EGI-Engage

Cross Border Procurement of e-Infrastructure services: Opportunities, Barriers, Use cases, Best Practices

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Abstract

This report presents the results of the cross-border procurement of e-Infrastructure services study within the EGI-Engage project. Barriers that inhibit procurement are defined and a set of case studies examined to identify best practices that can overcome such procurement barriers. Analysis of the barriers, case studies and best practices led to a series of opportunities being proposed for the future planning of EGI and the Open Science Commons.

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DELIVERY SLIP

	Name	*Partner/Activity*	*Date*
From:	Bob Jones	CERN/WP2	
Moderated by:	Malgorzata Krakowian	EGI Foundation/WP1	
Reviewed by	Malgorzata Krakowian, Ohad Graber-Soudry	EGI Foundation/WP1 Head of Legal, European Spallation Source	23.02.3017 20.02.2017
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TERMINOLOGY

A complete project glossary is provided at the following page: http://www.egi.eu/about/glossary/

1 Executive Summary

EGI operates within a publicly funded research and academic environment providing services free at point of delivery with resources bought from grants dedicated to certain groups or disciplines either by direct allocation or by peer review. With the advent of cloud computing, business models and user expectations have been shifting towards on-demand and pay-for-use service provision increasing flexibility and agility. This shift motivated EGI to explore new service definitions by enabling the possibility to provide ICT services that can be paid for the use, along with the more traditional procurement of resources to be managed and offered for free to the owners.

The vision of EGI is to establish a market of service providers and consumers that can operate according to a variety of business models, where services are delivered under a contractual framework and according to measured SLAs. EGI-Engage has analysed opportunities and barriers for cross-border procurement of e-Infrastructure services from Research Infrastructures and large research collaborations. The output of this study will be of importance to funding agencies and policy makers to define the role of e-Infrastructures for the European Research Area (ERA), to ensure persistency of services and shape the landscape of future partnerships.

A series of barriers to procurement of e-Infrastructure services have been identified that directly impact the public research sector and the ERIC legal structure that is used to coordinate many Research Infrastructures. Case studies of existing procurement actions are documented and a number of best practices are derived that can help overcome the barriers that deter procurement and the pay-for-use model.

The analysis of the identified barriers, best practices and use-cases led to an examination of a set of potential opportunities for cross-border procurement:

- **Procurement Framework**: Selection and validation of services on conformance with legal, business and technical requirements;
- **Service Catalogue**: Organise conformant services into a catalogue through which they can be more easily procured;
- **Joint Procurement**: Group of procurers commit to collectively procure conformant services;
- **Service Credit Scheme**: Multi-year procurement commitment at a European level in the context of the European Open Science Cloud.

Each successive opportunity represents increasing added value for the stakeholders with the key questions being 'who pays?' and what risks are the participating parties ready to accept. The potential role of EGI in the opportunities is highlighted concluding with a number of recommendations to prepare a cross-border procurement scheme with the European Commission that could be used to establish an Open Science Commons. This cross-border procurement scheme would offer service credits to ESFRI Research Infrastructures and their associated user communities in a hybrid environment that brings together their own resources, publicly funded e-Infrastructures and commercial service providers. The scheme could make use the EGI Pay-for-Use pilot, service catalogue and e-GRANT portal as a basis for its implementation.

2 Contents

3 Introduction

Over the last several years, there has been a real push by e-Infrastructures evolving towards more service-oriented provision with more formal internal service management practices as well as on-demand allocation and even the introduction of pay-for-use capabilities, however there is an additional opportunity for analysing and revising the procurement process for e-Infrastructure services.

EGI operates within a publicly funded research and academic environment providing services free at point of delivery with resources bought from grants dedicated to certain groups or disciplines either by direct allocation or by peer review. With the advent of cloud computing, business models and user expectations have been shifting towards on-demand and pay-for-use service provision increasing flexibility and agility. This shift motivated EGI to explore new service definitions by enabling the possibility to provide ICT services that can be paid for the use, along with the more traditional procurement of resources to be managed and offered for free to the owners.

The vision of EGI is to establish a market of service providers and consumers that can operate according to a variety of business models, where services are delivered under a contractual framework and according to measured SLAs. EGI-Engage has analysed opportunities and barriers for cross-border procurement of e-Infrastructure services from Research Infrastructures (RIs) and large research collaborations. The output of this study will be of importance to funding agencies and policy makers to define the role of e-Infrastructures for the ERA, to ensure persistency of services and shape the landscape of future partnerships.

Cross-border procurement of e-Infrastructure services is an activity of the EGI-Engage project (NA2[1]) involving the partners CERN, BBMRI-ERIC, CSIC (LifeWatch), RBI (DARIAH), INGV (EPOS) and the EGI Foundation (representing EGI and liaising with the National e-Infrastructures - NGIs).

The work of this task is closely related to two other tasks: 1) 'EGI Marketplace' led by SWING (NA2.2) that has analysed the requirements for the EGI marketplace, produced a design and implemented prototypes that were demonstrated in September-October 2016[2]; 2) The work on the 'Pay-for-use Implementation' led by the EGI Foundation (NA2.2) that was reported in the 'EGI Sustainability and Business Development Plan' document D2.9 in February 2016[3]. The progress of the activity has been reviewed during sessions at events organised by the EGI-Engage project, namely: EGI Conference in Lisbon, May 2015[4]; EGI Community Forum in Bari; November 2015[5], EGI Conference in Amsterdam, April 2016[6]; Digital Infrastructures for Research 2016 in Krakow, September 2016[7].

The rest of this document is structured as follows: barriers to procurement and best practices for cross-border procurement are outlined in section 4; section 5 highlights important use-cases; section 6 presents a series of opportunities available to EGI and the document concludes with a summary in section 7.

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[1] https://wiki.egi.eu/wiki/EGI-Engage:WP2
[2] D3.7, EGI Service Registry and Marketplace prototype, https://documents.egi.eu/document/2914
[3] https://documents.egi.eu/document/2669
[4] https://indico.egi.eu/indico/event/2452/session/73/#20150520
[5] https://indico.egi.eu/indico/event/2544/session/19/#20151110
[6] https://indico.egi.eu/indico/event/2875/session/27/?slotId=0#20160407
[7] https://www.digitalinfrastructures.eu/content/cloud-procurement

4 Barriers and Best Practices

This section explains the barriers to procurement of cloud services by publicly funded research organisations and highlights a number of best practices that can overcome such barriers.

4.1 Barriers

The PICSE project identified and documented[8] a series of barriers to procurement by publicly funded research organisations that inhibit the wider adoption of cloud services, as summarised below.

The primary category encompasses legal jurisdiction impediments, which Eurostat highlighted as one of the main barriers to the procurement of cloud services. Indeed, services are often hosted in one country and consumed in another, hence cloud consumers' uncertainty about data location and the applicable laws in case of dispute or in relation to compliance. Prerequisites such as expertise and knowledge of both contractual and operational aspects also impede the purchase of cloud computing services. The barriers posed by the procurement process vary depending on the type of process used. Restricted procurement processes suffer from a lack of competition and higher costs while open procurement processes are time consuming, require detailed specifications to be ready at the start of the procurement process and therefore lead to higher tendering and evaluation costs.

An evident barrier for procurement of cloud services is the contrast between outdated procurement practices and emerging standard practices in the business world. Cloud Service Brokers (CSB[9]) act as an intermediary and aggregator of services provided by different cloud service providers and can reduce this barrier. The role of a CSB adds value by simplifying the procurement process, offering economies of scale and de-fragmenting the market, but raises a number of questions about associated costs, governance, liability and risk for the brokering organisation. CSBs are seen as aiding the procurement process but suffer from under-investment and thus are not sufficiently mature. In addition, the nature of cloud services and the pay-per-use method can complicate budget planning for research organisations.

