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CONNECTING

RESEARCH AND INNOVATION KNOWLEDGE CENTRE FOR ENGINEERING IN HERITAGE

CONNECTING Project

Final Workshop

e-proceedings

Topic: **Final Workshop**

Date: **Thursday, 28th of May 2026**

Time: **09:45 - 14:00 (EEST)**

Hosted by: **Cyprus University of Technology (CUT)**

Venue: **Tassos Papadopoulos Building**

Cyprus University of Technology, Limassol

Project Coordination Team

Acknowledgement: This project has received funding from the European Regional Development Fund and the Republic of Cyprus through the Research and Innovation Foundation of Cyprus under contract SMALL SCALE INFRASTRUCTURES/1222/0062.

Summary

The CONNECTING Final Workshop, held on 28 May 2026 at the Cyprus University of Technology (CUT) in Limassol as part of the EuroMed 2026 Digital Heritage Summit, served as the concluding dissemination event of the CONNECTING project. The workshop brought together researchers, engineers, cultural heritage professionals, public authorities, project partners, and technology providers to present the project's achievements and discuss future opportunities for collaboration in cultural heritage research and innovation.

The workshop highlighted the vision and outcomes of the Research and Innovation Knowledge Centre for Engineering in Heritage, established through CONNECTING. The project aims to strengthen cultural heritage documentation, monitoring, and preservation through the integration of advanced sensing technologies, digital infrastructures, and interdisciplinary expertise. Participants were introduced to the project's long-term vision of creating a sustainable knowledge hub that combines state-of-the-art equipment, scientific know-how, and data management capabilities to support heritage science and innovation.

A technical session showcased the infrastructure developed through the project and demonstrated how emerging technologies can support cultural heritage applications. Presentations covered UAV-based photogrammetry, LiDAR technologies, terrestrial laser scanning, underwater robotic platforms, cloud-based data infrastructures, and the management and re-use of high-resolution spatial datasets. Speakers emphasized the importance of integrated digital workflows that enable evidence-based decision-making and facilitate interdisciplinary research in heritage documentation and monitoring.

The workshop also featured a presentation of the STECCI Project by representatives of the University of Sarajevo. The project focuses on assessing the impacts of climate change on medieval stone monuments, particularly the UNESCO-listed stećci tombstones of the Western Balkans. The presentation highlighted the value of interdisciplinary approaches that combine climate modelling, environmental analysis, heritage science, and conservation planning. Opportunities for future collaboration between STECCI and CONNECTING partners in the areas of digital documentation, monitoring technologies, and risk assessment were also discussed.

A live demonstration of the CONNECTING equipment infrastructure provided participants with hands-on experience of several advanced technologies acquired through the project. These included the DJI Matrice 350 RTK UAV, Zenmuse P1 photogrammetric camera, CHCNAV RS10 SLAM mobile mapping system, CHASING M2 PRO MAX underwater ROV, and HAIP BlackBird V2 hyperspectral camera. The demonstration illustrated the potential of these systems for applications in cultural heritage documentation, environmental monitoring, structural assessment, and archaeological research.

The workshop concluded with an open discussion on the sustainability of the CONNECTING infrastructure and opportunities for future collaboration. Participants explored possibilities for joint research initiatives, international partnerships, infrastructure sharing, training activities, and the broader integration of digital technologies into cultural heritage management. There was strong agreement on the value of the Knowledge Centre concept and its potential to support future cooperation among academic institutions, public authorities, and heritage stakeholders.

Overall, the CONNECTING Final Workshop successfully demonstrated the project's achievements and reinforced the importance of advanced sensing technologies, digital infrastructures, and interdisciplinary collaboration in addressing contemporary challenges in cultural heritage documentation, monitoring, and preservation. The event provided a platform for knowledge exchange and established a strong foundation for the continued exploitation and long-term sustainability of the project's outcomes within the international cultural heritage community.

Agenda

Time	*Topic*
09:45 – 10:00	*Registration - Coffee*
10:00 – 10:30	**Welcome Notes** • **Vice-Rector of Financial Planning and Development Greeting** Prof. Evangelos Akylas (Cyprus University of Technology) • **Department of Antiquities Greeting** Mrs. Chrysanthi Kounnou, Curator of Antiquities • **Supporters Greeting** Prof. Branka Cuca (Politecnico di Milano) • **Project Introduction** Project Coordinator: Assist. Prof. Athos Agapiou (CUT)
10:30 – 12:00	**CONNECTING Infrastructure** • **Lidar and drone applications** Asst. Prof. Apostolos Papakonstantinou (CUT) -15' • **Underwater ROV Documentation and Exploration** Assoc. Prof. Stella Demesticha & Dr. Marinos Vlachos (UCY) – 15' • **Collection and processing of 3D terrestrial clouds** Prof. Dimitrios Skarlatos & George Kafataris (CUT) – 15' • **Cloud Data Centre Design and Implementation** Dr. Giannis Filippopoulos (InfraLabs) -15' • **Use and re-use of 3D data** Prof. Dimitrios Skarlatos (CUT) – 15' • **STECCI Project** Prof. Nusret Drešković (UNSA) – 5' Prof. Saida Ibragić (UNSA) – 10'
12:00 – 12:30	*Coffee Break*
12:30 – 13:15	**CONNECTING Equipment** Demonstration of the CONNECTING Equipment
13:15 – 14:00	**Discussion and Future Collaborations** Project Coordinator: Assist. Prof. Athos Agapiou (CUT)

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CONNECTING Final Workshop Summary

The CONNECTING Final Workshop was successfully held on Thursday, 28 May 2026, at the Cyprus University of Technology in Limassol, bringing together researchers, cultural heritage professionals, public authorities, technology providers, and project supporters to present the achievements and future perspectives of the CONNECTING project. The event served as the culminating dissemination activity of the project, highlighting the establishment of the Research and Innovation Knowledge Centre for Engineering in Heritage and demonstrating how advanced technologies can support the documentation, monitoring, and preservation of cultural heritage. Based on the workshop agenda, the event combined technical presentations, equipment demonstrations, and strategic discussions aimed at fostering future collaborations and maximizing the long-term impact of the project.

The workshop commenced with welcome addresses from distinguished representatives of academia, cultural heritage authorities, and project supporters. Prof. Evangelos Akylas, Vice-Rector of Financial Planning and Development of the Cyprus University of Technology, welcomed participants on behalf of the host institution. Greetings were also delivered by Mrs. Chrysanthi Kounnou, Curator of Antiquities at the Department of Antiquities, and Professor Branka Cuca from Politecnico di Milano, representing the project supporters. The opening session concluded with an introduction to the CONNECTING project by the Project Coordinator, Assistant Professor Athos Agapiou, who outlined the project's objectives, achievements, and vision for establishing a sustainable knowledge centre dedicated to engineering applications in cultural heritage.

The technical programme focused on the infrastructure developed through the project and showed a range of innovative technologies and methodologies for cultural heritage research. Presentations covered LiDAR and drone applications for heritage documentation and mapping, delivered by Assistant Professor Apostolos Papakonstantinou, while Associate Professor Stella Demesticha and Dr. Marinos Vlachos presented underwater documentation and exploration techniques using remotely operated vehicles (ROVs). Professor Dimitrios Skarlatos and George Kafataris demonstrated approaches for the acquisition and processing of terrestrial 3D point clouds, highlighting their value for digital recording and conservation purposes. In addition, Mr. Angelos Boubousis and Dr. Giannis Filippopoulos from InfraLabs presented the design and implementation of the CONNECTING Cloud Data Centre, emphasizing the role of digital infrastructures in supporting the storage, management, and dissemination of cultural heritage data. Further insights were provided on the use and re-use of 3D datasets for research, education, and heritage management applications.

The workshop also welcomed representatives from the University of Sarajevo, who presented the STECCI project. Professors Nusret Drešković and Saida Ibragić introduced the project's objectives and highlighted opportunities for collaboration in the fields of heritage preservation, environmental monitoring, and digital documentation. Their participation reinforced the international dimension of the workshop and demonstrated the value of cross-border cooperation in addressing contemporary challenges in cultural heritage research.

A dedicated equipment demonstration session provided participants with hands-on exposure to the technologies acquired through the CONNECTING project. The demonstration showcased the project's

state-of-the-art infrastructure and illustrated how advanced sensing, mapping, and documentation systems can be applied to cultural heritage research, environmental monitoring, archaeological investigations, and engineering assessments. This interactive session enabled participants to exchange experiences, discuss potential applications, and explore opportunities for future research activities.

The event concluded with an open discussion on future collaborations and the sustainability of the CONNECTING infrastructure. Moderated by the Project Coordinator, the session encouraged dialogue among participants regarding joint research initiatives, international partnerships, knowledge exchange, and the continued exploitation of the project's outcomes. Particular emphasis was placed on the role of interdisciplinary cooperation and shared research infrastructures in advancing cultural heritage science and supporting evidence-based heritage management practices.

Overall, the CONNECTING Final Workshop successfully demonstrated the project's achievements and highlighted the transformative potential of advanced engineering technologies, digital infrastructures, and collaborative research approaches in the cultural heritage sector. The event reinforced the project's long-term vision of establishing a sustainable knowledge centre and provided a valuable platform for fostering future partnerships, promoting innovation, and supporting the continued development of heritage documentation and preservation practices at both national and international levels.

Welcome Notes

Welcome address on behalf of Vice-Rector of Financial Planning and Development Greeting, Prof. Evangelos Akylas (Cyprus University of Technology)

Below is the entire speech.

Dear distinguished guests, Dear colleagues and project partners, Ladies and gentlemen,

It is a great pleasure to welcome you today to the final event of the CONNECTING project, an important initiative that reflects the value of collaboration, innovation and applied research.

As Vice-Rector for Financial Planning and Development of the Cyprus University of Technology, I am particularly proud of CUT's active participation in projects such as CONNECTING. These initiatives are of strategic importance for our University and for the wider research and innovation ecosystem of Cyprus, as they strengthen scientific excellence, encourage interdisciplinary cooperation and foster meaningful connections between academia, industry, public authorities and society.

At the Cyprus University of Technology, we firmly believe that research and innovation are key drivers for sustainable growth and social progress. For this reason, we consistently support initiatives that generate new knowledge, promote creativity and lead to practical solutions with real impact.

The CONNECTING project is an excellent example of how innovative thinking and collaborative effort can produce tangible outcomes and create added value for society. The achievements and results presented today demonstrate the importance of teamwork, commitment and shared vision in addressing contemporary challenges and advancing research and innovation.

I would like to warmly congratulate all researchers, academics and collaborating organisations involved in the successful implementation of this project. Your dedication, professionalism and hard work have been instrumental in achieving the project's objectives.

Allow me also to express my sincere appreciation to Assistant Professor Athos Agapiou, as the project coordinator, for ensuring the smooth implementation and successful completion of the CONNECTING project.

I would also like to extend my sincere thanks to our partners, the University of Cyprus, Infralabs and the Department of Antiquities, as well as to the project supporters, Politecnico di Milano, University of Aveiro, University College London, the Department of Land and Surveys, and Geofem. Your collaboration and support have been invaluable to the success of this initiative.

As a university, we remain committed to supporting high-quality research initiatives and strengthening our participation in projects that contribute to knowledge transfer, innovation and societal development.

I sincerely hope that the CONNECTING project will serve as a foundation for future collaborations, new research opportunities and even greater achievements in the years ahead.

Thank you very much.

Welcome address on behalf of Department of Antiquities, Mrs. Chrysanthi Kounnou, Curator of Antiquities

Below is the entire speech.

Dear **Vice Chancellor**,

Dear colleagues,

On behalf of the Department of Archaeology, I would like to express our warmest thanks and sincere congratulations to all the partners, researchers, and collaborators who contributed to the successful implementation of the CONNECTING project.

This project was a particularly important initiative for the creation of a modern Center of Knowledge and Innovation in the field of cultural heritage, utilizing advanced technologies and specialized equipment for the detection, documentation, monitoring, and analyzing archaeological sites and monuments, both on land and in the underwater environment.

A key strength of the program was the interdisciplinary collaboration that developed among archaeologists, engineers, geoinformatics scientists, IT specialists, and cultural heritage managers. This collaboration facilitated the exchange of knowledge and expertise, as well as the development of innovative approaches that substantially enhance the protection and management of our cultural heritage.

For the Department of Antiquities, as the authority responsible for the protection, management, and promotion of Cyprus's archaeological heritage, participation in CONNECTING was of particular importance. The program contributed to strengthening research and documentation capabilities, while also laying a solid foundation for the future use of new technologies and research tools to benefit the preservation and promotion of our cultural heritage.

It is now evident that the challenges surrounding the protection of cultural heritage require a fundamentally interdisciplinary approach. This approach can and must offer innovative tools, methods, and practical

solutions to real-world problems related to the preservation, management, and promotion of cultural heritage.

The research should focus on the management, protection, and promotion of monuments, archaeological sites, and museums, as well as their sustainable use. The issues to be examined range from the basic recording, documentation, and digital archiving of monuments to the development of advanced monitoring and conservation technologies. At the same time, it is necessary to address contemporary threats, such as the pressures of urban and tourism development, the impacts of climate change, extreme weather events, environmental pollution, and deterioration caused by natural or human factors.

The effective protection and promotion of cultural heritage is not only about preserving the past, but also about connecting it to the needs and challenges of contemporary society. The use of technology and scientific knowledge can contribute to the development of a sustainable model of cultural management, which will ensure both the long-term protection of monuments and their active integration into educational, social, and economic life.

In closing, I would like to note that we are confident that the project's results, the infrastructure created, and the partnerships developed will continue to yield significant results even after the program's completion, strengthening both research and the sustainable management of cultural heritage in Cyprus and beyond.

Thank you very much for your cooperation, and I look forward to working with you again in the future.

Supporters Greeting, Prof. Branka Cuca (Politecnico di Milano)

Professor Branka Cuca began by expressing both her professional appreciation and personal satisfaction in participating in the final event of the CONNECTING project, noting that as a Cypriot living and working abroad she was particularly pleased to witness the project's achievements. Reflecting on the nature of collaborative research initiatives, she emphasized that projects such as CONNECTING serve as dynamic platforms where knowledge is generated, tested, transferred, and shared, while simultaneously strengthening cooperation among academia, industry, and public institutions.

She described CONNECTING as an exemplary initiative that has successfully established a strategic research infrastructure for engineering in cultural heritage. According to Professor Cuca, excellence in applied sciences depends on three fundamental pillars: access to up-to-date knowledge, advanced research infrastructures, and active engagement with the scientific community, particularly early-career researchers. She noted that CONNECTING has successfully addressed all three dimensions through significant technological investments, training opportunities, workshops, conferences, and the active involvement of students and young researchers.

Professor Cuca further highlighted the project's efficiency in transforming ideas into practical outcomes, referring to its wide range of coordinated activities, experimental demonstrations, and applications in areas such as aerial surveying, 3D documentation, and digital heritage technologies. She stressed that beyond scientific excellence and operational efficiency, the project's most significant contribution lies in its societal impact, particularly in supporting cultural heritage preservation in the face of climate change and rapid technological transformation.

She also emphasized the project's contribution to the digitalization of cultural heritage and its alignment with broader national and European priorities for sustainable and inclusive development. Particular attention was given to CONNECTING's efforts in education, outreach, and public engagement, which she described as essential for building a resilient and socially responsible research community.

Concluding her remarks, Professor Cuca highlighted the project's holistic vision, recognising the strong links between environmental change, technological innovation, and heritage preservation. She expressed her appreciation for the collaboration developed throughout the project and noted that the conclusion of CONNECTING should be viewed not as an end, but as the beginning of new opportunities for cooperation, research, innovation, and cultural heritage preservation..

Introduction of the Connecting Project, Project Coordinator: Assist. Prof. Athos Agapiou (CUT)

The CONNECTING project (Research and Innovation Knowledge Centre for Engineering in Heritage) is a 30-month initiative (2023–2026) coordinated by Assistant Professor Athos Agapiou at the Cyprus University of Technology (CUT). Funded under the Research and Innovation Foundation's Strategic Infrastructures Programme (SMALL SCALE INFRASTRUCTURES/1222/0062), with a total budget of €759,680 co-funded by the European Regional Development Fund and the Republic of Cyprus, the project aims to establish a dedicated research infrastructure for engineering applications in cultural heritage. The initiative brings together four core partners and six international supporters with the objective of enhancing research excellence in the documentation, monitoring, analysis, and preservation of cultural heritage sites and monuments both on land and underwater.

The project is centred on the creation of a Research and Innovation Knowledge Centre for Engineering in Heritage, combining advanced sensing technologies, high-performance computing resources, and cloud-based data management services. Through CONNECTING, a comprehensive pool of state-of-the-art equipment has been acquired, including UAV platforms, RGB, multispectral and hyperspectral sensors, aerial LiDAR systems, terrestrial laser scanners, mobile mapping systems, environmental monitoring sensors, underwater remotely operated vehicles (ROVs), and multibeam echosounders. These technologies provide researchers, public authorities, and heritage professionals with access to advanced tools for non-destructive investigation and monitoring of cultural heritage assets.

A key component of the project is the development of a Cloud Data Centre and digital platform that supports the processing, storage, management, and dissemination of heritage datasets. The infrastructure incorporates high-performance computing capabilities, an online equipment database, and a heritage data repository operating according to FAIR data principles, promoting open access and facilitating collaboration among researchers at both national and international levels.

The project implemented a series of research and demonstration activities across five heritage sites in Cyprus, including the Tombs of the Kings, Amathus, Latsia, and the Mazotos and Nisia shipwrecks. These activities enabled the testing and validation of innovative methodologies for aerial, terrestrial, and underwater documentation, while generating valuable datasets for future research and heritage management applications. The infrastructure has also been utilized by external organisations, government departments, academic institutions, and researchers through training activities, demonstrations, and collaborative projects.

Beyond infrastructure development, CONNECTING has placed strong emphasis on training, dissemination, and capacity building. Workshops, summer schools, educational programmes, conference presentations, publications, and public engagement activities have contributed to the transfer of knowledge and the development of expertise in heritage technologies. The project has strengthened collaboration among engineers, archaeologists, geomatics specialists, ICT experts, and heritage professionals, while fostering international networking through partnerships with leading institutions and organisations across Europe.

The project has successfully established Cyprus's first dedicated research infrastructure for engineering in cultural heritage and has created a sustainable platform that will remain operational beyond the funding

period. By integrating advanced technologies, open-access data infrastructures, and interdisciplinary collaboration, CONNECTING contributes to evidence-based cultural heritage management and strengthens Cyprus's position within the international heritage research community. The project's legacy lies not only in its equipment and digital infrastructure, but also in the research capacity, partnerships, and opportunities it has created for future innovation in cultural heritage preservation.

