EOSC NORDIC

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D2.2: Cross-Border Collaboration Models – The Nordic Experience

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Abstract

This document is a deliverable of the EOSC-Nordic project supported by the European Commission under Horizon 2020. The deliverable is the work of Work Package two, *Policies, legal issues and sustainability*. This document discusses past experience of organising cross-border research, research infrastructure collaboration and access to research and infrastructure resources in the Nordic and Baltic region. It offers lessons learned with a view to the potential impact on the European Open Science Cloud (EOSC). Especially governance, resource sharing, coordination & harmonisation of policies, as well as cross-border funding are discussed. The document assesses the past developments against the anticipated EOSC model and provides recommendations on how to further develop cross-collaboration in relation to EOSC.

Executive summary

This deliverable is a study of cross-border research and research facility collaborations in the Nordic and Baltic countries. The study takes a case-based approach, examining collaboration cases, extracting lessons learned, considers the implications for the emerging EOSC, and makes recommendations for future cross-border research collaborations in light of EOSC.

The first part of the report is an examination of seven existing and past cross-border collaborations. Each collaboration is discussed with a focus on four main drivers of collaboration: governance, resource sharing, coordination and policy harmonisation, and cross-border funding.

After that the report examines lessons learned for each of the collaboration drivers, and additionally discusses the importance of understanding if collaborations are driven top-down or bottom up. The lessons examine what motivates collaboration as well as factors for the collaboration succeeding or failing in achieving its objective.

The report then examines implications for the emerging EOSC in each of the collaboration areas: governance, resource sharing, coordination and policy harmonisation, and cross-border funding; as well as challenges for collaborations in the context of the anticipated EOSC collaboration model.

Finally, the report makes five key recommendations – based on the lessons learned from the cases examined - for improving cross-border collaboration in the context of EOSC. As the EOSC model is not yet fully established, these recommendations identify future work that should be undertaken so that EOSC can fully facilitate cross-border research collaborations.

Recommendations for further work are:

1. Licensing and third country collaboration need common rules, policies, and processes.

2. Common understanding of using and sharing health and sensitive data is needed.

3. Focus on sharing data and its challenges, not only providing services.

4. Establish EOSC compliance for all resources in the European Union, at national and institutional levels. Resource compliance is more important than cross-border service delivery.

5. Good governance is a key factor in enabling successful collaboration.

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1. Purpose and scope of the document

The aim of this document is to provide a review of past experiences of organising cross-border collaboration and access to resources and to draw up lessons which can be reused in EOSC. Research, research infrastructure, and e-Infrastructure collaborations are considered.

The key aspects of collaborations considered are governance, resource sharing, coordination & harmonisation of policies, as well as cross-border funding. The deliverable assesses the past developments against the anticipated EOSC model and considers both the impact on EOSC as well as an initial set of recommendations on how to further develop cross-collaboration in the region in light of EOSC developments. As such, the deliverable offers insights for both stakeholders in the establishment of EOSC, and for Nordic and Baltic providers, institutions and policy bodies seeking to further cross-border collaboration.

It is to be noted that this document is produced at a time when the EOSC Association is being established and the EOSC Executive Board and Working Groups[1] are in the process of finalising EOSC guidelines and initial policy documents. As a result, the EOSC model for collaboration, data sharing, and cross-border service provision is still evolving. EOSC guidelines of particular relevance to the scope and findings of this deliverable are outputs such as the Rules of Participation[2] and EOSC Interoperability Framework[3]. The findings in this deliverable will be put into relation to these guidelines.

2. Methodology

The purpose of this deliverable is to illustrate cross-border collaboration models and experiences, and to make policy recommendations based on lessons learned from past and existing collaboration. To facilitate this, the starting point for the work has been a qualitative, case-based approach. This method has proven to be useful in other deliverables[4,5] in this work package.

The case-based approach allows studying how the different aspects expected to be discussed in the deliverable have been implemented in practice in different situations. It also allows the examination of practical experiences, good and bad, which are useful material for recommendations for future cooperation - a main target of the deliverable.

The cases have been selected based on the objectives of the deliverable and the key aspects of collaborations to be investigated: governance, resource sharing, coordination & harmonisation of policies, and cross-border funding. Each case offers important insight into at least one of these aspects but is not necessarily expected to address all the aspects; The study is purely qualitative. The cases have also been selected so that they are sufficiently diverse and represent different kinds of situations of collaboration: thematic research cooperation, e-infrastructure cooperation, sharing of resources, etc. Finally, cases have been chosen based on the information available publicly (references to the documents are given), as it is critical to the deliverable that findings can be publicly presented and discussed.

[1] https://www.eoscsecretariat.eu/eosc-working-groups
[2] https://op.europa.eu/en/publication-detail/-/publication/a96d6233-554e-11eb-b59f-01aa75ed71a1/language-en/format-PDF/source-184432576
[3] https://www.eoscsecretariat.eu/sites/default/files/eosc-interoperability-framework-v1.0.pdf
[4] https://www.eosc-nordic.eu/kh-material/deliverable-2-3-open-science-in-the-nordics-legal-insights/
[5] https://www.eosc-nordic.eu/kh-material/deliverable-2-4-the-eosc-delivery-chain/

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To verify that aspects discussed in this deliverable have been addressed appropriately and to get input on analytical points, interviews with key participants have been conducted. At least one representative from each case covered in this deliverable has been interviewed to assess that the findings are accurate.

3. Nordic and Baltic Collaboration Cases

As described in chapter 2, this study takes a case-based approach to analyse collaboration models. In this section we briefly introduce the cases chosen, and we describe the four key aspects of the cases used as basis for the descriptions and later analysis: *governance*, *resource sharing*, *coordination and harmonisation of policies*, and *cross-border funding*.

This chapter is the starting point for understanding how cross-border research and research infrastructure collaboration happens today and serve as the basis for the analysis of lessons learned (chapter4) and impact on EOSC (chapter 5).

3.1 The Cases

The seven cases described below are: NORDUnet[6], European Spallation Source (ESS)[7], EISCAT-3DD[8] (EISCAT), Baltic Grid[9], NeIC[10], the Gardar System[11] (Gardar), and the Nordic programme on health and welfare[12] (Health). A more detailed description of each case can be found in Appendix I.

3.1.1 NORDUnet

NORDUnet is the joint, international network of the Nordic national research and education networks (NRENs), established as a project in 1980 and incorporated as a company limited by shares in 1994. NORDUnet is incorporated as a company limited by shares in Denmark. It was chosen as a case because it has existed as a Nordic research infrastructure collaboration for 40 years and illustrates cost sharing and international influence as drivers for Nordic collaboration, as well as the importance of stable governance.

3.1.2 European Spallation Source (ESS)

The European Spallation Source ERIC[13] is a research infrastructure (established 2015) under construction in Lund, Sweden, that will eventually become the world's most powerful pulsed neutron source. The Data Management and Software Centre (DMSC) is located in Copenhagen, Denmark. In this case we are focusing on ESS Scandinavia, which was the collaboration setup between Denmark and Sweden in order to make a bid for the construction of ESS in Lund. It was chosen because it demonstrates a functioning collaboration of networks of institutions in Scandinavia, and because it illustrates the importance of political commitment as a driving force to form a major cross-border collaboration.

[6] https://www.nordu.net/
[7] https://europeanspallationsource.se/
[8] https://wiki.neic.no/wiki/EISCAT_3D_Data_Solutions
[9] https://cordis.europa.eu/project/id/026715
[10] https://neic.no/
[11] https://old.nordforsk.org/en/news/gemensam-nordisk-superdator-pa-island
[12] https://old.nordforsk.org/en/programmes-and-projects/programmes/nordisk-program-om-helse-og-velferd
[13] https://ec.europa.eu/info/research-and-innovation/strategy/european-research-infrastructures/eric_en

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3.1.3 EISCAT-3D Data Solutions and Support (EISCAT)

The EISCAT_3D Data Solutions (E3DDS), development carried out 2017-2020) and EISCAT_3D Support (E3DS, 2015-2018) were Nordic e-Infrastructure Collaboration (NeIC) development projects aiming at analysing e-Infrastructure requirements and supporting the EISCAT_3D community in the preparation of the implementation of the EISCAT_3D instrument, for aspects concerning e-infrastructure. EISCAT_3D is a new instrument for upper-atmosphere observation, under construction in the Arctic region of Norway, Sweden, and Finland. EISCAT-3DD is a collaboration between EISCAT and Nordic e-Infrastructure providers to create the basis for delivering the e-Infrastructure required by users of EISCAT_3D.

EISCAT_3DD was chosen as a case as it illustrates how Nordic e-Infrastructure Collaboration (NeIC)[14] as a well-known and established coordinator for a pan-Nordic project facilitated Nordic collaboration. It also shows the benefit of a cross-border consultancy service for e-Infrastructure for major science projects, utilising science expertise and national e-infrastructure resources and experts.

3.1.4 Baltic Grid

Baltic Grid was an European Grid infrastructure project (2005-2010) whose objective was to develop grid computing in the Baltic States and integrate it into the European Grid infrastructure. It was chosen as a case to demonstrate an example of Baltic and Nordic countries' cooperation and coordination in order to develop a cross-border-Infrastructure.

3.1.5 NeIC

NeiC is a ten-year project for cross-border e-infrastructure within Nordforsk, established in 2012 and regulated by a Memorandum of Understanding between Nordic and Baltic national research councils and NordForsk. It was chosen as a case because it is an example of Nordic and Baltic cooperation as well as a successful project establishing and maintaining distributed e-infrastructure collaborations. The case reflects some of the challenges of having a multi-layered e-infrastructure ecosystem.

3.1.6 The Gardar System (Gardar)

Gardar was a joint, Nordic High-Performance Computing (NHPC) facility established in Iceland, as a vehicle for Denmark, Iceland, Norway and Sweden to explore the possibility of sharing responsibilities of a single system. The Nordic High Performance Computing Project (NHPC) was established to commission the supercomputing facility. The project began in April 2011, and the Gardar system was up and running for three years (2012 – 2014). Gardar was chosen as a case to illustrate how cross-border collaboration involves complex national, policy and legal dynamics and how outsourcing hosting services to external providers can be successful under well agreed terms and conditions.

