



e-IRG White Paper 2021

Good practices of coordination within and across e-Infrastructures and thematic Research Infrastructures

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Foreword

Dear reader,

with this document e-IRG is following up on its previous policy paper entitled “National Nodes – Getting organised; how far are we? - Implementing the e-Infrastructure Commons and the European Open Science Cloud.” The document responds both to the 2018 Council Conclusions on EOSC that called for the e-IRG expertise, and also to the 2020 Council Conclusions on the new ERA, both of which encouraged the EC and the Member States/Associated Countries “**to increase the level of national and European coordination, in particular on research infrastructures and e-infrastructures**”.

The e-IRG White Paper 2021 is envisaged as a collection of separate but interrelated topics and starts with the area of “Good practices of coordination within and across e-Infrastructures and thematic Research Infrastructures”. It presents a set of paradigms at institutional, national, and regional level, showcasing either integral and holistic views or highlighting specific aspects, which may be useful for other institutions, countries, or regions. The good practices section is thus not considered complete or exhaustive. It is not an outcome of yet another questionnaire to all EU countries, rather a proactive response from some countries who came forward providing their experiences, which may be helpful for others. A set of guiding questions was prepared, yet the individual contributions that can be found in the annexes do not have the exact same structure, as it is clear that a one size fits all is not the case around Europe.

e-IRG is overlooking the whole e-Infrastructure spectrum, from networking and computing to data and other services (such as middleware, software, and related tools/services), covering not only short-term but also longer-term aspects, advising both Member States and the European Commission. Thus, the document covers all e-Infrastructure components, with emphasis in this first topic on coordination across the different horizontal (generic) e-Infrastructure components at institutional, national, and regional level, as well as across horizontal and vertical (i.e., thematic) infrastructures) with a diverse set of paradigms. e-IRG does not undertake any operative role or implementation mandates, e.g., within EOSC or EuroHPC and keeps an advisory role.

The EOSC initiative is focusing on establishing a ‘web of FAIR data’ whilst a diverse set of data processing and analysis capabilities are key in obtaining fundamental objectives of the EOSC as infrastructure facilitating the European Open Science policy. A more integrative approach across all such components without separation of data infrastructures from e-Infrastructures would favour Open Science and provide added value for the EU Research and Innovation Area.

Today, the degree to which different e-Infrastructures are coordinated and made interoperable within the entire e-Infrastructure landscape at national and international level varies hitherto heavily from country to country in Europe. e-IRG advocates an interoperable, federated ecosystem of domain-specific (vertical) Research Infrastructure and generic (horizontal) e-Infrastructures already at national level, which will facilitate the European level federation, such as in the form of EOSC.

Paolo Budroni
e-IRG Chair

Executive Summary

The first topic of the White Paper 2021 deals with good practices of coordination within and across e-Infrastructures and thematic Research Infrastructures at institutional, national, and regional levels. As there are different approaches across Europe, a set of examples at the different levels can help to better understand the European landscape, but more importantly such examples can be used to exchange experiences, transfer knowledge and lead to possible reuse of these examples in regions that may have similar characteristics. Besides the coordination examples at national and regional levels, it is important to note that an implementation of a holistic e-Infrastructure Commons approach at institutional level is also presented (Chalmers eCommons in Sweden). The Chalmers eCommons is thus acting as the main hub for the Chalmers university researchers and students accessing resources and interfacing with national, European, and international initiatives. Starting with such an organisation at institutional level may be easier and more straightforward than at national level and can anyhow help in the national-level organisation. e-IRG has been advocating for the required organisation and coordination at national level, in line with the 2018 Council Conclusions on EOSC and the more recent ones on the new ERA in 2020. Such organisation and coordination approaches will facilitate the federation at European level, as in the form of EOSC.

The coordination between e-Infrastructure service providers, research infrastructures and researchers are recognised as of utmost importance to further implement Open Science as the default policy in the research and education area. This document presents both long-standing and new coordination activities and initiatives at the various levels, mainly at the national one. Examples of national approaches are presented and analysed, providing practices that can act as possible paradigms for other countries.

