



ESA-ESPI Workshop
Space Data & Cloud Computing Infrastructures:
Policies and Regulations

7 July 2017, ESRIN, Frascati

Supported by:



ESA-ESPI Workshop

Space Data & Cloud Computing Infrastructures: Policies and Regulations

Outcome Report

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Background

The way of doing scientific research across all domains is undergoing a paradigm shift, enabled by fast-paced technological advancements and driven by the globalisation of the scientific community as well as by the increasing demand to address the “Grand Challenges” faced by society.

This rapid evolution is well exemplified by the opening of the research process, the astounding increase of producers and consumers of scientific data (including for example crowd-source initiatives), and, ultimately, by a massive increase of available data to be processed and disseminated, particularly through distributed computing.

In this regard, the employment of cloud infrastructures is immensely benefitting and advancing scientific research across all domains. Yet, this rapidly evolving technological landscape is also raising a number of new and unprecedented questions about rules and regulations, privacy, transparency and policies related to such data.

Although some science communities have established their own framework in terms of (big) data policy, for some others this process is not yet fully developed.

Moreover, the possibility to create unprecedented interconnections among different research communities also raises the question how these communities – and their data – can and will interact in the scenario of future large-scale cloud computing initiatives, with the ultimate aim of enhancing scientific collaboration, data dissemination and knowledge creation.

This one-day Workshop, organised on 7th July 2017 at the premises of ESA/ESRIN by the European Space Policy Institute (ESPI) in conjunction with the European Space Agency (ESA), addressed some of key policy and regulations questions – such as concerning data rights and IPRs – raised by today’s continuous digitalization process, and in particular by the growing use of distributed computing for science data.

Speakers of this Workshop ranged from high-level policy makers of European Institutions and Space Agencies to academic researchers as well as representatives of industry. They addressed an audience primarily composed of scientists and commercial (big) data users working with Earth observation and science space data, as well as of experts in scientific data policy, rights and regulations.

Keynote Speech

Policies and Regulations for Space Data in the Cloud Computing Era

Jean-Jacques Tortora, on behalf of Genevieve Fioraso

Cloud services are rapidly gaining significant importance in the field of Earth observation for data archiving, storage, search, access and download, as well as processing and value adding. Given the amount the amount of data produced by existing and planned systems, including Copernicus, robust cloud-based architectures must be established to effectively utilize the valuable informational resources collected. These cloud services will provide the means for analytical examination of extensive data sets, allowing new business models and insight into the valuable information obtained.

The Earth observation market is undergoing a disruption through cloud computing and other information technologies and solutions, which have already revolutionized countless other sectors. However, these new business models, such as Earth observation online services are just now emerging, but show significant promise for the future applications of space-based data. Some organizations have already begun to offer such services, but most traditional Earth observation companies have not fully taken advantage of the enabling technologies to leverage the sheer quantity of data being made available. It still remains to be seen whether the new services will be able to attract the traditional customers, such as the public sector, oil, gas, insurance, and even more importantly, whether they will attract new customers and ensure market growth.

Cloud-based services are still seen as an issue for public customers, due, in part, to public the boundaries of procurement laws and regulations. Procurement of cloud based services is hampered by several factors, including the diversity – and divergences – of service offerings, complex terms and conditions; concerns regarding data protection and data security concerns; risk of provider lock-in; and other factors.

As public customers represent, by far, the largest user community for Earth observation data and services, these constraints may manifest themselves as major hurdle. To ensure wider adoption of cloud services by public entities, ongoing work led by the European Commission seeks to limit the constraints and provide clarity.

The new business models are based on the use of multiple data inputs from multiple sources, which then are subjected to powerful value-adding and analytics tools. However, today, each data provider uses its own data license terms based on individual data policies, which limits the utilization and sharing of data, as users must identify, read, understand, accept and comply with all of the varied terms and conditions. Legal interoperability is, therefore, another important hurdle for the market evolution and must be addressed.

Due to this evolution, many new players, namely large IT service providers, but also large geospatial service providers are entering the Earth observation market. While this development offers new opportunities, there are also challenges for the traditional Earth observation companies, which, in Europe, are typically small organizations that may not be able to compete with the large players in terms of investments and global reach.

First new entrants were predominantly US companies, such as Google and Amazon, who sought to apply existing capabilities to the Earth observation market. Now, the European Union, in collaboration the

European Space Agency and EUMETSAT, is investing significant resources to ensure European cloud solutions. To illustrate, there is the on-going tender for utilization of data derived from Copernicus through the Copernicus Data and Information Services Provider, or DIAS, and a similar EUMETSAT tender is in preparation. However, the European players are generally said to be more expensive, less innovative and more reliant upon public funding than their US competitors. Are we really sure that Europe is achieving a sound and long-term level playing field for commercial activities?

The purpose of today's Workshop, organised by ESPI in conjunction with ESA, is to address the key policy and regulatory questions brought forth by digitalisation and cloud computing for Earth observation and science data. Our speakers include high-level policy makers from European institutions and agencies, academic researchers and industry representatives, who will provide their reflections, advice and guidelines to address the challenging policy, regulatory and legal issues related to the use of Earth and space data in cloud computing environments. The Workshop, in the interest of increasing the adoption of best practices and utilization of this data, seeks to engage scientists and commercial users, as well as experts on data policy, rights and regulations. The topics addressed should be of high interest for researchers in the broader space and science communities as well, as many of the themes are cross-cutting and wide ranging due to the applicability of cloud computing and data utilization in other sectors.

The opening session will address the general themes and reflect on current policies and regulations from the perspective of the European Commission and European Space Agency. The discussion will include an overview of the technologies at hand, removal of barriers to adoption, identification of supporting technologies and guidance from a high-level policy context. The first session will then spotlight the users and their needs, observing the challenges to operating in an increasingly digitised and rapidly evolving technological arena. Items on the agenda include access priorities, enabling equal and widespread use, and consideration of effects on other industries. In the second session, speakers will present from the perspective of cloud computing infrastructure providers and address many of the challenges raised by the users in the previous session. Other topics will include integration, protection of data integrity, future technological advances, and milestones in the implementation process. Finally, a roundtable closing session will discuss more space-specific regulatory landscapes and review takeaways from previous discussions. Key challenges, incentives, training, funding and governance will also be considered as the speakers distil the Workshop's takeaways.