3.1.7 Nordic programme on health and welfare (Health)

Within the frame of Nordforsk the Nordic Programme on Health and Welfare was set up (2012) to increase public health and welfare in the Nordic countries by focusing on key focus areas as identified within the programme. The programme is scheduled to run until 2024. The programme was chosen as a case in order to illustrate how issues related to resource sharing may be identified, how to involve stakeholders, and how

[14] https://neic.no/

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solutions to constraints and challenges can be demonstrated via programme outputs.[15] It also illustrates challenges in translating findings and conclusions to actions within a context that involves multiple actors across borders, and the challenges of administrative and policy barriers within countries.

3.2 Collaboration Drivers

In the description and analysis of the cases, we focus on four aspects of the collaborations: *governance*, *resource sharing*, *coordination and harmonization of policies*, and *cross-border funding*. Each of these aspects is a *collaboration driver*, i.e., something that facilitates, enables, and motivates the cross-border collaboration. As such, review of collaboration drivers is a useful instrument for understanding cross-border collaborations and for deriving lessons for their experience.

Governance relates to *the processes of interaction and decision-making among the actors involved in a collective problem that leads to the creation, reinforcement, or reproduction of social norms and institutions*[16]. In academic communities and public bodies, a range of formal and informal governance approaches are used, often with emphasis on consensus and (in cross-border collaborations) national interest. In our cases, the main focus is on differences between projects and more stable and long-term governance such as established legal entities.

Resource sharing means the concept of co-operation and sharing of resources, human, financial and material, with other organisations and national government bodies[17]. Resource sharing is often a main motivator for collaboration. In the collaboration cases used here, resource sharing can take many forms. It can be sharing of research data (a key focus of EOSC), it can be sharing of expertise, costly instruments, or unique e-infrastructure resources.

Coordination and policy harmonisation in this document refer to formal or informal coordination of national or institutional initiatives, or the adoption of policies in a way that ensures similarity across institutions and between countries. Such coordination and policy harmonisation can significantly lower barriers to data exchange, service adoption, etc., and thereby facilitate collaboration. Policies in this context may cover everything from data access and privacy to technology solutions, service architectures, and data formats.

Cross-border funding can be a specialised version of resource sharing, where funding is pooled and shared, i.e., to achieve economy of scale, or sharing of resources jointly acquired, for example for resources too costly for a single institution or country to fund. This can lead to sometimes elaborate cost-sharing instruments. Cross-border funding can also be associated with use of national resources or delivery of national services across borders, in which case some form of cross-border, financial compensation must be realised.

3.3 Governance

The governance structures in the cases vary. Governance can be based on company structure, like in case NORDUnet. Or it can be based on another kind of legal entity such as an ERIC in case of ESS. As NeIC and Gardar collaborations are based on inter-agency agreements, their governance structure is defined by the partners. Baltic Grid on the other hand functioned under EU projects and the governance relied on a typical project structure.

[15] https://old.nordforsk.org/en/publications/publications_container/a-vision-of-a-nordic-secure-digital-infrastructure-for-health-data-the-nordic-commons
[16] Hufty, Marc. (2011). Investigating policy processes: The Governance Analytical Framework (GAF).
[17] https://www.lawinsider.com/documents/eppzw9D7NN5

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When the governance structure is based on the establishment of a legal entity, it has a clear and well-established legal framework. The ways to engage important stakeholders are known. For example, in NORDUnet the shares of the company are owned by the ministries of the Nordic countries (or institutions delegated by the ministries). The shareholders elect a board of directors to oversee the governance. Historically, the board of directors has had a member from each country. This provides a clear relation to key national stakeholders - funding bodies and Nordic national research and education networks as representing national users. The NORDUnet board of directors takes advice from community working groups and advisory bodies, with representation from stakeholders from the member countries. This further ensures alignment between NORDUnet and the Nordic national research and education network strategy and tactics.

When there is no legal entity as basis for the governance, there is flexibility to choose. For example, in NeIC, the governance structure is made up of a board with national representatives for e-infrastructures, with a rotating chairmanship. It utilizes personnel from the national providers and thus connects its own governance structure to the governance structure of the participating countries.

In Gardar, the management board consisted of one member from each country and a representative from the Icelandic Ministry of Education, Science and Culture. In addition, Gardar had an administrative board, with representatives from the countries, and responsible for managing national and local user support.

The governance structure for EISCAT utilized the general project model employed by NeIC[18] where a collaboration agreement defines the scope of the collaboration, governance structures, as well as individual parties' responsibilities. The steering group reflected the different stakeholders: NeIC, EISCAT, including non-Nordic stakeholders.

3.4 Resource sharing

In NORDUnet, resource sharing happens primarily by sharing jointly funded infrastructure and service facilities, such as the international network. Resources are shared on a best-effort basis, without reservation or allocation. This way the Nordic national research and education networks jointly finance costly global network infrastructure for research traffic towards public and commercial actors. In addition, personnel resources may be shared by employing staff at NORDUnet. This allows the Nordic national research and education networks, NRENs, to share expertise and delegate representation for some tasks to NORDUnet. The big challenge is, that sharing resources without distributing costs according to usage, requires a great deal of trust and commitment from the funders, in order not to disintegrate into micromanagement and/or discussions on fairness. In the case of NORDUnet, the economic benefit for all the partners most likely outweighs any minor and short-term discrepancies in terms of fair-return, and because network capacity is a generic and collaborative-centred resource in its own right. One of the drivers for NORDUnet was also the high cost of international networking. Procuring jointly as NORDUnet increased market purchasing power, and reduced cost through economy of scale and sharing of expensive resources.

In ESS, Sweden and Denmark pool resources and competence, building the Neutron Source, the experiment stations and all technical support and logistics are currently being built in Lund, Sweden. The ESS is built as a single facility located in two countries, operated by a single organisation (rather than having separate, smaller facilities and multiple organisations). The ESS Data Management and Software Centre (DMSC) is in Central Copenhagen, Denmark, while the core instrument facilities are in Lund, Sweden.

In EISCAT, resource sharing happened within the NeIC collaboration framework. The main function of NeIC was to act as a facilitator for the collaboration and enable resource sharing across borders within the Nordic

[18] https://wiki.neic.no/wiki/Collaboration

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and Baltic region. The main resource shared in the project were experts from the participating e-Infrastructures, along with temporary computing facilities to perform simulations and experimental runs of workflows to confirm designs.

The Baltic Grid project was sharing computing and data storage resources, established grid computing clusters and provided network connections (via NORDUnet and GEANT).

In Gardar, a single HPC resource was procured and shared, with the computing resources distributed amongst the countries according to each country's share in the investment. The University of Iceland provided local representation and competence to serve the users as well as system administration in collaboration with representatives from each country.

In the Health case, a key aim of the initiative was to facilitate sharing of research data and clinical health data between institutions and across borders, because sharing these data resources would significantly impact scientific quality. In addition, there was a definite political will to cooperate and funds were made available. Key national stakeholders showed a will to invest in facilitating resource sharing within the Nordics.

3.5 Coordination and policy harmonisation

NORDUnet has achieved a significant degree of policy harmonisation. NORDUnet has facilitated technical coordination between the emerging Nordic NRENs which have evolved into harmonisation of policies, for both technology and participation in international collaborations. In the 1980's, NORDUnet and the Nordic NRENs adopted the US developed TCP/IP protocols (the technology now known as *the internet*), over its rival European ISO-OSI protocols. This tradition has been continued by Nordic NRENs in coordinating, creating and establishing common standards for digital identities, global connectivity, and more. NORDUnet is influential in European and global e-Infrastructures in large part due to this cross-border coordination of joint policies.

For EISCAT, the aim has been to pool data sources and gather stakeholders and expertise, and to ensure a coordinated approach to e-Infrastructure and data processing workflows for EISCAT_3D across the national providers. One outcome of this work is an understanding of the future EISCAT_3D e-Infrastructure requirements and how these requirements can be met using national resources. Proposals have been made to share national resources, in particular for networking by ensuring this is possible because of close coordination of technical and process approach among the providers.

For political coordination of the European Grid infrastructure, the-Infrastructure Reflection Group (e-IRG) was created in 2003. In e-IRG, each EU country, Switzerland and Norway were represented by 2 delegates and rotating governance according to the presidency of the Council of EU. The coordinating organization under the name - the European Grid Infrastructure Association or EGI - was created in 2010, but unfortunately the development of the NGI network covering all EU countries was not supported. A top-down management system was created without bottom level structure covering all already developed grid computing infrastructures in Europe. The development of the European Grid infrastructure for eScience was well planned and coordinated, but the very final stage did not establish sustainability.

Coordination and policy harmonization within the frame of NeIC happens via specific projects aimed at facilitating coordination and policy harmonization. An example of this is thematic projects such as the Tryggve-project[19], which is an extension of Elixir[20] and which, among other aspects, deals with harmonisation throughout the participating organisations.

[19] https://neic.no/tryggve/
[20] https://elixir-europe.org/about-us

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3.6 Cross border funding

In NORDUnet, cross-border funding is achieved mainly through a cost sharing agreement for ongoing operations. The cost of the NORDUnet network and related services is shared by the Nordic NRENs according to Gross National Income (GNI). In this way, the cost of shared resources is distributed among the stakeholders in a way that is seen as both fair and reasonable, and for national funders, more importantly, it creates a very stable funding regime which minimises large funding fluctuations over the years – something public funders always try to avoid. In addition, NORDUnet can provide usage-billed services on request of the national networks. In this case, cross border funding is achieved through direct payment for services rendered. As NORDUnet is an incorporated entity set up specifically for cross-border service delivery, this mechanism works.

In ESS, Sweden and Denmark are responsible for approximately half of the construction costs, budgeted at EUR 1,843 billion. The remaining construction costs are covered by other partner countries. In this case, cost sharing is agreed as part of the agreement to create the collaboration.

In EISCAT-3DD, funding came for example through Nordic e-infrastructure cooperation (NeIC), which is a ten-year program within Nordforsk and thus leverages existing Nordic cooperation structures for funding, as well as from EISCAT and the participating e-Infrastructures contributing resources to the project in-kind.

