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Abstract

This document describes the GÉANT Community Sourcing Strategy for Infrastructure Cloud based on interviews with National Research and Education Networks (NRENs) to understand the decision making process involved in their strategies for sourcing infrastructure to support local institutes. This process has begun with the NRENs who volunteered participation, and their collective thoughts and direction have been included in this document. The document will evolve as discussions with the community continue, with the aim to create a definitive reference resource for the community by December 2024.

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Executive Summary

This document presents the first step towards a potential collective cloud strategy and related services for the GÉANT community. The guide will explore the basis behind the support of infrastructure cloud within the GÉANT NREN community and will include questions that need to be addressed when making decisions on cloud sourcing based on workload attributes. The document is a working document that the WP4 Task 4 Above-the-Net Services Strategic Planning team (the Strategy team) will continue to evolve over the GN5-1 project duration as its discussions within the community are continued. A definitive reference resource for the community is planned to be published by December 2024.

Given the complexity and differentiated nature of cloud economics, existing capabilities and organisational constructs cannot fully capture the value at stake in harnessing services. For many institutes, sourcing organisations can bring financial and process discipline, but they often lack the technical depth and ability to define and map business demand in sufficient detail. This often leads to rigid sourcing standards that delay and constrain flexible capacity deployment. On the other hand, entrusting product or technology teams with the task can maximise agility, and grant developers the freedom to flexibly and rapidly configure resources. However, many institutes have observed that this approach leads to fragmented decision making, poor spend visibility, and insufficient financial discipline.

Top-performing universities are instead deliberate about bringing together technical, financial, and sourcing talent into a cross-functional cloud financial operations (FinOps) team to manage cloud sourcing and consumption. In some cases, companies can be successful by supplementing their existing sourcing or technology functions with relevant talent. This team is then empowered to orchestrate across stakeholders, translate the institutes' consumption needs into optimal cloud offerings and pricing arrangements, oversee and make rapid decisions around resource allocations and cloud usage, and track enterprise-wide cloud spend to ensure financial discipline. Importantly, this cloud-management team is provided with the right analytics, tooling, and automation, such as automated dashboards to better track cloud consumption in real time and advanced analytics to help project demand.

The FinOps team will explore the various NRENs' considerations regarding infrastructure cloud. The Strategy team realises that it will see differing priorities across Europe but understands that the community recognises that there is no one size fits all solution to infrastructure cloud. Each of the workloads, both storage-related and computational, in support of research and education activities in Europe will need to be considered individually. The Strategy team anticipates seeing the demand for a hybrid landscape comprising on-premise private cloud (virtualised infrastructure), community cloud platforms that are possibly hosted by the NRENs, commercial commodity cloud solutions (including Trusted/Virtual Research Environments), and the emerging commercial European sovereign cloud platforms.

1 Introduction

Over the years, universities have developed a robust model for sourcing IT infrastructure assets. It is episodic in nature, based on asset refresh cycles which follow a structured sequence: requirements to request for proposal (RFP) to negotiations to award. Success in this model requires solid negotiation and contracting skills, as well as the ability to engage the business at the right touchpoints in the process. The RFP juncture came to constitute the major point at which value was captured. Once the contract was signed, the organisational focus normally shifted to other areas until the next negotiation cycle.

Cloud economics mandates a fundamentally different approach. While Cloud Service Provider (CSP) selection and negotiation are critical components of the cloud journey—determining, for example, the price of services and discount levels—many of the decisions impacting value capture come afterwards. The very flexibility that cloud infrastructure provides means that universities must continuously make dynamic consumption decisions about which services and specifications are needed when and for how long. Each of these decisions can have significant cost implications if not deliberately carefully managed.

Cloud compute has introduced significant changes to both financial and operational models at institutes, such as:

- Replacing capital expenditure (Capex) with operating expense (Opex) models as infrastructure becomes a consumable monthly cost.
- The migration to DevOps and infrastructure-as-code from traditional separated roles within central IT.

