

Long-Tail-of-Science's Requirements for Commodity Cloud Services in Europe

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Abstract— Leveraging lessons learned on voucher schemes to access commercial cloud services, CERN is leading the task “requirements collection for commodity cloud services” in the Open Clouds for Research Environments (OCRE) project¹. To this end, CERN collaborated with the European Council of Doctoral Candidates and Junior Researchers (Eurodoc)² and the Marie Curie Alumni Association (MCAA)³ to launch a comprehensive survey targeted to individual researchers in Europe. The analysis of the responses allowed the identification of consumption habits, needs and technical requirements of individual researchers for commercial cloud services. The conclusions of this analysis are proposed as an input for the implementation of voucher schemes in the European Open Science Cloud (EOSC)⁴.

Keywords—commodity cloud, Long-Tail-of-Science, requirements gathering.

I. ACKNOWLEDGMENTS

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II. INTRODUCTION

In 2016, the European Commission proposed the creation of the European Open Science Cloud (EOSC), with the aim of offering Europe's 1.7 million researchers and 70 million science and technology professionals a platform to store, share and re-use their data across disciplines and borders. The minimum requirements for commercial or non-commercial entities that wish to participate in the EOSC as service providers have been discussed in the EOSCpilot project⁵. The requirement for one of the proposed innovative business model is the establishment of euro-denominated

¹ <https://www.ocre-project.eu/>

² <http://www.eurodoc.net/>

³ <https://www.mariecurialumni.eu/>

⁴ <https://www.eosc-portal.eu/>

⁵ <https://eoscpilot.eu/>



EOSC voucher⁶ distributed to individual researchers through grants, or supplementary awards, that can be used to purchase services from a set of compliant providers.

CERN started exploring the potential advantages of a voucher scheme implementation based on cloud credits already in two European projects: PICSE⁷ and EGI-Engage⁸. More recently, CERN led the Helix Nebula Science Cloud (HNSciCloud) project⁹ where voucher schemes were developed by the two consortia of companies, one led by T-Systems¹⁰ and the other by the RHEA group¹¹ that reached the project's pilot phase. The vouchers were distributed to end-users and feedback was gathered and analysed, allowing the identification of some essential elements for a flexible and efficient voucher scheme for the research community.

Building on this experience, CERN is participating in the OCRE project, that aims to accelerate cloud adoption in the European research community, by bringing together commercial cloud providers, Earth Observation organisations, and the research and education community. OCRE will encourage the consumption of commercial cloud services by research organisations as well as by individual researchers using cloud vouchers. CERN is leading the task "Requirements Collection for Commodity Services" under the Work Package "Community Outreach and Requirements". In this context, CERN gathered and analysed the requirements of individual researchers representing the European Long-Tail-of-Science. The Long-Tail-of-Science can briefly be defined as referring to individual scientists working on small-scale projects in multiple domains that produce scientific data which, combined, represents a significant portion of the total scientific output.¹²

This activity was performed from April 2019 to September 2019 and the outcome of the analysis detailed in this report is being taken into account in the preparation of the OCRE tender.

After listing some essential elements for a flexible and efficient voucher scheme for the research community, this paper explains the process followed to gather and analyse the requirements from the Long-Tail-of-Science for commercial cloud services in the context of the OCRE project. The results of the analysis are detailed in the third section of this paper and the next steps and implications for the EOSC are summarized in the fourth section.

III. LESSONS LEARNED FROM PREVIOUS EXPERIENCE

HNSciCloud is a European Pre-Commercial Procurement (PCP) project aiming to establish a hybrid cloud platform combining commercial services with existing publicly funded on-premise resources, to support the deployment of high performance computing and big-data capabilities for scientific research. In a competitive R&D process specific to PCP projects, two consortia were awarded contracts for the pilot phase:

- The consortium led by T-Systems, that includes Huawei, Cyfronet and Divia
- The consortium led by the RHEA group, that includes SixSq, Exoscale and T-Systems

Within this phase, the two consortia developed integrated voucher schemes as a R&D requirement of the project. In order to test the schemes, part of the total procured capacity was made available in the form of vouchers to be distributed to end-users. Details on this process are documented in a report published by the project¹³. The feedback provided by end-users was analysed by the project team and allowed the identification of essential elements for a flexible and efficient voucher scheme for the research community. These elements are listed below:

