FabSpace 2.0: Universities Fostering Open Innovation Enabled by Earth Observation and Geo-spatial Information

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Abstract
The investments made by the European Commission, the European Space Agency and the Member States in the Earth Observation downstream sector are fostering the development and operationalization of innovative applications and several governmental and industrial customers are progressively adopting them within e-Government and Industry 4.0 initiatives.
In this context universities must endorse a new role beyond knowledge providers: they need to become co-creators of innovations and key actors along the Science 2.0 principles.
FabSpace 2.0 is a project funded under the H2020 EU Programme that aims at stimulating open-innovation in Earth Observation (EO) and Geo-spatial Information (GI) with a catalysing role of universities that will bring together students, researchers, SMEs, civil society organizations, corporates and public authorities to solve everyday challenges. To do this, the project sets-up and operates opens spaces for innovation to create innovative applications and services using EO data and GI technologies. To have a cross exchange of competences and best practices, a European network of six founder FabSpaces has been established in France, Belgium, Germany, Greece, Italy and Poland and the extension of the network to fourteen new FabSpaces, at European and International level, has been implemented through a call for expression of interest.
This paper presents the FabSpace 2.0 project, describes the approach followed to foster open innovation enabled by EO and GI and provides a first set of outcomes and results achieved in the first two years of project execution.

Keywords
FabSpace 2.0, University Network, Open Innovation, Earth Observation, Geo-spatial Information, Open-data, education innovation.

1 Introduction

The Earth Observation (EO) sector is experiencing a huge transformation and is in a very dynamic phase, supported by several technology factors such as:

- Free Sentinel radar and multi-spectral data providing weekly revisit of the entire Globe, with guaranteed continuity over the next decade;
- Operational commercial satellites with proven operational capabilities of their very high-resolution (< 1 m) data;
- Increasing number of small satellite constellations offering very cost-effective high-resolution data;
- Cloud Infrastructure services, on a pay-per-use basis, for on-line access and processing of satellite data (as from the 5 DIAS-Data and Information Access Services funded by the European Commission);
- Artificial Intelligence techniques are more and more being used for automatic processing of EO data, also integrated with navigation and other Geo-spatial Information.

The investments made by the European Commission, the European Space Agency (ESA) and the Member States in the EO downstream sector, in line with the new European Space Strategy, are fostering the development and operationalization of the innovative applications and several governmental and industrial customers, attracted by a better price/performance, are progressively adopting them within e-Government and Industry 4.0 initiatives.

The huge amount of space derived available data, combined with diverse sources' data, the Internet of Things (IoT) and ever more powerful algorithms for data analytics and machine-to-machine direct interactions are opening new frontiers for innovative applications and services. Public sector and industry demand is also stimulating the design of new satellite missions in close link with specific application services, especially in relation to demonstrative small satellites (cube-sat).

A strong innovative culture is needed in order to fully exploit the potentialities offered by the new technologies and the new paradigms that are emerging. SMEs in particular need scientific and technical assistance in order to embed robust Earth Observation and Geo-spatial Information components into their services. Also, many end-users need to better understand the potentialities offered by EO and GI and to get involved in the development of new applications responding to their specific problems and needs.

Europe has a great chance to materialise great returns from its huge investment of tax-payer money in Copernicus and Galileo space programmes both in terms of scientific and technology advances and in terms of applications and services that can support industry productivity and competitiveness as well as public administration efficiency and effectiveness.

In this context, universities' role is crucial to stimulate new ideas and to bring different cultures together to create new value and fully benefit from ESA (EOEP5) and EC (H2020) funding for the development of downstream applications. The FabSpace 2.0 project has been conceived to contribute in filling the gap between user demand, often not expressed, and the possibilities offered by EO and GI by making universities open innovation centres for their region aiming at improving their contribution to the socio-economic and environmental performance of the societies in which they operate. In a collaborative research environment within universities, students and researchers can get in contact with end-user needs and have the possibility to rapidly prototype innovative EO applications and services, exploiting free Copernicus satellite data (both from Sentinel and Contributing Missions) plus Copernicus in-situ data and Core Services.