The need to continuously manage cloud consumption is accentuated by the rapidly evolving vendor marketplace and its continuous introduction of new offerings, features, pricing mechanisms, and regions. For instance, AWS has changed prices—mostly dropping them—more than 60 times since its launch in 2006. It introduced more than 20 new top-level services last year (2022) alone. Sourcing and managing the consumption of cloud in this world requires a deep understanding of the cloud ecosystem and continuous engagement with the business as partners.

As a result of the many options available to the institutes in terms of workload support today, from legacy on-premise platforms, on-premise private virtual stacks, NREN hosted community clouds, commercial public cloud, and commercial sovereign cloud platforms (decoupled from global cloud platforms, the Research and Education (R&E) community in Europe require assistance in the decision-making process when sourcing the appropriate solution. The Strategy team believes that this process can be supported within the community through discussions based on the collective experience of the NRENs and their constituents thus far. The Strategy team will provide a forum for collecting information through community discussions and evolve a reference resource as these progress.

The document will evolve as discussions with the community continue, with the aim to create a definitive reference resource for the community by December 2024. The document is structured as follows:

- Section 2 provides an overview of the considerations that are helpful for NRENs to consider in formulating their could infrastructure requirements.
- Section 3 details the cloud sourcing process, providing valuable pointers for determining a fit-for-purpose solution for any NREN.

- The Conclusion summarises the most pertinent consideration for a potential collective cloud strategy that have emerged from discussions with NRENs.
- Appendix A presents the questionnaire that is used to gather feedback from NRENs.

2 Infrastructure Cloud

The purpose of this section is to:

- Define the scope of the business requirement that requires an Information and Communications Technology (ICT) infrastructure solution.
- Classify the data that will be stored within the ICT infrastructure solution for the purposes of informing the data security requirements.
- Assess the most suitable infrastructure deployment model:
  - Public Cloud
  - Private Cloud
  - Hybrid Cloud
  - Co-Location / On Premise
- Assess the most suitable Service Provider and/or procurement pathway for sourcing the ICT infrastructure solution. The procurement process for public cloud will be undertaken in accordance with the Cloud Procurement Guidelines [Guidelines].
- Document the risk assessment to demonstrate that the cloud services team will implement sufficient controls to manage the risk in terms of the whole project but more specifically protecting the data that will be stored in the ICT infrastructure solution.

2.1 Cloud Service Models

The following cloud service models are available:

- **Infrastructure as a Service (IaaS)** - consumption of ICT infrastructure (server, storage, network, operating system) from a cloud provider.
- **Platform as a Service (PaaS)** - consumption of ICT platform to allow for the development, operation, and management of applications without the complexity of building and maintaining infrastructure.
- **Software as a Service (SaaS)** - on demand delivery of software applications, with cloud providers hosting and managing the application and its underlying infrastructure.

The diagram below illustrates the different responsibilities between the agency and the Cloud Service Provider (CSP) for each service model.