In Gardar the funding came as country contributions amounting to about 1 million euros. As with ESS, the cost sharing was agreed as part of establishing the collaboration.

4. Lessons Learned

The purpose of this chapter is to examine the experience of the cases presented in chapter 3 and Appendix 1, and to draw out the main lessons that can be learned from the cases. In chapter 3 we reviewed the cases and highlighted key aspects of each case in four areas: *governance*, *resource sharing*, *coordination and harmonization of policies*, and *cross-border funding.* In this chapter we will do an analysis based on these aspects to establish lessons on cross-border collaborations in general. This analysis will be used further in chapter 5 to inspect possible impact on the upcoming EOSC, and in chapter 6 to make recommendations for future cross-border collaboration in light of EOSC.

4.1 NORDUnet

The benefit of using a classic shareholder model for governance is that it is directly suitable for cross-border ownership. The disadvantage is that from a national policy body point of view, ownership of shares in a corporate entity incurs administrative overhead, e.g., for accounting procedures and transparency, and that it is by design inflexible. Substantial governance changes require changes to a five-way shareholder agreement. As a result, the model is suitable only for very long-lived, stable collaborations.

In the case of NORDUnet, the national overhead in terms of administrative resources can be substantial compared to the size of the activity. NORDUnet is not set up as a limited company in order to operate in a competitive market, but because it is a simple and proven governance model across borders. Regardless thereof, the legislation governing limited companies has to be followed. As a publicly owned limited company, NORDUnet is being monitored by the State Treasury particularly on issues relating to state aid and fair market competition and has to report on these issues. Therefore, it has a heavy administrative organisational format, particularly considering the actual size of the operation.

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Over the years, NORDUnet has grown from service as a market demand aggregator. It has a clear task and clear objective, and it has been able to contribute to harmonization of international network policy. It is an example of how to build up a sustainable and important organisation which through federation manages to provide a critical and central resource made available to reach end-users.

4.2 ESS

ESS was initially a bottom-up initiative, driven by scientific interests in building the next generation neutron source. It is hardly surprising that when experts in a specific field - in this case neutron science - are being asked if a new resource is valid and needed, chances are that they are going to say yes.

At a political level, the project reached momentum by being framed as not only a special tool for a small group of scientists but a tool that would be vital for a wide variety of both scientific and industrial applications, underlining an industrial policy of supporting a regional cluster of science and industry, supported by economic arguments about the importance of ESS in terms of influx of highly skilled people to the area.

But as the project gained political momentum, concerns were being raised within the wider scientific community - specifically on the size of the user base, and the value of the resource scientifically - and perhaps most importantly concerns about the cost versus benefit of ESS. Behind those concerns were two issues: 1) would the establishment of ESS reduce resources for other scientific fields, in a situation of fixed national budgets and 2) who bears the financial risks for the cost of construction and/or increased operational costs in the long run. Obviously, these concerns were borne out of past experiences, competition for funding between scientific fields, but also, in the case of Sweden, a clear priority of ESS over the MAX IV facility[21].

It is reasonable to suggest that the drive to put ESS in Lund was partly motivated by regional industrial and political interests and partly scientific. There was certainly a great deal of criticism of the decision. Already in 2008 the Swedish Royal Academy of Science addressed the Swedish government in a letter, criticizing the preconditions for ESS, namely, the scientific case, the user base and the economic sustainability of ESS, strongly suggesting that the establishment of MAX IV would be more beneficial for Swedish science[22]. Similar criticism was raised in Denmark.

The Nordic countries have traditionally not opted to drive the establishment of large-scale RI within the region. Much more commonly the Nordics have opted for these to be built in the larger countries and joining as non-hosting members[23]. In part because our scientific communities in actual numbers are small and because the financial responsibilities are very large compared to the overall science budgets. The Nordics tend also - or for that reason - to have a quite stringent scientific focus when making a decision to fund an RI. The change was probably influenced by two things: 1) Science has moved into the political arena, as a tool to support other policy goals - industrial and regional development goals and 2) the formalization of a decision-making structure through the establishment of ESFRI and its roadmap. Not only did ESFRI create a decision structure that enabled the ESS Scandinavia bid, it worked on the same logic of science supporting industrial policies and geopolitics.

But the financial risk of such a massive undertaking is still significant for small countries. In comparison, the current Danish share for the construction of ESS is larger than the state budget for public research grants.

[21] https://www.maxiv.lu.se/

[22] https://essochmaxiv.files.wordpress.com/2009/04/kva-brev.pdf

[23] *Most notably Denmark was once considered for the location of CERN, but this was deemed too large a project for Denmark to take on a leading role in.*

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Consequently, there is also a risk, for ministries involved, of a political backlash in case of budget overruns. No doubt ESS Scandinavia was established to share the financial risks between Denmark and Sweden.

However, ESS is a good example of how regional cooperation between a couple of Nordic countries can initiate a much bigger and wider collaboration covering relevant parts of the whole of Europe.

4.3 EISCAT-3D Data Solutions and Support

A key outcome of this project is an understanding of the future EISCAT_3D e-Infrastructure requirements and how these requirements can be met using national resources, possibly in a federated manner. The proposed e-Infrastructure stipulates substantial sharing of national resources, in particular for networking. The resulting network infrastructure delivers an order of magnitude more capacity by closely integrating shared national resources, than what could have been delivered by a single provider at a realistic cost. A key lesson from the EISCAT-3DD project is the importance of engaging with national stakeholders; and to establish early and open collaboration between researchers, research infrastructure, and e-Infrastructures providers, as this will bring together the wide range of expertise required to develop innovative solutions, and at the same time ensure consensus among the stakeholders on the delivery of the results.

4.4 Baltic Grid

The Baltic Grid was a good example of real cross-border collaboration in sharing of computing and data storage resources. There was strong coordination among the partners in keeping all grid computing systems operational and providing needed maintenance. Grid clusters in the Baltic States were used by scientists from CERN and Baltic scientists were able to use computing resources in Poznan Supercomputing Centre (Poland).

The coordinating organization under the name *the European Grid Infrastructure Association* (EGI)[24] was created in 2010. Unfortunately the challenges in development of an NGI network covering all EU countries was underestimated and not supported in any coordinated way by the Commission and the member states. The European grid infrastructure had a top-down management system without a bottom level structure covering all already developed grid computing infrastructure in Europe.

The European Grid Infrastructure was continued in 2010 by the EGI coordinated project EGI-InSpire. Unfortunately, in Latvia, Lithuania and many other countries, NGI's were not created and supported. As a result, just one organisation per country having a grid cluster was able to join EGI-InSpire. Also cloud computing was developing and this new technology replaced grid computing. Already in the BalticGrid-II there were attempts to create some experimental cloud computing instances, but the project had no continuation. However, the Riga Technical University HPC Centre[25] was established in June 2012 as a continuation of developments started in the Baltic Grid projects.

One lesson from the project is that unless cross-border, collaborative e-Infrastructure initiatives engage key national stakeholders and secure national participation in governance and operation, there is significant risk that the outcomes will not be sustainable.

[24] https://www.egi.eu

[25] https://hpc.rtu.lv/?lang=en

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4.5 NeIC

NeIC is an example of how putting resources together can facilitate collaboration without acting as a funding body as such. It has been successful in establishing and maintaining distributed e-infrastructure collaborations. It incorporates different collaboration models (development projects, community forming pre-studies, workshops, operations and affiliate programmes) through which organisations, service providers and users can engage in valuable activities[26].

The key lesson here, is that it can be very hard to navigate at a cross-border level when defining a role that is seen as relevant while not intruding on roles and responsibilities at national level.

4.6 Gardar

One of the lessons to be learned from Gardar is that when feasible, it is useful to seek collaboration with third parties and the private sector. In Gardar, the supercomputing facility was located in Iceland and it was hosted by a contracted third party, i.e., Advania Thor Data Center. Another company (Opin Kerfi) was in charge of installation, project management, implementation and system testing. The computing resources were distributed amongst the countries according to each country's share in the investment.

Gardar is also an example of how differences in national policies pose a challenge for cross-border collaboration. In addition, Gardar highlights the importance of securing support from all national stakeholders, not only funding bodies or e-Infrastructures. There was resistance from institutions and HPC experts, who perceived joint HPC facilities located outside their own institutions as a threat to local control and HPC competences.

Before starting the project, extensive negotiations took place between the consortium members to discuss and iron out the institutional and national differences. The potential deal-breaking matters were evaluated before any agreements could be made. Tax and legal affairs were also considered carefully, and tax rulings were issued when necessary[27]. Amidst strong opposition, the strategic need and advantage of a joint HPC facility in Iceland was agreed upon. The project was a major step towards joint strategic HPC operations and management.

The project was an example of giving all partners a chance to participate in a mutually benefiting investment and organising the distributed expertise to serve the end users efficiently. The positive experiences strengthened the strategic HPC thinking which consequently contributed to the realization of LUMI in EuroHPC.

4.7 Health

This case illustrates the importance of coordination and policy harmonisation, but at the same time illustrates challenges of overcoming silos resulting from domain-based national and institutional mandates. Despite commitment to collaboration at ministerial level, cross-border sharing in particular clinical data remains a controversial and difficult undertaking that must be handled case-by-case, and often by work-arounds.

[26] https://wiki.neic.no/wiki/Collaboration

[27] https://www.landsvirkjun.com/Media/lvwhitepaperreportnordic-high-performance-computing-system.pdf

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A central issue identified in the study[28] was the diversity of national and data owner policies. The majority of health data, especially clinical data, is controlled by hospitals or health authorities. Typically, health registers collecting data have their own individual legal framework specifying purpose and scope based on a specific clinical or administrative need - not scientific usage or access. Registers also frequently rest with multiple different administrative agencies. For this reason, scientists encounter different data sharing policies and practices, often with little national coordination, and with no coordination or common policies between countries. This complicates sharing for research, as researchers must in each case obtain permission for data use from each data owner, and in each case accommodate the particular policies of the data owner. In addition, the diversity of data owners and limited coordination can lead to lack of motivation for sharing. Often, the data owner and the researcher are from different organisations, with separate governance structures and specific mandates. The data owner may have little benefit providing data to scientists to justify the implied risk of sharing sensitive data, and so may be inclined to turn down requests or have long and protracted application processes with a lot of time-consuming documentation requirements. As the organisations involved, at least in the case of the Nordic countries, are part of different political resort areas, this is a complex issue to handle nationally, and more so in a cross-border setting.

