefit of the Republic of Mauritius.

By building on the momentum created during the **1st International Symposium on Space for Mauritius**, stakeholders are poised to transform the space landscape, ensuring that the nation capitalizes on the opportunities presented by the new space era.

29. Conclusions And Way Forward

Mauritius' journey into the space sector signifies a pivotal step toward national development. The symposium underscored the country's unique advantages, such as its geostrategic location and commitment to high standards of governance, which provide a solid foundation for space initiatives. Looking ahead, MRIC's planned actions focus on furthering satellite technology, strengthening international partnerships, and implementing policies that encourage innovation and investment.

The way forward involves six key strategic areas:

1. **Innovation and Project Funding**: MRIC aims to establish Mauritius as a hub for space-related projects by funding startups and satellite data ventures. Such initiatives will not only drive economic growth but also position Mauritius as a regional leader in space technology.

2. **Data Focal Point**: MRIC aspires to serve as the central node for satellite data relevant to Mauritius. This focus on data collection and dissemination will benefit local scientists and policymakers, facilitating informed decision-making across multiple sectors, including agriculture, environmental monitoring, and urban planning.

3. **Space-Based Solutions for Development**: Space technology will be applied to improve the quality of life in Mauritius, supporting sectors such as agriculture, disaster management, and fisheries. It is envisaged that collaborative efforts with entities like ISRO and other international organizations will enable the adoption of cutting-edge technologies for sustainable development.

4. **Strengthening Partnerships**: By establishing robust connections with countries advanced in space technology, Mauritius can tap into technical expertise and resources. Collaborative projects will provide opportunities for technology transfer, capacity building, and joint research initiatives.

5. **Revenue Generation and Sustainability**: The MRIC seeks to make its space initiatives self-sustaining by generating revenue through commercial ventures, including satellite data services and partnerships with private companies. A focus on entrepreneurship will cultivate a commercial ecosystem around space technologies, creating jobs and fostering innovation.

6. **Encouraging Startups in the Space Sector**: Through incentives and supportive policies, Mauritius will stimulate the growth of startups specializing in space technology. These ventures are essential to the creation of a dynamic and competitive space sector, ensuring that Mauritius remains adaptable and forward-thinking.

The insights and commitments gathered from the symposium provide a clear path for Mauritius to capitalize on the opportunities within the new space age. With sustained investment in human capital, infrastructure, and strategic partnerships, the nation can play a significant role in the global space economy, contributing to regional and international advancements in space technology.

In conclusion, Mauritius is poised to make substantial contributions to space exploration and related technologies. By harnessing its resources, fostering international collaborations, and promoting an inclusive space program, Mauritius can achieve its ambition of becoming a notable spacefaring nation in the coming years. The symposium's outcomes lay the groundwork for a thriving space industry, which promises both immediate and long-term benefits for the country's economy and its people.

30. Symposium in Photos


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