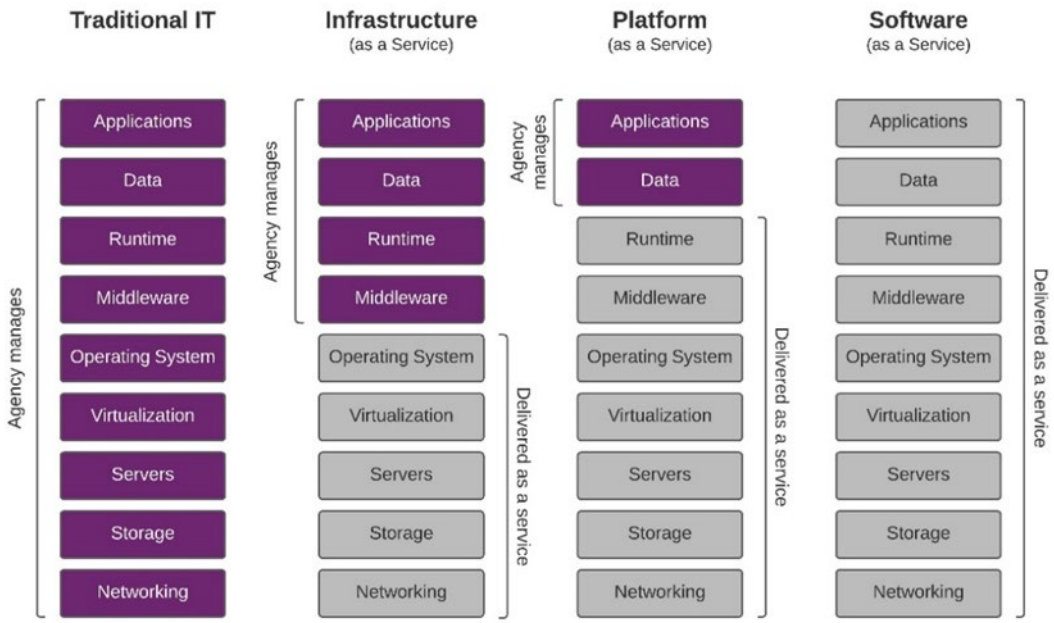

Figure 2.1: CSP responsibilities

2.2 Cloud Deployment Models

This section provides an overview of the available cloud deployment models.

Public Cloud Services - The cloud infrastructure is provisioned for open use by the general public.

Characteristics of public cloud services include:

- Commoditised service offerings – standard service offerings in terms of technical design and service levels offered to all consumers.
- On-demand self-service – consumers can unilaterally deploy computing capabilities automatically as needed without requiring human interaction with any service providers.
- Resource pooling – the cloud provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to consumer demand.
- Rapid elasticity – provides capabilities that can be elastically provisioned and released, in some cases automatically, to scale rapidly outward and inward according to demand. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be appropriated in any quantity at any time.
- Measured service – cloud systems automatically control and optimise resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported, providing transparency for both the provider and consumer of the utilised service.
- No-commitment – consumers can order services with no up-front costs, no long-term contracts, and pay-as-you-go pricing.

Private Cloud Services - The cloud infrastructure is provisioned for exclusive use by a single organisation. Characteristics of private cloud services include:

- Customised service offerings – technical design and service levels are customised to meet the organisation's specific requirements.
- Dedicated resources – the cloud provider's computing resources are provisioned for exclusive access by a single organisation.
- Commitment – private cloud services typically require a level of commitment in terms of a term-based contract and minimum volume commitments based on forecasted demand. Pricing is still consumption-based in terms of the pricing model and charges for additional capacity beyond the minimum commitment.

Hybrid Cloud Services – The cloud infrastructure combines Private Cloud Services and Public Cloud Services, with orchestration between the various platforms creating a solution that essentially functions as one combined infrastructure solution. This hybrid cloud definition maps to managed hybrid cloud services. Managed means there is a single management layer that combines the use of both private and public cloud environments.

Data Centre Terms

- Co-Location Services – External third-party data centre services used to house agency-owned infrastructure.
- On-Premise – Agency in-house data centre used to house agency-owned infrastructure.

3 Cloud Sourcing Process

Deciding on the correct service/solution for the support of a particular workload requires the consideration of a significant number of factors. This process is likely to involve a team reporting to the Chief Technology Officer (CTO). This document could assist in ensuring appropriate questions are asked and answered based on the experiences of the broader community thus far. Considerations such as data sovereignty and institutional digital autonomy will be explored as this document evolves in line with the communities' collective experience at any point in time.

3.1 Decision Support Tooling

NRENs have been and will continue to be interviewed according to the questions set out in Appendix A.

The responses to these interviews have been captured, and influence the observations and recommendations set out in this document.

The diagram below illustrates the five guiding principles that DevOps teams are recommended to follow when sourcing infrastructure cloud [Source].