CONNECTING Infrastructure

UAV & Airborne LiDAR a Geovisualization approach

The presentation explored the integration of UAV platforms and airborne LiDAR technologies for the documentation, monitoring, and analysis of cultural heritage and environmental sites. The speaker introduced the fundamental principles of LiDAR systems, explaining the different scanning mechanisms, scanning patterns, and mission planning parameters that influence data quality, point cloud density, and mapping accuracy. Particular emphasis was placed on the role of LiDAR technology as a non-destructive tool capable of rapidly capturing high-resolution three-dimensional information over large and complex areas.

The presentation provided an overview of the UAV-based LiDAR infrastructure acquired through the CONNECTING project, highlighting its ability to support high-precision geospatial data acquisition. Key aspects of mission design were discussed, including flight planning strategies, corridor mapping, calibration procedures, trajectory optimization, and the relationship between flight altitude, point density, and mapping scale. These parameters were presented as critical factors for ensuring reliable and accurate data collection in both heritage and environmental applications.

Several case studies demonstrated the practical implementation of LiDAR workflows. Examples included surveys conducted at the Holy Monastery of Saint Neophytos, the Petounta archaeological area, and environmental monitoring activities at Mavrokolympos Dam. Through these examples, the presentation illustrated the complete workflow from data acquisition and trajectory planning to point cloud generation,

terrain modelling, and three-dimensional visualization. The resulting datasets showcased the capability of airborne LiDAR systems to capture detailed topographic information, complex landscape features, and cultural heritage assets with a high degree of accuracy.

The speaker also highlighted the advantages of combining LiDAR data with complementary UAV imagery and geospatial datasets, enabling enhanced mapping, analysis, and decision-making. Particular attention was given to the value of these technologies for heritage documentation, landscape analysis, environmental monitoring, and long-term site management. The generated three-dimensional models and digital terrain products provide valuable resources for researchers, public authorities, and heritage professionals involved in conservation and planning activities.

Concluding the presentation, it was emphasized that UAV-based LiDAR technologies represent a powerful component of the CONNECTING research infrastructure, offering efficient, accurate, and scalable solutions for the collection and processing of geospatial information. The demonstrated applications highlighted the potential of these technologies to support future research, heritage documentation, environmental assessment, and evidence-based management practices in Cyprus and beyond.

Underwater ROV Documentation and Exploration, Assoc. Prof. Stella Demesticha & Dr. Marinos Vlachos (UCY)

The presentation focused on the use of Remotely Operated Vehicles (ROVs) for the documentation, inspection, and exploration of underwater cultural heritage sites. The speakers highlighted the growing importance of ROV technologies as a safe and efficient alternative to traditional diver-based surveys, particularly in challenging underwater environments characterized by depth limitations, low visibility conditions, and the need for non-invasive investigation methods.

Emphasis was placed on the capabilities of the CHASING M2 PRO MAX, a professional underwater ROV acquired through the CONNECTING project. The system integrates high-resolution imaging, advanced

navigation technologies, sonar-based positioning, and multiple sensors that enable detailed inspection, mapping, and data collection in underwater environments. The presentation demonstrated how complementary technologies, including Doppler Velocity Log (DVL) systems, distance lock sonar, and 360-degree imaging sonar, support precise navigation and stable operation even under limited visibility conditions.

A significant part of the presentation focused on the application of the system at the Nissia tou Protara Ottoman Shipwreck, located at a depth of approximately 28 meters. The site served as a pilot case study for testing non-invasive underwater documentation methodologies. The speakers presented the survey strategy adopted during the fieldwork, emphasizing the importance of systematic navigation paths, maintaining constant distances from target structures, and ensuring high image overlap for photogrammetric processing. These procedures enabled the collection of high-quality datasets suitable for detailed archaeological documentation and analysis.

The presentation further described the workflow used for generating three-dimensional models from ROV-acquired imagery. Using Structure-from-Motion (SfM) and Multi-View Stereo (MVS) techniques within Agisoft Metashape, the acquired images were processed into dense point clouds, textured meshes, and georeferenced 3D models. The resulting products provided both visual and metric information, demonstrating the potential of ROV-based photogrammetry for the accurate recording and monitoring of submerged cultural heritage assets.

The speakers also discussed the main challenges encountered during underwater data acquisition and processing, including water turbidity, lighting conditions, navigation constraints, and the absence of GNSS positioning underwater. These experiences highlighted the importance of carefully planned acquisition strategies and optimized survey workflows to ensure reliable and high-quality results.

Concluding the presentation, the speakers emphasized that ROV-based methodologies offer a flexible and effective solution for underwater heritage documentation, combining visual inspection, measurement, and three-dimensional reconstruction capabilities. The demonstrated workflows showcase the significant potential of the CONNECTING infrastructure to support future archaeological research, heritage monitoring, and conservation activities within Cyprus and beyond.

Collection and processing of 3D terrestrial clouds, Prof. Dimitrios Skarlatos & George Kafataris (CUT)

The presentation focused on the collection and processing of three-dimensional terrestrial point clouds using the CHCNAV RS10 SLAM LiDAR Scanner, highlighting its capabilities for the rapid and accurate documentation of cultural heritage sites. The speakers introduced the principles of Simultaneous Localization and Mapping (SLAM), explaining how technology enables real-time positioning and mapping while simultaneously generating detailed three-dimensional representations of complex environments.

Attention was given to the technical characteristics of the CHCNAV RS10 system, which integrates LiDAR sensors, multiple cameras, GNSS RTK positioning, inertial measurement units (IMU), and advanced SLAM algorithms into a single mobile mapping platform. The combination of these technologies allows for efficient

acquisition of high-density point clouds with centimeters-level accuracy, significantly reducing fieldwork and processing requirements compared to conventional surveying methods.

The presentation demonstrated the complete workflow from field data acquisition to point cloud processing and visualization through two case studies: the Holy Monastery of Saint Neophytos the Recluse and Tomb 7 at the Tombs of the Kings archaeological site. The speakers presented data collection strategies, trajectory planning approaches, and processing procedures used to ensure the quality and reliability of the generated datasets. Examples of the resulting 3D models and point clouds illustrated the scanner's ability to capture detailed geometric information in both indoor and outdoor heritage environments.

The results highlighted the advantages of SLAM-based mobile mapping technologies for cultural heritage applications, including rapid data acquisition, operational flexibility, and the ability to document complex architectural and archaeological structures with high levels of detail. The presentation also emphasized the contribution of the CONNECTING infrastructure in providing researchers and heritage professionals with access to advanced digital documentation tools that support conservation, monitoring, visualization, and long-term heritage management activities.

The session concluded by stressing the growing importance of mobile LiDAR technologies in heritage science and their potential to complement traditional surveying techniques, enabling faster, more efficient, and highly detailed documentation of cultural heritage assets.

Cloud Data Centre Design and Implementation, Mr. Angelos Boubousis and Dr. Giannis Filippopoulos (InfraLabs)

The presentation focused on the design, implementation, and operational capabilities of the CONNECTING Cloud Data Center, a cloud-based infrastructure developed to support the management, storage, dissemination, and visualization of cultural heritage and geospatial datasets generated within the project. The platform was designed as an integrated digital ecosystem that enables researchers, heritage

professionals, public authorities, and other stakeholders to access and interact with a wide range of spatial and cultural heritage information through interoperable web services and modern visualization environments.

The overall architecture of the infrastructure was presented, highlighting the integration of distributed storage technologies, metadata cataloguing services, geospatial publication workflows, and web-based visualization tools into a unified operational framework. The implemented system combines Hadoop-based storage services, GeoServer publication services, GeoNode catalogue environments, Cesium 3D visualization technologies, Potree point-cloud visualization services, and OGC-compliant geospatial standards to support the efficient management and dissemination of heterogeneous datasets.

Particular emphasis was placed on the operational workflows that enable dataset ingestion, metadata creation, geospatial publication, and user interaction. The presentation demonstrated how the platform supports the management of vector and raster geospatial datasets, orthophotos, drone-derived products, point clouds, three-dimensional models, and metadata resources through a centralized cloud environment. Examples were presented illustrating data upload procedures, catalogue services, layer management functionalities, metadata registration, and browser-based access to both two-dimensional and three-dimensional visualisation environments.

The speakers also highlighted the role of the Cloud Data Center in supporting open access, discoverability, and long-term preservation of research outputs. Through metadata-driven cataloguing services and user-oriented interfaces, the platform enables efficient dataset discovery, visualization, and controlled access while supporting interoperability with external geospatial services and research infrastructures. Special attention was given to role-based access control mechanisms, cybersecurity monitoring, logging services, and administrative tools that ensure the secure and sustainable operation of the infrastructure.

Concluding the presentation, speakers emphasized that the CONNECTING Cloud Data Center constitutes a key component of the project's long-term legacy, providing a scalable and sustainable digital infrastructure capable of supporting future research, data sharing, interdisciplinary collaboration, and cultural heritage management activities. The platform establishes the foundation for the long-term preservation, accessibility, and exploitation of heritage-related datasets generated through CONNECTING and future research initiatives.

Use and re-use of 3D data, Prof. Dimitrios Skarlatos (CUT)

The presentation focused on the long-term value of three-dimensional geospatial datasets and the importance of preserving, managing, and reusing digital heritage data beyond their original purpose. Professor Skarlatos demonstrated how advances in photogrammetry, LiDAR, terrestrial laser scanning, SLAM technologies, and Structure-from-Motion (SfM) methodologies have made the acquisition of 3D data increasingly accessible. However, he emphasized that the true value of such datasets often emerges years later, when historical information is required for change detection, reconstruction, analysis, or the study of sites that have been altered, damaged, or are no longer accessible.

Through a series of case studies, the presentation illustrated how archived aerial photographs and historical datasets can be transformed into three-dimensional models and integrated with modern geospatial data. Examples included the processing of archival aerial photographs from Greece and Cyprus, demonstrating how historical imagery can be used to reconstruct past landscapes, support legal and planning processes, monitor environmental changes, and assess long-term landscape evolution. Particular attention was given to change detection analyses, where historical reconstructions were combined with contemporary LiDAR datasets to quantify terrain changes and support environmental assessment activities.

A significant part of the presentation focused on the Mazotos shipwreck, one of the most important underwater archaeological sites in Cyprus. Professor Skarlatos demonstrated how photographic archives acquired for purposes other than three-dimensional reconstruction were successfully reprocessed years later using modern SfM-MVS methodologies to recreate detailed 3D models of the site. These reconstructions enabled the preservation of information from archaeological contexts that no longer exist in their original state and supported the development of virtual reality applications, digital exploration tools, educational environments, and serious games for training and public engagement.

The presentation further highlighted how advances in processing algorithms continue to unlock new opportunities from previously collected datasets. Examples included underwater image colour restoration,

bathymetric mapping from aerial imagery, and the integration of historical and contemporary datasets to improve analytical capabilities. These applications demonstrated that archived datasets often contain valuable information that can be reinterpreted and enhanced as new technologies and methodologies become available.

Concluding the presentation, Professor Skarlatos stressed the importance of systematic data preservation, open-access principles, metadata documentation, and FAIR data practices. He emphasized that the long-term impact of digital heritage projects depends not only on data acquisition but also on ensuring that original datasets, associated metadata, and processing information remain accessible for future research, innovation, and reuse. The presentation reinforced the role of the CONNECTING infrastructure in supporting sustainable data management and maximizing the scientific and societal value of cultural heritage datasets.

CONNECTING Equipment

Demonstration of the CONNECTING Equipment

Discussion and Future Collaborations, Project Coordinator: Assist. Prof. Athos Agapiou (CUT)

The presentation outlined the long-term sustainability strategy and business plan developed for the CONNECTING Research and Innovation Knowledge Centre for Engineering in Heritage. The proposed framework aims to ensure the continued operation, accessibility, and growth of the infrastructure beyond the project's funding period, positioning CONNECTING as a national and regional hub for engineering applications in cultural heritage.

Emphasis was placed on the vision for 2030, which foresees CONNECTING operating as an open-access research infrastructure supporting researchers, public authorities, heritage professionals, students, and private-sector stakeholders. The presentation highlighted the project's objective of providing advanced sensing technologies, high-performance computing resources, cloud-based data services, training opportunities, and expert support for cultural heritage documentation, monitoring, and preservation activities.

The business plan identified the main user groups and outlined the value proposition offered to each category, including academic institutions, public authorities, cultural heritage organisations, private companies, and international research partners. Different access models and service levels were presented to ensure efficient use of the infrastructure while promoting openness, collaboration, and knowledge exchange.

The presentation also examined potential funding opportunities and revenue streams that could contribute to the long-term sustainability of the infrastructure. These include participation in national and European research projects, provision of specialised services, training activities, strategic partnerships, and collaborative research initiatives. Attention was given to governance mechanisms, operational procedures, and quality assurance measures designed to ensure transparent management and effective utilisation of the infrastructure.

Concluding the presentation, it was emphasized that the sustainability of CONNECTING extends beyond financial consideration and includes the continued development of expertise, partnerships, data resources, and technological capabilities. The business plan therefore establishes a roadmap for maintaining and expanding the infrastructure's impact, ensuring that the investments made through the project continue to support research excellence, innovation, and cultural heritage management in Cyprus and beyond.

Acknowledgements & Sponsors

The CONNECTING Project gratefully acknowledges the financial support received from the European Regional Development Fund (ERDF) and the Republic of Cyprus, through the Research and Innovation Foundation (RIF) under contract SMALL SCALE INFRASTRUCTURES/1222/0062. This support enabled the establishment of the Research and Innovation Knowledge Centre for Engineering in Heritage and the successful implementation of its research, infrastructure, training, and dissemination activities.

The consortium extends its sincere appreciation to the Department of Antiquities of Cyprus, the University of Cyprus, and InfraLabs Research Centre for their collaboration and contribution throughout the project. Special thanks are also extended to the project's international supporters, namely Politecnico di Milano (Italy), University College London (United Kingdom), University of Aveiro (Portugal), the UNESCO Chair on Digital Cultural Heritage, the Department of Lands and Surveys of Cyprus, and GeoFEM Ltd, whose expertise, guidance, and continuous support strengthened the scientific excellence, international outreach, and long-term impact of the project.

The CONNECTING consortium would also like to thank all researchers, students, heritage professionals, public authorities, stakeholders, speakers, and participants who contributed to the project's activities and the success of the Final Workshop. Their active engagement, collaboration, and knowledge exchange have

played a key role in advancing research, innovation, and the sustainable preservation of cultural heritage in Cyprus and beyond.

Annex I – Presentations

Project at a Glance

Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING

THE RESEARCH PROMOTION FOUNDATION

PROGRAMMES

FOR RESEARCH, TECHNOLOGICAL DEVELOPMENT AND INNOVATION

"RESTART 2016 – 2020"

PROPOSAL DETAILS	
PILLAR	I. Smart Growth
PROGRAMME	RESEARCH INFRASTRUCTURES / SMALL SCALE INFRASTRUCTURES
RPF PROPOSAL NUMBER	SMALL SCALE INFRASTRUCTURES/1222/0062
PROPOSAL TITLE	Research and Innovation Knowledge Centre for Engineering in Heritage
PROPOSAL ACRONYM	CONNECTING

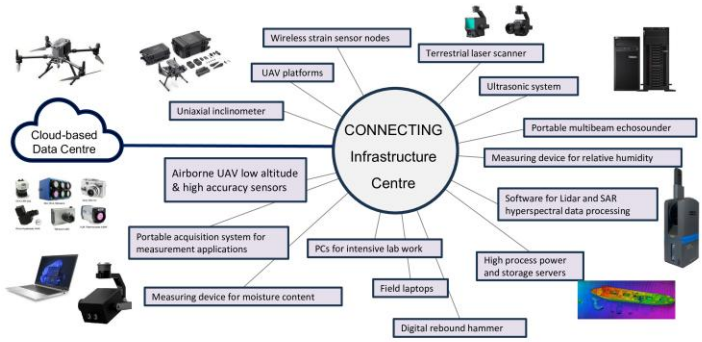
Co-funded by the European Union

Acknowledgement: This project has received funding from the European Regional Development Fund and the Republic of Cyprus through the Research and Innovation Foundation of Cyprus under contract SMALL SCALE INFRASTRUCTURES/1222/0062.

CONNECTING is built around the vision of the "**Strategic Infrastructures**" research call, towards the creation of a knowledge centre, equipped with **state-of-the-art sensors and platforms** that can promote research excellence about the detection, monitoring, documentation and analysis of cultural heritage sites and monuments, both in land as well as underwater.

WITH THE SUPPORT OF

Project at a Glance



Vision & Objectives

Establish a Knowledge Centre
Create a state-of-the-art research infrastructure for engineering in cultural heritage in Cyprus.

Advanced NDT Equipment Pool
Acquire aerial, ground & underwater sensing systems (drones, LiDAR, multibeam sonar, ROV) accessible to researchers.

Cloud Data Infrastructure
Build a high-performance computing & cloud data centre for processing and archiving heritage datasets.

Open Access & Collaboration
Make infrastructure accessible to national & international researchers; foster cross-disciplinary partnerships.

Training & Capacity Building
Deliver workshops, summer schools and training sessions to build local expertise in heritage technologies.

PROJECT VISION

"To create a pioneering research infrastructure that bridges cutting-edge geospatial technologies with Cyprus's rich cultural heritage, enabling sustainable preservation and evidence-based management for future generations."

CONNECTING Research & Innovation Knowledge Centre for Engineering in Heritage | CUT

Consortium & Supporters

CORE PARTNERS

CUT — Cyprus University of Technology — *Coordinator · Lead Partner*

InfraLabs — InfraLabs Research Centre — *Technical Partner*

UCY — University of Cyprus — *Research Partner*

DoA — Department of Antiquities — *Heritage Authority Partner*

INTERNATIONAL SUPPORTERS

POLIMI — Politecnico di Milano · Italy

UCL — University College London · UK

UAVEIRO — University of Aveiro · Portugal

UNESCO Chair — UNESCO Chair on DCH

DLS — Department of Land and Surveyors

GeoFEM — GeoFEM Ltd

The project is implemented under the programme of social cohesion "THALIA 2021-2027" co-funded by the European Union, through Research and Innovation Foundation.

Co-funded by the European Union

Republic of Cyprus

RESEARCH & INNOVATION FOUNDATION

Work Packages

WP1 — **Infrastructure Procurement & Setup**
Acquisition and installation of aerial, ground & underwater sensing systems; HPC server setup and cloud data centre deployment.

WP2 — **Research & Demonstration Activities**
Field campaigns at 5 demonstration sites; data acquisition, processing, and validation of NDT methodologies for heritage.

WP3 — **Data Management & Cloud Platform**
Development of online infrastructure database; open-access data portal; FAIR data principles implementation.

WP4 — **Training, Dissemination & Networking**
Summer schools, workshops, conference presentations, publications, and international networking activities.