Based on the information gathered from BBMRI-ERIC, DARIAH, EPOS and LifeWatch, as part of the cross-border procurement task in EGI-Engage, potential barriers to procurement where Research Infrastructures can act as procurers and public funded e-Infrastructures as service providers (bidders) have been highlighted. Some publicly funded resource providers have restrictions, which can limit their ability to sell their services. This may impact the focus (e.g. for research/innovation rather than commercial use) and geographical scope (i.e. may be limited to customers from the host member state) of their potential market and sale price (i.e. cost recuperation or for-profit). Also, the majority of publicly funded e-infrastructures are more interested in actively participating in the research and development of innovative services than selling commodity computing services.

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[8] D3.1 Procurement Barriers Report, June 2015, https://doi.org/10.5281/zenodo.18309
[9] CSB as defined by Gartner IT Glossary: "**Cloud services brokerage (CSB)** is an IT role and business model in which a company or other entity adds value to one or more (public or private) cloud services on behalf of one or more consumers of that service via three primary roles including aggregation, integration and customization brokerage. A CSB enabler provides technology to implement CSB, and a CSB provider offers combined technology, people and methodologies to implement and manage CSB-related projects"

4.1.1 The role of ERICs in the procurement process

An ERIC is a legal framework set up by the European Commission in 2009 (Council Regulation No 723/2009) to be used for establishing new research infrastructures or for operating existing research infrastructures that consider it useful to change their legal structure to become an ERIC. An ERIC operates under a non-economic basis although it may carry out limited economic activities related to its principal task. The ERIC legal framework may be used for new or existing single-sited or distributed research infrastructures.

ERICs, as coordinating bodies for RIs, frequently rely on in-kind contributions for ICT services to be provided by member states. The IT services to be acquired and operated by the central ERICs are limited with the majority of services and resources distributed in the member states.

The ERIC legal structure includes provisions on exemption from the EU directives on public procurement. ERICs are relatively young organisations and many are still in the process of determining the role that they could potentially fulfil in procurement of IT services to support research activities across their member states.

Representatives from the EGI-Engage Competence Centres supporting the Research Infrastructures (RIs) engaged in this activity, namely BBRMI, DARIAH, EPOS and LifeWatch, have studied their computing models and approach to the provisioning of resources. The RIs have existing services and datasets distributed across their member states which need to be integrated into their computing models. They already have or are in the process of establishing a European Research Infrastructure Consortium (ERIC) as a coordinating body. The IT services to be acquired and operated by the central ERICs are sometimes limited with the majority of services and resources distributed in the member states. The provisioning of the distributed services is typically the responsibility of the member states though it is recognised that there may be some advantages in the ERIC coordinating the joint provisioning of services, including IT services. If ERICs were to perform cross border procurement, it would need to be discussed with their member states to avoid the perception of duplicating the installed capacity in their countries which is made available 'in-kind'. The ERIC legal structure includes provisions for public procurement procedures and exemption from VAT and excise duty[10]:

> "*Being considered as an international organisation within the meaning of the directive on public procurement (Directive 2004/18/EU and Directive 2014/24/EU), an ERIC may adopt its own procurement rules based on transparency, non-discrimination and competition.*
>
> *An ERIC must be recognised by the host Member State as an international body within the meaning of Directive 2006/112/EC on VAT and as an international organisation within the meaning of Directive 2008/118/EC on excise duty.*
>
> *. . .*
>
> *Exemptions may apply to goods or services acquired by the ERIC for the official use of the ERIC. Definition of the scope, limits and conditions of the exemption may be part of the statutes or contained in a separate agreement among the members or with the host State.*"

The procurement mechanisms used by the member states may already include Public Procurement of Innovative solutions (PPI) and Pre-Commercial Procurement (PCP) as well as EU Structural funds and so attention must be paid to the possible constraints of combining these instruments on cross-border joint procurement.

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[10] http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=eric2

EGI has studied the possibility of adopting the ERIC legal framework and forming an overarching lightweight ERIC for the key pan-European e-Infrastructures, the so called DRI ERIC. The option has not been pursued by the pan-European e-Infrastructures but EGI has recently revised its governance model to be better aligned with the ERIC structure in order to prepare for an easy transition if a decision in that direction will be taken in the future[11].

4.2 Best Practices

The PICSE project produced a call for action[12] which includes a number of recommendations for public research organisations, cloud service providers and policy makers intended to remove barriers to cloud service procurement that are based on a set of 13 use-cases from which best practises have been derived.

Through discussions with RIs (BBRMI, DARIAH, EPOS and LifeWatch) during the procurement sessions at EGI events, the following PICSE recommendations were considered as directly relevant for the cross—border procurement activity in the EGI-Engage project.

Extract of PICSE recommendations for public research organisations:

1. Build internal competences on cloud procurement and share requirements & best practices

2. Adopt cloud-specific standards and identify these in procurements

3. Validate and use standard templates for tenders with standard contract templates and SLAs

6. Review internal procurement policies and make tenders SME-friendly

7. Encourage innovation and competition

9. Engage the industry and manage relationships with multiple suppliers

10. Adopt standards to improve the quality, security and sustainability of products and services

14. Implement pay-per-use procedures

17. Experiment in the cloud through free trials and small pilots

Extract of PICSE recommendations for cloud service providers (public and private sector):

4. Invest in the end-user facing services and in training the next generation of researchers

11. Engage with the demand side to understand the needs of the market.

12. Create a working economy between suppliers rather than always competing

15. Establish transparent cloud pricing within clear and publicly available service descriptions

18. Offer free, standalone tests of services

Framework procurement agreements are perceived as a good approach for the procurement of cloud services; along with PCP (Pre-Commercial Procurement), PPI (Public Procurement of Innovative solutions), and JPA (Joint Procurement Actions), which could potentially fulfil the needs of the research community. These instruments are described in more detail below.

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[11] EGI Governance: Analysis and Recommendations, D2.5, 13 June 2016, https://documents.egi.eu/document/2655
[12] http://picse.eu/sites/default/files/PICSE_Call_for_action_March2016_Booklet.pdf

4.2.1 Joint Procurement via PCP/PPI

Pre-Commercial Procurement (PCP[13]) is the procurement of research and development of new innovative solutions before they are commercially available. PCP works in conjunction with Public Procurement of Innovative Solutions (PPI[14]). PCP enables procurers to:

- Share the risks and benefits of designing, prototyping and testing a limited volume of new products and services with the suppliers, without involving State aid;
- Create the optimum conditions for wide commercialisation and take-up of R&D results through standardisation and/or publication;
- Pool the efforts of several procurers.

However, as joint PCP is a relatively new instrument for procurement number there are lots of lessons learnt that can be useful for organisations starting this approach.

The PCP approach is used when research and development are necessary to produce new solutions for which the requirements are well understood but competing solutions have not yet been compared. Via PCP, the public sector buys R&D to steer the development of solutions to its needs, gather information about the alternative solutions and avoids vendor lock-in at a later date by creating a competitive supply base. PCP is implemented by procuring from several suppliers in parallel and evaluating the progress via a series of critical review stages.

In comparison, Public Procurement of Innovative solutions (PPI) aims at a later stage in the development lifecycle where the public sector acts as launching customers of innovative commercial solutions that do not require further R&D in order to be brought to market. PCP and PPI are considered as complimentary instruments that can be combined in succession in order to encourage the development and commercialisation of innovative solutions. A graphical representation of the PCP and PPI process as supported via the Horizon 2020 programme is shown in Figure 1.