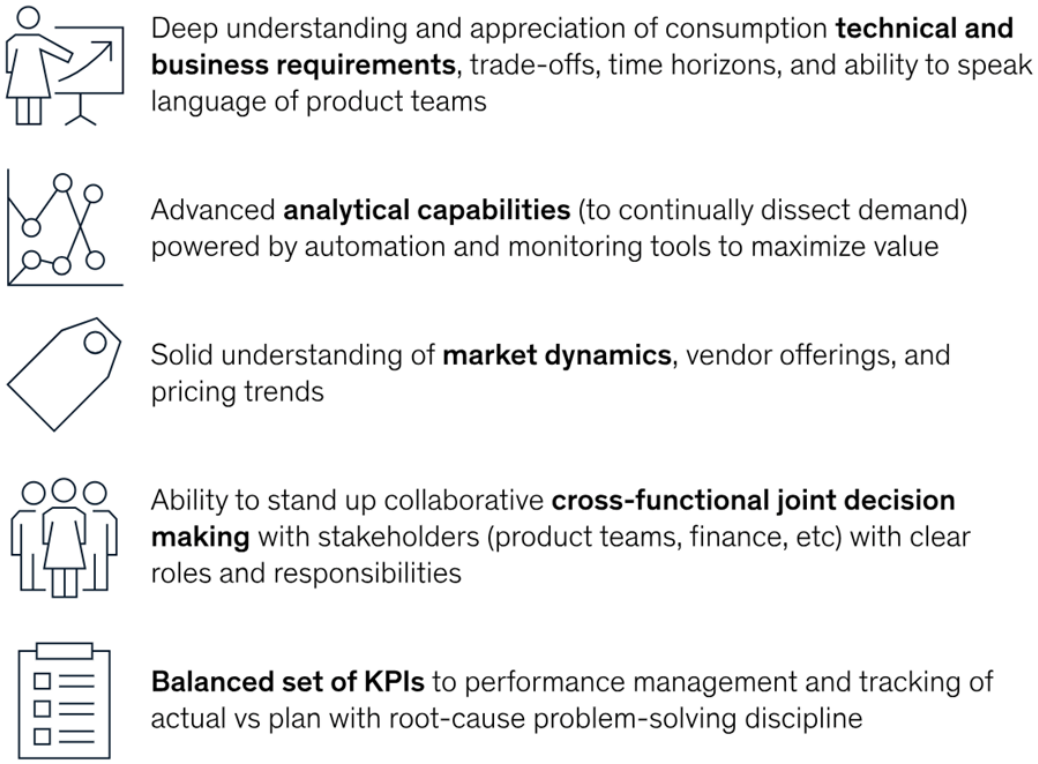

Figure 3.1: Guiding principles

3.2 Build or Buy

A fundamental question that many cloud sourcing projects are likely to address is whether to build the service or buy it. While the ability to build a service is usually determined by competences and availability of staff, a purchasing decision would often rely heavily on the available funding. The decision to buy or build is seldom an either/or decision. Each type of solution comes with different requirements and delivers different outcomes. NRENs typically service a multitude of different institutions that each have a wide range of requirements. Therefore, a one-size-fits-all cloud solution is seldom sufficient at the national level. Optimally, the build or buy decision is taken after a decision is made on what type of cloud service is needed. The decision should ideally find the best matches to requirements between the following types of cloud solutions:

Community cloud

A community cloud solution is typically conceived, built, and maintained by a community of users and is tailor-made for this set of users. A community cloud solution can be built for and governed by a particular research field with tailored requirements (such as a social sciences research community requiring domain-specific tools and the ability to manage types of sensitive data). Other community cloud solutions may focus on delivering a storage solution for general use for researchers and/or administrative purposes. The upside of choosing a community cloud is the ability to achieve full control of the solution. The downside may be found in balancing commercial sustainability with community governance. Community cloud solutions primarily require manpower to build and maintain the solutions.

Commercial cloud

A commercial cloud solution may be procured and implemented for the same reasons as a community cloud. The cost of building, managing and maintaining a community cloud could well justify the decision to consume commercial cloud services in a cost-optimised way.

The Open Clouds for Research Environments (OCRE) project has provided a wealth of testimonials and statistics on who uses commercial clouds in the research and educational domains, and to what extent. This type of information is not easily available for community clouds as they are by nature used and governed by individual communities. If you have not actively immersed yourself in a community cloud community, you may not even know it exists. Therefore, the Strategy team has conducted a series of interviews to shed light on what led to the building of community cloud solutions in the NRENs that have chosen to do so.

Hybrid community and commercial clouds

The decision to build or buy can also be mixed. This is relevant where staff are available to build and maintain some parts of the stack, but not others, or if part of the building or maintenance is chosen to be conducted in-house. Examples of this already exist within the NREN community.