- Fixed face value in monetary units
- Free at the point of use
- Defined duration of validity
- No limitation on the number of vouchers that can be consumed by an end-user
- Defined catalogue of services accessible with the voucher
- Up-to-date and detailed documentation and tutorials
- Near real-time usage monitoring
- Applicable Service Level Agreement (SLA)
- Clear data repatriation policy and associated costs

⁶ Prompting an EOSC in practice - Final report and recommendations of the Commission 2nd High Level Expert Group on the European Open Science Cloud (EOSC), European Commission, 2018, DOI 10.2777/112658

⁷ Garavelli, S., Amsaghrou, R., & Jones, B. (2016, April 26). Cloud Services Procurement Roadmap for Public Research Organisations. Zenodo. <http://doi.org/10.5281/zenodo.50504>

⁸ Cross-border procurement of e-Infrastructure services: Opportunities, Barriers, Use cases, Best Practices, 6 March 2017, <https://documents.egi.eu/document/3013>

⁹ <https://www.hnscicloud.eu/>

¹⁰ <https://www.t-systems.com/de/en>

¹¹ <https://www.rheagroup.com/>

¹² <https://ieeexplore.ieee.org/document/7747811>

¹³ <https://doi.org/10.5281/zenodo.2615456>

In addition, CERN is a partner in the EOSC-hub project¹⁴ Work Package 12. The EOSC-hub has a mission of bridging major European research infrastructures and the core e-infrastructure community to develop a common catalogue of data, services, and software for research. WP12 contributes to the design of future business models and procurement frameworks for acquiring digital services from both publicly funded and commercial providers. In this view, the EOSC-hub project published the results of a demand-side market research to understand the need and level of demand for digital services for research in the context of the EOSC¹⁵. It explores the manner in which such need and demand are currently met and challenges faced in respect of analysis workflows, data management, and related infrastructure and services. It identifies current and preferred delivery models for such services as well as funding streams and procurement strategies and proposes areas of improvement for business models. The report argues that cloud coins, vouchers, or credits forms a legitimate mechanism to provide access to services to users. In addition, it lists decisions that would need to be made about various policy matters relating to the vouchers. The recommendations made by the EOSC-hub project are complementing the experience with voucher schemes to access commercial cloud resources gathered via the HNSciCloud project.

IV. LONG-TAIL-OF-SCIENCE REQUIREMENTS GATHERING ACTIVITIES

To gather the needs of the Long-Tail-of-Science for commodity cloud services in the context of the OCRE project, CERN collaborated with two organisations: the European Council of Doctoral Candidates and Junior Researchers (Eurodoc) and the Marie Curie Alumni Association (MCAA).

Eurodoc is an international federation of 28 national organisations of doctoral candidates and junior researchers¹⁶ from 26 countries in the European Union and the Council of Europe. Eurodoc's objectives are, among others, to represent doctoral candidates and junior researchers at the European level, advance the quality of doctoral programmes and the standards of research activity in Europe, and promote the circulation of information on issues regarding early-career researchers. Eurodoc is fully committed to the transition to Open Science¹⁷ and supports the implementation of FAIR data via the EOSC¹⁸.

MCAA is a global network of researchers receiving or having received funding via Marie Skłodowska-Curie actions. This international non-profit organisation aims to enhance the flow of knowledge across different countries, sectors of the economy, and scientific disciplines, encourage networking, cooperation, and mutual understanding among MCAA members, and external stakeholders, and serve as a forum of debate for researchers and citizens.

Together, these two organisations represent several thousands of researchers specialised in different fields that are selected for their scientific excellence. Eurodoc and MCAA organisations, and the researchers they engage, were considered to be an appropriate representation of the Long-Tail-of-Science in Europe and were selected as the target audience for the requirements gathering activities in the context of the OCRE project.

To optimize the requirements collection, CERN, Eurodoc and MCAA agreed on a phased approach. First, the three organisations jointly created a questionnaire containing 20 questions (see Annex A). This survey was then disseminated throughout the Eurodoc network of national early-career representatives and Open Science Ambassadors. These representatives were nominated by the 28 organisations of Eurodoc to act as a liaison between Eurodoc and the association on Open Science and raise awareness of Open Science both nationally in their own country and association and across Europe via Eurodoc. They were being trained to promote and share information on Open Science and specifically Open Access, FAIR/Open Data, and EOSC.