In recognizing the quantity and utility of space-based data, it is of specific importance to ensure that the capabilities and methodologies are in place to most effectively harness the resources. Looking forward, we must anticipate the sector's growth and continually evaluate new uses for the data and take action to enable applications that improve the quality of human life on Earth. To do so, it is critical to maintain accessible, shared and re-usable data with the understanding that data-driven discovery and cross-disciplinary collaboration will lead to substantial innovation.

Workshop Sessions

During the Opening Session of this Workshop the speakers gave a general introduction on the topic and set the scene for the discussion from a high-level policy perspective. The reflection revolved around current data policies and regulations, presented by speakers from the European Commissions as well as the European Space Agency, with particular focus on the Space Science and Earth Observation domains.

The First Session put the spotlight on the users of cloud infrastructures, and their needs in terms of policies and regulations. Speakers from different scientific areas – astrophysics, fundamental physics and Earth science – highlighted the challenges that such data-intensive activities face today and in the future.

The Second Session offered the position and view of major cloud computing infrastructure providers, during which speakers presented their answers to the specific challenges on data policies and regulations raised in the previous session by the clouds' users.

Finally, a roundtable with selected speakers and experts debated the policy and regulatory landscape in (space) big data. In particular, the round table participants reflected on the question: "What are the key challenges in terms of policies, regulations and general legal aspects to pave the way for optimal technical solutions?"

Opening Session: Space Data in the Cloud Computing Era

A warm welcome and introductory message was delivered by **Josef Aschbacher**, Director of ESA Earth Observation Programmes (EOP), who set the stage for the day's discussions. Mr. Aschbacher's address included mention of ESA's Earth Observation activities which manage the largest Earth observation data throughput in the world, and highlighted the concept of Exploitation Platform as a central part of ESA EO data management evolution strategy. He further discussed the skyrocketing number of users of space-derived data and its valuable uses for societal benefit, as well as in commercial activities.

Nicolaus Hanowski, ESA/EOP Head of Ground Segment and Mission Operations Department, and **Daniel Quintart**, legal and policy expert at EC DG GROW, gave a joint presentation on the topic of space data and cloud computing. Mr. Hanowski in particular presented the role of policy in successful methods of innovation and cooperation. He pointed out the importance of anticipating user needs and of technology and policy developments as well as the need to create an architecture that maximizes the impact of data utilization. Mr. Quintart's presentation discussed policy and legal considerations for data utilization and compatibility standards, the need for a variety of useful data types, and potential methods of issuing licenses for a wide array of users to enable more efficient workflow. He stated that it is key to enable essential capabilities to explore the data and establish licensing modules that allow users to build individually-suited licenses.

Martin Kessler, Head of the ESA/SCI Operations Department, spoke to the audience on the topics of data policy, preservation and utilization from the ESA Space Science point of view. He noted that long-term preservation requires sharing of resources and that the current archive model provides information for download with software to exploit it, but retaining the software and knowledge for extended periods will be a key challenge.

In addition to an overview, the panellists discussed regulatory measures, removal of barriers to access and use of supporting technologies to utilize data. In the Q&A period, several answers were provided to audience

questions. The first highlight of the session was that, unlike for many space data, there is generally no proprietary period for Earth science data. Space data, which is typically gathered using instruments built at institutes using institutional or ESA funding, is often proprietary for an initial period, after which it is released to the general public, typically via internet download. In contrast, Earth observation data is generally made available, either free of charge or against license fees, immediately after ground reception.

The speakers noted that a goal within ESA is to continue engagement with companies to create partnerships that fill knowledge gaps and transfer knowledge. Work is continuing to increase harmonization of license terms and create ways to facilitate access and use. The process, while not entirely new, is relatively innovative for Earth observation data. The general sentiment of the panel was that continuing the free and open access data policy was paramount, especially when paired with the provision of software tools to utilize the data.

Overall the session concluded that public, open, free and accessible data is a must, but that policy decisions to enable effective and broad use must anticipate evolving user needs and must address issues such as licensing or compatibility standards. Cooperation among partners is paramount to establish harmonized practices.

First Session: The Science Cloud Users: Challenges and Needs

The first session then covered an overview of experiences, challenges and needs of users of cloud infrastructures across the astrophysics, Earth observation and fundamental physics communities. **Andrea Zacchei** of the Astronomical Observatory of Trieste discussed the implications of big data in space science, including use in the Planck and Euclid missions. The incremental release of Planck data has been supplemented by a release of 211 scientific papers, with 42 more in editing. All Planck data is available at the ESA-ESAC archive, the only public interface to these data. He further highlighted the upcoming Euclid mission, in particular its data processing structure. He concluded by noting that astronomical data should not simply be open, but also public, after its proprietary period, to allow for an effective reuse (as in the FAIR – Findable, Accessible, Interoperable, Reusable paradigm).

Bob Jones of the European Organization for Nuclear Research (CERN) discussed big data and cloud computing in High-Energy Physics, bringing CERN's long-time experience. He noted the importance of long-term distribution and sharing of data, as well as the need for hybrid cloud models to improve user accessibility and preserve data from loss over long periods. A hybrid model would also contribute to solutions to several ongoing challenges, including storage for the sheer quantity of data, federated identity management and service payment models.

Sasha Borovik, CFO of geodata service provider CloudEO, discussed data as a commodity and the potential for an API to aggregate data in one place for developers to more effectively utilize it, mentioning that many major industries are overlooked when it comes to apps to access useful data. Such an interface would likely utilize block chain technology, which has the potential to revolutionize a number of industries and sectors.