The different stages of the sourcing process are often represented as a decision tunnel. An example of this is set out below.

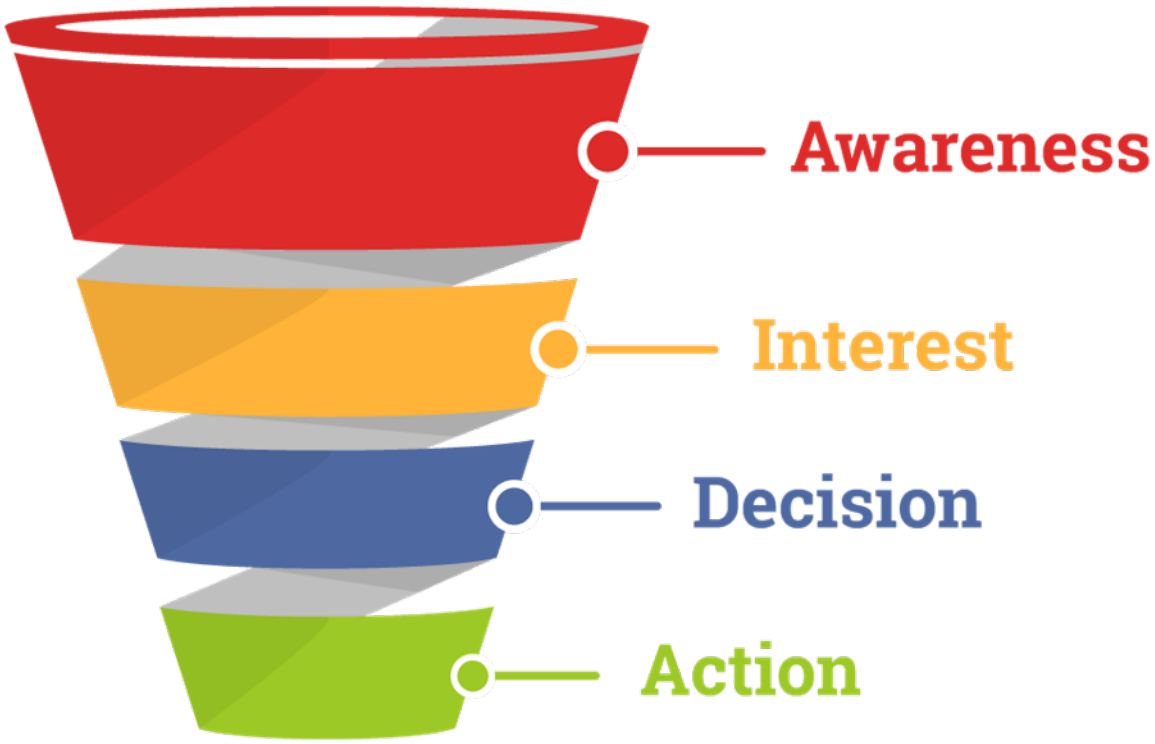

Figure 3.2: Decision Funnel

While the above diagram may seem overly simplistic, each of the stages will be explored in the sourcing process based on the experience of those in our community who have engaged extensively with the support of these services on behalf of their constituency.

3.2.1 NREN/Institute Awareness

Most NRENs are aware of the needs for virtualised hosting and compute needs in their own communities. Where digital autonomy is a priority for the local institutes, this drives collaborative community cloud deployments. These may be hosted by the NREN (in their own data centres) where the NREN is adequately resourced, or leading universities may host community cloud platforms in collaboration with other institutes. Community cloud platforms and services distribution is promoted and explored within the Special Interest Group for Cloudy Interoperable Software Stacks (SIG-CISS) activities.

Regarding public cloud, many NRENs have a fairly experienced cloud manager who is focused on the collective support of the GÉANT cloud procurement frameworks, in which they have participated since 2016 when the original GÉANT cloud framework was tendered, through the OCRE project cloud framework activities, and are now engaged in the preparatory work ahead of the OCRE 2024 framework tender. The NRENs agreed to host supplier webinars and training nationally, and promote awareness of commercial cloud opportunities.