Some ESFRI Research Infrastructures are making use of PCP/PPI financial instruments. For example, CERN, as coordinator of the High Luminosity LHC (HL-LHC), is leading the QUACO PCP project[15] to develop innovative superconducting magnets.

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[13] https://ec.europa.eu/digital-single-market/en/pre-commercial-procurement
[14] https://ec.europa.eu/digital-single-market/en/public-procurement-innovative-solutions
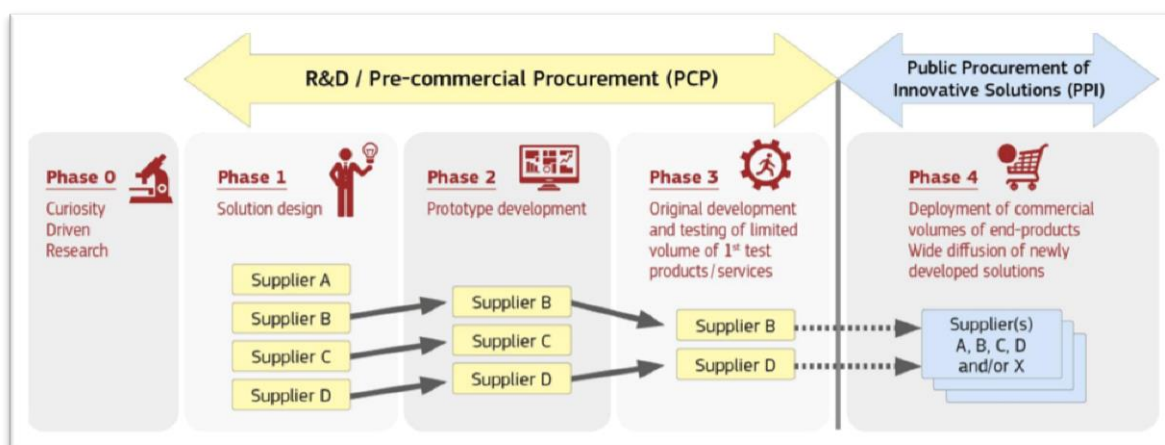[15] https://quaco.web.cern.ch

Figure 1 Pre-Commercial Procurement process as supported by Horizon 2020

4.2.2   Combining multiple funding streams

Attention must be paid to the potential impact of cross-border joint procurement via instruments such as Public Procurement of Innovative solutions (PPI) and Pre-Commercial Procurement (PCP) on the use of the other funding streams such as European Structural and Investment Funds (ESIF) since there are a number of practical difficulties in using both funding streams at the same time. ESIF funding is allocated by member states in agreement with the EC for projects in thematic areas including Research and Development, innovation and ICT[16]. Cumulative funding between H2020 and ESIF for a single action is possible but excludes the beneficiary from using EC funds to cover their required contributions (i.e. cannot use ESIF to cover co-fund share of H2020 project).

The combination of different funding streams, such as structural funds and Horizon 2020 project funds, to procure services has been investigated via a dedicated workshop organised by the ELIXIR-Excelerate project in Brno in October 2015[17]. Structural funds can be used to develop smart specialisation, including ICT, in the member states, with the majority of the funding being focussed on developing regions. The ESFRI Research Infrastructures are making use of structural funds. The Extreme-Light-Infrastructure (ELI) installations in Czech Republic, Hungary and Romania are being funded by means of structural funds as an example of how the instruments of the EU's regional policy can be used to serve both the objective of economic cohesion and the development of the European Research Area. A number of European member states have made use of structural funds for ICT. An example is the Polish Infrastructure for Information Science Support in the European Research Area (PL-Grid[18]) which is an NGI participating in EGI that has received structural funds via the European Regional Development Fund as part of the Innovative Economy Program since 2009.

EPOS organised a workshop in the context of the European Geosciences Union (EGU) general assembly 2016 event held in Vienna in April 2016[19]. The event addressed the technical, security as well as the legal and financial aspects of procurement including payment models and licensing conditions.

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[16] file:///C:/Users/jones/Downloads/key-digital-single-market_en%20(1).pdf
[17] http://www.ceitec.eu/elixir-excelerate-structural-funds-workshop/t2194#tab1
[18] http://www.plgrid.pl/en
[19] http://meetingorganizer.copernicus.org/EGU2016/orals/20393

BBMRI-ERIC organised and hosted a Cloud Computing workshop in the context of the CORBEL project engaging 11 Research Infrastructures from the BioMedical Sciences domain in October 2016[20]. Procurement of IT services was on the agenda and the discussion highlighted that the RIs were prepared to use a combination of publicly funded and commercial cloud services in a hybrid model. The adoption of commercial cloud services would require reassurance that sensitive data is handled appropriately and asserted that long-term data storage is seen as a responsibility for the public funded structures.

4.2.3   EGI pay-for-use pilot

The work performed on the EGI pay-for-use[21] pilot is directly relevant to the cross-border joint procurement activity and has highlighted some potential barriers to procurement. There are more than 350 resource providers involved in EGI and of those about 30 are informally publishing pricing information for their services via the EGI service registry (GOCDB) as part of their participation in the pilot. The EGI accounting portal has also been extended to take into account pricing information. Of the 30 resources providers publishing pricing information, 4 providers have signed a formal Letter of Intent stating their ability and willingness to sell resources from a legal/policy point of view (another to be provided shortly). The e-GRANT portal provides access to the catalogue of services and a means for matching supply to demand with support for negotiation. Resource providers have control over which proportion of their services are made available for sale via the portal. e-GRANT is currently being evolved as the back-end client portal to support the EGI Marketplace thanks in part to the work conducted through supporting pay-for-use developments.

However, there are restrictions on resource providers that may affect their ability to publish pricing information and sell their services. For example, some resource providers may only be allowed to sell their services in the publicly funded research and education sector to avoid competing with commercial service providers. Similarly, other resource providers may sell their services abroad but not within their own national borders since they have been funded to provide such services to their nationals.

Currently, the EGI Foundation is serving only as a matchmaker bringing the customer and the provider together, but with all contracts and agreements being directly signed between them. There is a potential role for the EGI Foundation to become a central broker in this model by developing appropriate contracts, associated Service Level Agreements and billing processes. A number of legal aspects have to be addressed, such taxation and liability, which have been studied by the EGI Foundation with the help of an external consultant. Several providers have expressed interest in participating as a group with the EGI Foundation handling all customer-facing responsibilities. This model is being explored through a use case of a commercial organisation delivering computational fluid dynamic training running and cloud containers on the EGI FedCloud[22]. This brokerage model does not only apply to computer services and may include consultancy, software development, training, etc.

The ability to determine the cost of consumed services, even if there is no financial transaction involved, can be a useful service to the RIs in order to help them estimate their IT budgets for the future.

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[20] http://www.bbmri-eric.eu/news-events/corbel-1st-annual-general-meeting-agm/

[21] In this document: pay-for-use refers to service provision that foresees charging to the customer (as opposed to free-at-point of use); pay-per-use refers to the specific pricing model where the charge depends on how much the service was used according to predefined metrics

[22] https://www.egi.eu/blog/egi-supports-belgian-sme-in-cfd-training-24-nov-2016/

5 Use-Cases

This section describes a number of cloud services procurement case studies in the public research sector that are particularly relevant for the cross-border procurement study of EGI.

This PICSE H2020 project collected and published[23] a set of thirteen case studies documenting how public sector organisations worldwide have either carried out a process to procure cloud services, or are considering doing so. The experiences vary in term of success and offer insights into how the procurement of cloud services is impacting their current processes. Nine case studies describe the experience of public sector organisations. One such case study, together with two more recent ones, are described below.