The Earth Observation experience was further discussed by **Wolfgang Wagner**, Head of Science at the Earth Observation Data Centre (EODC), who articulated that choosing a cloud service requires consideration for both performance and legal certainty, as well as interoperability. Given the importance of cooperation in open data access, he also discussed a shared infrastructure and investment project for cloud computing at TU Wien Science Center.

The first session's panel remarks, moderated by **Christophe Arviset**, Head of Data and Engineering Division at ESA/SCI, provided a spotlight for the users of cloud infrastructures and their needs in terms of policies and regulations. Speakers compared and contrasted their different areas of expertise, including astrophysics, high-energy physics and Earth science to identify challenges that such data-intensive activities will need to overcome today and in the future. The panellists touched on the access priorities for different user groups, methods for encouragement of widespread use, ensuring equal access and enabling technologies that will further supplement the space data environment.

On the topic of procurement and regulations, it was noted that the digital single market and joint cross-border procurement must be addressed. While it is likely that users will bring different tools to utilize data, a pool of common resources should be assembled including hardware and software for all involved scientific organizations. Currently, most procurement occurs for individual entities according to their own needs and joint procurements, namely cross-border, are still very limited. However, while collaborative and shared models could significantly reduce individual expenses, focussing on operational costs for combining and sharing the available systems. Policy should support a wider use of such collaborative procurements.

For the European Open Science Cloud (EOSC), success could be measured by how few outside resources must be utilized by users to access and manipulate data. The intention is to provide a full suite, preventing the need to bring third-party tools into the equation. Sponsorship of end users is also encouraged, as it is the EOSC belief that end users should not be required to pay for use of public data. Bringing together the EOSC and data providers will remain a challenge and small steps will be necessary to improve the interoperability and conformance will be better defined as experience is gained.

Overall the session underlined the importance of pooling & sharing and cooperation schemes in the domain. In addition to open and shared data, shared tools and pooled resources could provide a more cost-effective and user-friendly solution for all parties, could limit procurement efforts, and increase European-wide collaboration.

Second Session: The Cloud Computing Providers' View

In the afternoon, the second session presented the perspective of major cloud computing commercial providers and publicly-funded partnerships.

Per Öster, Director of the CSC - IT Center for Science and Chair of the EUDAT Executive Board, presented to the audience on the cloud computing relevance of EUDAT, a consortium that was created in response to an EC report to study how Europe can gain from collaborative data infrastructure in cloud services. Also included in his presentation were the Collaborative Data Infrastructure (CDI), the evolution from CDI to EOSC and the SeaDataCloud for collection of marine data.

Marc Ferrer from Atos spoke about the challenges in the space data economy that affect telecom, navigation, science and Earth observation, with the most impactful change being identified as the massive increase in available data. He concluded by stating that the next major revolution will occur in science and Earth observation and that IT has significant promise to boost data usage with applications in data immunity and security policy.

As Head of the Security and Specialised Services Division, **Maryline Lengert** reviewed the cloud challenges within ESA's IT infrastructure, including a number of boundary conditions such as ESA security policy, U.S.

legal framework that could affect ESA data, contractual lock-ins and consumerization. ESA IT's response to these conditions, noting that "one size does not fit all", include integration of infrastructure, platform and software applications as a suite of cloud-based service with the pursuit of hybrid models in the near future.

Davide Salomoni, Director of Technology at INFN and Project Coordinator of INDIGO-DataCloud, focused on INDIGO's ongoing projects and their relation to space data and cloud computing, including Earth observation. INDIGO currently provides a number of services for scientific data, such as architecture, analysis and software to support projects for scientific organizations, government entities and commercial providers.

Andreas Falkner, Vice-President for Cloud Business at T-Systems, spoke to the audience about the Open Telekom Cloud and cloud computing as a means for digitization of science and industry. Major trends in his perspective include an increase in both produced and consumed data, fast-paced innovation and cross-industry collaboration, which create a market for solutions in cloud computing, security, encryption and software applications.

The second session was moderated by **Massimo Comparini**, Director of the European Association of Remote Sensing Companies and CEO of e-GEOS. This panel offered the position and perspectives of major cloud computing infrastructure providers, during which speakers responded to questions on the specific challenges on data policies and regulations raised in the previous session by the users, as well as by the audience. Some topics discussion included protection of data integrity, incentivization, integration, technological advances and achievement milestones for implementation.

Third Session: Cloud Computing Policy and Regulations for Space Data: a Legal Assessment

The Workshop final session was comprised of a roundtable among selected speakers, which was chaired by **Ingo Baumann**, a founding partner of BHO-Legal and expert on space, IT and procurement law. This expert roundtable provided reflections on the day's subject matter, as well as new considerations, particularly around the key challenges in terms of policies, regulations and general legal aspects to pave the way for optimal solutions.

Mr. Baumann began the session by noting that in both space science and Earth observation, cloud computing has gained significant traction in recent years and is expected to give rise to new business models and general growth, especially in Earth observation. Value-adding functions of cloud computing adoption, such as long-term archiving, accessible storage, efficient search, powerful processing and servicing could impart important shifts in the commercial market from traditional, small Earth observation companies to major industry giants in the IT and cloud computing environment, such as Google and Amazon, T-Systems, Atos and SAP as well as large geospatial players, such as Hexagon or ESRI. From a policy perspective, the European Commission has set forth effort to create more effective solutions, such as the Copernicus Data and Information Access Service (DIAS) tender, which will create partnerships to effectively share valuable Earth observation data with users.

On the subject of the emergence of a digital Earth observation market, Sasha Borovik reported that entry price for current users is quite high and not accessible for small companies. The data is available, but the capabilities for handling and analysing the massive data sets are not yet fully provided. The CloudEO solution makes software available to developers in order to allow them to create products. Similar start-ups do not fear large companies, as the support provided by crowdsourcing helps to even the playing field and the contributors could potentially be compensated through awarding of digital tokens. Such an approach could

undermine traditional IT giants, as well as a number of other related industries by automating processes and providing distributed ledgers of transactions.