In parallel, the survey was also advertised at the Eurodoc Annual Conference¹⁹ in Brussels on the 1st April 2019, at the Researchers Meet Innovators event²⁰ organised by MCAA in Berlin on 11th July 2019, and on the Eurodoc and CERN openlab²¹ websites.

This multi-channel dissemination method generated 81 responses to the questionnaire by researchers in the Eurodoc and MCAA networks between 1st April and 1st September 2019.

¹⁴ <https://www.eosc-hub.eu/>

¹⁵ <https://www.eosc-hub.eu/deliverable/d121-procurement-requirements-and-demand-assessment-submitted>

¹⁶ <http://www.eurodoc.net/eurodoc-members>

¹⁷ <https://doi.org/10.21820/23987073.2018.6.64>

¹⁸ <http://eurodoc.net/sites/default/files/attachments/2017/133/eurodocfp9statement.pdf>

¹⁹ <http://eurodoc.net/conference-agm-2019>

²⁰ <https://www.ocre-project.eu/events/researchers-meet-innovators>

²¹ <https://openlab.cern/>

V. LONG-TAIL-OF-SCIENCE REQUIREMENTS ANALYSIS

The process for analysing the survey responses is described below. A subset of the data was first analysed by CERN in June 2016, relating to the 64 responses received at that point in time. The results were reviewed by MCAA and Eurodoc, before being presented in the OCRE webinar that took place on the 9th June 2019²². The analysis was run again in August 2019 based on 78 answers. The updated results were presented to the European Commission in September 2019, during the OCRE project review. By 1st September, 81 responses were received. However, 9 responses were judged incomplete and therefore removed from the dataset. A final analysis of the dataset of 72 responses was performed in October 2019 for the publication of this document.

VI. LONG-TAIL-OF-SCIENCE REQUIREMENTS FOR COMMERCIAL CLOUD SERVICES

The qualitative analysis was divided into three parts: the respondents' profiles, their current usage of commercial cloud services, and their needs for such services.

A. Respondents' profiles

Among the 72 persons who responded to the form, 53% are female and 47% are male. Overall, the respondents are citizens of 31 different countries, among which 18 are members states of the European Union (EU). Approximately 74% of the respondents are citizens of EU member states, of which 42% are citizens of Central and Eastern European countries²³. In addition, the majority of the respondents are performing their research in Europe. The detailed breakdown of the respondents nationality is available in Figure 1 below.

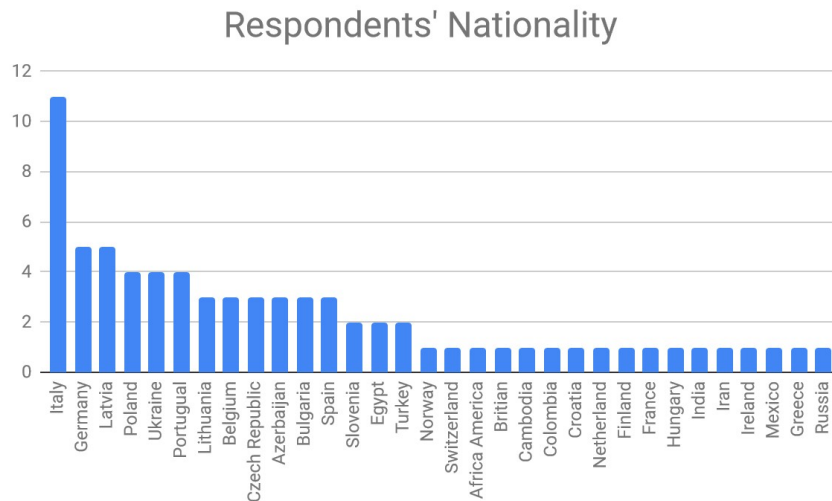


Figure 1: Nationality breakdown of the respondents of the requirements gathering survey

The distribution of respondents per country reflects the membership of MCAA and Eurodoc. Italian researchers represent the largest share of researchers in the MCAA network (~14% of MCAA members have the Italian nationality)²⁴. In addition, the Italian association member of Eurodoc, the Associazione Dottorandi e Dottori di Ricerca Italiani (ADI)²⁵, is known as one of the most active and responsive national associations of Eurodoc.