The goal of this paper is to present the FabSpace 2.0 concept, describe the approach followed to foster open innovation enabled by EO and GI and to provide a first set of outcomes and results achieved in the first two years of project execution. This paper also provides an insight about the development of a university network combined with business incubation centres, that has the aim of creating an International cooperation framework for sharing experiences and best practices among players with different background and experience. In the last part of the paper some considerations are provided about the future evolution of the FabSpace 2.0 activities, after the project end, that are being planned with the involvement of ESA.

2 What is FabSpace 2.0?

FabSpace 2.0 is an international project carried out, over a period of three years (March 2016 – February 2019), funded by the European Union under the H2020 Programme. Its goal is to create innovative applications and services using open spatial data and geo-information technologies (Del Frate et al, 2017).

The initial network of partners consists of six founder FabSpaces in France, Belgium, Germany, Italy, Greece and Poland, each one composed by a local University and the local ESA Business Incubation Centre (BIC), under the coordination of the Université Toulouse III - Paul Sabatier in Toulouse, as project leader. Other fourteen new FabSpaces are in the starting blocks and will open soon in France, Italy, Spain, the Netherlands, the Czech Republic, Lithuania, Cyprus, Armenia and Cameroon (see endnote for the full list of founders and new FabSpaces 2.0).

FabSpace 2.0 means interdisciplinary teams of young people using open source software and tools to process open geo-spatial data to create innovative applications and geo-information services. Researchers from renowned universities provide the technical support, while ESA BICs - with years of experience in the European market - foster useful application development and business incubation.

The project delivers a collaborative research environment within universities, enabling students and researchers to rapidly prototype innovative Earth Observation

applications and services. This collaborative research environment includes the following physical and virtual elements:

- **A one-stop shop**, with access to Earth Observation data and a wide range of other data as well as free software and data processing tools to develop new digital applications.
- **A free-access place & service**, where students, researchers and external users:
  - can make use of data and of a software platform for designing and testing their own applications, getting technical support;
  - can receive training to improve their capacity to process data and develop new applications with space data as well as to set up new entrepreneurship initiatives
- **An educational layer** including both Earth Observation and entrepreneurship training
- **A network**, of students, researchers, entrepreneurs, project managers in industry and public authorities and civil society organisations
- **Two communities**, the community of local partners and stakeholders plus the community of all the FabSpaces in the global network;
- **An economic activity**, developed and operated with the aim of reaching the break-even;
- **A concept currently under development**, evolving rather than being designed.

3 What are the FabSpace 2.0 objectives?

The purpose of FabSpace 2.0 is to foster the co-creation of new innovative solutions enabled by Earth Observation and Geo-spatial Information at International level. Universities must endorse a new role as co-creators of innovation in the context of Science 2.0 principles by to setting up a creative environment in which developers from the civil society or industry or the academic research, public administrations and civil organisations can meet, work together, co-create new tools and business models. Figure 1 depicts the new cooperative scenario that FabSpace 2.0 is building.