Research projects often must find ways to work around the lack of common policies and to the lack of motivation to share data. For example, in the case *PM Heart* described in *Open Science in the Nordics: Legal Insights*[29], rather than aggregate data from several countries, analysis and application of algorithms was done locally in each country, and only results combined. Technical solutions are possible for scaling this approach and have been a part of Nordic projects[30], but it is nevertheless a barrier for doing cross-border research on health data. This is in particular an issue for research subjects where data is sparse, i.e., for rare diseases[31].

It is essential that initiatives for cross-border exploitation of health data include the health authorities. Without the active participation of health authorities and the institutions governed by these authorities, cross-border data sharing will not work, no matter the number of political declarations of joint research, open science, etc. This has huge impact for EOSC. Clinical data is essential for a future EOSC and data lake approach to European medical research and pharma industry. Hence, health authorities, hospitals, and other health sector institutions are key EOSC stakeholders.

This project provided a report which illustrated challenges related to resource sharing etc[32]. These were for example a need for dialogue between key stakeholders related to issues ranging from technical implementation to a common view and harmonization of legislation and policies.

The Health project was regarded as a success. In a study by NeIC, it was a good example serving as a model for future collaborative HPC partnerships in the Nordic region.

[28] https://old.nordforsk.org/en/publications/publications_container/a-vision-of-a-nordic-secure-digital-infrastructure-for-health-data-the-nordic-commons
[29] https://www.eosc-nordic.eu/kh-material/deliverable-2-3-open-science-in-the-nordics-legal-insights/
[30] https://drive.google.com/file/d/1TopZ2bilospLF8Xy4poRWI3XdI8MXqLo/view
[31] https://www.eosc-nordic.eu/kh-material/deliverable-2-3-open-science-in-the-nordics-legal-insights/
[32] https://old.nordforsk.org/en/publications/publications_container/a-vision-of-a-nordic-secure-digital-infrastructure-for-health-data-the-nordic-commons

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4.8 Top-down vs Bottom-up Collaborations

The collaboration drivers can act[33] in both a bottom-up and a top-down fashion.

In some cases, collaborations are initiated by practitioners working together, based on joint research interest, a desire to share date or develop better tools, often in an ad-hoc manner. Such collaborations evolve *bottom-up*, developing joint governance, resource sharing, or funding. For example, the starting point for NORDUnet was a desire for experts to share experience and jointly develop practice. This informal collaboration between network engineers of the Nordic academic sector gradually developed into a formal joint networking project and eventually into a provider of international connectivity for the Nordic research and education networks with cost sharing. From there, NORDUnet came to represent the Nordic research and education sector in European and global collaborations and evolved into a platform for network-centric services for the academic sector.

The bottom-up approach is also seen in the *Health case,* but in combination with a top-down approach. The desire to share health data across borders has emerged in a range of research projects, and a number of attempts have been made, garnering experience with mechanisms and the barriers for such sharing. This led to an initiative by policy bodies to create a political process aiming to lower barriers and facilitating sharing.

EISCAT-3DD is another example of a collaboration created bottom-up. In this case, the EISCAT collaboration had existed for many years, and funding for a new instrument was being secured through applications to research councils. The expanded nature of the instrument led researchers to a realisation of a need for an upgrade e-Infrastructure, and the creation of new analysis software. As EISCAT is by its nature a cross-border instrument, this led to a collaboration with national e-Infrastructure providers in Sweden, Norway and Finland, and a realisation of the need for a collaboration between researchers, EISCAT, and the providers. From this was developed a joint project with Nordic funding between EISCAT and the participating national providers to simulate data flow as well as to understand how to leverage resources at the national providers in question. Scientific needs and existing research problems were the basis, and the collaboration was started and driven by researchers.

Baltic Grid was a collaboration for several years by scientists in EU projects in order to coordinate the development of an e-infrastructure.

NeiC is an example of a more top-down approach. NeIC was created to be the home of regional infrastructure collaboration and is regulated and sustained via a Memorandum of Understanding between Nordic and Baltic national research councils and NordForsk. In this case, the starting point for the collaboration is a *political desire* to have a joint collaboration body, and a *will to jointly fund* the activities. From there, NeIC has developed practical collaboration between national e-Infrastructure providers and research communities.

ESS is another example of a top-down collaboration. The starting point for ESS is scientific and industrial needs, but the initiating driver is mainly political. In 1999, the OECD declared that a new generation of neutron sources should be built in the US, Asia and Europe. The first iteration of ESS Scandinavia was realized in 2002 as a response to the OECD request to set up a new neutron source in Europe. There was a clear momentum at the political level because ESS was regarded as not only a special tool for a small group of scientists but a tool that would be interesting in a wide scientific application and with industry. From an industrial policy perspective, ESS was supported by the idea of a regional cluster of science and industry. It

[33] As demonstrated by the cases

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was also supported by economic arguments about the importance of ESS in terms of influx of people to the area.

Yet another top-down initiative is Gardar. Here the starting point was a policy desire to realise a joint, Nordic HPC facility as well as a policy desire to create a facility with minimal CO2 emission using geothermal energy. Gardar was developed to explore the possibility of creating such a system and sharing responsibilities of a single system between Iceland, Denmark, Norway and Sweden. In particular, the goal was to understand organisational, political and technical challenges of jointly developing and running a research infrastructure. The consortium also wanted to investigate financial and operational benefits of joint ownership and management of supercomputers.

Also in NORDUnet the bottom-up approach is no longer the only driver. As European and global research network collaboration has grown, the increased voice and political influence gained from acting jointly has become a secondary driver.

5. Implications for EOSC

In this chapter we revisit the analysis of the cases and consider the implications and impact on the emerging EOSC in the areas of *Governance*, *Resource sharing*, *Coordination and policy harmonisation*, and *Cross-border funding*.

5.1 Governance

The cases show a quite clear distinction between collaborations created bottom-up vs. collaborations created top-down. In bottom-up collaborations such as NORDunet, Baltic Grid, and ESS, researchers or practitioners come together on a shared agenda, gradually building up research collaborations and a need for shared data and shared infrastructure resources and services arise from this. In the top-down case (e.g, NeIC), a governance or political body sees an opportunity for synergy centered on institutions, fields, or a specific research agenda. In these cases, availability of resources is a way to attract researchers and foster collaboration.

These different starting points significantly impact the governance of collaborations.

For EOSC, it will be important to consider how to foster and support both types of collaborations. Mechanisms must be in place for bottom-up and informal collaboration to grow, find partners in European countries, and to secure the cross-border resources needed. At the same time, EOSC must be a viable instrument for funding bodies, member states, or the EC to foster collaboration on a societal or research agenda, or centered on a national or pan-European resource.

The cases also illustrate different approaches to governance, especially a distinction between governance in an academic tradition (common in academic institutions and research collaborations), public sector governance (as used for example in cross-border initiatives with member state representation), and private sector governance as done in incorporated entities. All three models have merit and have strengths and weaknesses. The co-existence of these three forms of governance is likely to impact EOSC itself and the collaborations possible within the EOSC framework.

It should be noted that, at least in the Nordic and Baltic countries covered by the cases here, creation of new legal entities is approached cautiously, as they are seen as having significant overhead. In particular, while having benefits related to cross-border funding and service charging, the incorporated model is seen as inflexible and quite heavy for the owners. As a result, there is often a preference to incorporate new collaborations into existing structures or to govern them inside existing structures. This has an impact on, e.g., expectations for the newly formed EOSC Association.

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5.2 Resource sharing

A central issue for cross-border collaborations (and open science in general) is collaborations on sensitive data. Such collaborations can be difficult even in a single country due to privacy concerns. When done in a cross-border setting, legal and policy barriers are increased significantly[34]. The resulting combination of legal restrictions on data sharing and institutional or national policies of minimising risk and exposure is a serious limitation for cross-border collaboration on health data. Despite a number of efforts in the Nordic countries over several years, the issue persists. Unless significant progress can be made in this area, this will limit the usefulness of EOSC in the health research.

The most effective examples of resource sharing we see are for resources acquired and operated with sharing in mind e.g., Gardar. However, a significant portion of the available resources are acquired by universities, projects, research Infrastructures, etc., with specific mandates for their use. It is complicated and often impossible to share such resources outside their original scope. In addition, there is often not a mechanism in place that allows for financial compensation between institutions or projects to facilitate sharing. This results in resource silos, with no mechanisms for sharing and low motivation for resource collaboration. For EOSC, this can ultimately lead to a situation where EOSC-wide resources are only available from pan-European e-Infrastructures, and where most resources are restricted by mandates for use nationally, for particular research Infrastructures, etc.

As formalised cross-border resource sharing - with cost sharing, resource reservation, payment, etc. - is often difficult to establish, sharing often happens either through establishment of project specific resources, or through pilots where individual researchers, using their personal leverage, contribute local resources through an informal sharing process. This can work but is often done in an ad-hoc manner. Formalisation of such arrangements is hard, in particular where cost sharing is involved, because that typically involves decision-makers not directly involved in the specific project. The major challenge here is payment for resource use, not resource access or sharing. Since e-infra funding is mostly channelled towards national entities, it is usually difficult to allow for cross-border funding transfer. A lack of such mechanisms and a lack of incentives for creating the formal mechanism for resource sharing will restrict the availability of resources and the potential for sharing in EOSC.

In recent years, as Research Infrastructures have increased in size and cost, and as more emphasis is put on trans-national programs such as the ESFRI roadmap, there is a movement towards a growth in the layers of governance, moving sharing and decision-making further away from users. This is further increased by a movement towards national representations, shifting governance of resources from researchers and academic governance towards members state delegates and public sector governance.