Shifts in the legal aspects due to the evolution in the Earth observation market were also observed by Mr. Baumann. Whereas traditional legal issues for Earth observation have focused on space law and measures such as shutter control and national security regulations on resolution, discussions now are focussing on IT and data law. While many of these considerations are not new issues in the IT sector, they are new for Earth observation, and, as with any market convergence, new light is being shed on old questions and new answers are then necessitated. Some of these key legal issues include copyright protection of data, legal interoperability of multiple data licenses, cybersecurity, privacy, or warranty and liability exclusions in Earth observation licenses. When considering legal issues in cloud computing, there are a number of EU regulations and directives, including those for data protection, e-commerce, network information security, as well as the proposal for digital content directive, not to mention regulations for critical infrastructure on national and European levels.

It was reported by Daniel Quintart that the EC is currently working on new legislative measures for an upcoming update of the Copernicus regulation. It was also noted that a clear and advanced general issue exists in the mandatory storage of data in just one member state, as it could be seen as a restriction to the freedom of providing data services in the single market. Due to the Internet of Things concept, there are now a number of devices constantly producing data, and it must be considered which entities are entitled to use this data and whether or not the manufacturer is required to share it. While it may be a long debate, the general sentiment is that geospatial data is not subject to copyright, as it is not a product of creativity, but one of observation, though such data could be protected by contracts. While there have not yet been major Earth observation and space science-related lawsuits, there is an increasing level of litigation on open source software and other IT and data issues on an international scale. The convergence between traditional geospatial data providers and traditional IT companies in the digital space economy, however, may introduce new legal challenges.

Finally, on the topic of public procurement, Ingo Baumann highlighted that there are important boundaries to consider, which are representative for international organizations, but also applicable to national public organizations. The major concerns include control over and location of the data, data security and confidentiality, long-term service availability, adequate service level agreements, interoperability and avoidance of provider lock-in situations. Additional legal barriers are said to include divergences in national laws resulting from the implementation of EU legislation, national legislation regarding the transfer of data to the cloud, and public procurement law. Comparatively, the top four concerns of users of data are control over data, privacy, data confidentiality and adequate service level agreements.

When asked about improvements to the procurement process, the panel reported that the complexity of the European Union and its Member States requires a great deal of interoperability. The European Interoperability Framework, which was originally designed for public administration, may help address other legal interoperability problems between nations. Organizational interoperability of a technical nature was not deemed as great of a challenge to scientific organizations as other types, such as legal and semantic interoperability. By trading off a certain level of prescriptiveness and observing specifications, organizations face a continuous dilemma in the public procurement process and lose a degree of creativity. To address these challenges, it was recommended that stakeholders understand and employ cooperative processes in which they use the same terminology to develop a sense that work is being done on a common project and limit confusion between organizations and government entities.

Conclusions

New data policies and high-capacity cloud computing infrastructures have deeply transformed the availability of Space data and derived products. Space data archives are now going through an evolution towards becoming science data exploitation and collaborative platforms, to be supported by cloud computing infrastructure.

The Workshop highlighted that, together with the expertise to define, build and operate the corresponding Space missions, the right policies and regulations for data management as well as data use, in particular for the cloud computing environments, have become key enablers for a strong European role in Space data utilisation.

Furthermore, there is common agreement that public, open, free and accessible space data is a must, and that policy decisions to enable effective and broad use must anticipate evolving user needs – in particular with regard to licensing and compatibility standards.

Additionally, pooling & sharing and cooperation schemes are seen as important ways to provide a more cost-effective and user-friendly solution for all parties. Indeed, the employment of cooperative processes between stakeholders is necessary to achieve clearer and mutual understandings between each other, and limit confusion, including in procurement processes.

From a legal perspective, in order to pave the way for optimal solutions, it is noted that it would be essential to transfer the experience and expertise gained in the general IT domain into the Space data domain, with the ultimate objective to facilitate the data use even further.

Annex 1: Agenda and Presentations

Thursday 6 July 2017		
16:00 – 19:15	Arrival of participants at selected hotels in Frascati	
19:15 – 19:30	Bus transfer from Piazza Marconi (Frascati) to Villa Grazioli	
19:30 – 21:30	Welcome drink and buffet dinner at Villa Grazioli	
21:30	Bus transfer from Villa Grazioli to Piazza Marconi (Frascati)	
Friday 7 July 2017		
8:15 – 8:30	Bus transfer from Piazza Marconi (Frascati) to ESA/ESRIN	
8:30 – 9:00	Registration and welcome coffee	
Opening Session. Space Data in the Cloud Computing Era Moderator: Jean-Jacques Tortora , Director, ESPI		
9:00 – 9:10	Opening Speech	Genevieve Fioraso , former French Minister of Education and Research, Member of Parliament
9:10 – 9:25	Welcome and Introduction	Josef Aschbacher , Director, ESA/EOP
9:25 – 9:55	Joint Session ESA EOP/EC DG GROW	Daniel Quintart , EC DG Grow
		Nicolaus Hanowski , Head of Ground Segment and Mission Operations Department, ESA/EOP
9:55 – 10:10	ESA Science	Martin Kessler , Head of Operations Department, ESA/SCI
10:10 – 10:30	Q&A	
10:30 – 11:00	Coffee and networking break	
First Session. The Science Cloud Users: Challenges and Needs Moderator: Christophe Arviset , Head of Data and Engineering Division, ESA/SCI		
11:00 – 11:15	Big Data Space Science: ESA Planck & Euclid	Andrea Zacchei , INAF-OATs
11:15 – 11:30	The Fundamental Physics Perspective	Bob Jones , CERN
11:30 – 11:45	The Earth Observation Experience /1	Sasha Borovik , CFO, CloudEO
11:45 – 12:00	The Earth Observation Experience /2	Wolfgang Wagner , Head of Science, EODC
12:00 – 12:20	Q&A	
12:30 – 14:00	Lunch at ESRIN canteen	