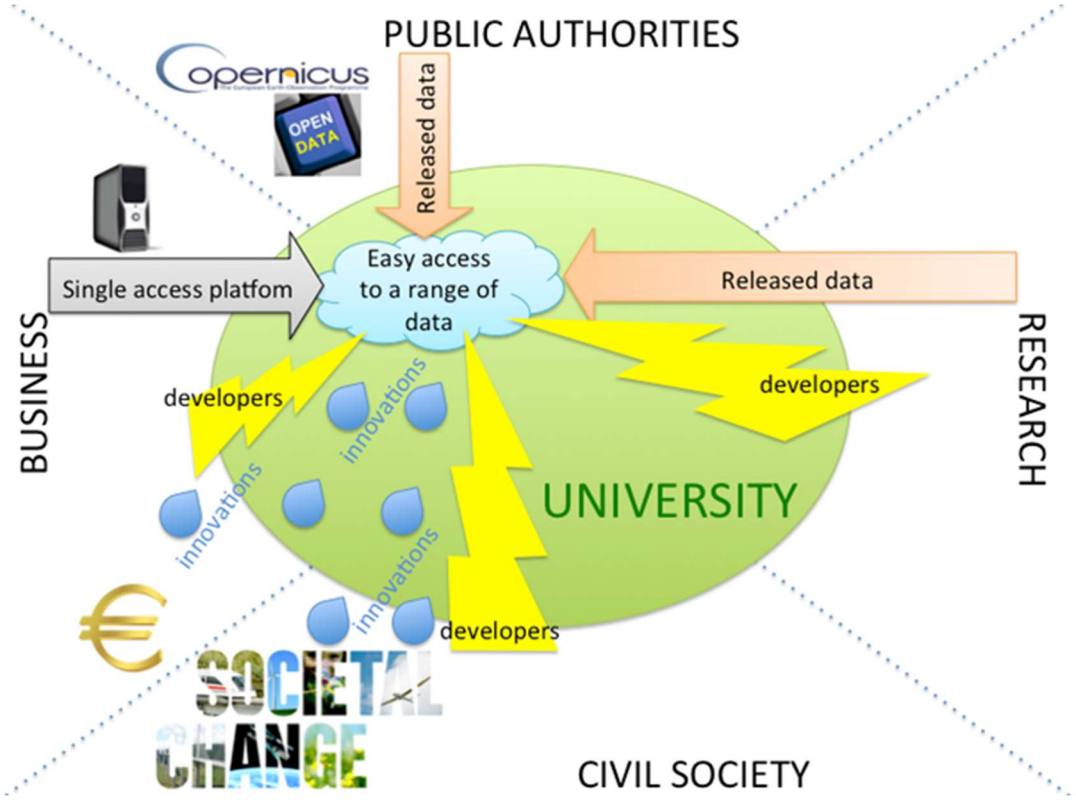

Figure 1: FabSpace 2.0 Cooperative Scenario

To pursue its purpose, FabSpace 2.0 has set four key objectives:

- *Objective 1:* Set up and operate at universities a free-access place & service where students, researchers and external users can make use of a data platform and design and test their own applications
- *Objective 2:* Train the users to improve their capacity to process data and develop new applications
- *Objective 3:* Network students, researchers, entrepreneurs, project managers in industry and public authorities and civil society organisations and consolidate user needs, foster the co-creation of new innovative solutions, support further business development
- *Objective 4:* Exploit, sustain and disseminate the concept by: demonstrating financial sustainability for the new university services, setting up business plans at the level of each local FabSpace service, expanding the concept into new universities worldwide and creating new FabSpace service.

4 What is the FabSpace 2.0 approach?

University resources (knowledge, advanced technologies in particular) are a key asset to foster innovation and growth, however they are underexploited. This analysis is developed in the 2014 Independent Expert European Group Report on Open Innovation

and Knowledge Transfer. In spite of the recent revolution that has widespread technology transfer offices in universities in the last decades (technology push model), the rise of open innovation has changed the paradigm of the innovation process, from linear to a complex system with a range of contributors.

One of the most often used definition for open innovation is: 'the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and to expand the markets for external use of innovation, respectively' (Chesbrough et al., 2006). The first process is called inbound open innovation and the second out- bound open innovation (Gassmann and Enkel, 2004).

Open innovation has become increasingly important because industry is looking for shorter innovation cycles and reducing R&D cost, so becoming interested in business ideas and products not only developed internally.