To some extent this is a consequence of the need to accommodate a wide user base and because facilities are increasingly complex and costly to run. It is also a consequence of a general trend toward professionalised public sector management and governance. These tendencies will have implications for EOSC and may indeed be amplified by it. The consequence may be a risk of disengagement from researchers and an added governance overhead. At the core, the issue here is that the larger and more expensive the collaboration, the less amenable will it be to collaboration-by-trust.

Thematic collaborations - such as EISCAT - may avoid some of these issues. Such collaborations have a clear focus and a limited community, and so may find engagement and informal approaches to bottom-up collaboration and governance more realistic.

[34] https://www.eosc-nordic.eu/kh-material/deliverable-2-3-open-science-in-the-nordics-legal-insights/

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5.3 Sharing HPC resources in the context of EOSC

High Performance Computing (HPC) resources have become a major investment. For this reason, resources nationally and at EU level are increasingly being funded and operated in a collaborative environment between multiple institutions, rather than through institutional investments and/or research grants. This makes perfect sense in terms of economy-of-scale, complexity and useability. However, with that also comes formalized agreements, protocols - basically governance for resource allocation. We have found that this type of collaborative arrangement, funders focus on return on their investment. In the case of universities, that means ensuring that their scientists get access to resources. Rarely is the issue of dealing with users from outside the consortia addressed, if not directly barred from access, as is the case with access to national HPC resources in Sweden. Adding to this is the problem of presenting viable funding streams outside the membership fee that would be able to support the operations of the infrastructure. Typically, a host will work to ensure that 100% of the costs are covered by the consortia in order to minimize financial risks, but this also means that the consortia members expect to get 100% of the resources back. The move into collaborative HPC also means that the scientists themselves no longer control the infrastructure, and have little or no possibility to share resources themselves (or have any funding to access resources themselves). This move into more institutionalized HPC provision will have a direct impact on the ability of researchers to share and access resources with scientists from other countries.

National and institutional funders are primarily concerned with ensuring that resources are provided to "their" researchers, and will create governance, oversight and review systems with that in mind. Servicing foreign, cross-border users is not a prime concern. In addition, national HPC services are primarily governed by membership mode. This creates an insiders/outsiders perspective. Pay-by-usage cost recovery is not common and uncomfortable as it creates financial risks, not having a fixed income from membership fees. In effect scientists have no resources to share, and no money to buy cross-border resources.

5.4 Coordination and policy harmonisation

The Nordics have many years of experience in seeking to coordinate policy - particularly on access to registry data, infrastructure investment and shared digital resources. The Nordic experience shows that this is very difficult to do successfully.

Improving scientists' access to registry data is hard in a national environment - mainly and reasonably because access needs to adhere to legislation and requirements specified by data controllers. But it also relates to the fact that the legislation and access policies rest with many different public actors across different ministries. It is very hard to have a common understanding of the problems and issues and a common willingness to improve data access policies. It can be achieved with a clear political mandate nationally. But the complexity is multiplied many times over, when seeking to coordinate policy across borders. The number of actors that needs to be involved increase significantly. Possibly more significant, the legislation and organizational setup is likely to be different across five countries. Finally, the governance political culture may differ. Add to this that political mandates will be limited to a national scope, it is clear that governance and policy become complicated. What we have found is that in the case of coordinating data access policy across countries, there are very few drivers for policy harmonisation, compared to the number of potential stumbling blocks. This in turns reflects the fact, that whereas there might be political willingness to coordinate policy, even expressed in policy statements, these will rarely be able to drive any change, in our view simply because this is a policy area that is technical and complex and involves valid concerns about data security and public trust.

As illustrated by the Health data case, working across national, administrative domains (i.e., across ministerial boundaries) is hard and challenging, and often leads to silos of information, policies, and governance. It has proved very hard to make significant progress in this area even between the Nordic countries, despite their cultural similarities and a strong will to collaborate in this area. The existence of such national silos could

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prove a significant barrier for EOSC and may require comprehensive harmonisation of policies across member states and domains.

A related matter here is the motivation of stakeholders to contribute to the EOSC objectives. We see that specific policy is often institutional and derived from the requirements of each institution and their use cases. While national policies for, e.g., open science exist, they are mostly a statement of intent. This creates a lack of uniformity of policy which complicates collaboration. There is an apparent lack of drivers for policy harmonisation.

Except for ERICs and other institutions created with a European scope, institutions usually do not have a policy for how to make resources available for researchers abroad. There is a lack of a generally accepted or implemented mechanism for cost-recovery for cross-border resource consumption is lacking. This, and the lack of drivers, is a barrier for EOSC resource sharing and for an objective of having EOSC incorporate national and institutional resources.

5.5 Cross-border funding

Except for the EC programmes such as Horizon Europe, research funding is naturally national. Many collaborations happen without any cross-border funding. In such collaborations, participants typically each acquire resources nationally and share them, often informally, within the scope of the collaboration.

When cross-border funding is required, it is often achieved through the establishment of cross-border institutions, with cost-sharing agreements. This requires a high degree of formalisation and takes significant effort to set up and maintain governance-wise. For these reasons, national governance bodies are often hesitant to this approach. In addition, once cross-border institutions have been established, there is a risk of being detached from national / institutional objectives, with results or services not being integrated with national resources.

Instruments for cross-border funding often create an institutional focus, with funding rigidly allocated, with significant governance overhead, and with limited room for manoeuvring or expanding outside the original scope. There is (at least in the Nordic countries) a general scepticism about channelling financial resources to external service providers (why not spend resources nationally?) unless there is a clear science case and/or political will and dedicated funding for it (ESFRI, ESS, CERN, ESA, EuroHPC).

This focus on national funding along with the restrictions and hesitation on cross-border funding and cost-sharing has implications for the mechanisms that will be available to realise EOSC, the level of governance and overhead required, and the efficiency and flexibility possible.

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6. Improving Cross-Border Collaboration

In order to improve cross-border collaboration, at least five findings have been recognized based on the discussions in this document. They are not provided here as any concrete solutions but rather recommendations for further work. Addressing the five aspects raised here will increase both the value of collaborative projects and the likelihood of a successful EOSC.

Recommendation 1: Licensing and third countries

The first recommendation is to set up a task force to tackle the different aspects of licensing. Licensing should not be left for individual research groups to handle, but enough expertise and support should be provided. The EOSC rules of participation recommend the use of open software licenses, whenever possible. The goal should be that there are as few different licenses as possible, they are easy to use and the contract conditions are known. The whole process of sharing data should be easily understandable and simple for researchers.

We recommend that the task force, or a related task force, address collaborations dealing with third countries, particularly in relation to GDPR regulations and Dual Use issues. Common rules and clear instructions are needed here as well. According the EOSC RoPs, providers and users are expected to handle data according to "relevant legislation and guidelines on data protection and privacy including GDPR"[35].

Recommendation 2: Health and sensitive data

The second recommendation is connected to health data which is a valuable source of information and innovation. Too often, however, it is very difficult to find common understanding about the rules and regulations, the end result being that data is not shared. It is easier not to take any risks. A similar finding is identified in the *Legal Interoperability and the FAIR data principles*[36] study published by the EOSC FAIR Working[37] Group, where is it pointed out that regulatory data exclusivity poses a sector-specific reuse limitation for health data.

Starting with regional collaboration, such as Nordic or Baltic ones, could be a way to find wider understanding of common needs, to facilitate cross-border use of health data and find common ways and understanding of secure processes and policies.

Recommendation 3: Centering research collaboration

As EOSC is about facilitation of research collaboration across borders, initiatives should acknowledge this and not concentrate on the needs of service providers. As mentioned in the EOSC Rules of Participation[38], EOSC services are expected to align with EOSC architecture and interoperability guidelines in order to establish cooperation and enrich the user experience. It is important to address the challenges of sharing data across borders, not only facilitate delivery of services across borders. Resource sharing, cross-border services and cross-border data sharing are very much linked to each other.

[35]https://op.europa.eu/en/publication-detail/-/publication/a96d6233-554e-11eb-b59f-01aa75ed71a1/language-en/format-PDF/source-184432576
[36] https://zenodo.org/record/4471312#.YDixHi9Q2v4
[37] https://www.eoscsecretariat.eu/working-groups/fair-working-group
[38]https://op.europa.eu/en/publication-detail/-/publication/a96d6233-554e-11eb-b59f-01aa75ed71a1/language-en/format-PDF/source-184432576

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Recommendation 4: EOSC resources and compliance

In order to meet the objectives of data sharing, research collaboration and resource federation in EOSC should encompass European Union, national, institutional and commercial resources. We recommend that national and institutional resource providers think about EOSC in terms of EOSC compliance for infrastructures, not just becoming EOSC service providers. The EOSC interoperability framework aims to provide a trusted and sustainable framework for all stakeholders including scientific communities and infrastructures. The primary goal should be that scientists using the infrastructures would be able to participate in EOSC-based collaborations. We recommend that EOSC facilitates this work by providing guidelines for access and usage etc.

Recommendation 5: Good governance is a key factor in enabling successful collaboration

As noted in the EOSC interoperability framework,[39] EOSC recognises the need for a clearly-defined governance structure to handle interoperability across organisations and disciplines. The recently formed EOSC Association[40] is expected to operate as the legal entity in charge of governing and overseeing EOSC operations. It will function as a not-for-profit organisation[41] governed by three bodies: a general assembly, an executive board, and a programme office. The EOSC Association will formalise the EOSC Partnership[42] in a memorandum of understanding (MoU) with the European commission.

The establishment of the EOSC Association is a step in the right direction towards advancing sustainable open science practices. It will provide clear expectations and rules of engagement that are important in ensuring alignment between all the stakeholders.

[39] https://www.eoscsecretariat.eu/sites/default/files/eosc-interoperability-framework-v1.0.pdf
[40] https://www.eosc.eu/#about
[41] https://www.eosc.eu/sites/default/files/EOSC_Statutes.pdf
[42]https://ec.europa.eu/info/sites/info/files/research_and_innovation/funding/documents/ec_rtd_he-partnership-open-science-cloud-eosc.pdf

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7. Conclusion

This document illustrates how lessons learned from existing regional collaboration experiences, such as Nordic and Baltic ones, can be good basis for creating an EOSC that enable cross-border research collaboration for all of Europe. It is often easier to study important aspects and details of collaboration between countries in a region and from there draw conclusions for the wider, European level collaboration.