WP5 — **Project Management & Quality Assurance**
Coordination, financial management, progress reporting, risk management, and quality control across all work packages. 22 deliverables tracked across all WPs.

State-of-the-Art Infrastructure

✈ AERIAL SYSTEMS
- VTOL Fixed-wing & Multi-rotor Drones
- RGB, Multispectral & Hyperspectral Cameras
- Aerial LiDAR System
- Thermal Infrared Camera

UNDERWATER SYSTEMS
- Multibeam Echosounder
- Remotely Operated Vehicle (ROV)
- Underwater Photogrammetry Rig
- Side-scan Sonar

GROUND SYSTEMS
- Terrestrial Laser Scanner (TLS)
- SLAM Mobile Mapping System
- Ground Penetrating Radar (GPR)
- Soil Moisture, Ultrasonic & Strain Sensors

COMPUTING INFRASTRUCTURE
- High-Performance Computing Servers
- Cloud Data Centre (OpenStack)
- Photogrammetry & GIS Software Suite
- Online Infrastructure Database Portal

CONNECTING field team with drone system at Mavrokolympos Dam

State-of-the-Art Infrastructure

Cameras

Strategic Research Infrastructure

CHASING M2 PRO MAX – Overview & Key Specifications

Overview:

- Professional Underwater ROV designed for advanced inspection, mapping, and sampling operations.
- Fully portable and deployable by one person.

Key Specs:

- Depth Rating: 200 meters
- Max Speed: 3 knots
- Battery Life: Up to 5 hours (with dual 700Wh batteries)
- Thrusters: 8 vectored thrusters (omnidirectional movement)
- Payload Capacity: Up to 7 kg
- Stabilization: Built-in IMU and depth hold
- Camera: 4K UHD / 12 MP with low-light sensor and laser scaler support
- Lighting: Dual 4000-lumen LED lights (adjustable)

WITH THE SUPPORT OF

State-of-the-Art Infrastructure

Cameras

DJI Zenmuse P1

Full-Frame Sensor

- 45 MP high-resolution imaging
- Interchangeable lenses (24/35/50mm)

High-Precision Mapping

- RTK module for centimeter-level accuracy
- Global Mechanical Shutter (1/2000s)

Efficient Data Capture

- 3 fps continuous shooting
- Covers 3 km² in one flight

Smart Workflow

- TimeSync 2.0 for real-time alignment

DJI Zenmuse L2

High-Precision LiDAR

- 240,000 points per second
- 70° field of view

Survey-Grade Accuracy

- RTK-supported centimeter-level precision
- 450m detection range (50% reflectivity)

Integrated RGB Camera

- 20 MP CMOS sensor
- Mechanical shutter for precise imaging

Efficient Data Capture

- Up to 3 returns per pulse for dense vegetation
- Covers 2.5 km² in a single flight

Seamless DJI Integration

- Works with DJI Terra for real-time point cloud processing

HAIP BlackBird V2

DJI Integration

- Works with Matrice 300 & 350 RTK
- DJI Skyport V2 for quick attachment

Hyperspectral Imaging

- 500–1000 nm (VNIR) range
- 100 spectral bands

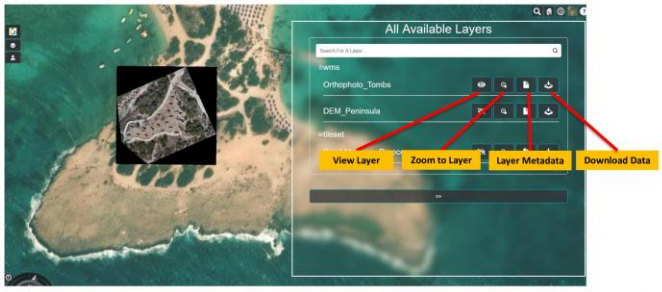
High Precision & Efficiency

- Push-broom linescanner technology
- Optimized for aerial mapping & analysis

WITH THE SUPPORT OF

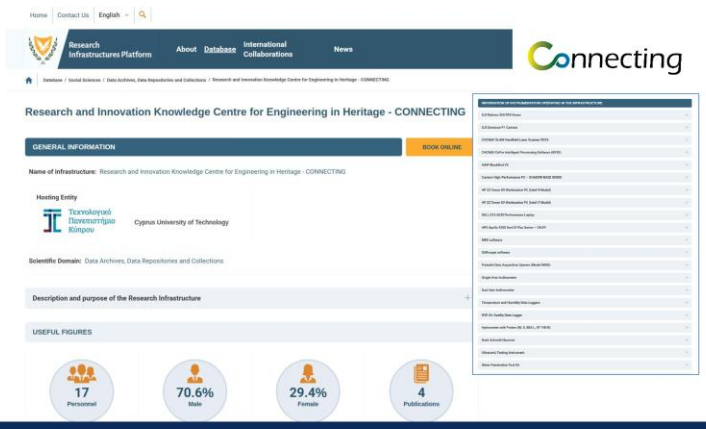
State-of-the-Art Infrastructure

User Interface: Data Functionalities



WITH THE SUPPORT OF

State-of-the-Art Infrastructure



Cloud Data Centre & Digital Platform

High-Performance Computing (HPC)
Dedicated servers for photogrammetric processing, point cloud analysis, and large-scale geospatial computation.

OpenStack Cloud Infrastructure
Private cloud deployment enabling scalable storage, virtual machines, and remote access for consortium researchers.

Heritage Data Repository
Centralised archive for 3D models, point clouds, orthomosaics, and sensor datasets from all demonstration sites.

Online Infrastructure Database
Public-facing portal cataloguing all CONNECTING equipment; supports open-access requests from external researchers.

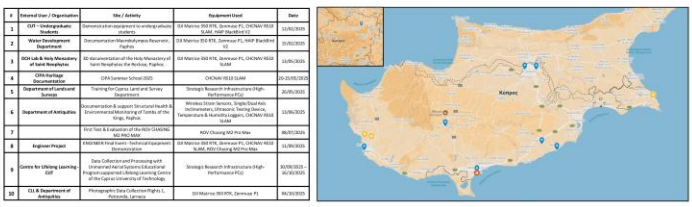

Real-time 3D point cloud capture inside Byzantine church

5 Demo Sites | TB+ Heritage Data | FAIR Data Principles | OA Open Access

Demonstration Sites

Achieved 20+ activities completed

- Involvement of external authorities, academia & private sector
- Full operational workflows to be established: data collection → processing → visualization
- Infrastructure showcased **nationally & internationally**, reinforcing open-access use



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Demonstration Sites

Dissemination, Training & Impact

Scientific Dissemination
- ✓ Peer-reviewed journal articles published
- ✓ Conference presentations (ISPRS, EGU, etc.)
- ✓ Open-access datasets on public repositories
- ✓ Project website: connecting-infra.eu

Media & Public Engagement
- ✓ TV & radio interviews (Kanali 6 & others)
- ✓ Press releases & news articles
- ✓ Social media presence & outreach
- ✓ Public open days at heritage sites

Training & Education
- ✓ International summer school on heritage NDT
- ✓ Workshops for researchers & practitioners
- ✓ Student training & thesis supervision
- ✓ Online tutorials and documentation

International Networking
- ✓ 6 international supporting organisations
- ✓ Bilateral research exchanges
- ✓ EU project networking (Horizon Europe)
- ✓ UNESCO & DoA collaboration

Media coverage – drone survey at Mavrokolympos Dam (Kanali 6)

PROJECT IMPACT AT A GLANCE

5+	10+	100+	5
Publications	Events	Researchers	Sites Mapped

Conclusions & Key Achievements

- Successfully established Cyprus's dedicated research infrastructure for engineering in cultural heritage
- Comprehensive equipment pool covering aerial, ground & underwater sensing technologies now operational
- Demonstration sites documented with state-of-the-art NDT methods; datasets archived & open-access
- Cloud data centre & online infrastructure database deployed and accessible to the research community
- International network of 6 supporting organisations strengthens Cyprus's position in heritage research
- Significant training & dissemination activities completed; next-generation researchers trained
- Project legacy: sustainable infrastructure available beyond project end for future research

Acknowledgement

This project has received funding from the European Regional Development Fund and the Republic of Cyprus through the Research and Innovation Foundation of Cyprus under contract SMALL SCALE INFRASTRUCTURES/1222/0062.

Project Website
connecting-infra.eu

Follow us on X (Twitter)
@CONNECTING_EU

CONTACT & MORE INFORMATION
www.connecting-infra.eu
Cyprus University of Technology (CUT)


Thank you all — and let's stay Connecting
Research and Innovation Knowledge Centre for Engineering in Heritage
Connecting
THANK YOU FOR YOUR ATTENTION
CONNECTING Final Workshop
28 May 2026
Co-funded by the European Union
Republic of Cyprus
RESEARCH & INNOVATION FOUNDATION
Acknowledgement: This project has received funding from the European Regional Development Fund and the Republic of Cyprus through the Research and Innovation Foundation of Cyprus under contract SMALL SCALE INFRASTRUCTURES/1222/0062.
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DEPARTMENT OF ANTIQUITIES CYPRUS

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Connecting

UAV & Airborne LiDAR
a
Geovisualization approach

CONNECTING Final Workshop
28 May 2026

As Professor
Papakostantinou Apostolos

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Early Stage

"we always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten."
1990s, Bill Gates

Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Infrastructure Equipment)

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Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Infrastructure Equipment)
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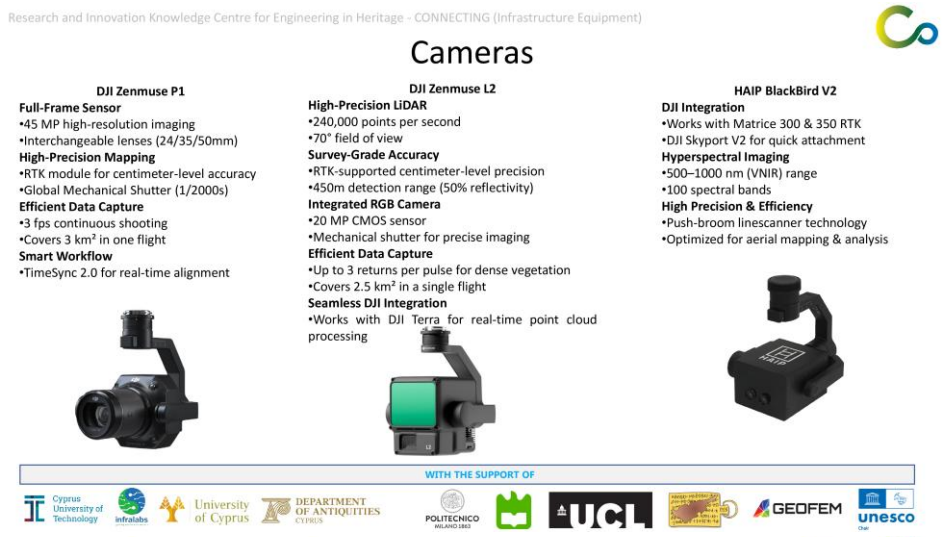
Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Infrastructure Equipment)
Cameras
DJI Zenmuse P1
Full-Frame Sensor
•45 MP high-resolution imaging
•Interchangeable lenses (24/35/50mm)
High-Precision Mapping
•RTK module for centimeter-level accuracy
•Global Mechanical Shutter (1/2000s)
Efficient Data Capture
•3 fps continuous shooting
•Covers 3 km² in one flight
Smart Workflow
•TimeSync 2.0 for real-time alignment
DJI Zenmuse L2
High-Precision LiDAR
•240,000 points per second
•70° field of view
Survey-Grade Accuracy
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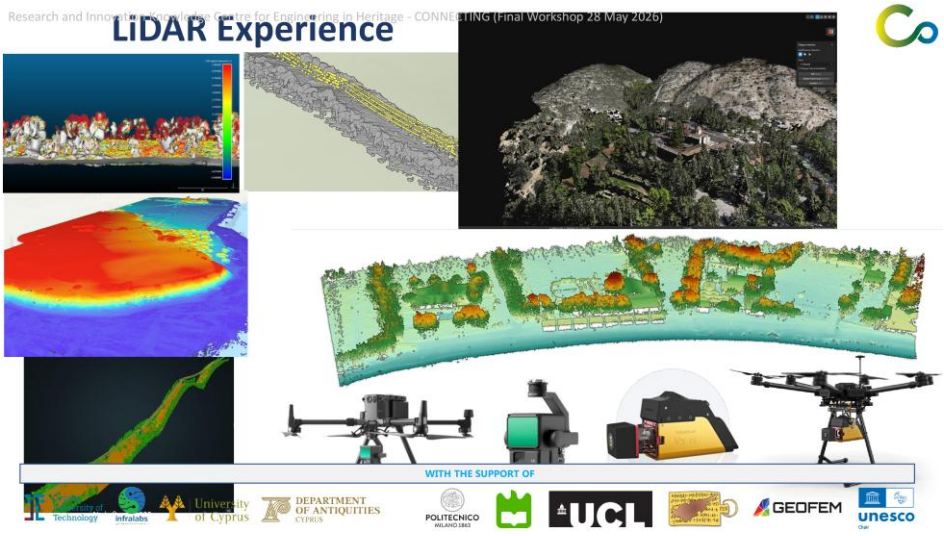
Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Final Workshop 28 May 2026)
LiDAR Experience
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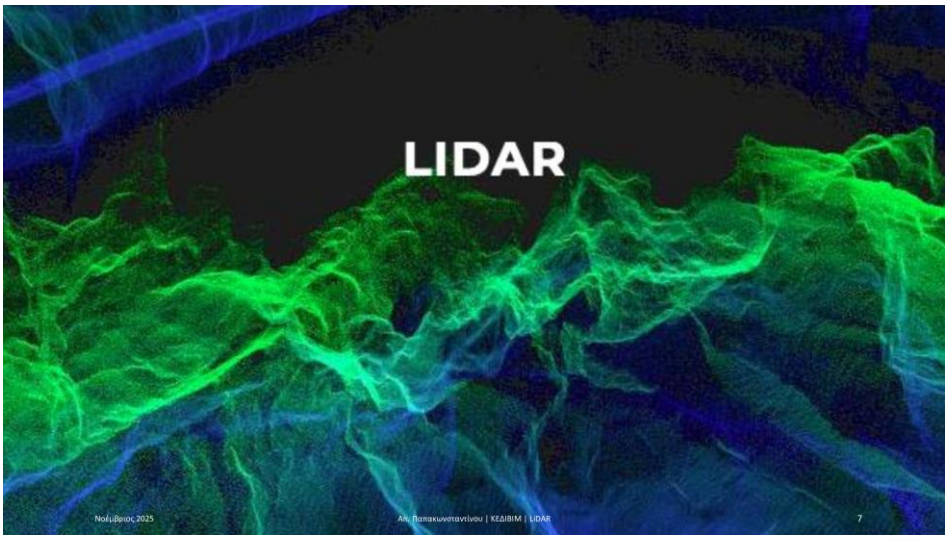
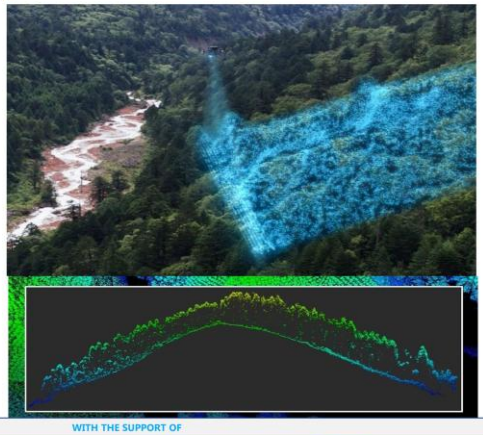


What is LiDAR (video)

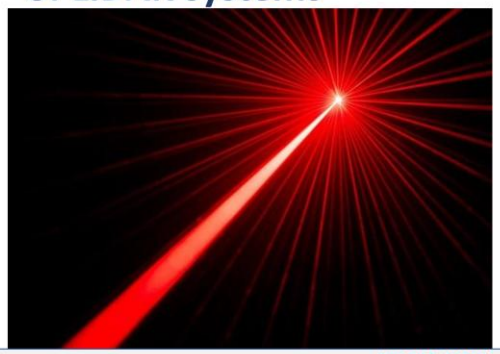
Sensor Configuration

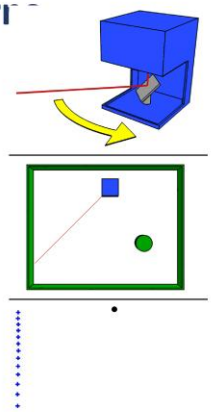
- When collecting LiDAR data, there are several sensor options.
- Sensor or laser configuration might be different for bathymetry or topography.



- Scanning Pattern
- Sensor Wavelength
- On the Horizon

Scanning Mechanisms & Patterns of LiDAR systems





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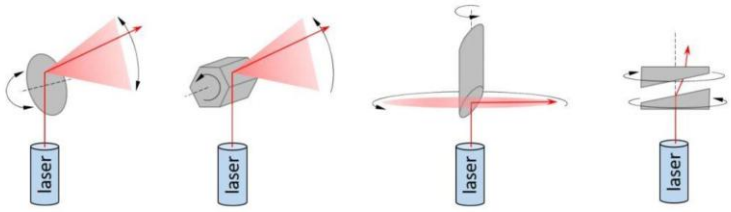
Scanning Mechanisms



Ταλαντούμενος καθρέφτης | *περιστρεφόμενος πολυγωνικός καθρέφτης* | *περιστρεφόμενος καθρέφτης* | *περιστρεφόμενο σφηνοειδές πρίσμα (1-2)*

Different scanning mechanisms: (a) **oscillating mirror**; (b) **rotating polygonal mirror**; (c) **rotating mirror**; (d-e) **rotating wedge prism**; (e) **two rotating wedge prisms**.