That is why co-creation must become the new approach to innovation at university and universities have to become co-creators of innovations in addition to their role of education and knowledge providers. Universities will not replace businesses and give up basic research, they should rather collaborate with businesses to tackle market challenges and capitalize on opportunities. That is why universities must become the catalysts of new triple- (or quadruple-) helix relations with businesses, public administrations and civil society. Open innovation requires universities to move beyond their traditional role of knowledge sharing, through publication and teaching, to become the focal point and catalyser of an innovation process involving a network made up of students, firms, research organisations, citizens and public institutions.

Open innovation can be implemented in many different ways that are still being researched to better understand the internal and external environment characteristics affecting performance.

The open innovation approach implemented within the FabSpace 2.0 project, for creating innovative EO driven application value, is structured along several steps through which universities are stimulating and fostering entrepreneurial students through entrepreneurship and incubation programmes and become the ideal environment for engaging. The various steps of the FabSpace 2.0 approach are synthetically represented by the functional diagram depicted in Figure 2.

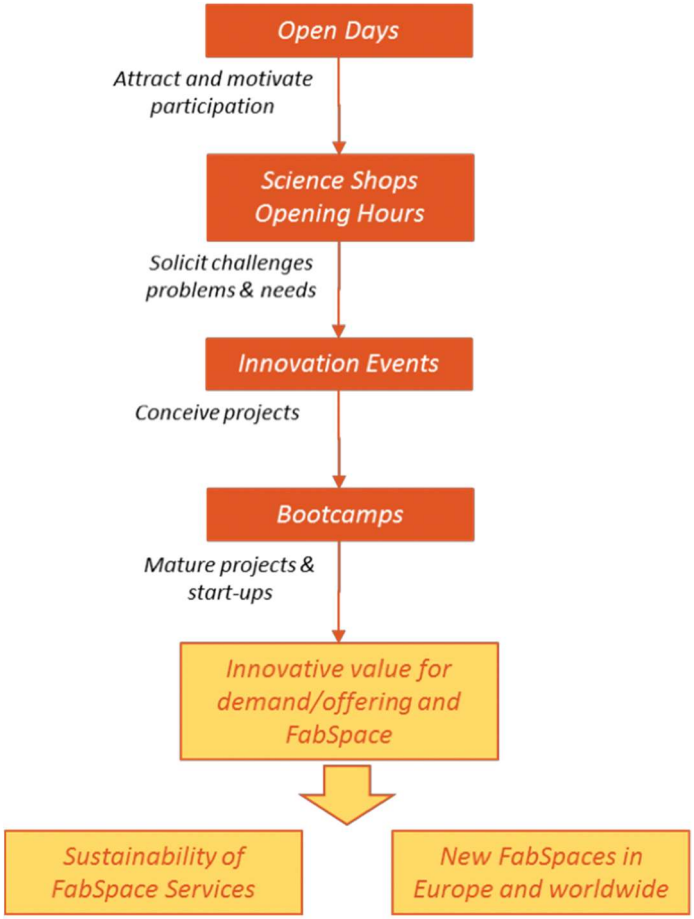

Figure 2: FabSpace 2.0 Implementation Logic

Open days are events (seminars/workshops) organised by the project partners to show and explain the FabSpace infrastructure and activities linked to EO and navigation satellite data acquisition and management. In total twelve Open Days are organized, two in each of the participating countries, after the FabSpace platform has become operational. Additional Open Days are organized in cooperation with Public Authorities/Agencies (e.g. ESA and National Space Agencies).

Space Science Shops, according to the EC means "a non-profit organization bringing together students, researchers and civil society (civil society organizations, public authorities, SMEs, designers, innovators, etc.) to tackle real life issues and explore opportunities for a sustainable future". Within the FabSpace context, the "Space Science Shop" can be either a workshop focused on application domains of EO and satellite navigation uses (i.e. agriculture and forestry, energy, environment and resource efficiency, intelligent transport systems, smart cities, health and well-being) or meetings with external stakeholders (civil society organisations, public authorities and companies) for defining societal needs and challenges. Business partners of the project make use of their networks to upstream needs from various external stakeholders, thereby contributing

to increase the number of challenges and ensure diversity in their contents. This diversity is a prerequisite to attract many participants with different interests, sensibilities and innovative capabilities.