Input from NREN Interviews So Far

- The Swiss NREN was able to gather awareness of the need for a national solution through a smoother process than in Denmark. This was likely due to fact that the upcoming Swiss service was to replace an existing national service. The stakeholders were therefore already aware of some important benefits and drawbacks of the existing solution. Denmark, on the other hand, did not possess a national solution and chose to perform a competition between the existing solutions to evaluate which could be scaled to the national level.
- The level of awareness at the institutional level in Denmark was also more fragmented than in Switzerland since some universities had universally adopted their own cloud solution while others had not.

3.2.2 NREN/Institute Interest

Cloud services are highly topical and all of the European NRENs are aware of the fact that their constituents have need for variable, scalable storage and compute services. Through the various activities driving awareness, there is significant interest in many countries in supporting the consumption of hybrid cloud services (a mix of both community and commercial). As real demand for services presents itself, options will be explored via the various national and regional cloud fora.

As the NRENs across Europe have varying levels of resourcing, their ability to fully engage in the support of both community cloud options and the current commercial framework contracts may be limited. The frameworks allow NRENs to have a very light touch 'referrer' role, and a far more resource- and service-intensive 'underwriter' model. Referring could simply entail making call-off contracts available to the institutes, while underwriting suggests robust internal procurement teams buying on behalf of the institutes. The current NREN signup process for the OCRE 2024 cloud framework shows that 40 NRENs are interested in participating, but with only a handful choosing the underwriter role. The others will be supporting the framework locally with some minimum commitment to related community activities.

Input from NREN Interviews So Far

- Both NRENS interviewed had a similarly high degree of interest in providing relevant cloud services to their communities. This interest was similar even though one (Switzerland) had a higher head count and better skill sets on community clouds than the other. The Danish NREN had to rely on staffing and skillsets provided at individual universities.

3.2.3 NREN/Institute Decision Making

Various workload-related factors need to be considered when selecting from the many possible services available. Through collaborative engagements within the community, the strategy team will attempt to compile a comprehensive list of education and research workloads and describe these in terms of their individual nature and requirements.

Where workloads demand high availability, support for data protection, national sovereignty etc., appropriate decision making suggestions will be considered and described.

National sovereignty and the digital autonomy of the institutes were highlighted by most NRENs as their most fundamental concern when considering the hosting of R&E workloads in the public cloud. This reflects the view of the European Commission and is explored in the various conversations pertaining to the development of European data governance and policy. In terms of decision making, this may be the most influential factor regarding the evaluation of the various different hosting options presented to the local constituencies.

The decision behind the development of a national repository (possibly for research data) service may be initiated and funded by the local ministry of education. This decision could, for example, be made based on security audits of local institutes that identify potential threats in terms of research data management.

Input from NREN Interviews So Far

- In the two interviews conducted, a community cloud solution was chosen. The driving factor was ensuring digital and data sovereignty. Data sovereignty was perceived as storing data nationally. In both cases the building and governance of the service was thoroughly discussed and confirmed at the NREN's board of directors.
- In neither case the NREN had a formal sourcing strategy for cloud solutions. The framework for the decisions on building or buying seemed to be taken on a case-by-case basis. This approach can be seen as pragmatic and tailored to the service being discussed, but it also might lead to different outcomes on similar decisions taken at different times and with different attendance in the board of directors.
- As importance grows, it is important to pay more attention to some of the misconceptions that exist within the community. A community cloud solution was seen as the only viable approach to ensure wide adoption in Denmark, but sensitive data commercially hosted within the sub-region (on AWS in Norway, for example) might be one of the many exceptions to that rule.
- In both cases (Switzerland and Denmark) a community cloud solution was actively chosen instead of a commercial cloud solution for their bespoke needs. In Denmark's case the national institutions have widely adopted commercial cloud solutions through OCRE for other purposes, while Switzerland has seen a very limited adoption of commercial cloud services through OCRE.
- Control of the full stack adds benefits and drawbacks. From a legal point of view the risk of transferring data can be mitigated by controlling the full stack. However, sometimes the expected benefits and drawbacks may prove false when the solution is implemented. The two interviews completed thus far focus on solutions that are not yet operational.