O. Péntek, Contribution to the generation of 3D-colour maps of natural environments from data from a multi-sensor system for drone, PhD thesis, 2020

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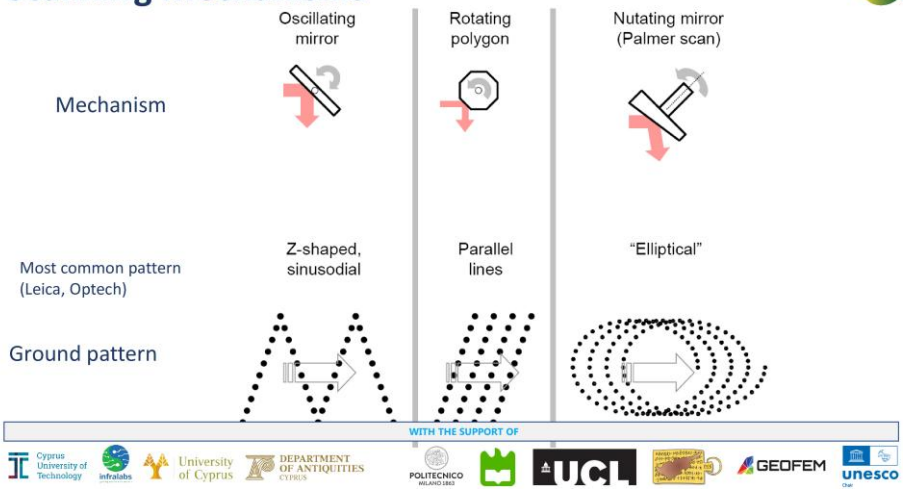
Scanning Mechanisms



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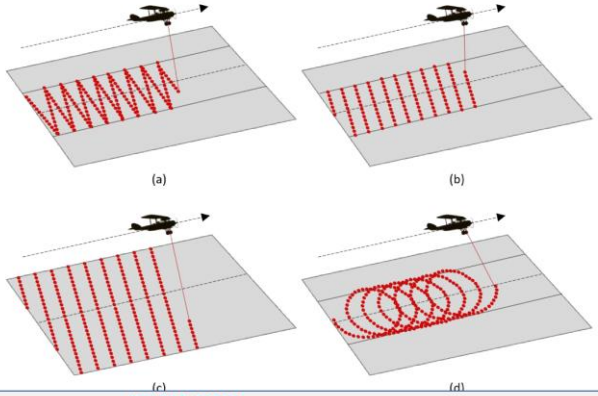
Scan patterns of LiDAR systems

Different scan patterns;
(a) pattern generated by an **oscillating mirror**;

(b) pattern generated by a **rotating polygonal mirror**;

(c) pattern generated by a **rotating mirror**;

(d) pattern generated by a **rotating wedge prism**.

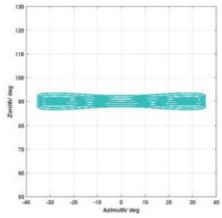


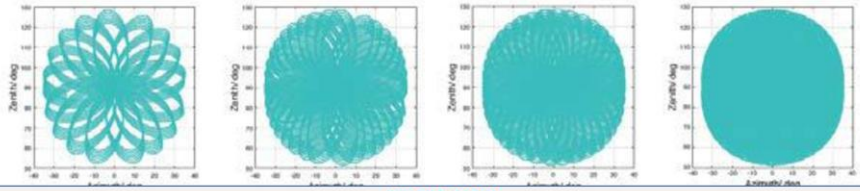
Scanning pattern

REPETITIVE **NON REPETITIVE**

Scanning patterns

- **REPETITIVE επαναλαμβανόμενη σάρωση**
- **NON REPETITIVE μη επαναλαμβανόμενη σάρωση.**





Repetitive scanning pattern

- **Μέθοδος Επαναλαμβανόμενης Σάρωσης**
- Η επαναλαμβανόμενη σάρωση καλύπτει μόνο το οριζόντιο οπτικό πεδίο (70°×3°).

The FOV is 70°×3°.
This scanning mode features a narrow scan range but high accuracy.

Non-Repetitive scanning pattern

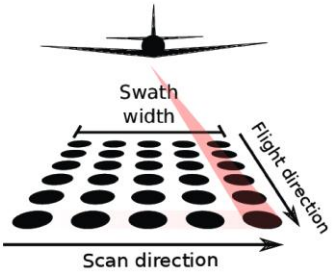
- **Μέθοδος Μη Επαναλαμβανόμενης Σάρωσης**
- Η μη επαναλαμβανόμενη σάρωση καλύπτει μόνο το οριζόντιο οπτικό πεδίο (70.4°×75°).

The FOV is 70°×75°.
This scanning mode features a wide scan range, which can obtain more facade information.
This mode is recommended for taking photos of complex structures, such as the facades of a building.

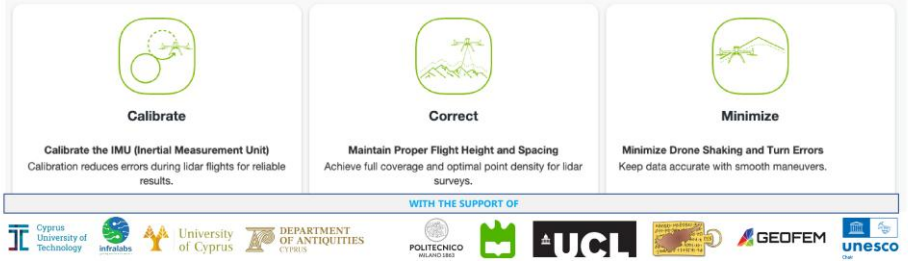
Mission Planning DJI L2

Mission Type CORRIDOR

LiDAR Mission Basics



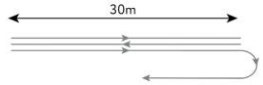
LiDAR Mission Basics

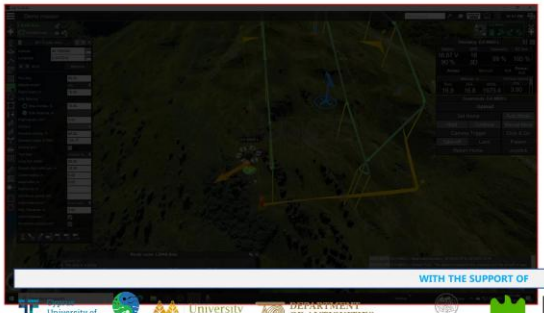


LiDAR Mission Basics

IMU Calibration

- Eight figure
- U-shape
- DJI L1, L2 calibration (back and forth)

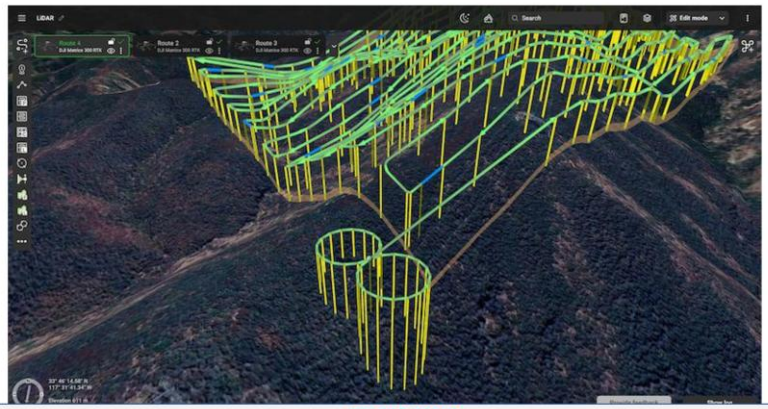




DJI recommends performing a back-and-forth pattern every **100 seconds** or every **1000 meters** during the flight mission

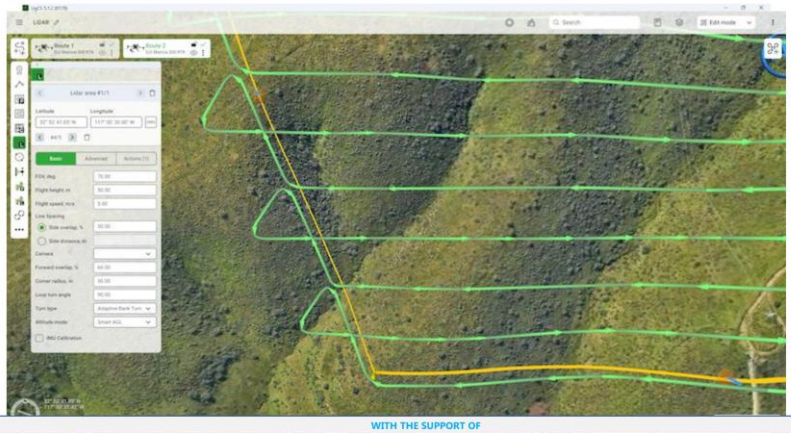
Research and Innovation Simulation Centre for Engineering in Heritage (CONNECTING (Final Workshop 28 May 2026)

LiDAR Mission Basics

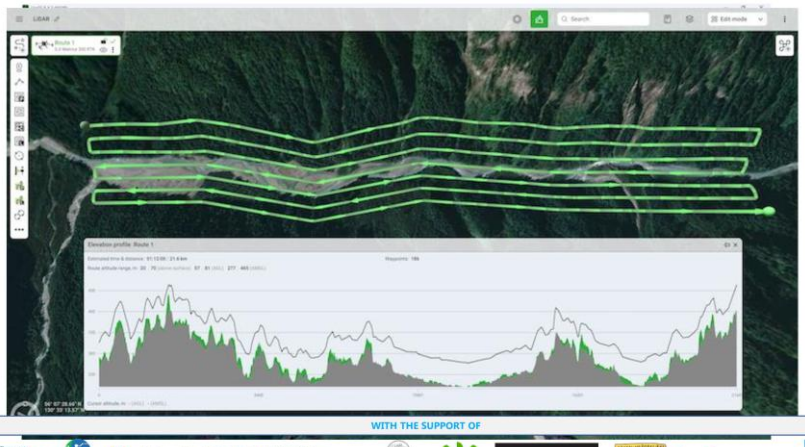


Research and Innovation Simulation Centre for Engineering in Heritage (CONNECTING (Final Workshop 28 May 2026)

LiDAR Mission Basics



LiDAR Mission Basics



Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Final Workshop 28 May 2026)

LiDAR Data Products

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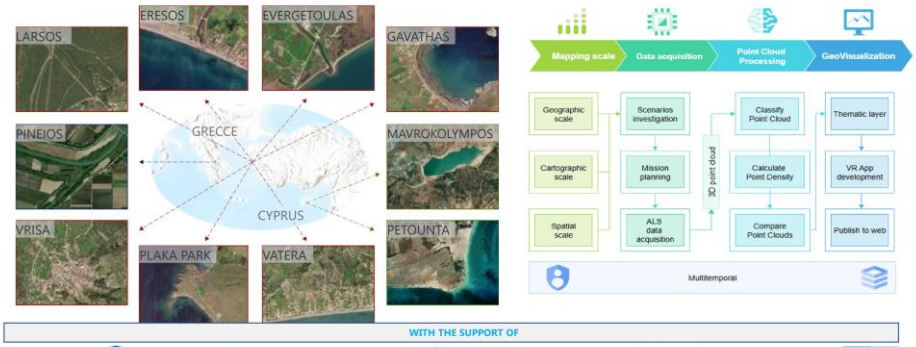
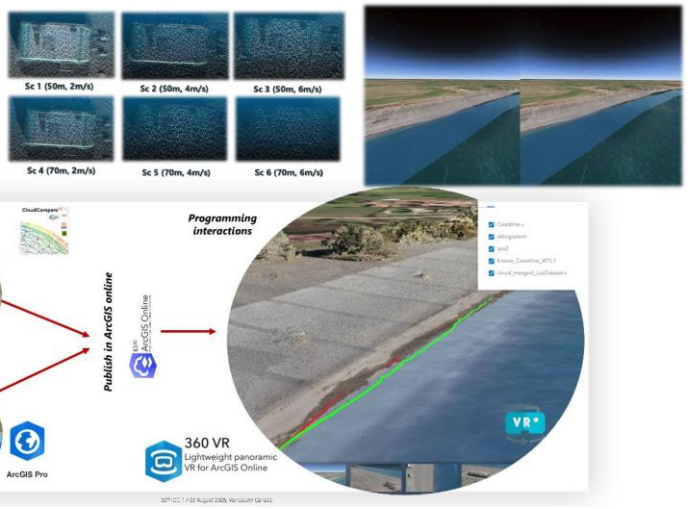
Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Final Workshop 28 May 2026)

Revisiting Drone LiDAR Point Cloud Density & Cartographic Scale: Requirements for Scale-Consistent 3D Cartographic Products



WITH THE SUPPORT OF

VR Geovisualization of Spatiotemporal Coastline Changes using UAV & Airborne LiDAR



Mapping scale

$$\text{Scale} = \frac{1}{\frac{\text{Spatial Resolution}}{\text{Visual Acuity}}}$$

Nyquist

$$\rho_t = \frac{1}{(GA/2)^2}$$

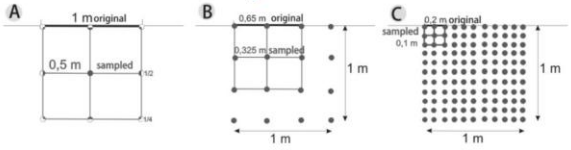
where GA the geometrical accuracy in meters

ASPRS

$$Point\ Density = \frac{1}{(Point\ Spacing)^2}$$

$$Point\ Spacing = \frac{1}{\sqrt{Point\ Density}}$$

Theoretical Lidar Point Density for Topographic Mapping in Large Scales



Two-dimensional principle of the Nyquist frequency, applied to LiDAR points.[1]

Scale	Nyquist	Point spacing (Theoritically)	Raster resolution ASPRS
1:100	6400pts/m2	0,0125m --> 1,25 cm	2,5cm or 2cm
1:250	1024pts/m2	3,125cm	6,25cm or 5cm
1:500	256pts/m2	6,25cm	12,5cm or 10cm

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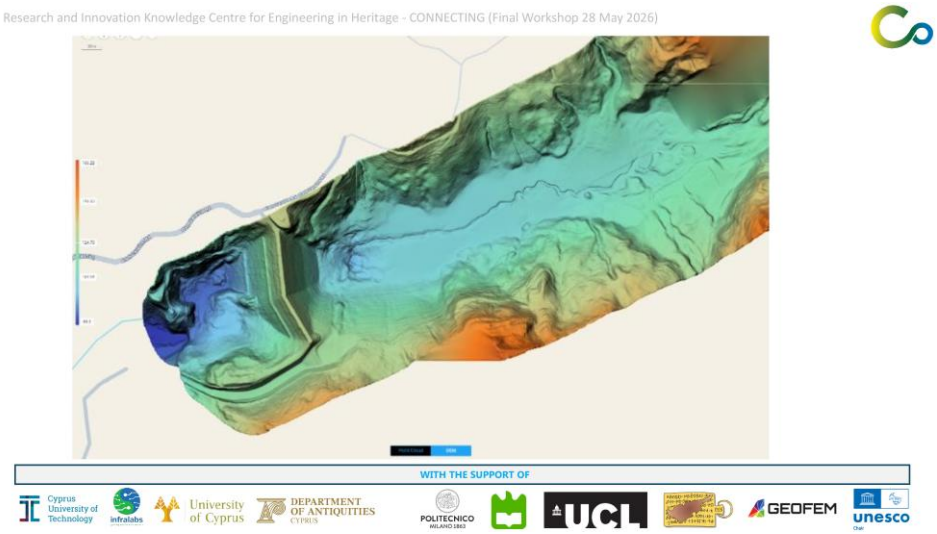
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Απομάκρυνση αδρανών υλικών
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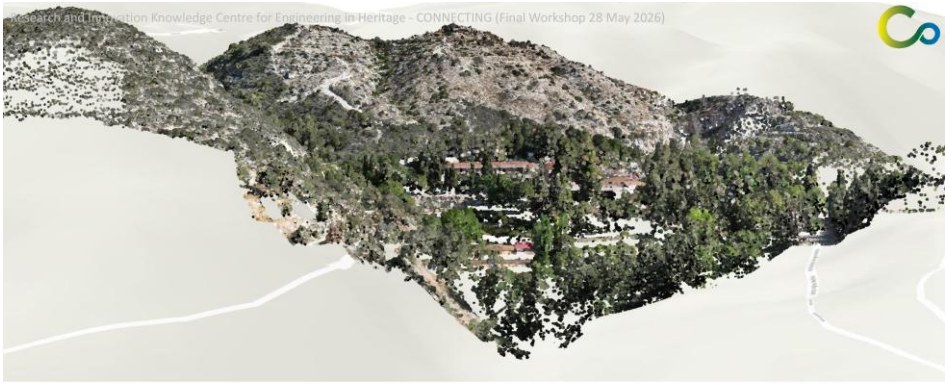
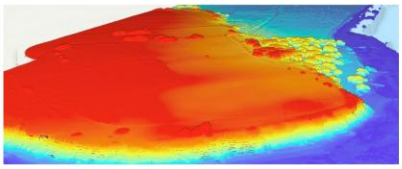


2025 Αγ Νεόφυτος



2025 Πετούντα

2025 Πετούντα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Underwater ROV Documentation and Exploration

Assoc. Prof. Stella Demesticha
Dr. Marinos Vlachos

CONNECTING 1-Day Workshop
28 May 2026

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Why ROVs?

- Divers are limited (depth, safety)
- Low visibility conditions
- Need for non-invasive documentation

- Traditional methods have limitations in underwater environments. ROVs provide a safer and more efficient alternative

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CHASING M2 PRO MAX – Overview & Key Specifications

Overview:

- A compact professional ROV designed for inspection, mapping and sampling, deployable by one operator.

Key Specs:

- Depth: 200 meters
- Max Speed: 3 knots
- Battery Life: Up to 5 hours
- Thrusters: 8 vectored thrusters
- Payload Capacity: Up to 7 kg
- Stabilization: Built-in IMU and depth hold
- Camera: 4K UHD / 12 MP
- Lighting: Dual 4000-lumen LED lights

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CHASING M2 PRO MAX – Key Capabilities

Key Capabilities:

- High-resolution imaging
- Stable navigation
- Multi-sensor integration
- Operation in low visibility

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CHASING M2 PRO MAX – Navigation & Sensors

Enhanced Control:

- Control Console: touchscreen console for professional field use.
- WSRC Waterproof Remote: mobile operation in wet conditions.
- 200m E-Reel: Motorized tether management for efficient deployment/recovery.

Precision Navigation:

- Distance Lock Sonar: Stabilization and spacing from target surfaces.
- WaterLink DVL: Bottom-lock positioning and velocity measurement for improved ROV navigation.
- Ping360 Sonar Kit: 360° scanning sonar for visualizing surroundings in low-visibility conditions.

CHASING Control Console

CHASING WSRC Waterproof Remote

CHASING Adapter Box

E-Reel 200m

CHASING WaterLink DVL

Distance Lock Sonar

CHASINGPing360 Sonar Kit

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CHASING M2 PRO MAX – Accessory Suite – Extended Capabilities

Sampling & Inspection Tools:

- Grabber Arm: Precision retrieval and manipulation of underwater objects.
- Sediment Sampler: Collects seabed samples for environmental monitoring and analysis

Measurement & Visualization:

- Laser Scaler: Projects fixed-distance laser dots to measure objects/structures.
- Ping360 Sonar: Rotating imaging sonar for detailed spatial awareness.