Second Session. The Cloud Computing Providers' View		
Moderator: Massimo Comparini , EARSC Director and CEO e-GEOS		
14:00 – 14:15	EUDAT	Per Öster , Director at CSC – IT Center for Science, Chair of the EUDAT Executive Board
14:15 – 14:30	ATOS	Marc Ferrer , ESA Client Executive, ATOS
14:30 – 14:45	The ESA IT Infrastructure	Maryline Lengert , Head of the Security and Specialised Services Division, ESA IT Department
14:45 – 15:00	INDIGO - DataCloud	Davide Salomoni , Director of Technology at INFN, Project Coordinator of INDIGO-DataCloud
15:00 – 15:15	T-Systems	Andreas Falkner , Vice-President for Cloud Business, T-Systems
15:15 – 15:30	Q&A	
15:30 – 15:45	Coffee Break	
Third Session. Cloud Computing Policy and Regulations for Space Data: a Legal Assessment		
Moderator: Ingo Baumann , Partner, BHO-Legal		
15:45 – 16:45	Roundtable among selected speakers	
16:45 – 17:00	Q&A	
17:00 – 17:30	Wrap-up & Closing Remarks	Jean-Jacques Tortora , Director, ESPI
17:30	End of the event Bus transfer from ESA/ESRIN to Fiumicino Airport	

➤ **Programme Committee:**

Nicolaus Hanowski (ESA)
Henri Laur (ESA)
Pier Giorgio Marchetti (ESA)
Martin Kessler (ESA)
Christophe Arviset (ESA)
Jean-Jacques Tortora (ESPI)
Matteo Tugnoli (ESPI)

➤ **Organising Committee:**

Matteo Tugnoli (ESPI)
Arne Lahcen (ESA)

➤ **Conference Webpage:**

A dedicated webpage for the Workshop is available at the following address:

<http://old.esaconferencebureau.com/2017-events/space-cloud-computing-2017/home>

Annex 2: List of Participants

LAST NAME	FIRST NAME	ORGANISATION	COUNTRY
ABE	Satoshi	Fujitsu Cloud Technologies LTD	Japan
ALMEIDA	Nuno	DEIMOS	Portugal
AMLER	Esther	ESA	Italy
ARVISET	Christophe	ESA	Spain
ASCHBACHER	Josef	ESA	Italy
BALDESI	Gianluigi	ESA	France
BARKER	Alexandra Siobhan Elish	Airbus	United Kingdom
BARROS	Serge	Airbus Defence and Space	France
BAUMANN	Ingo	BHO Legal	Germany
BEAUREGARD	John Christopher	ESPI	United States
BOROVIK	Sasha	CloudEO	Germany
CASTILLO GUEVARA	Ursula Liliam	SIOI	Italy
CATTADORI	Marco	PwC Strategy&	Netherlands
COLUCCI	Angelo	ASI	Italy
COMPARINI	Massimo Claudio	e-GEOS	Italy
CORDEY	Ralph	Airbus	United Kingdom
DAVE	Anilkumar	ASI	Italy
DE FANO	Caterina	ASI	Italy
DEITERS	Gerhard	BHO Legal	Germany
DOYLE	Eric	ESA	Italy
FABBIANI	Martina	SIOI	Italy
FALKNER	Andreas	T-Systems International GmbH	Germany
FERRARELLI	Luca	Vitrociset	Italy
FERRER	Marc	Atos	France
GALANTI	Marco	Vodafone Global Enterprise	Italy
GIORGI ALBERTI	Giacomo		Italy
GIRARDO	Luca	ESA	Italy
HANOWSKI	Nicolaus	ESA	Italy
HÖRSCH	Bianca	ESA	Italy
IAPAOLO	Michele	Randstad / ESA	Italy
JONES	Bob	CERN	Switzerland
KESSLER	Martin Francis	ESA	Spain
KIKUCHI	Koichi	JAXA	Japan
KURIYAMA	Ikuko	JAXA	Japan
LAHCEN	Arne	ESA	France
LEGRÉ	Yannick	EGI Foundation	Netherlands

LENGERT	Maryline	ESA	Italy
LOPES	Cristiano	ESA	Italy
LUKASZCZYK	Agnieszka	Planet	Belgium
MALERBA	Simona	ASI	Italy
MARANESI	Marcello	Independent Consultant	Italy
MARGARIT MARTIN	Gerard	GMV Aerospace and Defence S.A.U.	Spain
MARQUARD	Uwe	T-Systems International GmbH	Germany
MONDON	Emmanuel	AdviceGEO	Germany
MORÓN RODRIGO	Reyes	DEIMOS IMAGING SLU	Spain
MOUGNAUD	Philippe	ESA	Italy
MUSTAFEE	Indranil	Airbus Defence and Space Ltd.	United Kingdom
NAKAMURA	Shinsaku	Japan Space Systems	Japan
NAOYUKI	Fujita	JAXA	Japan
ÖSTER	Per	CSC - IT Center for Science	Finland
PARRELLA	Rosa Maria Lucia	ASI	Italy
PAVESI	Brunella	Telespazio	Italy
PIDGEON	Alastair	RHEA Group	United Kingdom
PIPERNO	Osvaldo Walter	ASI	Italy
QUINTART	Daniel	European Commission	Belgium
RHIMBASSEN	Maria	University Toulouse 1 Capitole	France
ROSSI	Federico	VITROCISSET SpA	Italy
SALOMONI	Davide	INFN	Italy
SATO	Ryuichi	Japan Space Systems	Belgium
SPIRITO	Germana	ASI	Italy
TORTORA	Jean-Jacques	ESPI	Austria
TUGNOLI	Matteo	ESPI	Austria
VALDESPINO	Sofia	EUMETSAT	Germany
VAUDO	Ersilia	ESA	France
VIDMA CHARLES	Emilio José	Indra Sistemas, S.A.	Spain
WAGNER	Wolfgang	TU Wien	Austria
ZACCHEI	Andrea	INAF	Italy