Innovation Actions/Events can take various forms: call for ideas/idea box (targeting students, young professionals, citizens, etc.), Hackathons (targeting mainly technical students and young professionals), Start-up weekends (targeting a multidisciplinary population of engineering, business, students, etc.), App Camps (targeting IT developers, EO experts, etc.). The aim of Innovation Actions/Events is to connect the FabSpaces to a community of users interested in the conception of projects or start-ups by organising actions/events where participants play, create, learn, mentor and invent from the FabSpace resources. Students, researchers, experts, mentors, start-uppers and other interested communities are invited to these actions/events around various sessions that tackle one or several challenges defined during Space Science Shops.

Bootcamps are defined, in the education field, as a "short, intensive, and rigorous course of training" and, in entrepreneurship education in particular, a bootcamp is meant to be an intensive and hands-on series of courses that aims to provide participating would-be-entrepreneurs with the fundamental business concepts and knowledge on how to run a company and accelerate their ideas into start-ups. As such, the "FabSpace Bootcamp" is an intensive training programme of business education topics, tailored to the needs of selected individuals of each local FabSpace actions/events. The FabSpace Bootcamp provides to the participating teams not only theoretical but also practical knowledge on specialized issues that help them to turn successfully their ideas into innovative enterprises. Bootcamps are offered to the most promising concepts proposed by the FabSpace users. The purpose is to provide sufficient support to mature their projects in order to assist them for the creation of start-ups or for the development of new services that can be capitalised by existing SMEs.

5 FabSpace 2.0 outcomes/results

In the first six months of the project, the set-up of the open spaces and of the data access platforms took place and this, together with the involvements of the local FabSpace managers, enabled the activation of the university free-access place & service planned as project Objective 1, where students, researchers and external users can make use of a data platform for designing and testing their own applications.

In parallel specialised training courses in EO and GI topics as well as in business/management have been designed and activated, in line with project Objective 2, to train various entities to improve their capacity to process data and develop new applications and to support leadership and entrepreneurship. Initial promotion and animation actions, including Open Days, Space Science Shops and Innovation Events

have also been implemented to diffuse the FabSpace 2.0 concept and to attract participation of the various stakeholders to the project activities.

During the second year (2017-2018), the FabSpace 2.0 activities have reached full steam in all the planned domains, with a more substantial involvement and networking of students, researchers, project managers in industry and public authorities, entrepreneurs and civil society organisations. User needs and requirements have been analysed and the co-creation of new innovative solutions started within various Innovation Actions/Events, in line with project Objective 3.

Also, actions aiming at project Objective 4 have been performed for disseminating the FabSpace 2.0 concept into new universities in Europe and for creating new FabSpace services to build a sustainable approach for the FabSpace 2.0 centres.

In summary, the following results have been achieved:

› 14 new universities (more than the 7 originally foreseen) have been selected to become new FabSpaces 2.0 (12 in Europe and 2 outside of Europe, see list in the endnote) and the network now consists of 14 FabSpaces, as depicted in Figure 3.