There will always be local and regional differences to take into consideration in the context of European level collaboration, but there are also important challenges and aspects discussed in this document that need to be addressed in all regions. In the report we have studied cross-border research and research facility collaborations in the Nordic and Baltic countries. The first part of the report examined seven existing and past cross-border collaborations. Each collaboration has been analysed with focus on four main drivers of collaboration: governance, resource sharing, coordination and policy harmonisation, and cross-border funding.

The report provides lessons learned for each of the collaboration drivers, and additionally discussed the importance of understanding the different dynamics of whether collaborations are driven top-down or bottom up. There are different motivations for collaboration as well as different dynamics for the collaboration succeeding or failing in achieving its objective.

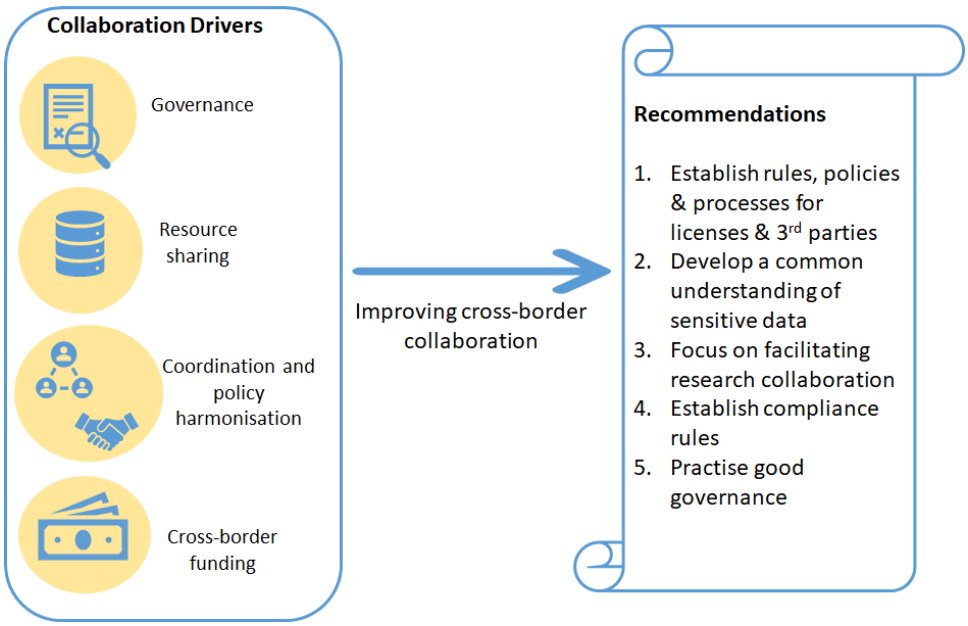

Figure 1: Cross-border collaboration drivers and recommendations

We examined implications for the emerging EOSC in each of the collaboration areas; governance, resource sharing, coordination and policy harmonisation, and cross-border funding, as well as challenges for collaborations in the context of the anticipated EOSC collaboration model.

Finally, we offered five recommendations – based on the lessons learned from the cases examined - for improving cross-border collaboration in the context of EOSC. As the EOSC model is not yet fully established, these recommendations identify future work that should be undertaken so that EOSC can fully facilitate cross-border research collaborations:

1. Licensing and third country collaboration need common rules, policies, and processes.
2. Common understanding and harmonisation of practices of using and sharing health and sensitive data is needed.

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3. A greater emphasis should be put on sharing data and its challenges, not only providing services.
4. Establish EOSC compliance for all resources in the European Union, at national and institutional levels. Resource compliance is more important than cross-border service delivery in order to facilitate cross-border collaboration.
5. Good governance is a key factor in enabling successful collaboration.

In closing, this report has illustrated the diversity of Nordic and Baltic cross-border collaboration. In the cases, governance, resource sharing, coordination and policy harmonisation, and cross-border funding was handled according to situational needs. Furthermore, successful collaborations can be seen to arise out of coalitions of the able and willing. This is embodied for example in the NeIC collaboration mode, supporting collaboration where they emerge.

We believe this report presents important findings that can inform how the Nordic and Baltic countries engage in cross-border research and infrastructure, in the context of EOSC. The findings will be brought to the attention of relevant policy bodies in workshops and targeted publications. The findings may also inform the cross-border data exploitation in EOSC, in particular for health data. These findings will be shared through European projects such as EOSC Future, and through collaborative task forces of EOSC projects. This aspect will also be explored further by EOSC-Nordic in a study of *Cross-border collaboration in the context of EOSC*, to be published in the fall of 2021.

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Appendices

Appendix 1: Existing Cross-Border Collaborations

In this appendix are descriptions of the cases that have been discussed in the document: what kind of projects or entities they are, how are they governed, financed and coordinated and what kind of contributions they have made concerning policy harmonization. The cases have been chosen so that they would well address experiences that have been recognized as important regarding cross-border collaboration. Analysis of the experiences and lessons learned for cross-border collaboration and regarding EOSC are in the document.

Case: NORDUnet

Why case was chosen

NORDUnet[43] is the joint, international network of the Nordic national research and education networks[44] (NRENs). NORDUnet was started as a technical collaboration between network engineers of the Nordic academic sector and developed into a provider of international connectivity for the Nordic NRENs in the second half of the 1980's[45]. NORDUnet came to represent the Nordic research and education sector in European and global network collaborations and evolved into a platform for network-centric services for the academic sector[46].

After a pioneer period of technical innovation, the main driver for the NORDUnet collaboration was the high cost of international networking. The Nordic academic sector needed connections of Europe and North America, and increasingly to the commercial internet. Procuring jointly as NORDUnet increased market purchasing power, and reduced cost through economy of scale and sharing of expensive resources. As European and global research network collaboration grew, the increased voice and political influence gained from acting jointly became a secondary driver.

NORDUnet has existed as a Nordic research infrastructure collaboration for 40 years, and has been successful in delivery of infrastructure, in increasing Nordic influence on the evolution of European and global research infrastructures, and has been largely stable in terms of cost, cost sharing, governance, and service delivery despite dramatic changes in the infrastructure landscape. NORDUnet illustrates cost and influence as drivers for Nordic collaboration, as well as the importance of stable governance.

Governance

NORDUnet is incorporated as a company limited by shares in Denmark. This provides a clear and well-understood governance mechanism and legal framework, with clear responsibilities defined by law. The shares are owned by ministries of the Nordic countries (or institutions delegated by the ministries). The shares are owned 20% by each country. The shareholders elect a board of directors to oversee the governance. Historically, the board of directors has had a member from each country, each a C-level manager from the NREN.

[43] https://www.nordu.net/content/about-nordunet
[44] https://www.nordu.net/content/nordic-nrens
[45] https://www.nordu.net/content/history-nordunet
[46] https://40.nordu.net/Anniversary-Publication.html

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This provides a clear relation to key national stakeholders - funding bodies and NRENs as representing national users. The NORDUnet board of directors assume responsibility for budgets, sets strategic direction for the NORDUnet collaboration and services provided, and serves as a consensus body for forming joint positions, in particular in relation to international collaborations and EC initiatives.

The NORDUnet board of directors takes advice from community working groups and advisory bodies, with representation from stakeholders from the member countries. This further ensures alignment between NORDUnet and NREN strategy and tactics.

All NORDUnet governance is by tradition based on consensus. Voting in the board of directors or advisory bodies is possible but is in practice never done.

Resource sharing

The key driver of NORDUnet is resource sharing, both networking and people, in order to achieve economies of scale and maximize impact. Through NORDUnet, Nordic NRENs jointly finance costly global network infrastructure for research traffic towards public and commercial actors. Network resources are shared on a best-effort basis, without reservation or allocation. Accounting of network usage by the members is done and reviewed regularly by governance bodies.

In recent years, NORDUnet has evolved into a system of sharing national optical network resources. Under this scheme, NORDUnet and NRENs share national resources, reducing the need for additional resources and increasing the utilisation of costly, national resources. Sharing is facilitated by cost recovery, using NORDUnet intermediary.

In addition to network resource sharing, NORDUnet is used as a vehicle for sharing of personnel resources. NRENs delegate some tasks, in particular international projects and representation, to NORDUnet, sharing staff. Likewise, the NORDUnet collaboration delegates in particular engineering work to NRENs, sharing expertise and staff.

Coordination & Policy harmonisation

On inception, NORDUnet served to facilitate technical coordination between the emerging NRENs. This coordination evolved into harmonisation of (mostly technology) policies. As an example, NORDUnet and the Nordic NRENs were the first outside the USA to adopt the US developed TCP/IP protocols (the technology now known as *the internet*) and promote it over rival European ISO-OSI protocols.

Cross border funding

The cost of operating NORDUnet is shared between the Nordic NRENs according to Gross National Income (GNI). The cost sharing is updated annually, using a GNI-based distribution key maintained by the Nordic Council of Ministers. In addition, NORDUnet can provide usage-billed services on request of the NRENs.

For the Nordic NRENs, the financial contribution to the NORDUnet cost sharing represents a significant part of their overall budget, reflecting the importance and cost of international networking for the NRENs.

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Case: European Spallation Source (ESS)

Why case was chosen

The European Spallation Source ERIC (ESS) is a research infrastructure under construction in Lund Sweden that will eventually become the world's most powerful pulsed neutron source, once it becomes operational in 2023.[2] The ESS Data Management and Software Centre (DMSC) will be located in Copenhagen, Denmark.[3] ESS will enable scientists to see and understand basic atomic structures and forces at length and time scales unachievable at other neutron sources.[6]The ability to produce indirect and non-invasive images of molecular structures has made spallation technology an indispensable tool in the development of new materials and products, that will help discover and develop new materials with applications in manufacturing, pharmaceutical drugs, aerospace, engines, plastics, energy, telecommunications, transportation, information technology and biotechnology.