CHASING Grabber Arm

CHASING Sediment Sampler

CHASING Laser Scaler

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Case Study: Nissia tou Protara Ottoman Shipwreck (Cyprus)

- Underwater cultural heritage site (Ottoman period shipwreck)
- Located near Protaras, Cyprus (~28 m depth)
- Complex structure with scattered remains
- Survey conducted using CHASING M2 PRO MAX ROV
- Focus on non-invasive documentation and inspection
- Test site for ROV-based photogrammetry and mapping workflows

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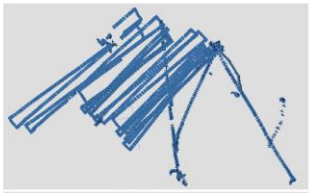
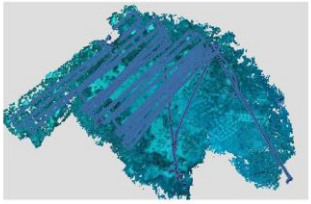
Data Acquisition Strategy for Underwater Documentation

- Systematic survey trajectories (parallel / circular paths)
- Constant distance from target (using Distance Lock Sonar)Low and stable navigation speed (minimize motion blur)
- Time-lapse image acquisition
- High image overlap (>70%) for photogrammetry
- Sensor-assisted navigation:
  - DVL → stabilization
  - Ping360 sonar → search & awareness
- Structured acquisition is critical for reliable 3D reconstruction





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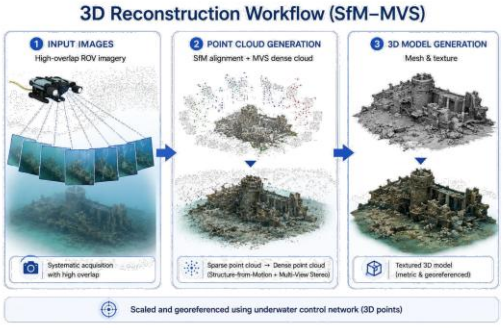
3D Reconstruction Workflow (SfM–MVS)

- Input: High-overlap ROV imagery
- Processing software: Agisoft Metashape
- Workflow steps:
  - Image alignment (SfM)
  - Sparse point cloud generation
  - Dense reconstruction (MVS)
  - Mesh & texture generation
- Scaling & georeferencing:
  - Underwater control network (3D points)



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Results: 3D Reconstruction & Inspection Outputs

- Input: High-overlap ROV imagery
- Processing software: Agisoft Metashape
- Workflow steps:
  - Image alignment (SfM)
  - Sparse point cloud generation
  - Dense reconstruction (MVS)
  - Mesh & texture generation
- Scaling & georeferencing:
  - Underwater control network (3D points)

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Challenges & Lessons Learned

Environmental Challenges
- Water turbidity → reduced visibility
- Backscatter from artificial lighting
- Variable underwater conditions

Operational Challenges
- Limited positioning (no GNSS underwater)
- Tether management constraints
- Navigation in complex structures

Data & Processing Challenges
- Large image datasets → high processing time
- Reduced image quality affects reconstruction
- Need for high overlap and stable acquisition

Acquisition strategy is more critical than equipment alone

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Conclusions

- ROV-based workflows enable efficient underwater documentation
- High-quality imagery supports 3D reconstruction and inspection
- Acquisition strategy is critical for reliable results
- Environmental conditions remain a key limiting factor
- Strong potential for heritage documentation in Cyprus

- **From exploration to metric documentation: ROVs as a key tool for underwater heritage**

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Collection and processing of 3D terrestrial clouds using the CHCNAV RS10 SLAM LiDAR Scanner

Case Studies: 1) The Holy Monastery of Saint Neophytos the Recluse
2) Tomb 7 - Tombs of the Kings Archaeological Site

Prof. Dimitrios Skarlatos & Georgios Kafataris (CUT)

Final Workshop - 28 May 2026

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SLAM technology

Simultaneous Localization and Mapping (SLAM)

SLAM allows the scanner to:

- Determine its position in real time
- Simultaneously create a 3D space

The RS10 is a complex technology and integrates:

- LiDAR sensor
- 3 cameras
- GNSS RTK receiver
- IMU sensor (INS & accelerometer)
- SLAM algorithms

2 different setups

Real time point cloud on tablet

CHCNAV RS10 – Main technical specifications

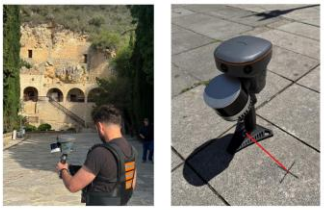
Specification	Value
Absolute accuracy	≤ 3-5 cm
Relative accuracy	≤ 1 cm
Range	0.5 – 120 m
Measurement rate	320,000 pts/sec
Field of view	360° (h) × 270° (v)
RTK/PPK support	Yes
Cameras	3 × 5 MP
Working time	~1 hour (each battery) Offers battery "hot swapping" during acquisition!
Weight	~2 kg

Methodology and workflow

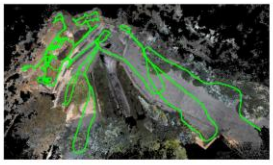
Field workflow
1. Site planning and trajectory design
2. RTK initialization in open space (optional)
3. Scan acquisition
4. GCPs acquisition (optional)
5. "Loop free or closure" execution

Processing workflow
1. Import raw data
2. SLAM trajectory optimization
3. Noise filtering and cleaning
4. Final optimized Point cloud generation
5. Export

Software used
- CHCNAV CoPre



RS10 operation and GCPs acquisition



Slam trajectory at Saint Neophytos

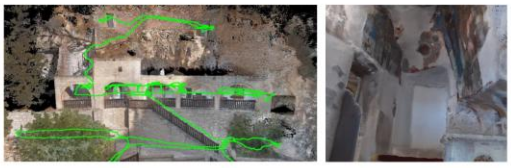
1st Case study - The Holy Monastery of Saint Neophytos the Recluse

Project description
- Historical religious monument
- Complex exterior and interior geometry
- Narrow rooms, passages and low lighting conditions
- Tourists were inside the monastery as the scanning took place
- Limited GNSS availability
- Size of scan area 50*30 m (Monastery 20 * 6 m)

Objectives
- Rapid 3D documentation of interior and exterior spaces
- Production of detailed point cloud

Field procedure
- RTK initialized outside the monument
- Continuous transition from outdoor to indoor environment. Forward walking when entering rooms!
- Walking distance 0.5-1 m/s
- Multiple loop closures performed
- Free loop end !

Saint Neophytos Monastery



Point cloud – Exterior and interior

Results obtained

Total scan took just 15 minutes and processing less than 2.5 hours!
TLS requires more than 40 static setups (more than 3 hours of scans) and processing more than 4 hours !

2nd Case study – Tomb 7, Tombs of the Kings

Project description
- Archaeological underground tomb
- Complex chambers , columns and walls
- Limited GNSS availability
- There were no people at the Tomb
- Size of scan area 40*20 m (Tomb 7, 15 * 20 m)

Challenges
- Narrow confined spaces
- Reduced lighting
- Underground environment

Field procedure
- Similar scenario to Saint Neophytos
- Backward walking when entering chambers!

Tomb 7 - Atrium

Tomb 7 - Chamber

Results obtained

Total scan took just 10 minutes and processing less than 2 hours!
TLS requires 35-40 static setups (2.5-3 hours of scans) and processing more than 4 hours !

RS10 advantages and limitations

Advantages
- Very fast data acquisition
- Reduced fieldwork time (stable RTK signal → No need for GCPS acquisition)
- Simultaneous indoor and outdoor operation
- More complete point clouds than TLS
- Easy operation in confined environments
- Real-time visualization
- Faster processing time than TLS

Limitations
- Lower relative accuracy compared to TLS
- Possible trajectory drift in long paths
- Noise from reflective surfaces and people (also applies for TLS)
- GNSS signal loss indoors!
- 2kg is too heavy for long scans!

SLAM RS10 vs Traditional TLS

Feature	RS10 SLAM	TLS
Acquisition speed	Very fast	Slow
Accuracy	Moderate	Very high
Completeness	High	Moderate
Mobility	Excellent	Limited
Setup time	Minimal	High
Indoor mapping	Excellent	Good
Large areas	Efficient	Time - consuming
Operator effort	Low	High
Processing time	Fast	Slow

vs

Best practices during acquisition

RTK and initialization
- Start acquisition in open space for RTK initialization
- Maintain GNSS connection before entering indoor areas

Trajectory and movement
- Predefine the route before scan
- Perform loop closures
- Smooth and continuous movements
- Avoid sudden rotations and fast motion
- Maintain stable walking speed (0.5-1 m/s)

Indoor mapping
- Avoid scan the same room multiple times unnecessarily
- Ensure overlap between trajectories
- Avoid excessively long linear paths without loops
- Prefer enter room backwards !

Noise reduction
- Cover mirrors and reflective surfaces when possible
- Scan when no one is inside!

Conclusions

- The CHCNAV RS10 is an effective tool for rapid 3D documentation
- SLAM technology enables efficient indoor and outdoor mapping
- Particularly suitable for archaeological and heritage applications
- Proper acquisition strategy significantly improves final results
- Loop closures are essential for trajectory optimization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CONNECTING CLOUD DATA CENTER

The CONNECTING Cloud Data Center has been developed as an integrated cloud-based infrastructure supporting the ingestion, management, storage, publication, visualisation, and dissemination of heterogeneous geospatial and cultural heritage datasets within the CONNECTING ecosystem.
The implemented architecture combines distributed Hadoop-based storage services, interoperable OGC-compliant geospatial publication services, metadata catalogue environments, and WEB data visualisation services into a unified operational framework.

The infrastructure integrates:
- distributed HDFS storage mechanisms,
- GeoServer geospatial publication workflows,
- GeoNode metadata and catalogue services,
- Cesium-based 2D/3D rendering environments,
- Potree point-cloud visualisation services,
- and interoperable web-based dissemination platforms.

The implemented architecture supports:
- scalable dataset management,
- OGC-compliant geospatial services,
- browser-based 2D/3D visualisation,
- metadata-driven discoverability,
- and secure RBAC-controlled interaction workflows across the distributed cloud environment

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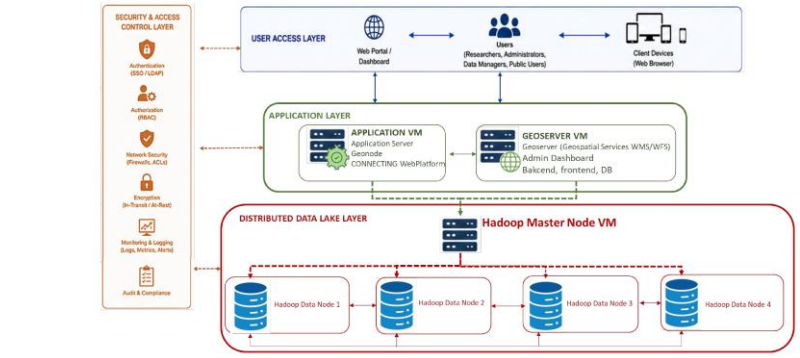
CONNECTING DATA CENTER INFRASTRUCTURE ARCHITECTURE



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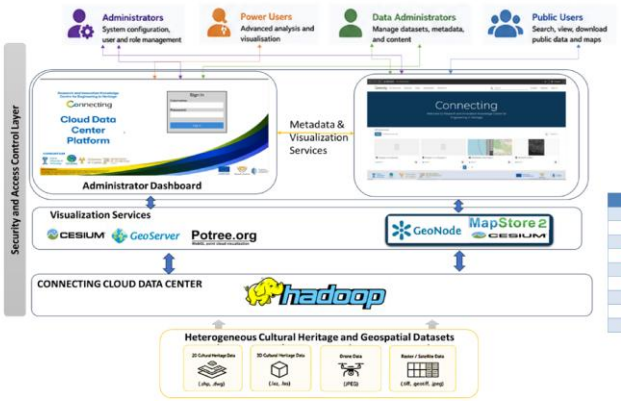

CONNECTING DATA CENTER LOGIC ARCHITECTURE

Component	Functionality
Hadoop Data Lake	Distributed storage and scalable data management
GeoServer	OGC-compliant geospatial publication services
GeoNode	Metadata management and catalogue services
MapStore	Web-based geospatial visualisation
Cesium	2D and 3D geospatial visualisation
Potree	Point cloud visualisation
REST APIs	Service interoperability and communication
Administrator Dashboard	Infrastructure control and management
CONNECTING Web Platform	User interaction and dataset dissemination

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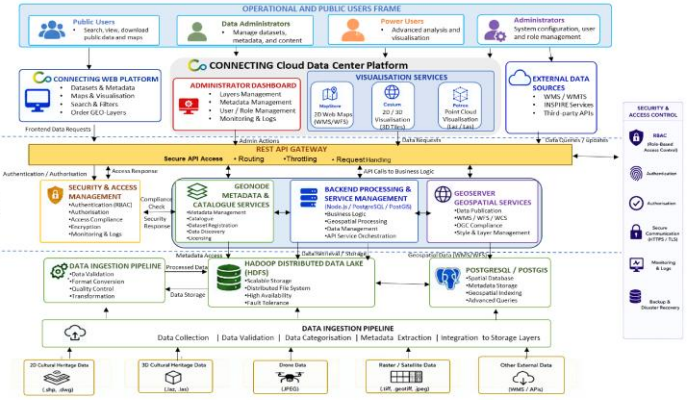
CONNECTING DATA CENTER SERVICE ARCHITECTURE



CONNECTING DATA CENTER SERVICE ARCHITECTURE

CONNECTING Platform Environment	Operational Service	Main Functionalities	Core Technologies	Operational Workflow
Administrator Dashboard	Data Upload and Ingestion Services	Dataset upload, ingestion workflows, external geospatial service integration, WMS/WFS creation	Administrator Dashboard, Geoserver, REST APIs	Upload and registration of geospatial and cultural heritage datasets
Distributed Infrastructure Services	Distributed Storage Services	Distributed storage, dataset replication, scalable management of heterogeneous resources	Hadoop HDFS, Hadoop Data Nodes	Storage and management of structured and unstructured datasets
Administrator Dashboard	Metadata and Catalogue Services	Metadata registration, dataset organization, discoverability, catalogue management	Geonode, Geoserver	Metadata-driven organization and dataset indexing
Administrator Dashboard	Geospatial Publication Services	Geospatial dissemination, interoperable geospatial services, OGC-compliant publication	Geoserver, OGC Services	Publication and dissemination of geospatial resources
CONNECTING Web Platform	Visualisation Services	2D/3D visualisation, raster interaction, point cloud visualisation, browser-based exploration	MapStore, Cesium, Potree	Interactive visualisation and analytical interaction with datasets
CONNECTING Web Platform	User Interaction and Dissemination Services	Dataset discovery, metadata browsing, search services, public and controlled access workflows	Geonode Web Platform, REST APIs	User interaction and access to operational services
Administrator Dashboard	Administrative and Monitoring Services	RBAC management, operational control, logging, cybersecurity monitoring	Administrator Dashboard, Monitoring Services	Infrastructure governance and operational control

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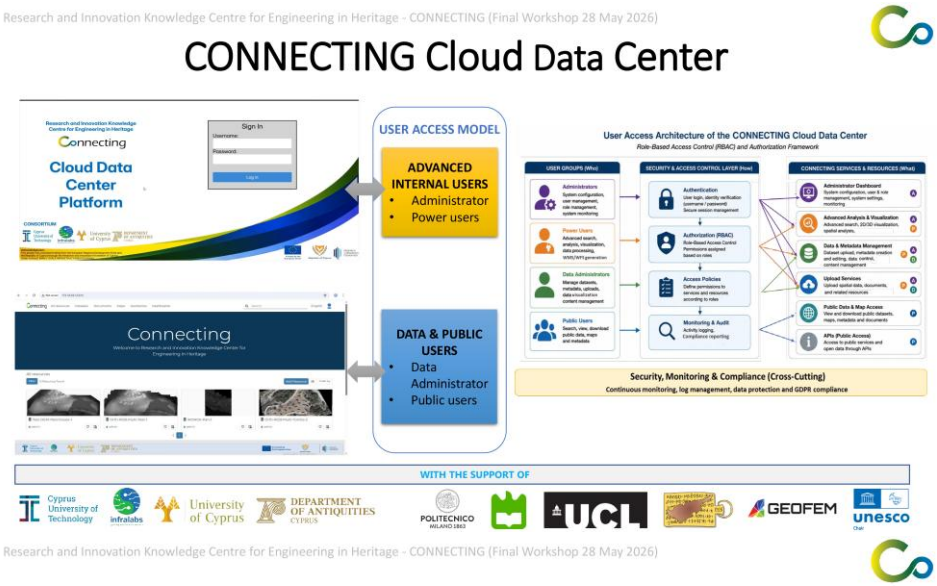
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CONNECTING Cloud Data Center
Cloud Data Center Platform
USER ACCESS MODEL
ADVANCED INTERNAL USERS
Administrator
Power users
DATA & PUBLIC USERS
Data Administrator
Public users
User Access Architecture of the CONNECTING Cloud Data Center
Security, Monitoring & Compliance (Cross-Cutting)
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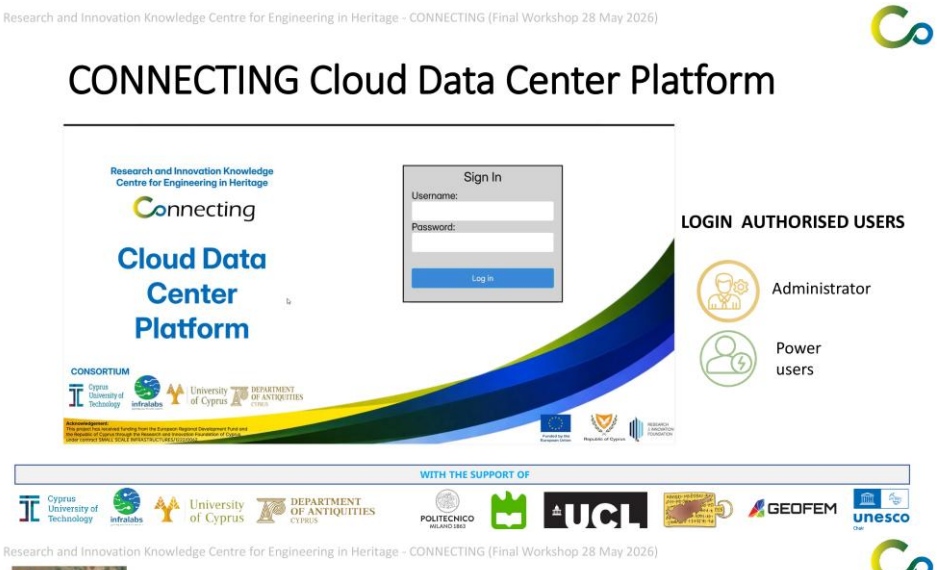
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CONNECTING Cloud Data Center Platform
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Cloud Data Center Platform
Sign In
Username:
Password:
Log in
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LOGIN AUTHORISED USERS
Administrator
Power users
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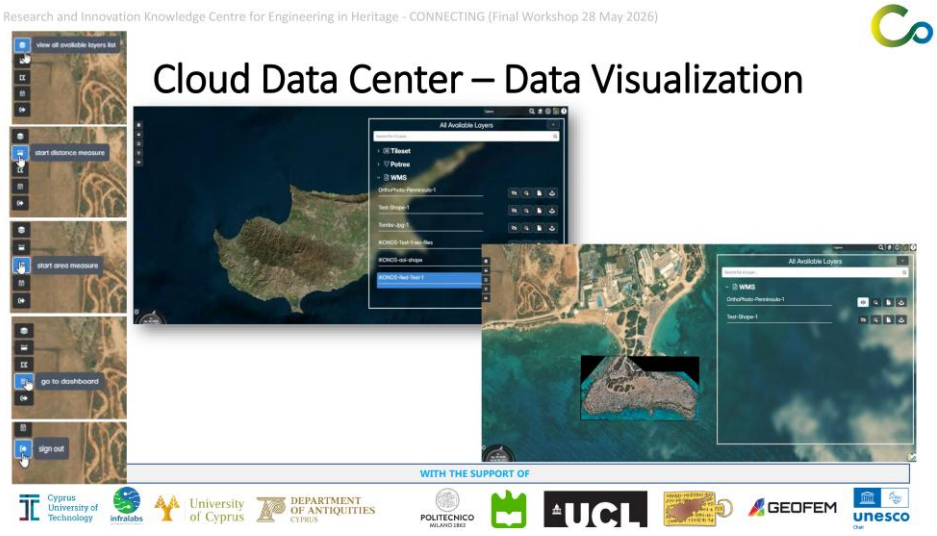
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Cloud Data Center – Data Visualization
view all available layers list
start distance measure
start area measure
go to dashboard
sign out
All Available Layers
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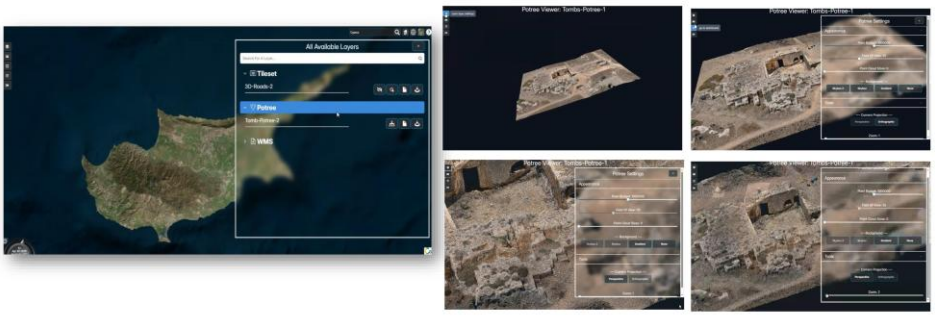
Cloud Data Center – Data Visualisation Potree