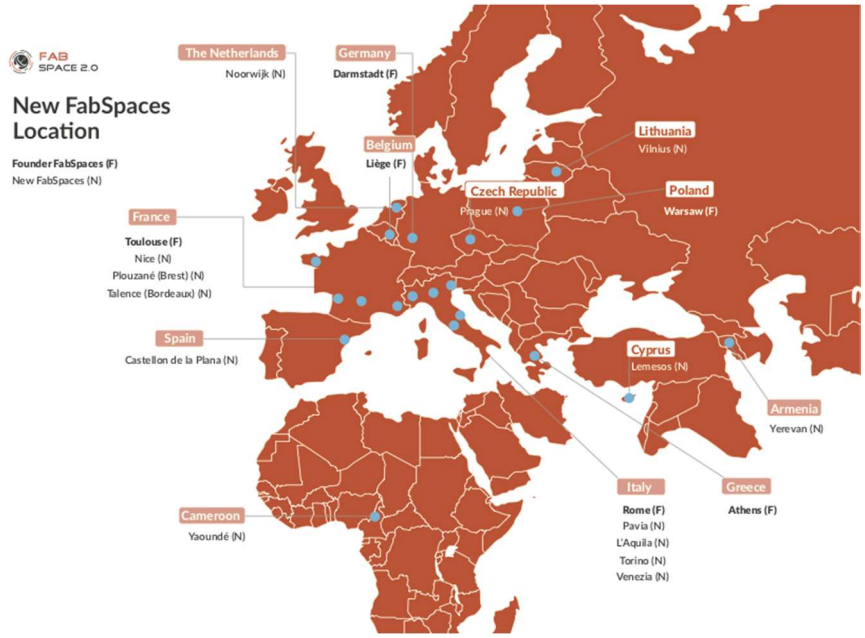

Figure 3: The FabSpace 2.0 Network

› More than 500 people have been trained on Earth Observation data/applications and on entrepreneurship

› Tens of use case challenges (humanitarian aids, transport, agriculture, forestry, energy, environment, insurance, etc.) have been handled in the various countries to develop innovative ideas for new applications oriented to solve specific end-user problems; they have gone through the first bootcamps in order to prepare the best concepts for possible incubation at the ESA BICs;

- Three main lines of revenue sources have been identified from interactions with FabSpace 2.0 users to build the future sustainability of the FabSpaces 2.0
- The European Space Agency has demonstrated great interest in the project objective and, starting in 2018, will get progressively involved with a central hub function.

A major challenge for FabSpace 2.0 is to build the financial sustainability of the local FabSpace services. Therefore, FabSpace services need to aim at generating revenues, including income from business activities conceived within each FabSpace deriving from various customers outside the academic world.

During the third year each of the founder FabSpaces will work on its own sustainability & business plan to be operational at the very end of the project. The three main lines of revenue have been identified in:

- Training Programs (for Industry, Institutions and professionals) addressing, at different specialization level and for different industrial and institutional sectors, the possible applications and the rapidly evolving scenario of Earth Observation and Geo-spatial Information
- Application & Technical Assistance for assessing, developing and exploiting new application ideas in various sectors, both for end-users and for IT Industry/SMEs; this involves also Intellectual Property developed with FabSpace contribution and participation to R&D project funded by EU or at national/local level
- Specialized Services of various nature, related to Earth Observation and/or space technology (e.g. to corporates interested in improving their visibility as innovative companies involved in new technologies and sustainability issues or looking for talented people to be recruited and become their staff)

To support the implementation of a sustainability model, a dedicated study is analysing focus on the different cultures and the potentially conflicting objectives of the stakeholders involved in FabSpaces in order to identify solutions to improve FabSpace operations and efficiency in generating new projects and new value.

6 Conclusions and recommendations

We live in an interconnected ecosystem based on technological infrastructure, with almost limitless availability of data, including geo-spatial data. At the core of the development of the now emerging (geo)information society is the ability to convert the "raw" data into useful information and knowledge. The ability to use the potential of the available geo-spatial data and to create innovative applications and services, is essential to support sustainable development within the Industry 4.0 and the Circular Economy.

FabSpace 2.0 aims at making universities open innovation centres for their regions, focusing on EO and GI but during the first phase of the project it appeared quite evident that different departments within the same university often work in isolation. More proactive and continued dialogue between EO departments and non-EO departments has to be pursued for improving interdepartmental cooperation to combine EO with other sciences also benefiting from the closer contacts that non-EO departments have with end-users and with real-life problems. This is true both in terms or educational innovation, for students and life-long learning, and in terms of creating innovative applications.