Annex 3: Speakers' Biographies

Opening Session

Jean-Jacques Tortora

Jean-Jacques Tortora has been Director of the European Space Policy Institute (ESPI) in Vienna since June 2016. Before this, he worked for nine years as the Secretary General of ASD-Eurospace. From 2004 to mid-2007, he was head of the French Space Agency (CNES) office in North America and the Attaché for Space and Aeronautics at the Embassy of France in Washington, D.C. Previously he was Deputy Director for Strategy and Programs, responsible for the Industrial Strategy of CNES. Prior to that position, he was France's representative in the ESA Industrial Policy Committee and Joint Communication Board. From 1998 to 2000, Mr. Tortora was adviser to the French Ministry of Research for Industrial Policy Funds management, aiming at industry competitiveness support and new space applications and services development and promotion. Mr. Tortora started his professional career in 1984 at the French military procurement agency, DGA, as a naval weapons integration and test engineer, expert in signal processing and warships acoustic discretion.

Genevieve Fioraso

A student of Hypo-Khâgne, she obtained a master's degree in English, then worked as an English teacher in Amiens. In 1978 she left teaching and moved to Grenoble, where she served first as Information Officer, then managing Documentation and Press for the City of Grenoble, where she began collaborating with Hubert Dubedout, city's mayor and MP, and became his parliamentary attaché in 1983. On 16 May 2012 she was appointed Minister for Higher Education and Research in the French government of Jean-Marc Ayrault. Since 2008 she has been deputy for the Economy, Universities and Research for the City Council of Grenoble. During her previous term she was Deputy Assistant for the Economy, Innovation, Trade and Craft, and First Vice-President of Metro -Agglomeration community of the Grenoble Alpes Métropole, in charge of economic development. Since 2003, she has been the CEO of the S.E.M. Minatec Entreprises (public-private venture, entrusted with the marketing of high-tech building of Minatec). She also serves as Chair of the Institut d'Administration des Entreprises Grenoble, Business Administration Institute of Grenoble. She was recently appointed Chair of the Advisory Council of the European Space Policy Institute (ESPI).

Joseph Aschbacher

Joseph Aschbacher is ESA Director of Earth Observation. Born in Austria, he studied at the University of Innsbruck, graduating with a Master's and a Doctoral Degree in Natural Sciences. His professional career in ESA began in 1990. During 1994–2001 he worked at the European Commission Joint Research Centre in Ispra, Italy, where he was the Scientific Assistant to the Director of the Space Applications Institute. He returned to ESA HQ in Paris in 2001, and in 2014, he was promoted as Head of Programme Planning and Coordination in the Directorate of Earth Observation Programmes at ESA ESRIIN, where he was responsible for planning ESA's Earth observation programmes and for formulating and implementing programmatic and strategic decisions across the Directorate.

Daniel Quintart

Daniel Quintart is a legal expert with the European Commission working in the fields of IPR and information technology. He joined the Copernicus programme in 2011 to draft the Copernicus data and information policy Regulation. He is currently focusing his work on the big data challenges and solutions for Copernicus.

Nicolaus Hanowski

Nicolaus Hanowski graduated from Ludwig Maximilians University Munich in Geo-Sciences, Remote Sensing Planetology. He worked at the German Aerospace Center (DLR) in Oberpfaffenhofen as an Assistant in Planetary Spectroscopy Optoelectronics at the Institute of Planetary Exploration. Between 1994 and 1998, he was Research Assistant and Ph.D. Student at the Institute of Meteoritics of the University of New Mexico. Between 1998 and 2000, he was a Scientist and Study Manager at DLR. Between 2000 and 2009, he worked on numerous scientific projects including BIRD, Eutelsat W5, Hotbrid 6, GRACE, SATCOMBw, TanDEM-X, Galileo and TET. He joined ESA in 2009 as Division Head for Science Operations Development in the ESA Directorate of Science and Robotic Exploration. Since 2014, he works at the Earth Observation Programme Directorate in Frascati and is currently Head of Ground Segment and Mission Operations Department.

Martin Kessler

Martin Kessler has a background in astronomy. He became Project Scientist of the Infrared Space Observatory (ISO) satellite in 1984 and maintained this role throughout the design, development, launch, operational and post-operational phases of the mission until release of the final data archive in 2001. At that point, Martin returned from ESA/ViISPa (now ESAC) to ESA/ESTEC to take up responsibility for developing the science operations for ESA's astronomy missions. In 2009, he became Head of the Science Operations Department at ESAC, Spain with overall responsibility for all ESA's space science missions in operations and also for the development of the science operations of future missions.

First Session

Christophe Arviset

Christophe Arviset is Head of the Data and Engineering Division at ESA's European Space Astronomy Centre (ESAC) in Spain, close to Madrid. This includes responsibility of ESA's space science missions in post-operations phase (i.e. Herschel, Planck and Rosetta), all technical IT services and other cross missions engineering activities to support Science Operations at ESAC. Furthermore, he is heading the ESAC Science Data Centre, hosting science data archives of more than 20 ESA space science missions. He has been playing an active part of international data alliances (International Virtual Observatory Alliance and International Planetary Data Alliance) since their creation, and had been chairing the IVOA for the last two years. Initially Computer Science engineer by training, Christophe has developed more than 20 years of experience in science operations with special focus on science data management, data archives and long term data preservation.