The majority of the respondents are PhD candidates (~40%) or postdoctoral researcher (~36%). A minority is assistant professor (~7%) and associate professor (~7%). The researchers are specialised in diverse fields of research. The most represented fields are engineering and technology (~29%), natural sciences (~16%), social sciences (~15%) and medical and health sciences (~15%). Several factors may explain the high response rate from researchers specialised in engineering and technology. First, this field is the second most represented field in the MCAA network (~20% of MCAA members are working in engineering)²⁶. Then, it is probable that researchers in engineering and technical fields are more familiar with IT tools than researchers in other fields, and therefore more interested in using them for their research.

²² <https://www.ocre-project.eu/events/ocres-4th-webinar-tender-and-adoption-funding>

²³ According to the definition from the Organisation for Economic Cooperation and Development (OECD),

<https://stats.oecd.org/glossary/detail.asp?ID=303>

²⁴ <https://www.mariecurialumni.eu/charts>

²⁵ <http://www.eurodoc.net/na/adi>

²⁶ <https://www.mariecurialumni.eu/charts>

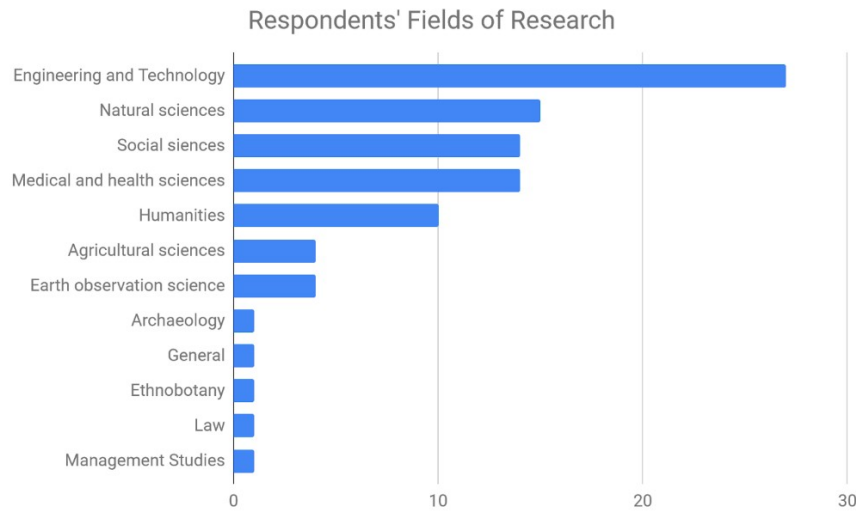


Figure 2: Fields of research of the respondents of the requirements gathering survey

B. Current usage of commercial cloud services

Half of the respondents are currently using commercial cloud services for research purposes. The main barriers to the use of commercial cloud services are the fact the respondents' universities/institutes do not pay for commercial cloud services (~27%) and that the researchers do not want to pay for the services themselves (~21%).

The researchers who are currently using commercial cloud services for their research are mostly using file management tools. About two thirds (~69%) are using Dropbox and approximately 42% are using WeTransfer. In addition, more than half of the respondents (~67%) are using Google Cloud. As some researchers are not familiar with the different cloud services available on the market, the questionnaire displayed a list of commercial cloud service providers they could choose from. The list provided is the following: Amazon Web Services (AWS), Automium and Enter, Cloud Sigma, Dropbox, Dimension Data, Exoscale, Figshare, Google Cloud, ITSoft, KPN, Lattelecom, Microsoft Azure, Oracle Cloud, Sparkle, T-Systems, Vancis and WeTransfer. This list has been established based on the services providers selected in the GEANT IaaS Framework²⁷ and additional most known service providers such as Dropbox and Wetransfers. The respondents could select the option "other" and add cloud service providers that were not available in the list. The figure 3 below shows the relative usage of commercial cloud services by the respondents.