3.2.4 NREN/Institute Action (Procurement/Deployment)

Based on the analysis of workload requirements and platform suggestions, the NRENs and institutes will be able to select from an extensive range of options ranging across:

NREN community cloud hosting (infrastructure)

- Many of the NRENs have developed their own hosting capabilities over time. These NREN community cloud platforms often use Open Stack deployments that require the development and retention of in-house resources. As the NRENs realise the significant commitment this represents, many have opted to partially outsource related services to local providers rather than retain skills in-house.
- NRENs are also aware of the opportunity to underpin their own hosting services using commercial (public) cloud platforms. If the consumption of these services is fully optimised (and there is s growing call for a community approach towards cloud optimisation), this can drive the cost of hosting down. This option also gives NRENs significant benefits in terms of scaling up and down their services based on demand.

Institutional on-premise hosting and support

- On-premise hosting at the institute still supports many/most of the education and research workloads, both in terms of storage and compute. NREN-supported community activities (such as special interest groups) allow the local community to share related knowledge and resources.
- As research data is seen to be a key emerging player in the European data economy, on-premise solutions need to ensure high availability, connectivity, security, and accessibility. These factors are often responsible for the transitioning of large data workloads to low-cost commercial cold storage type solutions.

Commercial IaaS/PaaS/SaaS

- Almost all of the European NRENs are participating in the current OCRE framework and have indicated that this will continue through the tendering of the subsequent framework. This indicates that the GÉANT community is aware of the growing demand for commercial cloud services by the institutes, and by the European e-Infrastructures as demonstrated by the European Open Science Cloud (EOSC) Future project.
- NRENs have elected to support the consumption of commercial services at the institutes at varying degrees. A number of the NRENs are themselves consuming commercial cloud services in order to deliver on their own bespoke services (as does GÉANT).

Input from NREN Interviews So Far

- Determining the importance and the consumption level of community cloud solutions is almost impossible. This is due to the nature of the community cloud solutions that the Strategy team has identified. None of the community cloud solution seek to mimic the offerings of hyperscalers such as Microsoft, AWS or Google and can, therefore, not be compared directly to them.
- Community cloud initiatives often seek to build and maintain tailored solutions for very specific purposes. Some grow almost organically from small communities to larger communities when similar requirements from the communities are identified and collaboration commences. This tends to go under the radar and is not necessarily discussed or decided upon in a normal decision making forums. This has, for example, been the case for some of the cloud solutions that entered into the competition in Denmark.
- The interviews identified the desire to establish full control of the whole stack of the service. This came about based on the nature of the data expected to be managed by the service (in terms of compliance with regards local privacy guidelines). This was pursued In order to provide sufficient comfort and full support by relevant legal experts, data protection officers, and other stakeholders with specific requirements regarding data sovereignty and data privacy.
- In the Danish example of DataVerse, this led to inhouse development of the whole stack, while, in the Swiss example, this led to limitation on the private partner, who is set to maintain hardware and the lower levels of the stacks. The safeguards were to invest in the company and have a golden share that enables the NREN to veto strategic decisions the company may make that could have a negative impact on the service.

4 Conclusions

While it is too early in the process to draw significant conclusions, it is possible to identify some common threads based on the community's extensive experience in participating in fora such as the NREN Cloud Managers collective, and following the various conversations held by the SIG-CISS (special interest group for cloudy interoperable software stacks). The few focused NREN interviews on infrastructure cloud sourcing strategies that have already been conducted has also provided some interesting considerations.

Firstly, besides having different approaches to national data sovereignty and digital autonomy, it is generally agreed that different infrastructure cloud solutions apply to the different types of workloads found across the research and education landscape. Also, where SaaS solutions are consumed, as is extensively the case in modern education environments, student management, financial and human capital management, and learning management solutions, these may well be hosted by the software vendor themselves (the natural of SaaS).

Research workloads are employing a number of innovative and sophisticated compute services in support of machine learning and artificial intelligence, employing the use of virtualised digital twins of almost everything. This landscape requires equally sophisticated network, trust and identity, and security services. Research data is being mandated by funders to remain online for sharing according to the Findability, Accessibility, Interoperability, and Reusability (FAIR) data principles.