Andrea Zacchei

Graduated in Astronomy at Bologna University with 110 cum Laude. In 1993-95 under contract with software house Simulmondo with the responsibility of developing multimedia products. From June 1995 to October 1997 under contract with the Space Telescope Science Institute in Baltimore in the framework of the GSC2 project; – in charge of developing algorithms for data processing pipeline and tool for data quality and

production of the catalogue. From October 1997 to October 2001 at the CGG (centro Galileo Galilei); – responsible for the *TNG* (4 meter class Telescope) control software (WSS), for the Archives at the Telescope and for the *DOLORES* low resolution spectrograph instrument. From October 2001 staff astronomer at INAF-OATs (Osservatorio Astronomico di Trieste) involved in the Data Processing Centre (DPC) for the Low Frequency Instrument (LFI) of the ESA *Planck* mission, with responsibility for the integration of the data processing pipeline and act as Level 1 Manager; and subsequently, as DPC manager with the responsibility of the entire data analysis chain and operations during fly. From 2014 involved in the ESA *Euclid* mission (that should fly on 2021) as ECSGSM (Euclid Science Ground Segment Manager) with responsibility of the entire Euclid consortium software/infrastructure design and implementation. As quantified by INSPIRE, he has published a total of 234 papers, 164 refereed as of May 2017, resulting in a total of 25,462 citations and an *h*-index of 65, both excluding self-citations.

Bob Jones

Bob Jones was the Head of CERN openlab between January 2012 and December 2014, for the CERN openlab fourth phase. He is as well as a member of the IT department head office with responsibilities in EC co-funded projects. Following a B.Sc. (Hons) in Computer Science from Staffordshire University, Bob joined CERN in 1986 as a software developer with the information technology department providing support for the physics experiments running on the Large Electron Positron (LEP) particle accelerator. He completed his PhD thesis in Computer Science at Sunderland University while working at CERN. He has been involved in several research projects for the Large Hadron Collider (LHC) accelerator and has contributed to online software system for the ATLAS experiment at the LHC. Before joining openlab, Bob was a leader of the European Commission funded series of EGEE projects that helped develop the world-wide grid system that is used to process LHC data and he is now involved in major EC funded projects.

Wolfgang Wagner

Wolfgang Wagner was born in Wels, Austria, in 1969. He received the Dipl.-Ing. (MSc) degree in physics and the Dr.techn. (PhD) degree in remote sensing, both with excellence, from the Vienna University of Technology (TU Wien), Austria, in 1995 and 1999 respectively. In support of his master and PhD studies he received fellowships to carry research at the University of Bern (1993), Atmospheric Environment Service Canada (1994), NASA Goddard Space Flight Centre (1995), European Space Agency (1996), and the Joint Research Centre of the European Commission (1996-1998). From 1999 to 2001 he was with the German Aerospace Agency (DLR), first as a project assistant at the Institute of High Frequency Technology and later as the head of the SAR Applications team at the German Remote Sensing Data Centre. In 2001 he was appointed professor for remote sensing at the Institute of Photogrammetry and Remote Sensing of TU Wien. From 2006 to 2011 he was the head of the Institute of Photogrammetry and Remote Sensing and since October 2012 he has been the head of the newly founded Department of Geodesy and Geoinformation. Further university functions have been: member of the board of the Faculty of Mathematics and Geoinformation (since 2004), member of the TU Wien Senate (2006-2010), and coordinator of the Geodesy and Geoinformation group (2004-2012). Furthermore, he is co-founder of the Earth Observation Data Centre for Water Resources Monitoring (EODC), acting as head of science since December 2014.

Sasha Borovik

Since graduating from Harvard Law School in 1999, Sasha Borovik has been working as an international attorney, entrepreneur and a team manager for some of the best corporations and law firms in Silicon Valley,

Seattle, Washington DC, Munich, Paris, London and emerging markets. As a lead attorney, he handled some of the biggest technology deals, public-private partnerships, anti-trust, compliance and tax investigations, as well as some of the gravest internet security breaches in history. He has experience opening new markets, bringing in new cloud-based and life-sciences products, technology and services. As a member of several management teams, he was leading companies' legal and growth strategy across the world. He has also established several international start-ups. He speaks seven languages and is admitted to professional bars in the EU and in the state of New York, and is currently CFO at CloudEO.

Second Session

Massimo Comparini

Massimo Comparini is CEO at e-GEOS and EARSC Director. He has a Master Degree in Electrical Engineering, Remote Sensing and Radar Systems, University of Rome "La Sapienza", and a Degree in Strategy at the Graduate School of Business, Stanford University, CA. He began his career in the space industry in 1983 at Selenia Spazio reaching the role of Chief Technology Officer. In Thales Alenia Space, he took up the role of Deputy Chief Technical Officer, CTO and VP for R&D, Technology, Product Policy and IPR. In 2013 he was appointed Chief Technical Officer at Telespazio. He is also the Chairman of Space Innovation in the Italian Technology Platform SPIN IT. In 2016, he has been appointed as CEO of e-GEOS.

Per Öster

Dr. Per Öster is Director at CSC – IT Center for Science Ltd, Finland with responsibility of the Research Environments business area. The business area comprises supercomputing and distributed computing services, scientific application support, HPC support, and software engineering. Dr Öster joined CSC in 2007. Per Öster graduated in Physics from Uppsala University and got his Ph.D. at the University of Gothenburg. He was the Chair then Chair of Board of the European Grid Initiative Council between 2009 and 2012. At the IT Center for Science, he worked as Director in different domains such as Research Environments, Application Services and now Research Infrastructures. Dr Öster has more than 20 years of experience in scientific computing from both academia and industry. Recent specific commitments and positions of trust include chair of the European Grid Initiative Council (EGI) and chair of the EGI.eu foundation executive board.

Marc Ferrer

Over the years Marc Ferrer have moved from being a software developer, technical responsible, and project director on various space programs. Then he moved to business development position with delivery responsibilities and a true will to tackle innovation subjects. Marc is now in charge of the Space Market at Atos.