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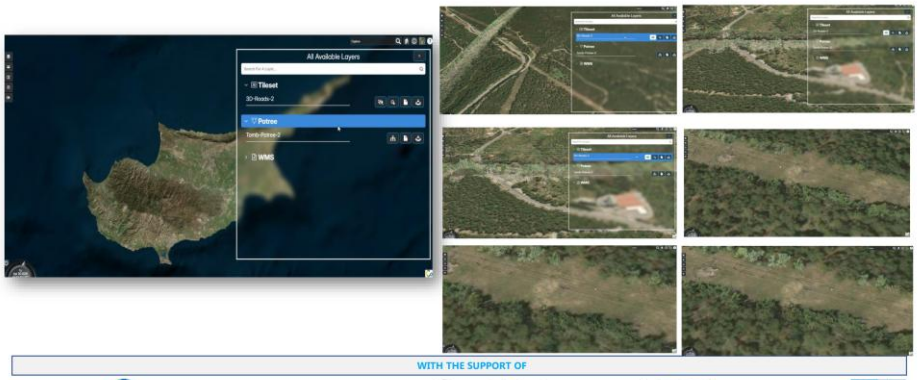
Cloud Data Center – Data Visualisation 3D Tiles



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Cloud Data Center – Administrator Dashboard

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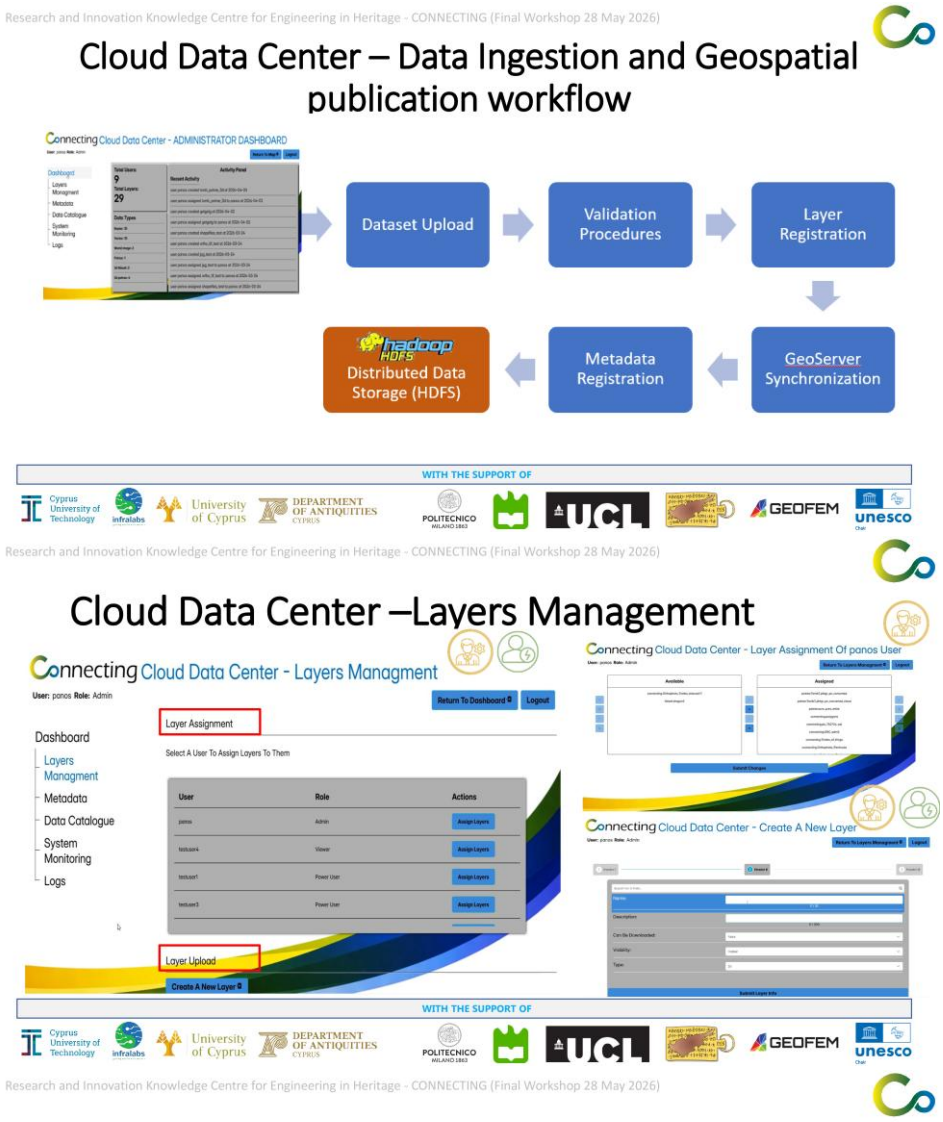
Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Final Workshop 28 May 2026)
Cloud Data Center – Data Ingestion and Geospatial publication workflow
Connecting Cloud Data Center - ADMINISTRATOR DASHBOARD
Dataset Upload
Validation Procedures
Layer Registration
GeoServer Synchronization
Metadata Registration
Distributed Data Storage (HDFS)
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Cloud Data Center –Layers Management
Connecting Cloud Data Center - Layers Managment
Connecting Cloud Data Center - Layer Assignment Of panos User
Connecting Cloud Data Center - Create A New Layer
Dashboard
Layers Managment
Metadata
Data Catalogue
System Monitoring
Logs
Layer Assignment
Layer Upload
Create A New Layer
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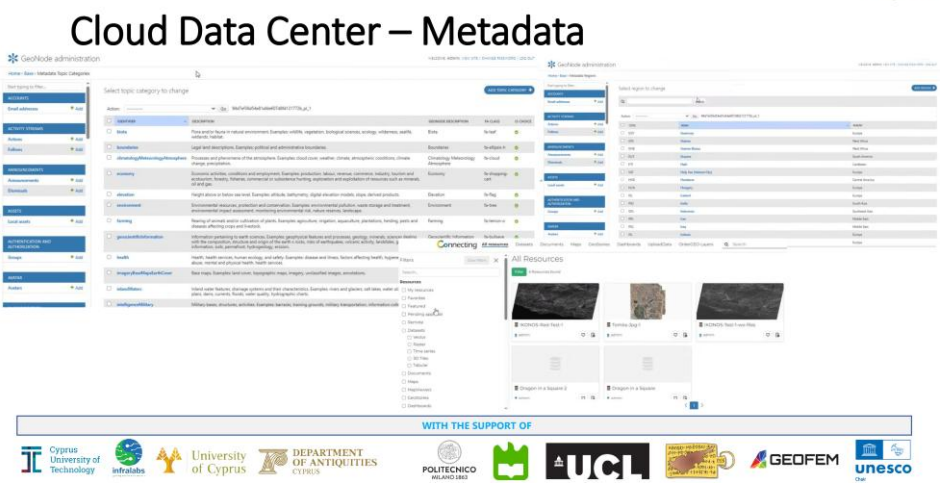
Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Final Workshop 28 May 2026)
Cloud Data Center – Metadata
GeoNode administration
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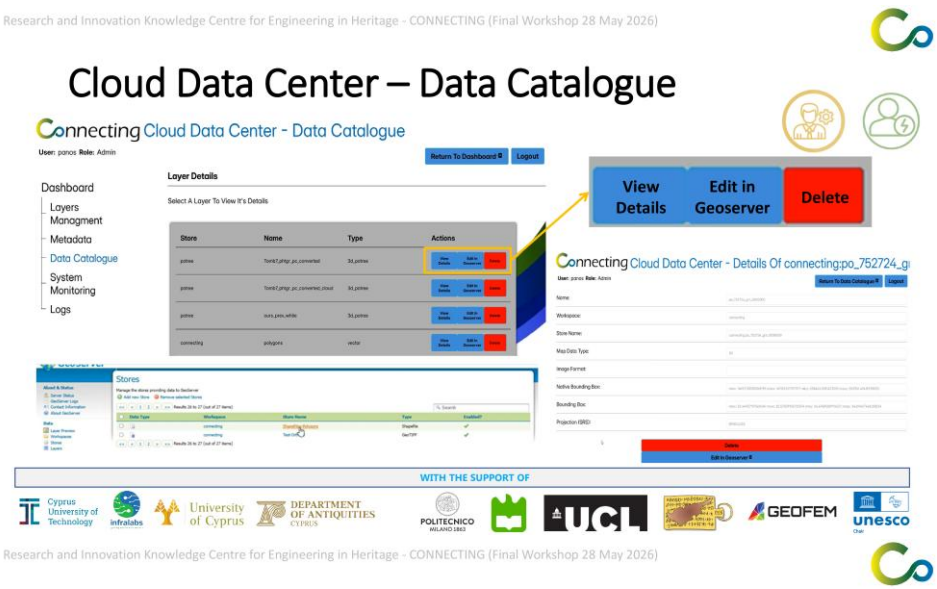

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Cloud Data Center – Data Catalogue

Data Category	Supported Formats	Visualisation Environment	Integrated Technologies
2D Geospatial Vector Data	SHP, dwg	CONNECTING Web Platform / CONNECTING Cloud Data Center	Geoserver WMS/WFS, MapStore, Cesium
Raster, Orthophotos, and Satellite Data	TIFF, GeoTIFF, JPEG	CONNECTING Web Platform / CONNECTING Cloud Data Center	Geoserver, MapStore, Cesium
Drone-Acquired Datasets	GeoTIFF, JPEG	CONNECTING Cloud Data Center / CONNECTING Web Platform	Cesium, MapStore
Point Cloud Data	LAS, LAZ, e57	CONNECTING Cloud Data Center	Potree, Cesium
3D Geospatial Data	3D Tiles, OBJ	CONNECTING Cloud Data Center / CONNECTING Web Platform	Cesium
Metadata Resources	XML	CONNECTING Web Platform	Geonode Catalogue Services

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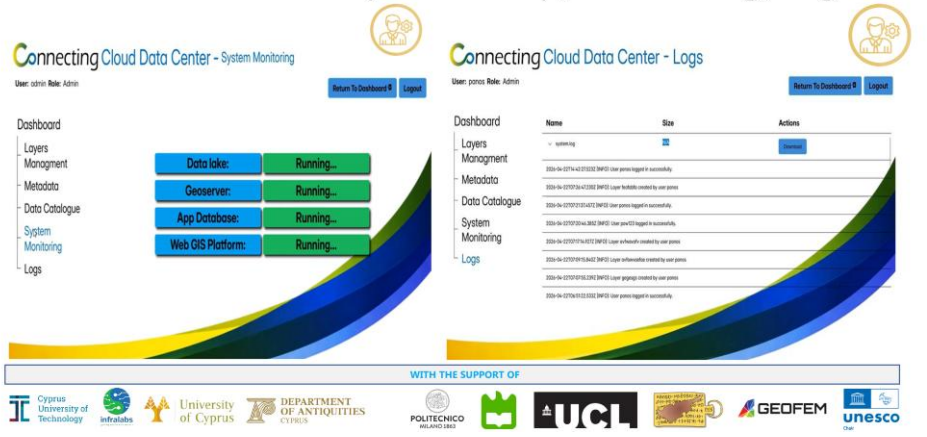

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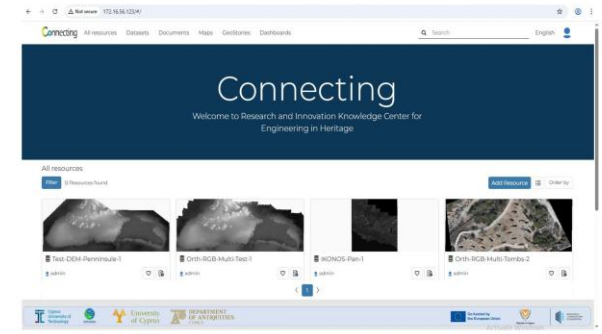
CONNECTING WEB PLATTFORM / USER SERVICES



LOGIN AUTHORISED USERS

Data Administrator

Public users

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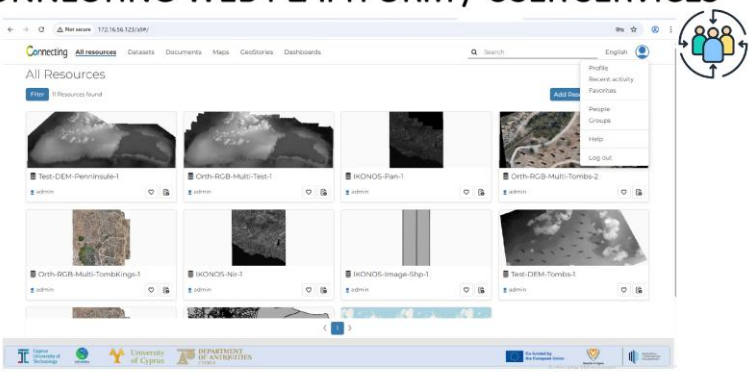

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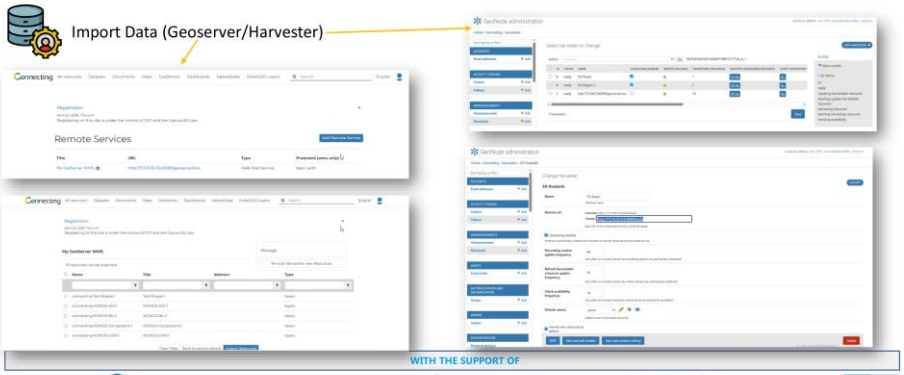