5.1 Helix Nebula Science Cloud Pre-Commercial Procurement

The Helix Nebula – the Science Cloud (HNSciCloud)[24] is a €5.3 million Pre-Commercial Procurement (PCP) tender for the establishment of a European hybrid cloud platform to support the deployment of high-performance computing and big-data capabilities for scientific research. It covers the procurement of R&D services for the design, prototype development and pilot use of innovative cloud services. The tender is operated as a competitive development with contracts in each phase (design, prototype, pilot) being awarded to multiple contractors using Most Economically Advantageous Tender (MEAT[25]) criterion.

The R&D services procured by HNSciCloud will be integrated with resources in data centres operated by the buyers group (CERN, CNRS, DESY, EMBL-EBI, ESRF, IFAE, INFN, KIT, STFC, SURFsara) and with European-scale publicly funded e-Infrastructures (GEANT network and EGI FedCloud) using open source solutions to build a hybrid platform on which a competitive marketplace of European cloud players can develop their own services for a wider range of users, beyond research and science.

The group of procurers have committed their own procurement funds, manpower for testing and evaluation of the resulting services, use-cases with applications & data as well as their in-house IT resources in order to develop the platform. The resulting common platform will be evaluated by end-users and exploited as the incubator for new businesses and scientific activities engaging a growing number of buyers, suppliers, and users.

The innovative cloud services provided through the platform are being designed and implemented to address a set of challenges that require a combination of services at the Infrastructure as a Service (IaaS) level:

- **Compute and Storage** – support a range of virtual machines and container configurations working with datasets in the petabyte range;

- **Network Connectivity and Federated Identity Management** – provide high-end network capacity for the whole platform with common identity and access management;

- **Service Payment Models** - explore a range of purchasing options to determine the most appropriate ones for the scientific application workloads that will be deployed.

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[23] Research Procurement Case Studies, Sara Garavelli, January 2016, https://doi.org/10.5281/zenodo.46973
[24] HNSciCloud Project http://www.hnscicloud.eu/
[25] The most economically advantageous tender (MEAT) criterion enables the contracting authority to take account of criteria that reflect qualitative, technical and sustainable aspects of the tender submission as well as price when reaching an award decision.

The procured cloud services will be integrated with the procurers' in-house resources and publicly funded e-Infrastructures to provide a hybrid platform for end-users from a wide range of scientific fields[26] including high energy physics, life sciences, astronomy, neutron/photon sciences and the long tail of science. The set of 17 use-cases that will be supported by the procurement include those directly connected to 7 Research Infrastructures that appear in the ESFRI 2016 roadmap[27], namely:

- **Euro-BioImaging:** European Research Infrastructure for Imaging Technologies in Biological and Biomedical Sciences
- **CTA:** Cherenkov Telescope Array
- **BBMRI:** Biobanking and BioMolecular resources Research Infrastructure
- **ELIXIR:** A distributed infrastructure for life-science information
- **ESRF Upgrades:** Extremely Brilliant Source
- **European-XFEL:** European X-Ray Free-Electron Laser Facility
- **HL-LHC:** High-Luminosity Large Hadron Collider

The tender evaluation process has completed and the award decision for the design phase has been made. The tender documents were downloaded more than 220 times and 10 bids were submitted engaging approximately 30 international companies, SMEs and public research organisations from 13 countries. After evaluation of the bids, four consortia have been awarded contracts:

- **T-Systems**, Huawei, Cyfronet, Divia
- **IBM**
- **RHEA Group**, T-Systems, exoscale, SixSq
- **INDRA Systems**, HP, Advania, SixSq

A recent public consultation on the interest of public procurers for innovation procurements of ICT based solutions for Horizon 2020 has been published by the EC[28]. The public consultation gathered a total of 186 replies and concluded for the 2018-2020 work program:

- Public procurers across all sectors of public interest are interested to start innovation procurements. At both local and international level, public procurers show a genuine interest in innovation procurements.
- Public procurers identified a list of procurement needs for innovative solutions that cover a wide range of topics across the different societal challenges while in other domains such as finance, education and culture or research infrastructures, procurers have concrete innovation procurement needs.
- Public procurers across all areas of public interest have 'large' needs for new innovative ICTs (between 10% to 60% of their annual purchasing budget). Public procurers have a keen interest to procure innovative ICTs in all areas in the ICT LEIT work programme. Big data, IoT, IT platforms with smart data modelling, analysis and automatic learning tools and smart city solutions were the most recurrent themes for procurers in all sectors of public interest.
- More than 80% of public procurers indicate that - to address their procurement needs - they need end-to-end solutions that require combinations of different ICT technologies from on average 3 to 4 different ICT categories. For PCPs in particular also 'comparisons between' different ICT technologies from several ICT categories are needed.

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[26] http://www.hnscicloud.eu/hnscicloud-user-groups
[27] http://www.esfri.eu/esfri_roadmap2016/roadmap-2016.php
[28] Public Consultation on the interest of public procurers for innovation procurements of ICT based solutions for Horizon 2020 WP2018-20 Summary of Findings, October 2016,

- Procurers are very willing to share information about their procurement needs with other procurers and to collaborate in the implementation of an innovation procurement with other procurers.

- There is clearly more response from procurers in advanced countries that have a national innovation procurement policy/action plan than from other lagging countries (e.g. Eastern Europe). Cooperation at EU level can also help address the need for learning and experience sharing on innovation procurement between advanced and lagging countries.

A number of lessons have been learned by HNSciCloud about the H2020 Pre-Commercial Procurement funding model for the development of innovative cloud services intended to support the scientific programmes of Europe's research communities and are listed here below.

The lead procurer model proved appropriate for HNSciCloud. Having the lead procurer identified and agreed when preparing the project proposal meant the project was able to progress quickly through the tender preparation phase.

The ability to include additional procurers in the buyers group after the Grant Agreement was signed provided helpful flexibility to the PCP. A procurer was added after the project started and before the requirements gathering was completed but it did require some adjustments to the procurement budget amongst members of the buyers group, which resulted in an amendment to the grant agreement. This was possible because CERN took the role of lead procurer and 'anchor tenant' with sufficient financial commitment and flexibility to accommodate such changes.

In preparation for the use of the procured services, the consortium and contractors are actively investigating Service Level Agreements. Details of the proposed Service Level Agreement (SLA) were part of the award criteria for the design phase of the tender. The tender called for an equitable and mature SLA framework and highlighted the SLA template produced by the SLALOM[29] EC project as an example. The HNSciCloud will pursue the convergence on suitable SLAs and build on the Common Reference Model and questionnaires produced by the SLA-Ready[30] EC project with analysis coming from the CloudWATCH[31] EC project to identify high priority aspects for the use-cases to be deployed.

The HNSciCloud tender preparation provided an opportunity to take a critical look at the emergent cloud standards and identify those that were sufficiently mature and relevant to be used as a means of evaluating commercial service propositions. Of the standards available, the following were identified by the group of procurers as being relevant for this tender:

- The ISO/IEC 19086 standard for Service Level Agreements
- The ISO/IEC 27000 series of standards, notably ISO/IEC 27017 and ISO/IEC 27018, for information security of the resulting services
- The IEEE 1016-2009 system design document (SDD standard) for documenting the design of the hybrid cloud architecture

It is likely that further standards will be identified and referenced during the subsequent phases of the PCP.

An initial analysis at this stage of the project suggests that:

- The majority of bids were submitted by companies from European Member States.
- SMEs were attracted by the tender and have participated in the bidding consortia.