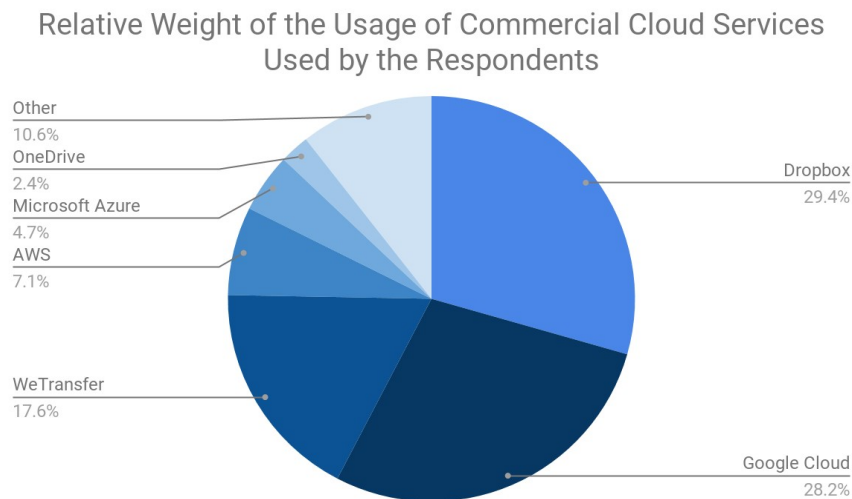


Figure 3: Relative weight of the usage of commercial cloud services used by the respondents

While a significant share of researchers are accessing the services free of charge (~64%), approximately 47% are personally paying for these services and for around 33% access to the commercial cloud services is funded via their

²⁷ <https://clouds.geant.org/geant-cloud-catalogue/geant-cloud-catalogue-iaas/>

universities or institutes. In the majority of the cases, the respondents are accessing commercial cloud services using more than payment model. For instance, many researchers are accessing some services for free and by personally paying for other services.

The main way of accessing the three most used commercial cloud services (i.e. Dropbox, Wetransfers and Google Cloud) is via freemium models. Details on the means used by the respondents to access these three commercial cloud services are available in Figure 4.

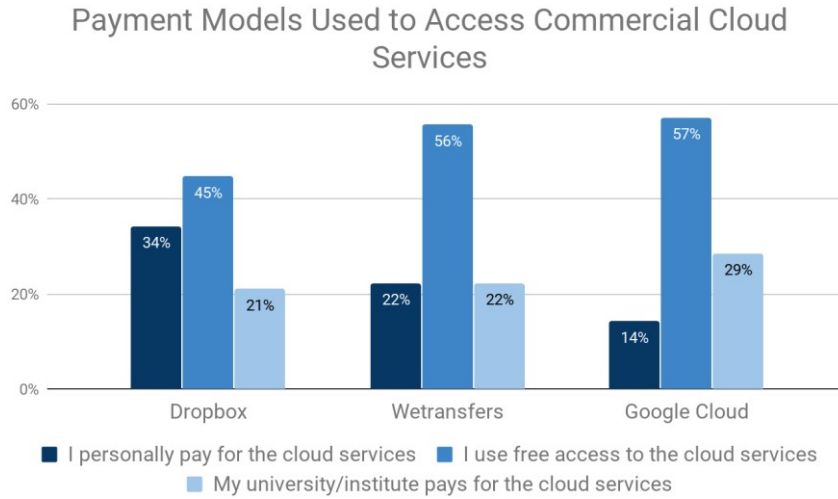


Figure 4: Payment models used to access commercial cloud services

Finally, the majority of the respondents have either some experience (~51%) or a lot of experience (~10%) with commercial cloud services. Approximately a third of the respondents have no experience with commercial cloud services.

C. Need for commercial cloud services

Approximately half of the respondents(~49%) are in need of a medium²⁸ capacity of commercial cloud services, with high processing needs, requiring large software and data usage. A third of the respondents (~34%) have low processing needs that require small-scale software and light data usage. A small proportion (~16%) has intensive processing needs, necessitating huge software and data usage. This data is represented in Figure 5 below.