ESS was chosen as a case due to being able to illustrate Nordic countries making use of funding opportunities via the EU as a vehicle to achieve added value, as well as showcasing political aims as reasons for cooperation.[47]

In the argumentation from the Swedish government, the regional perspective was central in the argumentation to host ESS jointly with Denmark. As the cost for ESS was seen to be inevitable the reasoning was that having the facility in the Nordics would achieve economic benefits, that is strengthened scientific industrial perspective for the hosting nation.

Furthermore, the motivation to host ESS was driven by research policy targets such as the coordination with existing initiatives[48], and with the aim to act as a counterweight to centralization of RIs to continental Europe. As such acting as a regional clustering, aiming to secure and develop the interests of the Nordic countries, and Germany.[49]

The European Spallation Source (ESS) is an interesting case in the context of EOSC because of the similarities in the dynamics of the process leading up to their respective establishment as key European priorities. The interesting thing is not what ESS is now - a large European Research Infrastructure project. The interesting part is what came before that - the ability of two sovereign nations to join forces to establish ESS within the region through the establishment of ESS Scandinavia.

The case will highlight the dynamics and challenges of working together on a large project, balancing scientific needs, political priorities and differences in processes and culture in a political decision-making process across borders.

Governance

In 1999 OECD declared that a new generation of neutron sources should be built in the US, Asia and Europe. A European international task force was set up, in order to gain support and draft a concept for the ESS. This work was finalized in 2003. The first iteration of ESS Scandinavia was realized in 2002 as a response to the

[47]https://www.regeringen.se/49b71a/contentassets/b2806c1bb86a417eaa5638e466a23dae/svenskt-vardskap-for-ess
[48]https://www.vr.se/download/18.2412c5311624176023d25a8e/1555337532415/Europeiska-spallationskaellan-vaerldsledande-verktyg_VR_2016.pdf
[49]https://www.regeringen.se/49b71a/contentassets/b2806c1bb86a417eaa5638e466a23dae/svenskt-vardskap-for-ess

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OECD request to set up a new neutron source in Europe and in preparation of the work of the task force. At the time this was organized through a network of research institutions in Scandinavia.

Two lines of governance were created: a steering committee, composed of representatives from the many partner countries; and a board of directors, formally bound to represent the interests of Sweden and Denmark, the legal and administrative owners of ESS.

Over the next five years a competitive site selection process played out, with the support of the ESFRI roadmap process. On May 28 2009 Lund, Sweden was chosen as the preferred site for the establishment of ESS. In 2010, ESS became ESS AB, a publicly held company with 75% of its stock held by Sweden and 25% by Denmark. This continued until ESS became a European Research Infrastructure Consortium, or ERIC,[7] on 1 October 2015. European Spallation Source ERIC is governed by the European Spallation Source ERIC Council, which is bound by the Statutes ratified by the ERIC Member Countries. Detailed documentation on the ERIC legal framework can be found on the EC's website.

The Founding Members of the European Spallation Source ERIC are the Czech Republic, Denmark, Estonia, France, Germany, Hungary, Italy, Norway, Poland, Spain, Sweden, Switzerland and United Kingdom.[7] The construction costs are budgeted at EUR 1,843 billion Approximately half of the construction costs are covered by Sweden and Denmark. The remaining construction costs are to be covered by the remaining partner countries

Resource sharing

The Neutron Source, the experiment stations and all Technical support and logistics are currently being built in Lund, Sweden. The ESS Data Management and Software Centre (DMSC) is located in Central Copenhagen. DMSC designs, develops and supports the ESS scientific data pipeline, including experiment control, data acquisition, data curation, scientific web applications, data reduction, data analysis and modelling, data systems and data centre operation. Currently the ESS DMSC is supported by the Niels Bohr Institute at Copenhagen University.

Coordination & Policy harmonisation

The whole point of ESS Scandinavia was to coordinate efforts to make an effective bid for hosting ESS, and in April 2009 Denmark and Sweden formally made an agreement to that effect. The agreement stipulated that Sweden would cover 35% of construction costs and Denmark 12,5% of the budgeted project of then 1.670 MEur. The finalizing of this agreement came only 6 weeks before the decision to locate ESS in Lund was formally adopted by the ESS stakeholders.

Cross border funding

The construction costs are budgeted at EUR 1,843 billion Approximately half of the construction costs are covered by Sweden and Denmark. The remaining construction costs are to be covered by the remaining partner countries. The operational costs of ESS are funded through established mechanisms for ERIC's and is based on a cost distribution based on the participating countries GDP.

Case: EISCAT 3D Data Solutions and Support

Why case was chosen

EISCAT_3D is a new instrument for upper-atmosphere observation, under construction in the Arctic region of Norway, Sweden, and Finland. The EISCAT_3D Data Solutions (E3DDS), development carried out 2017-2020) and EISCAT_3D Support (E3DS, 2015-2018) were Nordic e-Infrastructure Collaboration (NeIC)

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development projects aiming at analysing e-Infrastructure requirements and supporting the EISCAT_3D community in the preparation of the implementation of the EISCAT_3D instrument, for aspects concerning e-infrastructure. The project was led by NeIC), with participation from national e-Infrastructure providers and science institutions in Sweden, Norway and Finland.

As an implementation project to EISCAT, the EISCAT 3DD project set out to leverage the national e-infrastructure cooperation originally set out for EISCAT_3D, and existing Nordic cooperation. The project designed and simulated the data flow and computing workflow from the antenna arrays of the upcoming EISCAT_3D radar sites to the central data storage and computing site.

The collaboration built on the existing collaboration between EISCAT_3D and participating national providers which aimed to produce software for the data flow simulation, benefiting from know-how at the national providers involved. The collaboration related to a research problem, an existing community (EISCAT), and was articulated and carried out by researchers themselves, with coordination provided by NeIC. Experts in distributed computing at the national providers worked with EISCAT_3D to deliver a data processing model and to ensure software can utilize existing e-infrastructures.[50] The project worked with relevant network providers to deliver a design for a high-performance network for the instrument sites.

This case was chosen to illustrate how a project is able to facilitate Nordic collaboration and provide a consultancy service for e-Infrastructure for major science projects, utilizing science expertise and national e-infrastructure resources and experts.[51]

Cross border funding

The project was funded by NeIC[52] leveraging existing Nordic cooperation structures for funding, as well as manpower available at existing national provider organizations. The funding, in cash, and in-kind, for the specific project was divided between the EISCAT association, NeIC, and the participating national providers, weighted differently for each project deliverables. The main function of NeIC within this project was to function as a facilitator for the collaboration to aggregate contributions from the stakeholders.

Governance

The governance structure for the project utilizes the general project model used within NeIC, which via a collaboration agreement defines the scope of the collaboration, governance structures, as well as individual parties' responsibilities and deliverables.[53] For this project in specific the steering group reflected the different stakeholders: NeIC, EISCAT, including non-Nordic stakeholders.[54] The projects' Reference Group consisted of EISCAT, national providers, NORDUnet and NeIC representatives.

Resource sharing

Resource sharing within the frame of NeIC is done via allocations of project funds across borders, as well as via specific projects aimed at facilitating resource sharing across borders within the Nordic and Baltic region.[55] The main function of NeIC within this project was to, specifically for resource sharing, function as a facilitator related to e-infrastructure resources (including computing, storage and networks) as in-kind contributions from the national providers[56].

[50] https://wiki.neic.no/wiki/EISCAT_3D_Data_Solutions
[51] Data flow and processing solutions for EISCAT_3D Collaboration Agreement
[52] https://www.nordforsk.org/programs/nordic-e-infrastructure-collaboration-neic
[53] https://wiki.neic.no/wiki/EISCAT_3D_Data_Solutions
[54] Data flow and processing solutions for EISCAT_3D Collaboration Agreement
[55] https://neic.no/about/
[56] Data flow and processing solutions for EISCAT_3D Collaboration Agreement

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Coordination & Policy harmonisation

Related to coordination, the role of NeIC and the different stakeholders, such as EISCAT and the participating providers, was to pool and function as a facilitator for gathering stakeholders and expertise.[57]

Case: Baltic Grid

Why case was chosen

The Baltic Grid[58] was one of the European Grid infrastructure projects. It may serve as a good example on how Baltic and Nordic countries were involved in cooperation and coordinated development of e-Infrastructure.

Objective of the project was development of grid computing in the Baltic States and integration into the European Grid infrastructure. The European Grid infrastructure was under development since 2001 funded by the EU Framework Programmes in several interlinked projects (DataGrid[59], EGEE[60], SEE-GRID[61] etc.). There were 2 subsequent Baltic Grid projects: Baltic Grid (2005-2008) and BalticGrid-II[62] (2008-2010). These projects were focused mainly on 3 Baltic States (Estonia, Latvia and Lithuania) just starting the development of grid computing, therefore more experienced partners were also involved - Switzerland (CERN), Poland and Sweden as the project coordinator. Belarus was also involved during the second stage of the project.

Governance

Funding for the Baltic Grid projects came from EU Framework Programmes, so the governance was organized as for the EU Framework projects. There were altogether 13 partners from 7 countries involved in the projects representing universities, research organisations, computing centres and NREN's.

Typical networking activities in the Baltic Grid projects were: Education, Training, Dissemination and Outreach; Applications Identification and Collaboration; Policy and Standards Development. Initially for grid computing there were devoted activities as Grid Operations and Network Provisioning, as well as research related activities. The project partners were organizing All-Hands Meetings and Open Day events, participation in workshops and conferences, as well as Summer Schools and other training events. Achieved results were evaluated by reviewers very well and it can approve that overall project governance was done well.

Resource sharing

The European Grid infrastructure for eScience was created for sharing of computing and storage resources. One of the main applications was planned computing and data management required by the particle physics experiments on the Large Hadron Collider (LHC) of CERN. As grid computing was becoming popular, it's usage spread to many science fields round Europe and globally.