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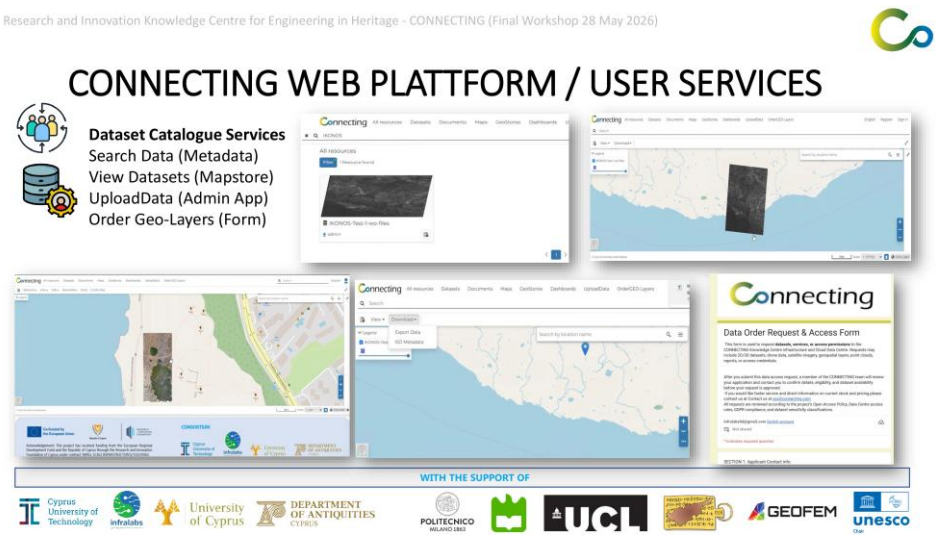
Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Final Workshop 28 May 2026)
CONNECTING WEB PLATTFORM / USER SERVICES
Dataset Catalogue Services
Search Data (Metadata)
View Datasets (Mapstore)
UploadData (Admin App)
Order Geo-Layers (Form)
Connecting
Data Order Request & Access Form
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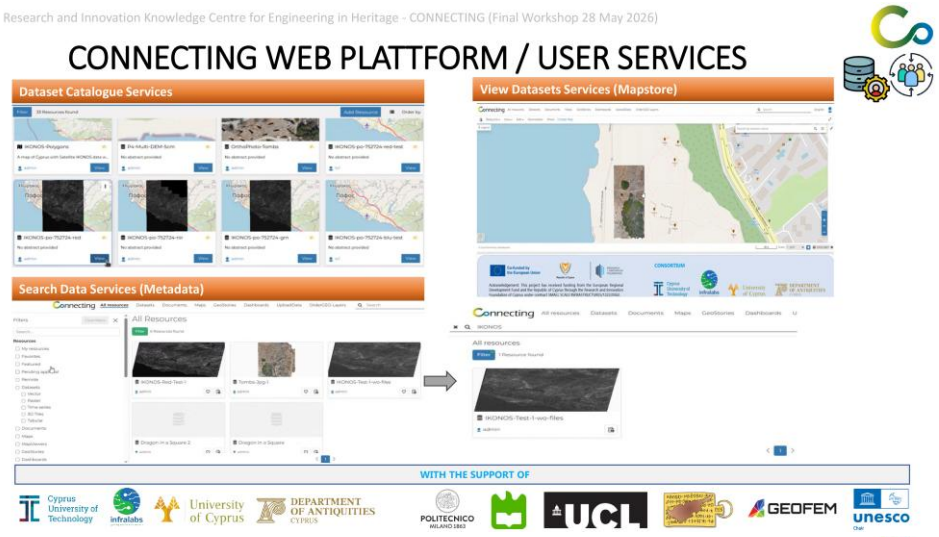
Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Final Workshop 28 May 2026)
CONNECTING WEB PLATTFORM / USER SERVICES
Dataset Catalogue Services
View Datasets Services (Mapstore)
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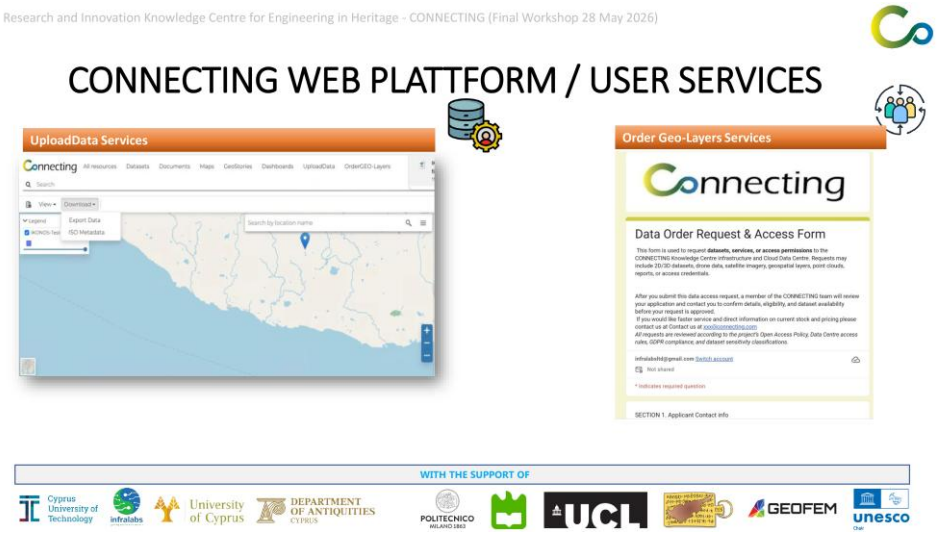
Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Final Workshop 28 May 2026)
CONNECTING WEB PLATTFORM / USER SERVICES
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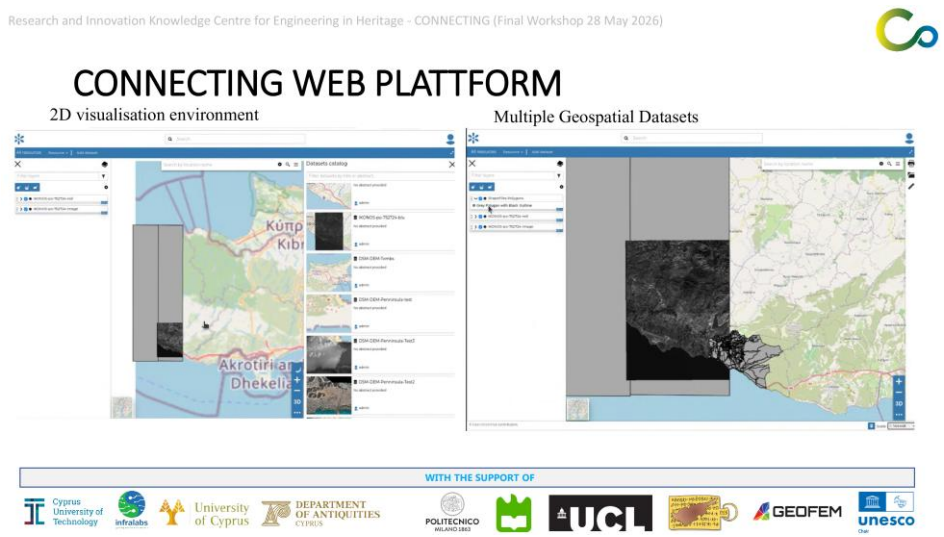
Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Final Workshop 28 May 2026)
CONNECTING WEB PLATTFORM
2D visualisation environment
Multiple Geospatial Datasets
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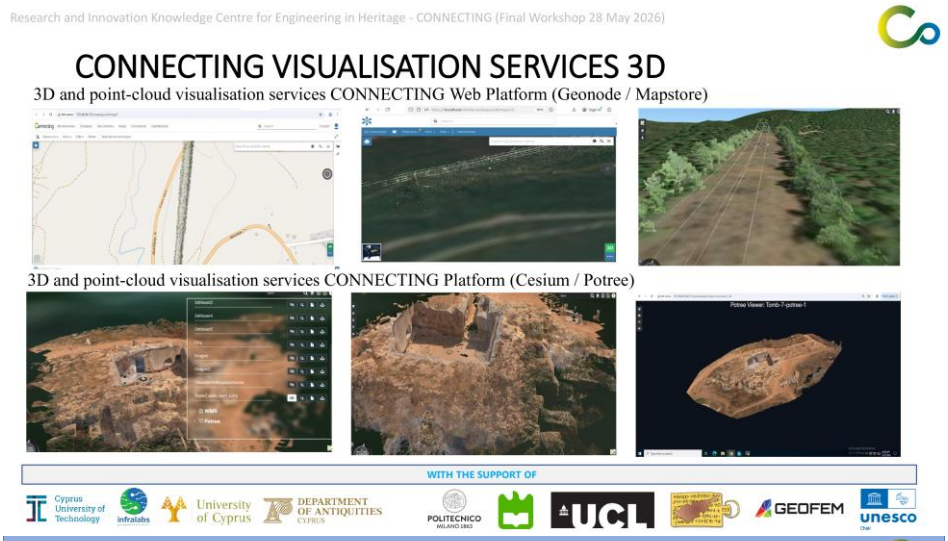
Research and Innovation Knowledge Centre for Engineering in Heritage - CONNECTING (Final Workshop 28 May 2026)
CONNECTING VISUALISATION SERVICES 3D
3D and point-cloud visualisation services CONNECTING Web Platform (Geonode / Mapstore)
3D and point-cloud visualisation services CONNECTING Platform (Cesium / Potree)
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Use and re-use of 3D data

Prof. D. Skarlatos, CUT

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Acknowledgement: This project has received funding from the European Regional Development Fund and the Republic of Cyprus through the Research and Innovation Foundation of Cyprus under contract SMALL SCALE INFRASTRUCTURES/1222/0062.
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Why reuse 3D data?

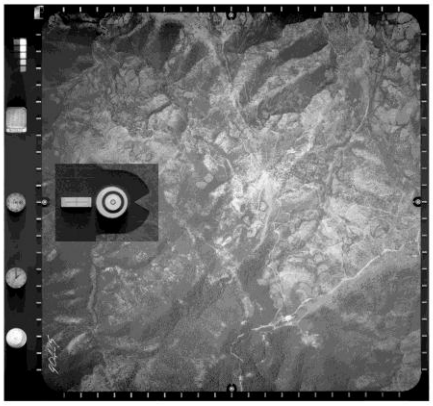
Today, 3D geospatial data are 'easy' to collect

- Manned or unmanned Lidar flights
- Low unmanned flights with extremely high-resolution photos
- TLS & SLAM
- SfM-MVS 3D reconstruction

But sometimes this is not enough

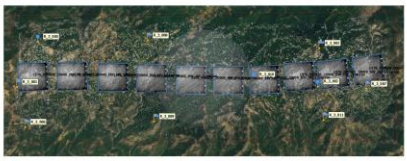
- We need to create maps of what has been
- Something which was destroyed, or something we have access no more
- Comparison it with today for change detection

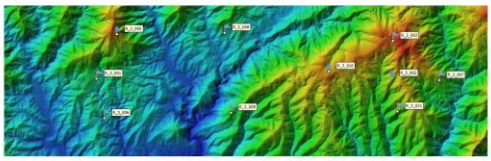
Film archive aerial photos 1977 (Roads)



- According to Greek legislation country roads are those that existing 25.07.1977 (Νόμος 653 ΦΕΚ Α΄214/5.8.1977)
- Thousands legal disputes to courts
- In 2024, national campaign to use 1977 archive photos to set legally all roads
- Scanned @12μm, 1:20000 scale photos, resulting in 0.24m GSD

Scanned archive aerial photos 1977 in Greece





Number of images:	10	Camera stations:	10
Flying altitude:	2.92 km	Tie points:	16,942
Ground resolution:	23.0 cm/pix	Projections:	41,381
Coverage area:	62.1 km²	Reprojection error:	0.434 pix

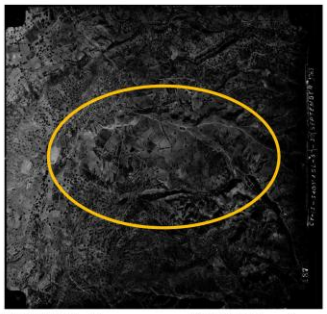
Count	X error (m)	Y error (m)	Z error (m)	XY error (m)	Total (m)
7	0.829526	0.464475	0.261398	0.95071	0.985991

Table 3. Control points RMSE.
X - Easting, Y - Northing, Z - Altitude.

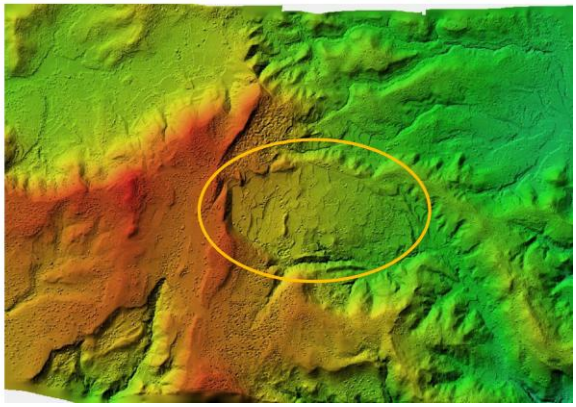
Count	X error (m)	Y error (m)	Z error (m)	XY error (m)	Total (m)
3	0.369882	0.861495	1.30791	0.937543	1.60923

Table 4. Check points RMSE.
X - Easting, Y - Northing, Z - Altitude.

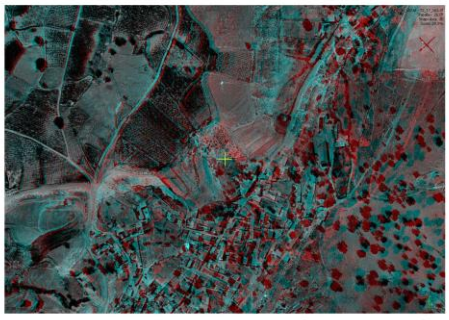
Scanned archive aerial photos 1963 in Cyprus (land slide – Pissouri – change detection)

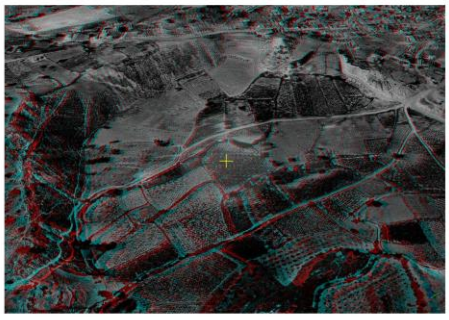


Number of images:	5	Camera stations:	5
Flying altitude:	1.66 km	Tie points:	2,352
Ground resolution:	14.2 cm/pix	Projections:	5,044
Coverage area:	7.96 km²	Reprojection error:	0.537 pix

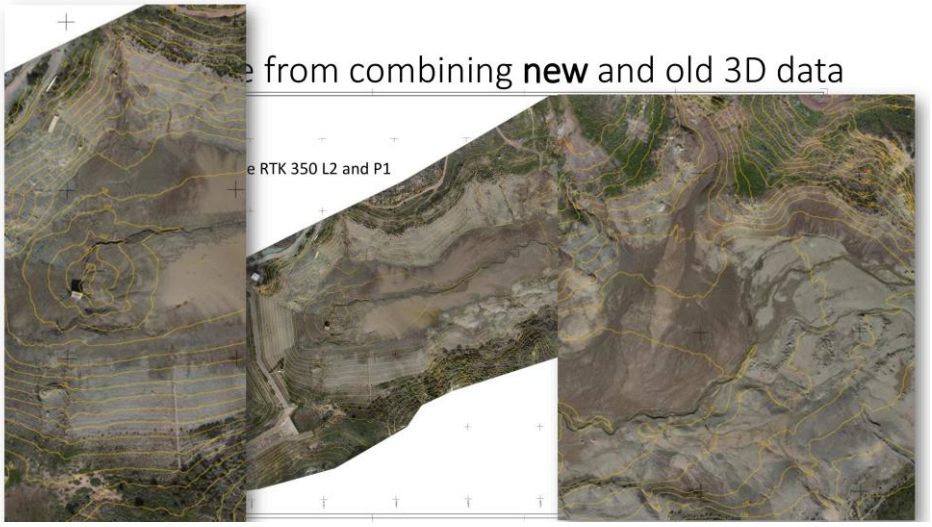


Scanned archive aerial photos 1963 in Cyprus (land slide - Pissouri)

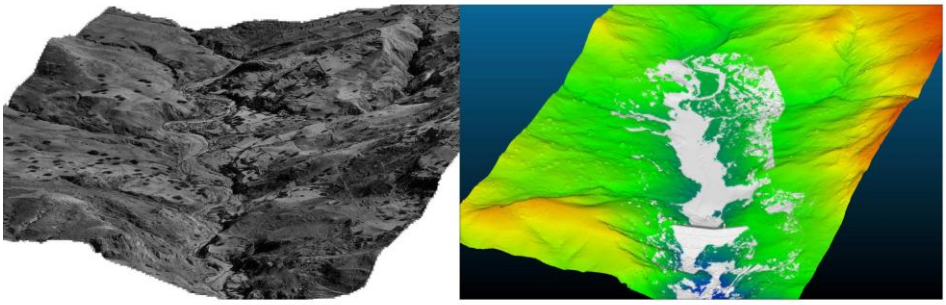




StereoViewing (red-blue glasses) capability for photo interpretation
Either the original high resolution photos OR the 3D reconstructed textured model



Added value from combining **new** and **old** 3D data



Film aerial 1963

Film 1963 – LiDAR 2025

Such comparison data can be used to verify the water storage volume

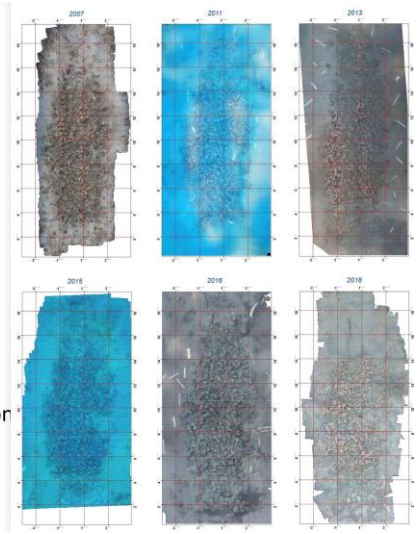
Mazotos shipwreck

- Mazotos classical era shipwreck
- In 2007, 236 photos with low coverage were acquired to form a photomosaic, of the undisturbed site, with 'scale', to be used for 2D sketches
- Underwater 3D documentation of archaeological sites
  - Since 2010, MoU with Maritime Archaeological Research Laboratory of UCy and Prof. S. Demesticha
  - In 2010 use of SfM & MVS for full 3D modelling

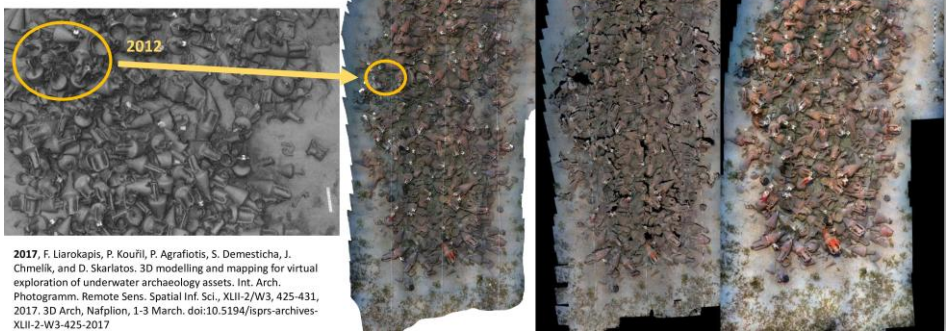
2012, Skarlatos, D., Demestiha, S., Kiparissi, S. An 'open' method for 3D modelling and mapping in underwater archaeological sites. International Journal of Heritage in the digital era. Vol. 1, No 1. pp 1-24. Doi: 10.1260/2047-4970.1.1.1

Mazotos undisturbed shipwreck 3D model in VR

- The undisturbed site had to be used in iMARECULTURE VR application
  - …but it didn't exist any more
- In 2007, 236 photos captured for photomosaic creation
  - Not 3D, hence low overlaps
- In 2017, recreation of the 2007 3D undisturbed 3D reconstruction
  - Based on 2012 excavated 3D reconstruction
  - Big holes in 3D model because of small overlaps and complex shape of the object
  - Chromatic discrepancies