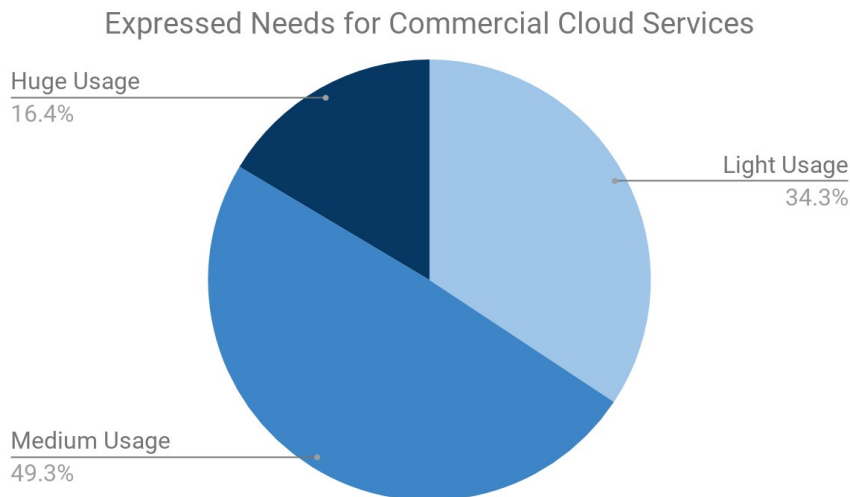


Figure 5: Expressed needs in term of commercial cloud services of the respondents

²⁸ In the context of the survey, light usage of commercial cloud services corresponds to low processing needs, requiring small software and data usage. Medium usage corresponds to high processing needs, requiring large software and data usage. Huge usage corresponds to intensive processing needs, necessitating huge software and data usage.

The respondents are mostly interested in accessing storage (~64%) and compute (~51%) services. Researchers are also looking for engineering software tools and services, such as MATLAB, Mathematica, Ansys, AutoCAD (~30%), and artificial intelligence, machine learning, and deep learning services, such as Keras and TensorFlow (~20%). Finally, researchers are keen on using commercial cloud services to manage (~24%), visualise (~24%), and share (~20%) their data. The details of the cloud services that are of interest for the respondents are available in Figure 6.

Commercial Cloud Services of Interest for the Respondents

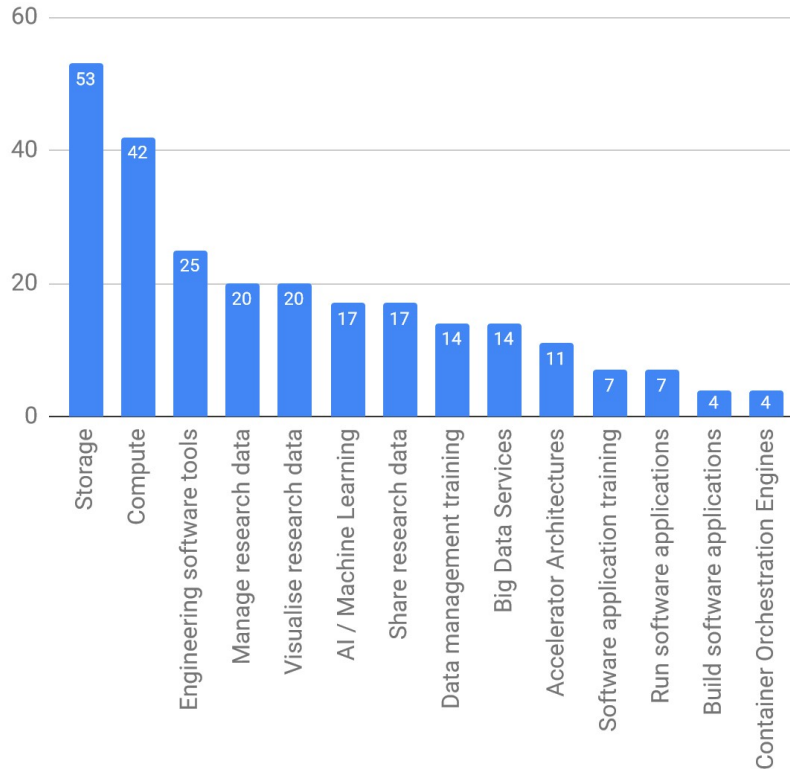


Figure 6: Commercial cloud services of interest for the respondents of the requirements gathering survey