In the Baltic Grid project were established grid computing clusters and provided network connections (via NORDunet and GEANT), attracted experts from different fields as potential users and they were certified. In

[57] Data flow and processing solutions for EISCAT_3D Collaboration Agreement
[58] https://cordis.europa.eu/project/id/026715
[59] https://cordis.europa.eu/project/id/IST-2000-25182E
[60] https://eu-egee-org.web.cern.ch/index.html
[61] https://ulakbim.tubitak.gov.tr/en/projelerimiz/see-grid-see-grid-ii-ve-see-grid-sci
[62] https://cordis.europa.eu/project/id/223807

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2006 there were already 23 (26 in April 2007) operational clusters in the Baltic Grid connected to the European Grid Infrastructure and over 250 certified local users. Pilot applications were from High Energy Physics, Material Science and Bioinformatics, but later Baltic Sea Modelling, Engineering, Language Processing, Computational Chemistry and other applications were developed.

Coordination & Policy harmonisation

For political coordination of the European Grid infrastructure the e-Infrastructure Reflection Group[63] (e-IRG) was created in 2003. In e-IRG each EU country, Switzerland and Norway were represented by 2 delegates and rotating governance according to the presidency of the Council of EU. Already in the e-IRG workshop in Rome 2003 were defined the main strategic objectives[64]. The e-IRG group was having meetings 4 times a year and organized 2 workshops every year, as well as developing Recommendations, White Papers and other policy documents.

For sustainability of e-Infrastructures services the e-IRG group in 2005 created the White Paper with recommendation[65]. It had envisaged an idea of federated e-Infrastructure services and was based on the GEANT experience in coordinating NREN's - to create a National Grid Initiative (NGI) organization in all EU countries and coordinate them by a European Grid Organization (EGO). The coordinating organization under the name *the European Grid Infrastructure Foundation* or *EGI*[66] - was created in 2010, but unfortunately the challenges in development of an NGI network covering all EU countries was underestimated and not supported in any coordinated way by the Commission and the member states. Hence, formation of a sustained network of NGIs failed.

Development of the European Grid infrastructure for eScience was well planned and coordinated, but the very final stage failed to maintain sustainability.

Cross border funding

The Baltic Grid project funding came from EU Framework Programmes FP6 and FP7.

The European Grid Infrastructure was continued in 2010 by EGI coordinated project EGI-InSpire. Unfortunately, in Latvia, Lithuania and many other countries NGI's were not created and supported. As a result, just one organisation per country having a grid cluster was able to join EGI-InSpire. After the end of the Baltic Grid projects in May 2010 the created grid computing infrastructure was fully operational and served users for a few years mainly through local financial support.

Case: NeIC

Why case was chosen

NeiC is a ten-year project for e-infrastructure within Nordforsk, established in 2012.[67] It is regulated and sustained via a Memorandum of Understanding between Nordic and Baltic national research councils and NordForsk. NeIC has dual roles, partly to function as the body responsible for the operational responsibility for the Nordic distributed Tier-1 facility that is part of the Worldwide LHC Computing Grid (WLCG) that

[63] http://e-irg.eu/
[64] http://e-irg.eu/e-irg-workshop-december-2003
[65] http://e-irg.eu/documents/10920/249442/Luxembourg+White+Paper+2005
[66] https://www.egi.eu
[67] https://neic.no/about/

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provides computing and storage for CERN and is used by high energy physicists worldwide. The second part is to facilitate Nordic e-infrastructure collaboration, this via initiating and facilitating joint projects between Nordic and Baltic organisations participating in NeIC.[68]

NeIC has been chosen as a case due to its success in establishing and maintaining distributed e-infrastructure collaborations. It does not act as a funding body - its primary goal is to facilitate collaborations. It incorporates different collaboration models (development projects, community forming pre-studies, workshops, operations and affiliate programmes) through which organisations, service providers and users can engage in valuable activities.[69]

Governance

The governance structure for NeIC is made up of a board with national representatives for e-infrastructures, with a rotating chairmanship. It utilizes personnel from the national providers and thus connects its own governance structure to the governance structure of the participating countries.[70]

Cross border funding

The NeIC programme was funded by Nordforsk[71]. This funding in turn comes from the participating national providers and is negotiated between NeIC //Nordforsk and relevant organisation(s), such as funders, in each participating country. It leverages existing Nordic cooperation structures within Nordforsk for funding.

Coordination & Policy harmonisation

Coordination and policy harmonization within the frame of NeIC is investigated via specific projects aimed at facilitating coordination and policy harmonization.[72] An example of this is thematic projects such as the Tryggve-project, which is an extension of the Elixir project[73] and which, among other aspects, deals with harmonization throughout the participating organisations.

In order for NeIC to effectively facilitate collaboration and deliver value, it uses a NeIC project management model[74] based on the Tieto's PPS Project management model.[75] This helps in creating common guidelines for handling various project activities.

[68] https://neic.no/about/
[69] https://wiki.neic.no/wiki/Collaboration
[70] https://wiki.neic.no/wiki/EISCAT_3D_Data_Solutions
[71] The Nordic e-Infrastructure Collaboration (NeIC) | NordForsk
[72] https://neic.no/about/
[73] https://neic.no/tryggve/
[74] https://wiki.neic.no/wiki/Project_process
[75] https://www.tietoevry.com/en/services/business-and-technology-consulting/pps/

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Case: The Gardar System

Why the case was chosen

Denmark, Iceland, Norway and Sweden wanted to explore the possibility of sharing responsibilities of a single system. This led to the Nordic High Performance Computing Project (NHPC) joint venture between Danish Center for Scientific Computing (DCSC), the University of Iceland, UNINETT Sigma and the Swedish National Infrastructure for Computing (SNIC)[76]. The goal was to "understand the organisational, political and technical challenges involved in the joint development and running of research infrastructure"[77]. The consortium wanted to investigate the financial and operational benefits of joint ownership and management of supercomputers.

The NHPC project commissioned a supercomputing facility called Gardar. It was located in Iceland to take full advantage of available natural energy resources in terms of low-cost electricity and cost-efficient cooling solutions[78]. The project began in April 2011, and the Gardar system was up and running for three years starting from January 2012.

The case was selected to demonstrate the following: (1) Cross-border collaborations often involve navigating complex national, political and legal dynamics. Success often depends on open dialogue motivated by shared goals and political will by all parties (2) outsourcing hosting services to external providers can be successful under well agreed terms and conditions. (3) Significant obstacles were overcome by compelling strategy and the sheer determination of the national supercomputing centres and the Icelandic ministry.

Governance

As a pilot project, the NHPC collaboration was a means to experiment with joint procurement, installation, administration, operation and user support. NHPC had two boards. The management board consisted of one member from each country's national supercomputing centre and a presentative from the Icelandic Ministry of Education, Science and Culture. It was responsible for procurement, evaluation and selection of NHPC hardware acquisition[79]. Similarly, a system administration group with one sysadmin per country handled national and local user support.

Resource sharing

As mentioned earlier, the supercomputing facility was located in Iceland. It was hosted by a contracted third party i.e Advania Thor Data Center. Another company (Opin Kerfi), was in charge of installation, project management, implementation and system testing[80]. The computing resources were distributed amongst the countries according to each country's share in the investment.

The University of Iceland provided local representation and competence to serve the users. In addition, it was in charge of system administration in collaboration with representatives from each country. The local system administration team provided application management and user support to its country's users[81].

[76] https://advania.com/?PageId=0620be86-26d3-11e4-93f5-005056bc0bdb&newsid=c12edfaa-4264-11e4-93f5-005056bc0bdb

[77] https://old.nordforsk.org/en/news/gemensam-nordisk-superdator-pa-island

[78] https://old.nordforsk.org/en/news/gemensam-nordisk-superdator-pa-island

[79] https://utmessan.is/images/stories/2012%20Utmessan/Taeknilina/UTmess_nhpc.pdf

[80] Press Release and Announcement of Opening Event for the NHPC Supercomputer on 16th April, 2012

[81] https://utmessan.is/images/stories/2012%20Utmessan/Taeknilina/UTmess_nhpc.pdf

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Coordination & Policy harmonisation

The NHPC project was a major step towards joint strategic HPC operations and management. "The NHPC project set a goal to promote cross-border cooperation through computational science, but allowed individual countries to allocate the NHPC resources independently and support the users in each country individually"[82]

Cross border funding

The implementation of the NHPC project was funded through shared contributions from each country, amounting to about 1 million euros.

Case: Nordic programme on health and welfare

Why the case was chosen

Within the Nordic countries, a need has been identified for a common cross-border approach to sharing of health data. In order to fully make use of health data for research, health care, and innovation, a common approach and joint policies are needed. Within the framework of Nordforsk the Nordic Programme on Health and Welfare was set up to increase public health and welfare in the Nordic countries by focusing on key focus areas as identified within the programme. The program gathered national stakeholders from academia and funding bodies. The programme outputs include reports, registers, as well as programme related calls.[83]

The programme has been chosen as a case in this deliverable as it provides an example of how issues related to resource sharing may be identified, how stakeholders may be gathered, and how remedies to constraints and challenges may be illustrated via programme outputs.[84] Furthermore, an argument for choosing the case is that it illustrates challenges in translating findings and conclusions to actions within a context that involves multiple actors across borders, and administrative barriers within countries. Finally, this case illustrates the role of policies for sharing of sensitive data.

Resource sharing

Political will, availability of funding, and participation of key national stakeholders to take stock of issues related to health data within research, health care and innovation demonstrate a will from national stakeholders to invest in facilitating data and resource sharing within the Nordics. The report, *A VISION OF A NORDIC SECURE DIGITAL INFRASTRUCTURE FOR HEALTH DATA: THE NORDIC COMMONS* envisions a Nordic Health Data Commons. The report illustrated challenges related to resource sharing, such as a need for significantly increased dialogue between key stakeholders related to issues ranging from technical implementation to a common view and harmonization of legislation and policies. [85]

[82] https://www.landsvirkjun.com/Media/lvwhitepaperreportnordic-high-performance-computing-system.pdf
[83] https://old.nordforsk.org/en/programmes-and-projects/programmes/nordisk-program-om-helse-og-velferd
[84] https://old.nordforsk.org/en/publications/publications_container/a-vision-of-a-nordic-secure-digital-infrastructure-for-health-data-the-nordic-commons
[85] Ibid, p 7

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