Mazotos undisturbed shipwreck 3D model in VR

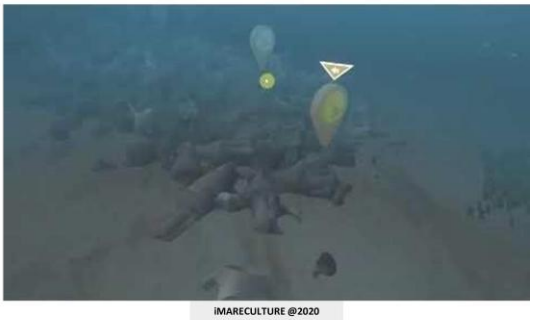


2017, F. Liarokapis, P. Kouřil, P. Agrafiotis, S. Demesticha, J. Chmelík, and D. Skarlatos. 3D modelling and mapping for virtual exploration of underwater archaeology assets. Int. Arch. Photogramm. Remote Sens. Spatial Inf. Sci., XLII-2/W3, 425-431, 2017. 3D Arch, Nafplion, 1-3 March. doi:10.5194/isprs-archives-XLII-2-W3-425-2017

Mazotos dry visit (VR application)

The dry-visit has 8 points of interest

1. The Bow
2. Anchors
3. Bow hypothetical stowage
4. Large Chian amphora
5. Small Chian amphora
6. Non-Chian Amphora Types
7. The stern
8. Jugs



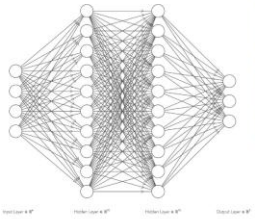
Mazotos Serious Games: Excavation Modular VR game

- Three modules
  - Discovery and exploration
  - 3D Documentation
  - Excavation
- Training VR modules, with distant collaboration
  - Student training
  - Before they go underwater, saving a lot of valuable diving time
  - Supporting telepresence of the tutor
- Evaluation results were encouraging

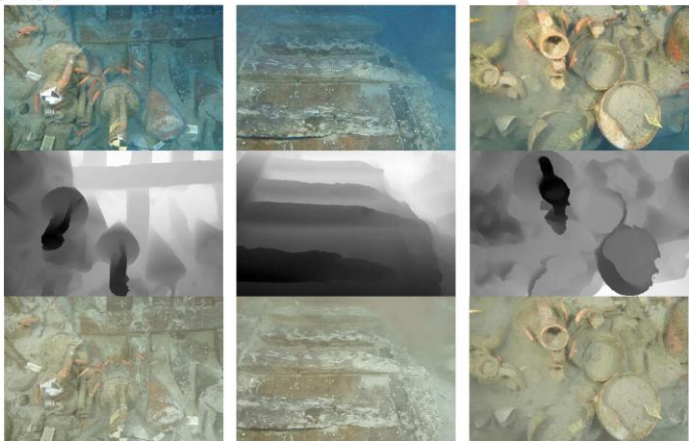
iMARECULTURE @2020
Masarykova University, HCI Lab

2020, Underwater Search and Discovery: From Serious Games to Virtual Reality. F Liarokapis, I Vidová, S Rizvić, S Demesticha, D Skarlatos. International Conference on Human-Computer Interaction, 178-197

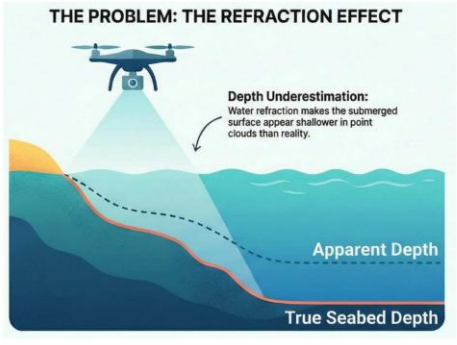
Colour restoration in archive UW photos PhD M. Vlachos

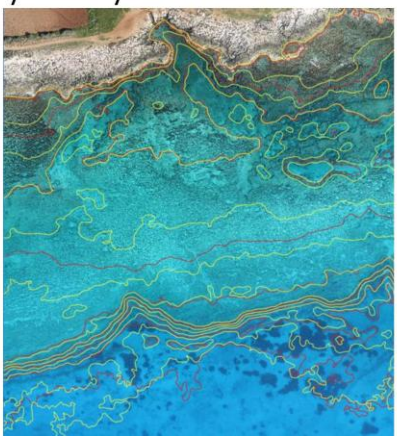


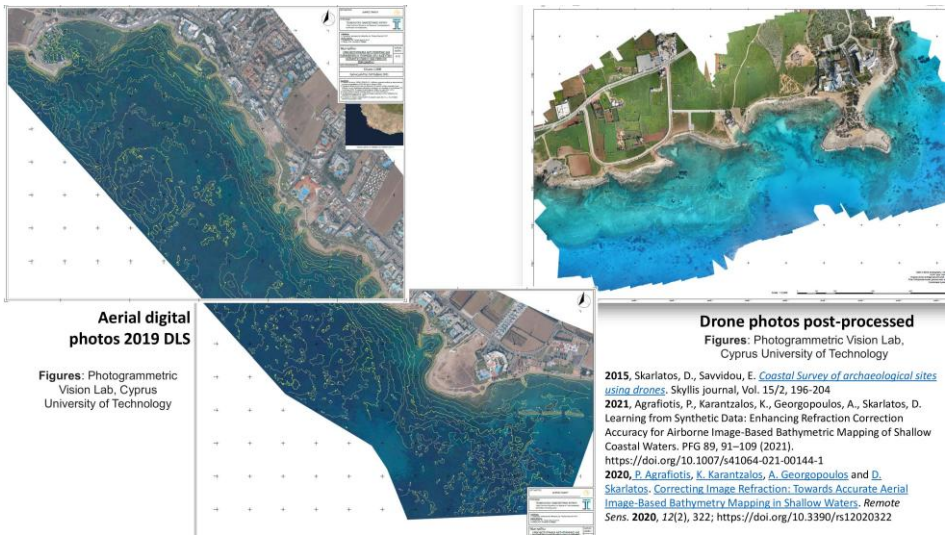
2021, Vlachos, M., **Skarlatos**, D. An extensive literature review on underwater image colour correction. *Sensors 2021, 21(17), 5690*; https://doi.org/10.3390/s21175690
2022, Vlachos, M., A. Calantropio, D. **Skarlatos**, and F. Chiabrando. 2022. MODELLING COLOUR ABSORPTION OF UNDERWATER IMAGES USING SFM-MVS GENERATED DEPTH MAPS. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences XLIII-B2-2022, pp. 959-966. **BEST POSTER AWARD**



Archive aerial photo bathymetry







Aerial digital photos 2019 DLS

Figures: Photogrammetric Vision Lab, Cyprus University of Technology

Drone photos post-processed

Figures: Photogrammetric Vision Lab, Cyprus University of Technology

2015, Skarlatos, D., Savvidou, E. *Coastal Survey of archaeological sites using drones*. Skyllis journal, Vol. 15/2, 196-204

2021, Agrafiotis, P., Karantzalos, K., Georgopoulos, A., Skarlatos, D. Learning from Synthetic Data: Enhancing Refraction Correction Accuracy for Airborne Image-Based Bathymetric Mapping of Shallow Coastal Waters. PFG 89, 91–109 (2021). https://doi.org/10.1007/s41064-021-00144-1

2020, P. Agrafiotis, K. Karantzalos, A. Georgopoulos and D. Skarlatos. Correcting Image Refraction: Towards Accurate Aerial Image-Based Bathymetry Mapping in Shallow Waters. *Remote Sens.* **2020**, *12*(2), 322; https://doi.org/10.3390/rs12020322

Take away

- Re-use, open up several applications & override the need to re-acquire
- Old 3D data may have added value that we cannot foresee now
  - Through the development of new processing algorithms
- Store Data
  - Including original data (photos)
  - Cloud or Physical ?
- Open data
- Paradata & metadata
- IPR, Licensing and accreditation

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28 May 2026

Co-funded by the European Union

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CONSORTIUM

Cyprus University of Technology · infralabs · University of Cyprus · Department of Antiquities Cyprus

ERDF CO-FUNDED · SMALL SCALE INFRA/1222/0062

Research & Innovation Knowledge Centre for Engineering in Heritage

Advancing non-destructive technologies for cultural heritage documentation, monitoring & preservation in Cyprus

ACRONYM	COORDINATOR	DURATION	TOTAL BUDGET
CONNECTING	Assist. Prof. Athos Agapiou · CUT	30 months · 2023 – 2026	€ 759,680

Co-funded by the European Union · Republic of Cyprus · Research & Innovation Foundation

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Project at a Glance

2/12

€759K	30mo	4+6	5WPs
Total Budget (88% ERDF funded)	Project Duration 2023 – 2026	Partners + International Supporters	Work Packages 22 Deliverables

CONTRACT	LEAD INSTITUTION	FUNDING SCHEME	DEMONSTRATION SITES
SMALL SCALE INFRASTRUCTURES / 1222 / 0062 Research & Innovation Foundation (RPF), Cyprus	Cyprus University of Technology (CUT) Coordinator: Assist. Prof. Athos Agapiou	European Regional Development Fund (ERDF) 88% EU + 12% national co-financing	5 sites: Tombs of the Kings, Latsia, Amathus, Mazotos shipwreck, Nisia shipwreck

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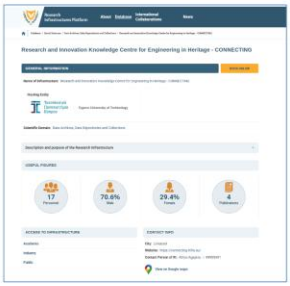
Vision for 2030

By 2030, CONNECTING should operate as a recognised national and regional hub for engineering in heritage, offering managed access to advanced equipment, expert services, data workflows and training. Its role should be to support evidence-based preservation, risk assessment, digital documentation and sustainable management of heritage assets on land and underwater.

The intended position is not to compete with private survey companies on routine services, but to provide high-value research-grade capacity where advanced equipment, methodological integration, quality assurance, interpretation, data governance and multidisciplinary expertise are required. The strategic objectives of the CONNECTING are summarised below:

Strategic objective	Post-project target
Open access	Maintain transparent application, evaluation, safety and access procedures for internal and external users.
Operational use	Achieve regular annual use across research, education, public-sector and professional projects.
Financial sustainability	Recover a meaningful share of annual maintenance and expert support costs through diversified revenue streams.
Scientific excellence	Generate joint publications, data products, protocols and demonstrators linked to competitive proposals.
Policy relevance	Support public authorities with evidence products for heritage management, monitoring and risk assessment.
European integration	Participate in Horizon Europe Cluster 2, ECCCH, Interreg, COST and MSCA networks.

Vision for 2030



Core asset groups

The core asset groups of the CONNECTING project are presented below.

Asset group	Main equipment / capacity	Sustainability role
Aerial survey systems	DJI Matrice 350 RTK, high-resolution photogrammetric camera, multispectral/hyperspectral capability and related processing software.	High-demand service line for mapping, heritage site documentation, landscape monitoring, vegetation stress, risk mapping and training.
3D scanning and mobile mapping	Handheld SLAM LiDAR scanner and point-cloud processing workflows.	Rapid documentation of monuments, interiors, excavation areas, historic buildings and urban heritage.
Underwater and maritime systems	ROV, multibeam echosounder and underwater documentation workflows.	Specialised niche capacity for submerged heritage, harbour structures, coastal infrastructure and maritime archaeology.
Structural and environmental monitoring	Wireless strain sensors, inclinometers, ultrasonic testing, humidity/temperature and air quality sensors.	Evidence for condition assessment, preventive conservation, structural risk and long-term monitoring.
Computing and data infrastructure	High-performance processing, storage, data centre workflows, repositories and web viewers.	Backbone for data processing, FAIR sharing, digital services, reuse and future integration with European cloud initiatives.
Expert services and protocols	Trained staff, workflows, application forms, access policy, IPR and data governance.	Transforms equipment into reproducible, safe and high-quality services.

End-user groups and value proposition

Quadruple helix group	Potential end-users	Needs addressed by CONNECTING	Engagement route
Academia / research	CUT laboratories, UCY, international universities, archaeological missions, PhD and MSc projects	Access to advanced sensing, shared datasets, methods, publications, training and project demonstrators	Open access calls, collaboration agreements, joint proposals, training schools
Government / public sector	Department of Antiquities, Department of Lands and Surveys, municipalities, civil protection, ministries, ports and coastal authorities	Evidence for mapping, monitoring, risk assessment, documentation, policy and public-interest decisions	Framework agreements, pilot services, priority access for strategic public projects
Industry / SMEs	Surveying firms, engineering consultancies, ICT firms, cultural tourism operators, conservation companies	Advanced equipment access, technical validation, data processing, joint service development, innovation support	Service catalogue, subcontracted support, innovation vouchers, joint product pilots
Civil society / communities	Museums, cultural foundations, UNESCO networks, local communities, NGOs, schools	Accessible digital heritage outputs, educational content, public engagement, heritage awareness	Outreach, public datasets where appropriate, exhibitions, citizen science demonstrations
European networks	Horizon Europe consortia, ECCCH actors, Interreg partnerships, COST actions, MSCA networks	Cross-border demonstrators, interoperable data, methodological protocols, training and mobility	Proposal pipeline, network membership, thematic working groups

Opportunity areas

Opportunities areas are summarised below, indicating also potential funding instruments and potential clients.

Opportunity area	Rationale	Likely instruments / clients
Climate-resilient cultural heritage	Heat, drought, wildfire, flood, erosion and coastal hazards are increasingly relevant for heritage sites and historic centres.	Horizon Europe Cluster 2, Cluster 5/6 synergies, Interreg Euro-MED, municipalities, civil protection.
Digital heritage data spaces	European cloud and data-space initiatives require interoperable, well-documented, high-quality heritage datasets and tools.	ECCCH / Cultural Heritage Cloud, Horizon Europe, data-centre services, repositories.
Municipal heritage and urban monitoring	Municipalities need practical documentation and risk evidence for historic buildings, public spaces and cultural routes.	Local authorities, RIF calls, Interreg Greece-Cyprus, service agreements.
Underwater and coastal heritage	Cyprus has strategic maritime heritage potential and specialised underwater documentation capacity remains limited.	Departmental authorities, ports, maritime archaeology, blue economy projects.
Professional training	Surveyors, engineers, archaeologists and heritage managers need applied training in new tools.	Paid seminars, summer schools, CPD modules, professional associations.
SME innovation support	SMEs can develop new products around data visualisation, remote sensing, digital twins and monitoring.	Innovation vouchers, CKTO, joint exploitation with Infralabs, RIF enterprise schemes.

Access tiers

The following access tiers are also defined:

Tier	User type	Pricing / access principle	Conditions
Tier A: Internal strategic access	CONNECTING partners, CUT/UCY researchers, agreed project demonstrations	In-kind or internal cost allocation	Must follow booking, safety, data and IPR rules.
Tier B: Public-interest subsidised access	Public authorities, early-career researchers, non-profit heritage projects	Reduced rate or waiver when strategic value is high	Requires clear public value, acknowledgement, and data-sharing plan where possible.
Tier C: Collaborative research access	National and European research partners	Covered by project budgets, collaboration agreements or co-funding	Joint publication, data and IP terms agreed in advance.
Tier D: Professional cost-recovery services	SMEs, consultants, paid projects, private missions	Cost-recovery or market-informed rate	Requires service agreement, liability provisions and defined deliverables.
Tier E: Training and capacity building	Students, professionals, public officers, international trainees	Course fee or project-funded participation	Safety and ethics modules included.

Governance, access and operational procedures

The governance model aims to remain simple enough to be used. A heavy administrative structure would discourage users and overload the team. At the same time, informal arrangements are not sufficient once the infrastructure is open to external users. The recommended solution is a light access desk supported by clear templates: request form, eligibility check, risk and safety check, costing sheet, access agreement, data/IP note and post-use feedback form.

The proposed model is a CONNECTING Infrastructure Board supported by a small Access Desk. The Board should include representatives from CUT, Infralabs, UCY and the Department of Antiquities, with the possibility to invite external experts for specific strategic issues. The Access Desk is be responsible for receiving booking requests, screening feasibility, coordinating technical evaluation, preparing quotations or access decisions, and keeping the infrastructure use log.

The access workflow will follow the open-access principles defined in D18 and be compatible with the national booking page. The booking page can serve as the public entry point, while the internal Access Desk performs the technical, financial and legal screening. Each request should be assigned a category, risk level and access route before any deployment is confirmed.

Step	Action	Output
1. Expression of interest	User submits request through national RI platform, email or CONNECTING website.	Request ID and initial user profile.
2. Feasibility screening	Access Desk checks objective, site, dates, equipment, staff and strategic fit.	Feasibility note.
3. Technical evaluation	Technical lead assesses method, permits, safety, processing and expected outputs.	Technical plan and risk level.
4. Data/IP review	Data/IP lead checks sensitive information, ownership, confidentiality and access terms.	Data and IP conditions.
5. Costing / access decision	Financial/admin support prepares cost recovery, waiver or project allocation.	Access approval, quotation or rejection with explanation.
6. Safety orientation	Approved users receive operational instructions and liability conditions.	Signed access conditions.
7. Deployment / service delivery	Fieldwork, processing, QA and output delivery.	Datasets, evidence brief, training or service output.
8. Archiving and feedback	Outputs logged; metadata prepared; feedback collected.	Use log, KPI update and improvement actions.

Funding roadmap

Funding route	Indicative focus	Role of CONNECTING	Timing
Horizon Europe Cluster 2 – Heritage	Cultural heritage protection, digital transition, participatory heritage, resilient cultural heritage, ECCCH use cases	Demonstrator platform, data provider, technology workflow, training and regional node	2026–2030
European Collaborative Cloud for Cultural Heritage	Interoperable data, digital tools, end-to-end use cases and cloud-ready workflows	Cyprus / Eastern Mediterranean testbed and provider of high-quality 2D/3D datasets	2026–2030
Interreg Greece-Cyprus / Euro-MED	Regional heritage, climate resilience, water/coastal heritage, cultural routes	Pilot infrastructure, field campaigns, municipal/public authority support	Annual monitoring
COST Actions	Networking, short-term scientific missions, working groups and training schools	Training and mobility host, working group leader	2026–2028
MSCA Doctoral Networks / Staff Exchanges	Researcher training in heritage engineering, geoinformatics, digital twins and data governance	Host infrastructure for secondments, datasets and PhD case studies	2027–2030
RIF national calls	Applied research, innovation vouchers, infrastructure use, public-sector/SME collaboration	National platform for experiments and service pilots	Annual
Contract research / framework agreements	Repeated mapping, documentation, monitoring and training for authorities or municipalities	Operational service provider with research-grade QA	2026 onwards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THANK YOU FOR YOUR ATTENTION
CONNECTING Final Workshop
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