D. Summary of the results

The audience for the survey are researchers affiliated to Eurodoc or MCAA. The majority are PhD candidates or postdoctoral fellows, performing research in Europe in various fields. The researchers are mainly European, with a fair good representation of Central and Eastern European countries²⁹ (i.e. ~31% of the respondents are citizens of a Central and Eastern European country). The gender representation among the respondents is balanced. Approximately half of the respondents are currently using commercial cloud services for their research, accessing mostly file management services such as Dropbox and WeTransfer, as well as Google Cloud. Researchers are mostly accessing these services via the free offers from commercial cloud providers or by paying themselves for the services. The main obstacle in using commercial cloud services is that the researchers' universities / institutes do not pay for these services.

About two-thirds of the respondents have either some or a lot of experience in using commercial cloud services. Approximately half of the respondents needs a medium usage of commercial cloud services, with high processing needs, requiring large software and data usage. Overall, researchers are mostly interested in storage and compute capacity, engineering software tools, and data visualization and management services.

VII. NEXT STEPS AND IMPLICATIONS FOR THE EOSC

The OCRE project foresees the launch a pan-European tender to deliver commodity cloud services for the research community in Europe. The Long-Tail-of-Science requirements for commercial cloud services identified in this report were proposed to the OCRE management team as an input for the preparation of this pan-European tender.

²⁹ According to the definition from the Organisation for Economic Cooperation and Development (OECD), <https://stats.oecd.org/glossary/detail.asp?ID=303>

In parallel, the OCRE working plan foresees a first batch of vouchers, accounting for a total of €400,000 to be procured under the existing GEANT IaaS Framework and distributed to individual researchers. One fourth of the total value (i.e. €100,000) will be distributed to the selected researchers affiliated with Eurodoc and MCAA. Eurodoc, MCAA and CERN are responsible for distributing these vouchers to the awardees and tracking their consumption. To this end, CERN plans to subcontract Voucherify³⁰, an SME based in Poland and created in 2016 that aims to provide organisations with scalable promotion infrastructures. The feature set, performance, flexibility, operational effort, and overall usability of the platform to track vouchers will be assessed and documented in the context of the OCRE project. The objective is to establish a proof of concept that explores a very lightweight mechanism for tracking vouchers distribution and consumption.

Finally, CERN will gather and analyse feedback and recommendations from individual researchers on their experience with vouchers to access commercial cloud services. The outcome of the analysis of the feedback and recommendations from the individual researchers will be documented and proposed as an input for the implementation of the future EOSC voucher schemes.

³⁰ <https://www.voucherify.io/>

ANNEXE A: REQUIREMENTS GATHERING QUESTIONNAIRE

Testing the European Open Science Cloud (EOSC)

This survey is for (early-career and senior) researchers who are interested in testing or using cloud services from the Open Cloud for Research Environments (OCRE) project, as part of the European Open Science Cloud (EOSC), and the CERN openlab. The survey will take 5-10 minutes to fill in. Successful candidates will be issued with vouchers/credits to use services on the cloud. Please note that filling in the survey does not guarantee automatic access to the vouchers. We are looking for a diversity of researchers across researcher types, gender, scientific disciplines, and geographical location. Planned testing of the cloud services will take place from September 2019. Successful candidates will be testing and using cloud services via the use of free vouchers/credits and provide feedback. A Privacy notice needs to be accepted to fill the form.

* Required



Privacy Notice *

In order to test and use cloud providers in the context of the EOSC, your name, email address, affiliation and your mailing list memberships according to the following privacy notice: <https://tinyurl.com/OCRE-PN>. Do you accept?