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[29] http://slalom-project.eu
[30] http://www.sla-ready.eu/
[31] http://www.cloudwatchhub.eu/

- Public sector organisations, such as universities, were attracted by the tender and have participated in the bidding consortia.
- A significant number of FP7 and H2020 projects were cited in the bids as sources of innovation contributing to the proposed solutions. If the suitability of these contributions is proven during the subsequent phases, it confirms that PCP offers a potential exploitation path for the results of EC funded projects.
- Open source software is widely recognised by service developers as an acceptable basis for developing innovative cloud services.
- Open source licenses are generally accepted as a means of distributing the results when accompanied by suitable business models.
- There is a willingness to develop standards-based solutions. This includes evolving existing products so that they can be delivered according to equitable SLAs and to adhere to certification schemes for service providers.

HNSciCloud has demonstrated the PCP instrument can be used to incite public and commercial service providers to co-design innovative services with research organisations that satisfy the pressing needs of Europe's research communities.

5.2 GÉANT tender for Infrastructure as a Service solutions

The content of this section is based on material published by GÉANT[32]. GÉANT and its NRENs have conducted a Pan-European tender to allow Research and Education institutions to consume cloud services. The tender for 36 countries aimed to ensure that:

- Suppliers offer an IaaS feature set which matches the needs of the European research and education community;
- Data is handled safely and suppliers meet European and national regulations;
- The community can aggregate demand and costs are affordable and predictable;
- Services can be acquired and used through the institutions' purchasing and management structures;
- Services are connected to the GÉANT and NRENs networks and are compatible with the community's Identity Management capabilities.

This demand aggregation in GÉANT, across the 36 participating NRENs, creates a substantial single digital market where procurement will be channelled through the framework agreements over the next four years. This framework agreement is an umbrella agreement that sets out the terms of under which NRENs may acquire and provide IAAS cloud services to their end user organisations via individual contracts. There was a strong interest in the tender from suppliers and the following providers have qualified and will become part of the GÉANT Cloud Catalogue IaaS portfolio during 2017:

- Amazon, through resellers: Arcus, Comparex and Telecom Italia
- Cloudsigma
- Dimension Data
- Interoute
- itSoft
- KPN
- Lattelecom
- Microsoft, through resellers: Atea, Cacttus, Comparex, Dom-Daniel, Infosoft, Micromail, Nextsense, Novabase, SoftwareOne, Span and Ymens

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[32] GÉANT IaaS Cookbook, Document ID: GN42-16-114E4, 27-01-2017

- NTT Europe
- T-Systems
- Telecom Italia
- Vancis

The GÉANT Framework is using the European Directive 2014/24/EU[33], which enables NRENs and their clients to legally procure from the framework in those countries where the Directive is in force (see the European Directive 2014/24/EU website for details on a per country basis). The GÉANT Framework is handled by the UK office of GÉANT and as such UK law applies. In some countries, additional national legal requirements or regulations may apply, e.g. data protection regulations and each NREN should confirm the legal status regarding the EU Directive and any additional requirements for their country.

Through the GÉANT cloud catalogue, the suppliers provide purchasing models which match with the financial structures and funding models in Research and Education: acquiring services with a purchase order, post-paid billing and accommodating capital expenditure through upfront commitments.

The tender also encourages suppliers to recognise the collective expenditure of all institutions, and present all customers with the same discount levels, based on the aggregated spending of the total Research and Education population.

GÉANT foresees a number of possible roles for each participating NREN in the implementation of the tender as described below:

- **Referrer:** The NREN understands and consolidates the needs of the sector, negotiates appropriate terms and conditions with vendor, conducts appropriate levels of due diligence to improve the value of the product for the sector. The vendor makes the improved proposition to the sector and NREN is paid a referral fee. The NREN does not sit in the contracting line.
- **Reseller:** In addition to the referrer role, the NREN acts as an aggregation point in the Higher Education sector, aggregating demand, and providing scale efficiencies. The NREN takes the reseller income at a responsible level with benefits for both the sector and the NREN. The NREN sits in the contracting line.

- **Underwriter:** In addition to the referrer role, the NREN commits to a level of purchase on behalf of the sector and achieves better pricing and a revenue share. The risk lies with the NREN to meet the difference between the commitment and the actual purchase. The NREN does not sit in the contracting line and is not seen as the supplier – but users get the services "for free".

The decision for a particular role is on a per-vendor basis, so an NREN could decide to be a Referrer for one vendor and a reseller for another. These possible roles for an NREN are represented graphically in Figure 2.
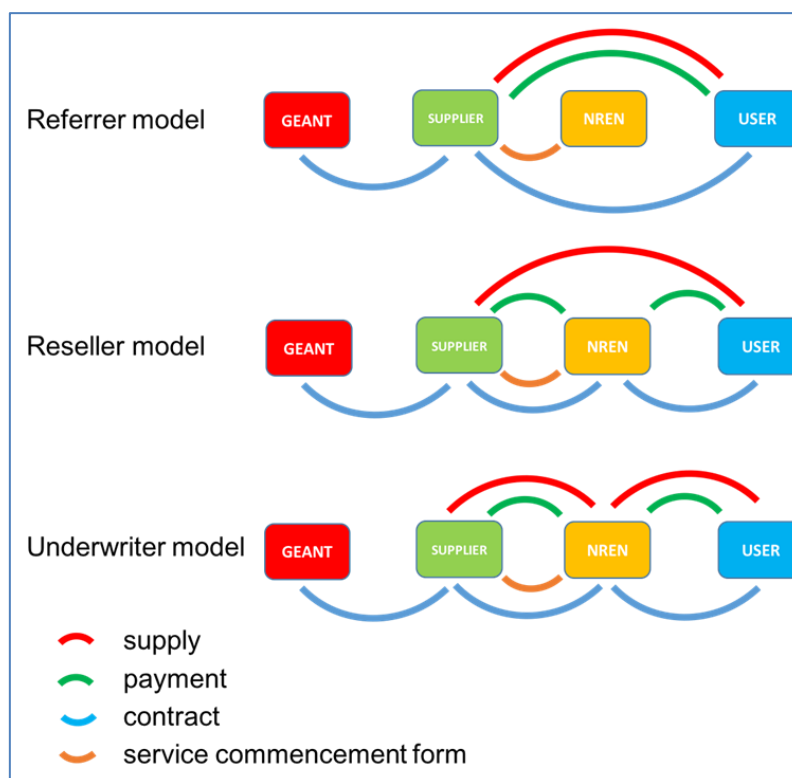
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[33] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:32014L0024

Figure 2 NREN models for the IaaS framework (© GEANT Limited on behalf of the GN4-2 project)

5.3 The Commons Credit Model

The content of this section is based on a USA National Institute of Health (NIH) blog entry by George Komatsoulis[34]. The *NIH Commons* is a shared virtual space that exploits new computing models to be scalable, cost effective and simplifies sharing with the objective of making the digital artifacts of biomedical research FAIR: Findable, Accessible, Interoperable, and Reusable. Over the last two years, the NIH has been working to implement the *Commons* through the Big Data to Knowledge (BD2K) program and other activities with many of biomedical informatics professionals. The Commons Credits Model is one element of these activities and is focused on creating a part of the infrastructure of the Commons by simplifying access to one of the key technologies that underpin the *Commons,* cloud computing.

The Commons Credits Model provides researchers access to cloud computing technologies by creating a competitive marketplace for biomedically useful information technology services. The premise of the Credits Model is quite straightforward: investigators apply for and receive dollar denominated vouchers ("commons credits") that can be used to purchase cloud computing resources from vendors that have met NIH standards for participation in the *Commons* ("conformant providers"). Distributing these credits to investigators, rather than directly to vendors, aligns market forces for maximum efficiency:

- investigators are incentivized to use the vendor that provides the best value for their particular research need;
- vendors are incentivized to compete for investigator's business by providing the best possible services at the lowest possible cost.