Maryline Lengert

Maryline Lengert, Head of the Security and Specialised Services Division in the ESA IT department, leads the provision of ICT and IT security services dedicated to ESA technical IT counterparts and supports the adoption of common solutions across the Agency, including private and public cloud. She has been involved since 2009 in various initiatives to catalyse the creation of a European owned public cloud, serving initially the Science Research Area. The "Strategic Plan for a Scientific Cloud Computing infrastructure for Europe" endorsed in June 2011 has been the first step for the creation of Helix Nebula, the Science Cloud public-private

partnership. Maryline has 25+ years of experience in the IT domain within an international environment. Her previous positions include Technical Manager and Operations Director for Hospital Integrated Information System in S.A.I.C. France, Quality Manager and Head of the Account Management and Requirement Analysis Division in the ESA IT Department. Maryline holds a PhD in Physics and a Master in International and European Studies.

Davide Salomoni

Davide Salomoni is Director of Technology (*Dirigente Tecnologo*) at the Italian National Institute for Nuclear Physics (INFN). He has more than 25 years of international experience in both private and public environments related to distributed computing and communication technologies. He currently leads the Software Development and Distributed Systems department at CNAF (Bologna, Italy), the INFN National Center dedicated to research and development on IT technologies. His interests are focused on the evolution, scalability and interoperability of Cloud computing and storage technologies. He is the Project Coordinator of the European project called INDIGO-DataCloud, funded with 11.1M€ under the Horizon2020 framework. INDIGO-DataCloud, a project between 26 academic and commercial partners, builds an open source Cloud computing and data platform targeted at multi-disciplinary scientific communities and deployable on heterogeneous infrastructures. He also leads or participates to several other national and international projects on distributed architectures. He is the coordinator of the INFN Cloud Computing national working group and is engaged with activities related to technology transfer in Universities, Public Administrations and commercial companies through seminars, courses and lectures.

Andreas Falkner

Andreas Falkner started to work as Telecommunication Engineer for Siemens AG in 1990. He was mainly appointed to international Projects in Asia, Africa, Americas and Europe. Since 1996 he had various management functions in the Broadband and Mobile Networks area within Siemens AG. Andreas decided to start up his own Consultancy Company for Project Management in 2006 to consult and manage large Mobile Network Projects in Latin America and Germany before he joined T-Systems International in March 2011 in the Strategic Area Energy as VP Operations. Since the beginning of 2016 Andreas Falkner is Vice President for Open Telekom Cloud in the Digital Division at T-Systems International. In this role he is responsible for Deutsche Telekom's Public Cloud offering. Andreas Falkner lives near Munich/Germany. He is married and has 3 children.

Third Session

Ingo Baumann

Ingo is founding partner of BHO Legal, a boutique space, IT and procurement law firm based in Cologne, Germany. Ingo's practice focuses on technology and R&D projects, especially within space, satellite navigation, Earth observation and geospatial industries. His client base includes space agencies, public research institutions, global satellite communications operators and other leading space industry stakeholders. Working for seven years as legal advisor within DLR, Ingo has large experience in all types of European and national research projects. He has been responsible for numerous projects under the EU Framework Research Program and under national research programs. His major project responsibilities within DLR included the set-up of cooperation mechanisms for the HALO Research Aircraft as well as satellite

projects SATCOMBw, SAR-Lupe and GMES. Before leaving DLR end of 2008, Ingo has been Head of the DLR Galileo Project Office and CEO of the DLR GfR mbH, the operating company of DLR for the German Galileo Control Centre. Ingo studied law in Muenster and Cologne, Germany. He wrote his doctoral thesis at the Cologne Institute for Air and Space Law on the international law of satellite communications, with a special focus on the privatization processes of the International Satellite Organizations INMARSAT, INTELSAT, EUTELSAT and INTERSPUTNIK. Ingo regularly speaks at space law conferences and Workshops and lectures at Leiden Institute of Air and Space Law or at the ECSL Summer Course. Ingo is a member of the Cologne Bar Association, the International Institute of Space Law (IISL), the European Centre for Space Law (ESCL), the International Bar Association (IBA, Outer Space Committee), the European Remote Sensing Association (EARSC) and other relevant institutions.

About the authors

Matteo Tugnoli has been working as Resident Fellow at the European Space Policy Institute (ESPI) in Vienna, Austria, since January 2015. In addition to being project manager for the ESA-ESPI Workshop on Space Data & Cloud Computing, his research activities encompass space transportation and the European strategy on access to space, as well as ESA Member States space governance and strategies. In ESPI he also works as Secretary for the European Interparliamentary Space Conference (EISC).

Prior to joining ESPI, he worked as Trainee in the Relations with Member States Department, Director's General Cabinet, of the European Space Agency (ESA HQ) in Paris, France.

He started his space career as Research Assistant at the Institute for Radioastronomy, National Institute for Astrophysics (INAF) in Bologna, Italy, where he carried out research on diffuse synchrotron radio emission (radio halos and relics) in clusters of galaxies.

Matteo has a Bachelor of Science in Astronomy and a Master of Science in Astrophysics and Cosmology, from the University of Bologna, Italy. He also has a Master in Space Policies and Institutions from the Italian Society for International Organizations (SIOI) and Italian Space Agency (ASI) in Rome, Italy.

Chris Beauregard is a second-year graduate student at the George Washington University Elliott School of International Affairs, where he is studying International Science and Technology Policy with a concentration in Space Policy and Commerce.

In summer 2017, he served as a programme management intern at the United Nations Office of Outer Space Affairs and as a visiting scholar at the European Space Policy Institute in Vienna, Austria.

In the past academic year, he also served as the staff assistant to Dr. Scott Pace at the Space Policy Institute and held the role of communications coordinator for the Space Generation Advisory Council. In addition to his studies, he is currently assisting GW's Micropropulsion and Nanotechnology Lab with the regulatory issues associated with launching the University's first satellite.

Mission Statement of ESPI

The European Space Policy Institute (ESPI) provides decision-makers with an informed view on mid- to long-term issues relevant to Europe's space activities. In this context, ESPI acts as an independent platform for developing positions and strategies.