☐ Yes

☐ No

Biography

Where did you hear about the testing? *

☐ European Council of Doctoral Candidates and Junior Researchers (Eurodoc)

☐ Marie Curie Alumni Association (MCAA)

☐ Other:

What type of researcher are you? *

- ☐ PhD candidate
- ☐ Postdoctoral researcher
- ☐ Assistant professor
- ☐ Associate professor
- ☐ Full professor
- ☐ Other: _____

What is your field(s) of research ? *

You can select more than one option

- ☐ Agricultural sciences
- ☐ Engineering and technology
- ☐ Earth observation science
- ☐ Humanities
- ☐ Medical and health sciences
- ☐ Natural sciences
- ☐ Social sciences
- ☐ Other: _____

What is your first name? *

Your answer _____

What is your last name? *

Your answer _____

What is your gender? *

- ☐ Male
- ☐ Female
- ☐ Prefer not to say
- ☐ Other: _____

What is your nationality ? *

Your answer _____

In which country do you do your research? *

Your answer _____

What is your research institution? *

Your answer _____

What is your institutional email address? *

Your answer _____

Current Cloud Services

* Commercial cloud service = a service made available to users on demand via the Internet from a commercial provider's server as opposed to being provided by an institution's own servers (eg Amazon, Dropbox, Figshare, Google, Microsoft, and WeTransfer)

Are you currently using commercial cloud services for your research? *

- ☐ Yes
- ☐ No

Current Cloud Services

Which commercial cloud services(s) are you using for your research? *

- ☐ Amazon Web Services (AWS)
- ☐ Automium + Enter
- ☐ Cloud Sigma
- ☐ Dropbox
- ☐ Dimension Data
- ☐ Exoscale
- ☐ Figshare
- ☐ Google Cloud
- ☐ ITSoft
- ☐ KPN
- ☐ Lattelecom
- ☐ Microsoft Azure
- ☐ Oracle Cloud
- ☐ Sparkle
- ☐ T-Systems
- ☐ Vancis
- ☐ WeTransfer
- ☐ Other: _____

How do you pay for these cloud services for your research? *

- ☐ My university/institute pays for the cloud services
- ☐ I personally pay for the cloud services
- ☐ I use free access to the cloud services
- ☐ Other: _____

Are you interested in receiving free vouchers to test cloud services for your research? *

- ☐ Yes
- ☐ No

Barriers to use Cloud Services

What prevents you from using commercial cloud services for your research? *

- ☐ My university/institute does not pay for commercial cloud services
- ☐ I do not want to personally pay for commercial cloud services
- ☐ I do not know of relevant commercial cloud services
- ☐ I do not know how to use commercial cloud services
- ☐ I do not need any commercial cloud services
- ☐ I have access to non-commercial cloud services
- ☐ Other: _____

Are you interested in receiving free vouchers to test and use cloud services for your research? *

- ☐ Yes
- ☐ No

Cloud Service Credits/Vouchers

* Cloud service credit/voucher = a credit/voucher in increments of €250/€1000/€2000 that can be used by researchers to buy services on the cloud

What is your level of experience with commercial cloud services?
? *

- ☐ I have a lot of experience
- ☐ I have some experience
- ☐ I have no experience

Services for Experienced Cloud Users

Which cloud services are you interested in using? *

You can select more than one service

- ☐ Compute
- ☐ Accelerator Architectures (GPUs, FPGAs)
- ☐ Container Orchestration Engines (e. g. Kubernetes, Docker Swarm)
- ☐ Cloud Storage
- ☐ Big Data Services (e. g. Spark, Hadoop)
- ☐ AI / Machine Learning / Deep Learning Services (e. g. Keras, TensorFlow)
- ☐ Engineering Software Services and Tools (e. g. MATLAB, Mathematica, Ansys, AutoCAD)
- ☐ Other: _____

Services for Beginning Cloud Users

Which cloud services are you interested in using? *

You can select more than one service

- ☐ Build software applications
- ☐ Run software applications
- ☐ Manage research data
- ☐ Analyse research data
- ☐ Visualise research data
- ☐ Share research data
- ☐ Store research data
- ☐ Software application training
- ☐ Data management training
- ☐ Engineering software tools (MATLAB, Mathematica, Ansys, AutoCAD...)
- ☐ Other: _____

Cloud Service Usage

What type of cloud service usage do you need? *

- ☐ Light usage = low processing/small software and data usage
- ☐ Medium usage = high processing/big software and data usage
- ☐ Huge usage = intensive processing/huge software and data usage

Please briefly explain the research project for which you would like to use these cloud services! *

Your answer _____

Feedback Consent

* If you are interested in testing the cloud services using the vouchers then you need to answer positively to this question!

Do you agree to fill in a feedback form after testing the cloud services if you receive vouchers? *

☐ Yes

☐ No

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