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[34] https://datascience.nih.gov/BlogCommonsCreditsModelPilot

Further, since vendors can provide Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and/or Software as a Service (SaaS), it is hoped these capabilities can be useful to a broad range of researchers with different levels of sophistication in the area of computing. The implementation of the NIH commons credit model is represented graphically in Figure 3.
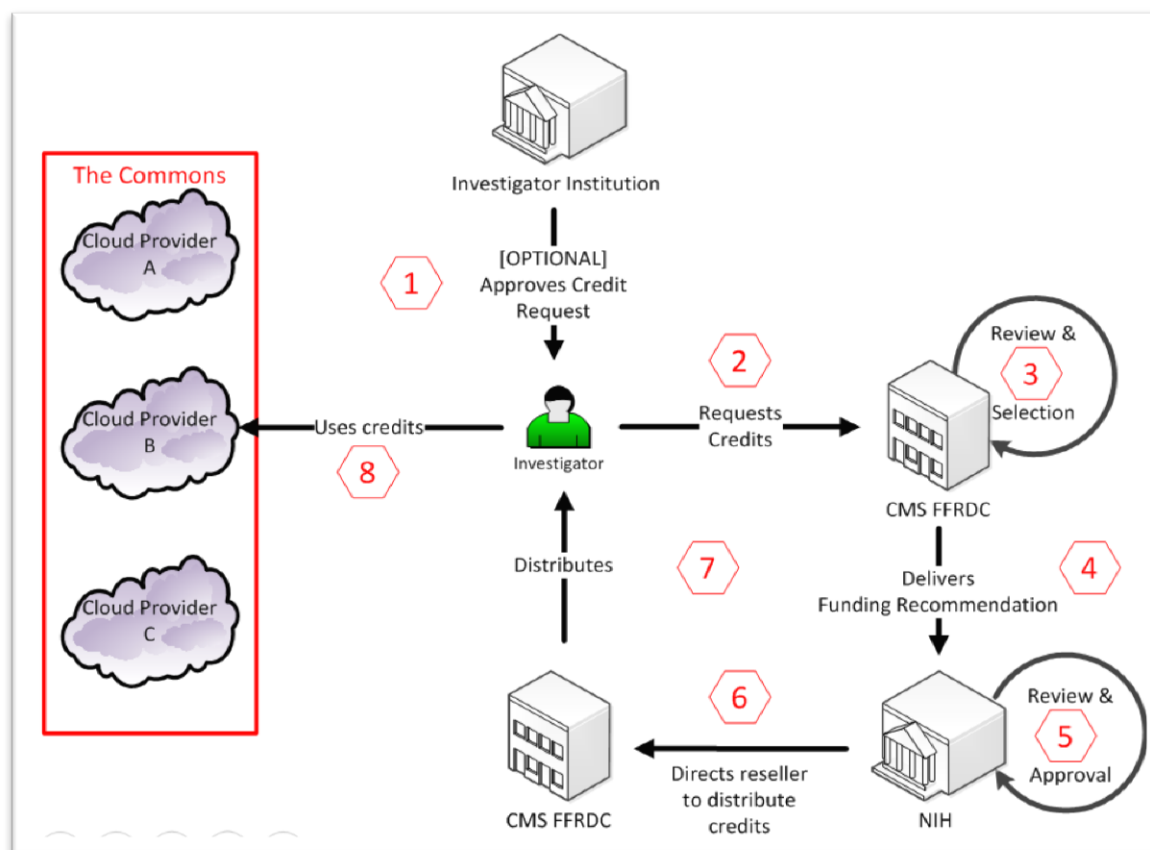

Figure 3 NIH commons credit model (credit: George Komatsoulis)

The 3 year pilot has completed its first year and arranged the preliminary steps needed to open the credit program. This includes working with potential providers and investigators to define a set of conformance requirements and a process for vetting provider conformance, setting up a portal to enable investigators to apply for credits, defining the triage and evaluation criteria for making credit distribution decisions, and working through the financial mechanism to award credits.

So far, two fully conformant vendors (DLT, a reseller of Amazon Web Services, and IBM) have fully executed the participation agreement that enables them to accept credits. Another 10 applications, of which 5 have been certified as compliant with NIH requirements, are still negotiating various aspects of the participation agreement required to accept credits. In addition, the first batch of credits has been issued to a test group of *Commons* investigators who are providing feedback on the portal and processes as well as uncovering potential problems with the distribution and use of credits. During 2017, it is expected that more than one thousand researchers will be allocated credits and subsequently the program will be opened to all NIH investigators.

6 Opportunities

There are a number of potential opportunities to be examined for cross-border procurement in the context of EGI's future planning. The opportunities are presented below as a series of steps where each step builds on the results of the previously presented opportunities.

6.1 Framework agreements

The selection of services and the validation of their conformance with legal, business and technical requirements against the specific needs of the R&E community across European member states is a time consuming and labour intensive activity. User communities and Research Infrastructures could rapidly procure services if the selection and validation steps had already been performed.

The GEANT IaaS tender offers framework agreements with the service providers and has a number of models where the role of the NRENs is remunerated as part of the procurement transaction. In a similar manner, but with remuneration solely for the supplier, the HNSciCloud PCP is allowing an extended set of procurers, known as the Adopter Group, to profit from a legal framework with its contractors in order to have access to the innovative services during the pilot phase.

The advantages for the procurer that such framework agreements offer when compared to performing service procurements independently, include:

- Rapid access to services that have been selected and tested by other members of the R&E community
- Make use of the legal framework and access conditions established by experienced public procurers for the R&E community

- Avoid having to invest time and effort to prepare and manage their own tender.

This basic cross-border procurement opportunity represents a minimal financial risk for the parties organising the activity because the resulting contracts can be established directly between the service provider and procurer. The advantages for the suppliers include a simplified means of access to the R&E market but the lack of a procurement commitment means that the volume discounts they offer are limited and may discourage them from making investments to satisfy additional needs of R&E users.

6.2 Catalogue of services

A logical extension of framework agreements is to organise the services into a catalogue through which they can be more easily procured. GEANT operates such a catalogue of cloud services that have passed a paper evaluation and for which contracts have been signed with the providers. This opportunity requires additional effort to manage and operate the service catalogue and it should be noted that the signature of the agreements entering the catalogue can be very time consuming. HNSciCloud is taking a further step by performing tests on the selected services to verify they are fit for purpose before exposing them to end-users. An alternative approach that involves a lower level of risk for the organising party is used by the Net+ community in the USA[35]

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[35] From next-generation Internet technology to next-generation cloud technology, Internet2 NET+ Initiative, http://www.internet2.edu/vision-initiatives/initiatives/internet2-netplus/

where users who are willing to act as early adopters and perform tests themselves are identified and they subsequently share the results of their evaluations with the community. As with the framework agreements opportunity described above, the contracts are established directly between the supplier and procurer.

A number of initiatives use service catalogues to establish a marketplace of services. Examples include the Fortissimo marketplace, Helix Nebula (HNX[36]) and Cloud28+[37]. Fortissimo is explained in more detail below.

> Fortissimo[38] is a collaborative FP7 project that enables European SMEs to be more competitive globally through the use of simulation services running on a high performance computing cloud infrastructure. The goal of Fortissimo is to overcome this impasse through the provision of simulation services and tools running on a cloud infrastructure. A "one-stop-shop" approach makes hardware, expertise, applications, visualisation and tools easily available and affordable on a pay-per-use basis. In 2015, Fortissimo created a Marketplace to enable users, and prospective purchasers, of high performance computing services to more easily access and purchase such services from both public and private suppliers. Suppliers pay an annual fee to sell their services via the Fortissimo marketplace. Contracts are established between users and suppliers directly though the marketplace does receive a commission on such contracts. Registered users access the marketplace free of charge. Through the marketplace users have access to preconfigured services and bundled packages consisting of software and high performance computing resources offered by suppliers and have access to consultants to help define their needs and find a service which will meet these on the Marketplace.