The sharing of research data employs ideologies supported by the broader nature of sharing within the European data economy and industry 4.0. European data governance and compliance with regards the employment of Artificial Intelligence (AI) must also be applied. This has a significant effect on how data needs to be hosted in order to facilitate the visitation of specific/thematic data by computational workloads (possibly using cloud at the edge services) on behalf of authorised users (i.e., other researchers). The use of the GÉANT community's networks, security, and trust and identity services will need to be carefully considered, along with the various options in terms of infrastructure cloud.

The Strategy team is seeing the emergence of Trusted/Virtual Research Environments (TRE/VRE) which provide specific support for the requirements of research in terms of infrastructure cloud. The work done by the EOSC Future project proved significant demand for partnerships between the providers of such services and the European research infrastructures. SURF in the Netherlands, GWDG in Germany, and D4SCIENCE/CNR in Italy provide good examples of such case studies procured through EOSC adoption funding initiatives.

The most significant conclusion that can be derived from conversations within the community is that data sovereignty, both national and regional, is becoming fundamentally important when deciding on solutions to infrastructure cloud. This is also explored in the early draft of the various policies being implemented by the European Commission, and national education departments. This goes well beyond the consideration of the General Data Protection Regulation (GDPR) and personal data management.

Appendix A NREN Questionnaire

In this latest version (Interview template v.02) the questions are derived from the JISC cloud manager's input at our latest cloud forum. For each question, the theme to be covered has been highlighted and added some examples of sub questions have been added.

1. What are your business goals and objectives? (high-level sourcing strategy)
   a. Higher level of sovereignty (wider options)
   b. Better access to industry-leading infrastructure or services
   c. Other – please provide sourcing strategy that applies to solution

2. What are your infrastructure cloud requirements (technical architecture)?
   a. User satisfaction in the form of new services or wider availability
   b. Interoperability with current or future architecture allowing for easy exchange and scaling of components and services.
   c. Other

3. What are your budget constraints (commercial issues)?
   a. New solution must not cost more than services being replaced or consolidated
   b. Cost avoidance of planned investments in a do-nothing scenario
   c. Other

4. What are your security and compliance requirements (security issues)?
   a. Adherence to standards (ISO27001, NIS2, etc)
   b. Balance between storage and processing under sovereign control or best-in-class – describe division of labor between you and private entities
   c. Other

5. What are your performance and availability requirements (ambition level)?
   a. Do you make use of a high availability setup with load balancing, redundancy and multiple sourcing of services?
   b. Have you aimed for best-in-class, market average or "just enough" for user experience and your SLA?
   c. Other

6. What are your disaster recovery and business continuity requirements (suggest deleted)?
7. What are your data sovereignty [digital sovereignty] and privacy requirements?
   a. At national or NREN level
   b. At solution level
   c. Other

8. What are your vendor management and governance requirements suggest deleted?
9. What are your service level agreement (SLA) requirements suggest deleted?

10. What are your scalability and flexibility requirements suggest deleted?
11. Were there other considerations that were or became important for the decision-making process?
    a. Your local head count or preservation of in-house competences
    b. Relevance or trust in the community
    c. Other

References

[Guidelines] https://clouds.geant.org/geant-cloud-catalogue/geant-cloud-catalogue-ocre/

[Source] https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/unlocking-value-four-lessons-in-cloud-sourcing-and-consumption

Glossary

AI	Artificial Intelligence
AWS	Amazon Web Services
Capex	Capital expenditure
CISS	Cloudy Interoperable Software Stacks
CSP	Cloud Service Provider
CTO	Chief Technology Officer
DevOps	A combination of software development (dev) and operations (ops)
EOSC	European Open Science Cloud
FAIR	Findability, Accessibility, Interoperability, and Reusability
FinOps	Financial Operations
GDPR	General Data Protection Regulation
ICT	Information and Communications Technology
IT	Information Technology
KPI	Key Performance Indicator
NREN	National Research and Education Network
OCRE	Open Clouds for Research Environments
Opex	Operating expense
R&E	Research and Education
RFP	Request For Proposal
SIG	Special Interest Group
TRE/VRE	Trusted/Virtual Research Environments