Stimulating results have been achieved so far by the project and others are expected in the coming third year of activities, but what will happen at the end of the project? Will the founder FabSpaces be able to self-sustain their services? Will the network expand further at International level?

The answers to these questions are difficult right now because, as said above, the FabSpace 2.0 is **a concept currently under development, evolving rather than being designed.** We are working in a very challenging area, at the crossroad of different cultures and different interests, where the various stakeholders are willing to get involved but have not yet fully understood their role, their return and, most of all, the kind of evolution they need to make to stay aligned with the evolution of our interconnected and rapidly evolving society.

One of the key initiatives that we are implementing is the cooperation with ESA which demonstrated great interest in the FabSpace 2.0 approach and has identified a convergence with their ΦLab Programme that is aiming at fostering open innovation in the EO sector with an end-to-end approach along the whole value chain. A study funded by ESA is undergoing for planning the evolution and further expansion of the existing FabSpace 2.0 network into the ΦLab University network (ΦUnet). ESA will contribute with their expertise and their on-going activities, at technical/application and training level, as well as by supporting the central hub function, especially in view of the International expansion of the network. With the ESA support, an extended goal for the network will be to foster the integration of downstream applications with new space technologies by researchers, students and SMEs, giving them the possibility to perform rapid prototyping of new generation of EO mission concepts (based on small satellites) and of the associated geo-spatial services.

With ESA playing a central hub function, similarly to the role Massachusetts Institute of Technology is playing for the FabLab network, the existing FabSpace 2.0 network will have the possibility to continue to grow in terms of capabilities, services, sustainability and size, also outside of Europe.

LIST OF FOUNDERS FABSPACES

France	› l'Université Toulouse III – Paul Sabatier. › Aerospace Valley	Toulouse
Italy	› Università degli Studi di Roma Tor Vergata › Lazio Innova–ESA BIC Lazio	Roma
Belgium	› Université de Liegeù › WSL–ESA BIC W-R	Liege
Germany	› Technische Universitat Darmstadt › CESAH–ESA BIC DA	Darmstadt
Poland	› Warsaw University of Technology › OPEGIEKA	Warsaw
Greece	› Institute of Communication and Computer Systems › CORALLIA-Athena Research and Innovation Center in Information Communication & Knowledge Technologies	Athens

LIST OF NEW FABSPACES

France	› INP Bourdeaux, NSEIRB-MATMECA	Talence
France	› GIS Bretagne Télédétection (IMT Atlantique), InnovationBrest	Plouzané
France	› Université Côte d'Azur Le Grand Château, Faculty of Sciences; SKEMA Business School	Nice
Cyprus	› Cyprus University of Technology, Eratosthenes Research Center	Limassol
The Netherlands	› Space Solutions Foundation and Wageningen University and Research, Earth Informatics	Noordwijk
Italy	› Politecnico di Torino, ITHACA;	Torino
Italy	› University of L'Aquila, The Center of Excellence CETEMPS of the University of L'Aquila	L'Aquila
Italy	› IE4ST – IstitutoEuropeo per lo SviluppoTecnologico	Venezia
Italy	› Università degli Studi di Pavia, Dipartimento di Ingegneria Industriale e dell'Informazione	Pavia
Czech Republic	› Czech University of Life Sciences Prague	Prague
Spain	› Universitat Jaume I, Institute of New Imaging Techniques	Castellon de la Plana

Lithuania	› Vilnius University, Faculty of Chemistry and Geosciences, Institute of Geosciences	Vilnius
Armenia	› National Academy of Sciences of the Republic of Armenia, Institute for Informatics and Automation Problems	Yerevan
Cameroon	› EUREKA Geo, Institute de Formation Professionelle Spécializé dans les métiers de la Géomatique	Yaundé

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