A large scale example of a service marketplace that serves the public sector of a whole country, is the UK government's digital marketplace[39].

> The Digital Marketplace is the eighth iteration of a collection of framework agreements that allows UK government departments and public sector organisations to buy off-the-shelf, pay-as-you-go cloud solutions from a list of preapproved vendors through an online store without needing to run a full tender or competitive procurement process; No OJEU (Official Journal of the European Union), Invitation to Tender (ITT), Request for price (RFP), request for quote (RFQ), request for information (RFI) or negotiation necessary.

> This approach has brought agile, iterative techniques into procurement with frameworks on the Digital Marketplace being refreshed regularly to allow more suppliers to apply, and to make sure that buyers have access to the latest cloud technology and digital suppliers. The Digital Marketplace aims to promote transparency and make it easy to introduce new suppliers to the UK public sector market which can compare all supplier products and companies listed side by side in an on-screen catalogue. The catalogue showcases supplier's service information, including service definitions, pricing and supplier's terms and conditions.

> At the end of 2016, the Digital Marketplace has so far supported UK public sector organisations to spend over £1.6 billion with digital and technology suppliers. 55% of that has been with small and medium-sized enterprises (SMEs).

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[36] http://hnx.helix-nebula.eu/
[37] http://www.cloud28plus.eu/
[38] https://www.fortissimo-project.eu/
[39] https://www.digitalmarketplace.service.gov.uk/

Suppliers using the Digital Marketplace do not need to be based in the UK to apply, but need to agree to the terms of the framework agreement and call-off contract, which are governed by the law of England and Wales. Scaling up this approach for use across the EU requires harmonisation of those agreements. The Digital Marketplace has been presented to the OECD and the Australian Digital Transformation Agency (DTA) has used open-source code supporting the UK's Digital Marketplace to create own Digital Marketplace.

6.3 Joint Procurement

Going beyond framework agreements and a service catalogue, the next opportunity is to engage in joint procurement. In joint procurement, a group of procurers agree to collectively procure a common set of services. Joint procurement can lead to efficiency and cost savings since the effort of performing the tender and resulting contracts is shared across the procurement group. It can also increase the procurers' purchasing power and lead to better collaboration, such as the sharing of knowledge and best practice. The experience of joint procurement in HNSciCloud has been positive and there are a number of important lessons learned that should be taken into account:

- Firm financial commitments by the procurers at the start of the activity are necessary to ensure that all parties are engaged
- Joint procurement is most effective when procurers can identify common needs
- The decision making process must be well defined in order to converge in a timely manner on commonly agreed requirements and priorities

There are different approaches to joint procurement: one of the procurers can be nominated as the lead procurer or the procurers can decide to establish a new legal entity which becomes the common procuring entity. The experience of HNSciCloud (and Cloud for Europe[40]) is that the lead procurer approach is the most effective but the lead procurer must be carefully chosen to ensure they are committed and have the necessary skills and financial strength to carry the activity through to completion.

The GEANT IaaS tender identified 3 possible service delivery approaches for NRENs: either as a referrer (institutions buy directly from the provider), a reseller (the NREN is involved in some/all of the contracting and billing) or an underwriter (the NREN purchases from providers and distributes to its community). The underwriter service delivery approach is similar to that of a national lead procurer in joint procurement.

The advantages, complexities and uncertainties of engaging in collaborative joint cross-border procurement by public procurers from European member states are discussed in a recent paper by Dr Albert Sanchez-Graells[41]. A brief analysis of the issues related to application of the latest EU public procurement rules (mainly Directive 2014/24/EU) outlined in the paper leads to the conclusion that they can be overcome by focusing the joint cross-border procurement within the research and education community taking into account the lessons learned from the case studies

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[40] Lessons Learnt from a joint EC Co-funded PCP - Cloud for Europe, Eleonora KUIPER et al., eChallenges e-2015 Conference Proceedings, ISBN: 978-1-905824-52-6, https://www.pianoo.nl/sites/default/files/documents/documents/lessonlearned-evaluatiecloudforeuropeproject-november2015.pdf

[41] Collaborative Cross-border Procurement in the EU: Future or Utopia?, Dr Albert Sanchez-Graells, 12 May 2016, In: Upphandlingsrättslig Tidskrift - Procurement Law Journal, Vol. 3, 12.05.2016, p. 11-37. http://ssrn.com/abstract=2734123

documented above and using well-defined financial instruments supported by the Horizon 2020 programme such as PCP for innovative service development and PPI for their first commercialisation in the research and education sector.

In the context of EGI, a joint procurement of e-infrastructure services on behalf of its participants could be envisaged but there are a number of choices in the implementation approach that would need to be discussed with the EGI stakeholders. For example, the choice of lead procurer, or Central Procurement Body (CPB), would need to be carefully considered given its key role that requires in-house procurement experience coupled with a multi-year financial commitment to ensure successful completion of an undertaking that typically spans at least 3 years. An alternative approach, respecting the European Union principle of subsidiarity, would be for NGIs to take a national underwriter role (as described in the GEANT service delivery model) on a voluntary basis. The engaged NGIs could then act as a procurement group coordinated by EGI.eu.
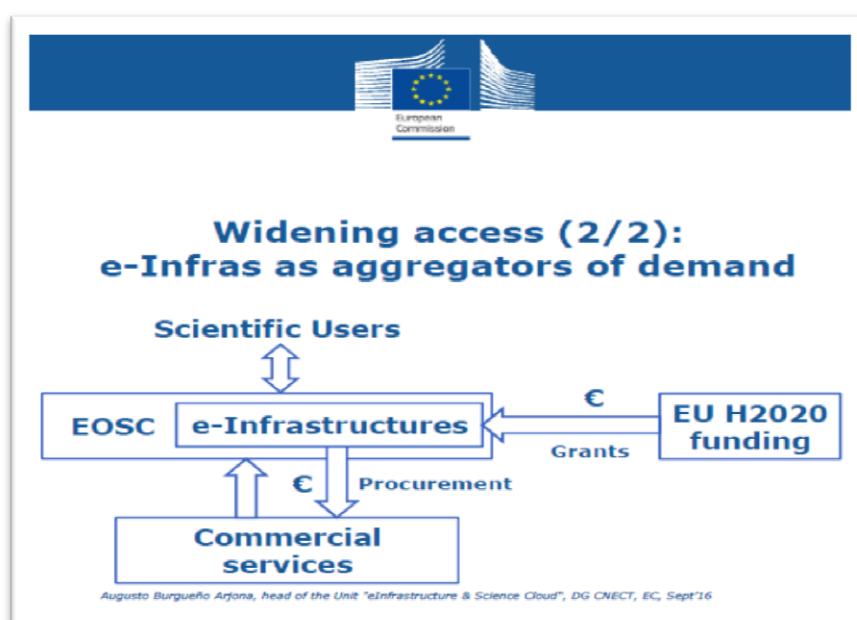
6.4 Service Credit Scheme

Figure 4 Possible role of procurement in future H2020 e-Infrastructure programme

A fundamental question in all of the procurement opportunities presented above is 'who pays?' The listed opportunities provide increasing added value as the procurement commitment becomes more clearly identified. A service credit scheme, such as the one being piloted by NIH, becomes possible if there is a significant multi-year procurement commitment at a European level. DG CONNECT has presented draft plans for a procurement activity in its future 2018-2020 work programme by which e-infrastructure organisations would procure commercial services using H2020 grant funds on behalf of scientific users in the context of the European Open Science Cloud (see Figure 4).

A service credit scheme could be a means of implementing such a procurement activity and establishing an Open Science Commons[42]. It would build on the steps outlined in the series of

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[42] http://go.egi.eu/osc

opportunities described above and lessons learned from the NIH Cloud Credit Commons, GEANT IaaS tender and the HNSciCloud Pre-Commercial Procurement.

The early users could be engaged via an open call through which ESFRI Research Infrastructures and their associated user communities can apply for support to have their applications deployed in a hybrid environment that brings together their own RI resources, publicly funded e-Infrastructures and the commercial service providers. The support would include consultancy and expertise in the deployment of their applications. The EGI Pay-for-Use pilot, service catalogue and e-GRANT portal (see section 4.2.3 above) offers a candidate implementation mechanism. Registered users of the e-GRANT portal could apply for grants corresponding to service credits, which they then use to pay for any services in the service catalogue on a pay-per-use basis.

Such a scheme could be implemented on a 3 year time scale:

- *Year 1*: preparation of the platform, open call for users and signature of contract agreements with conformant service providers.
  The services declared as conformant via the GEANT IaaS tender and those successfully completing the HNSciCloud PCP pilot phase could be used as an initial set of commercial services. This would have the advantage of not having to perform a dedicated tender and can be justified because both the GEANT and HNSciCloud tenders were based on an open competition according to European Union public procurement rules.
- *Year 2*: operation of a small-scale prototype with a limited number of early users selected via the open call, collection of feedback, assessment and implementation of improvements for a pilot service.
- *Year 3*: operation of a pilot service with an expanded set of users, collection of feedback, assessment and development of a roadmap for a full-scale production service.

The recently funded H2020 project eInfraCentral[43] which intends to implement a cross e-Infrastructure service catalogue could potentially provide a more inclusive service catalogue if it also integrates commercial service providers.

An important element of such a procurement activity would be the market analysis. The recently published 2016 edition of the e-IRG roadmap[44] recommends a service marketplace approach for implementing an e-Infrastructure commons. The e-needs gathered by e-IRG as part of the ESFRI 2016 Roadmap[45] procedure can potentially be used as a starting point. The information collected from RIs will be very valuable and hence the process should progressively collect more detailed information, including quantification of resources, especially from those RIs entering an operational phase and hence have more pressing and well-defined needs. EGI should work with the recently funded e-IRGSP5 support project[46] to use the ESFRI e-needs information gathering process for the 2018 update of the roadmap as a means of determining the scale and variety of e-infrastructures services that the RIs will need over the next 5 years.

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[43] http://www.efiscentre.eu/portfolio-item/european_e-infrastructure-services-gateway/
[44] eIRG 2016 roadmap, 22 December 2016, ISBN 978-90-823661-1-2, http://e-irg.eu/documents/10920/12353/Roadmap+2016.pdf
[45] http://www.esfri.eu/roadmap-2016
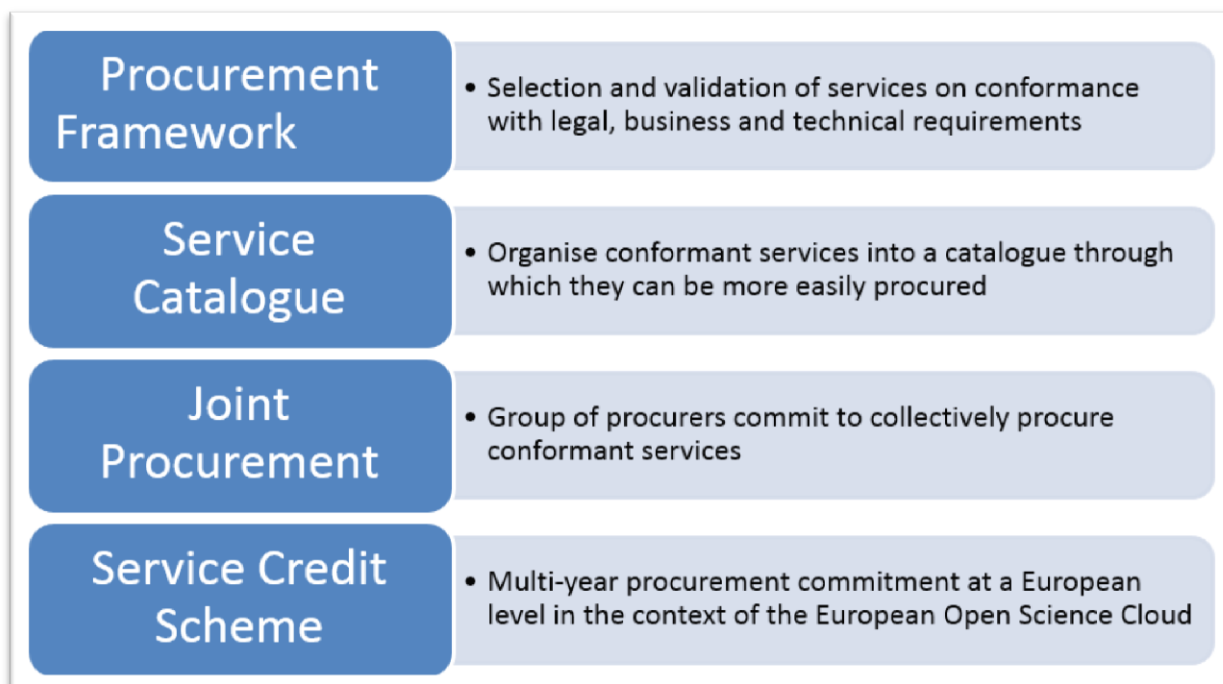[46] http://e-irgsp5.e-irg.eu/

Figure 5 Potential Procurement Opportunities for EGI

The series of opportunities presented in this section are summarised graphically in Figure 5.

7 Summary

The cross-border procurement activity of EGI-Engage has worked with BBMRI, DARIAH, EPOS and LifeWatch to identify a number of barriers to procurement of e-Infrastructure services for ESFRI Research Infrastructures, as well as best practices and use-cases.

Starting from the procurement barriers identified by the PICSE project, further analysis by the EGI stakeholders indicated that legal jurisdiction impediments as well as restrictions on publicly funded resources providers to sell their services limit the scope of cross-border procurement between public research organisations. In terms of procuring from commercial service providers, attention must be paid to combining funds from different funding instruments in each member state. While the ERIC legal structure includes provisions for public procurement procedures and exemption from VAT and excise duty, the IT services they are to acquire are generally limited with the majority of services and resources distributed in the member states and provided 'in-kind'. The role of a service broker adds value by simplifying the procurement process, offering economies of scale and de-fragmenting the market, but raises a number of questions about associated costs, governance, liability and risk for the brokering organisation.

The PICSE project also identified a number of best practices documented in the form of recommendations and a subset of these are considered as directly relevant and should be taken into account in any planned cross—border procurement activity.

Three use-cases were highlighted as examples of on-going procurements with the research and education community: two cross-border examples in Europe and one for an innovative commons credit model in the USA. All three examples focus on the procurement of commercial cloud services.

The analysis of the identified barriers, best practices and use-cases led us to examine a set of potential opportunities for cross-border procurement. Key questions in all of the procurement opportunities are 'who pays?' and what risks are the participating parties ready to accept. The opportunities offer more added value as the procurement commitment and acceptable levels of liability become more clearly identified. The potential role of EGI in the opportunities has been highlighted and a number of recommendations are made in order to prepare a cross-border procurement scheme that can be used to establish an Open Science Commons.