Several effective e-Infrastructure and Open Science coordination approaches at the national level are characterised by a combination of both bottom-up and top-down influences, bottom-up meaning initiated by a research organisation (and/or influenced by its users) and top-down coordinated by a high-level authority, such as a ministry, a research council, or a similar funding agency. Coordination approaches can take the form of a forum possibly governed by a Memorandum of Understanding (such as ICDI in Italy or the Austrian EOSC initiative) and can lead to the establishment of a legal entity. There is also a range of cases spanning from virtual (distributed) coordination institutions to fully integrated (centralised) institutions (legal entities). Such an example starting as a virtual organisation and moving into a legal entity is DeiC in Denmark; still the role of the universities in several activities as members of DeiC is key, safeguarding the bottom-up role. Similar is the case of SURF in the Netherlands, where despite the gradual centralisation of functions, the role of its members in the governance and decision taking is vital. A different example of a combination of top-down and bottom-up coordination is the German National Research Data Infrastructure (NFDI). In this case the funding for the NFDI call for proposals is provided by the federal ministry of education and research (BMBWF) and the Federal States (Länder), while the call is open to bottom-up coordinated consortia that -if successful- will effectively run their work programme controlled by the ministry.

An alternative coordination dimension is the level of influence imposed by the national Research Infrastructure roadmaps, including both thematic (vertical) and generic (horizontal)

infrastructures. These national roadmaps are in several cases major milestones for the national research system mapping the national landscape and documenting a list of infrastructures either of national or of European/international relevance. Such influence from the national roadmapping systems for the country coordination may range from light to strong. In the case of France, the influence is strong including strategic decisions for funding and participation in EU initiatives. Open Science is a key area in the roadmap, but also the roadmap is used at a generic level to have a good mapping of the landscape and avoid duplication of efforts. Poland and Portugal have also similar strong coordination influence by their national roadmaps.

National plans for Open Science either part of the national roadmaps or independent are another major driver for coordination in the countries. Already in the e-IRG National Nodes document in 2019 the French national plan for advancing Open Science was highlighted, with three main areas: Open Access to publications, research data “FAIRness” (Findable, Accessible, Interoperable, Reusable) and strong links with a sustainable European and international Open Science initiative (EOSC). Similar approaches before or after the French one were adopted in other countries either as part of the national roadmap (Sweden) or rather independent (Netherlands and Greece). In Hungary, despite the lack of a high-level policy on Open Science there is a high rate of adoption of Open Science approaches at institutional level, especially around open access.

Coordination paradigms at regional (cross-country) level are also presented with stronger or lighter federation levels, including the Nordic and the Iber (Spain-Portugal) cases. The Nordic e-infrastructure collaborations, such as NORDUnet or NeIC have over the years established successful frameworks, organizational structures and joint funding models that have facilitated the development and provisioning of joint Nordic e-infrastructure services. These Nordic collaborations have for some applications been further expanded to function beyond their initial core tasks and have become platforms for an aligned Nordic participation into wider international e-infrastructure collaborations. The IberGrid on the other hand is an example for an e-infrastructure collaboration which was bottom-up initiated (from the scientific communities) and then further ratified at the political level, focusing mainly on computing and data resources.

Reviewing more than ten examples across Europe, in several countries national fora, initiatives or institutions are (being) established to centralize or better coordinate the service provision to the research institutions and universities (e.g., HR-OOZ in Croatia, DeiC in Denmark, NFDI in Germany, SURF in the Netherlands, NordForsk in the Nordic region and ICDI in Italy). Furthermore, such initiatives intend to interface with the European ones such as EOSC, and related institutions, on behalf of their national users. In other countries (e.g., Portugal and France) the related ministries and their appointed organisations coordinate the efforts towards Open Science. In all countries NRENs are established and are key stakeholders in the e-Infrastructures service provision, spanning from the network itself, while in several cases NRENs expand to other areas (i.e., computing and data infrastructures). The role of the NRENs should thus not be underestimated as part of the EOSC implementation process, which can act as major coordination entities at national level. Also, national supercomputing activities and actors are established in most of the EU countries and are also interfacing with the EuroHPC initiative.

Coordination between all stakeholders across the various levels is thus key to achieve the envisaged goal of the European Open Science Cloud, EuroHPC and overall, of the e-Infrastructure Commons, for the benefit of research and innovation and in particular the individual

researchers. A more detailed analysis follows in the rest of the document, while a set of distilled recommendations is provided as part of the executive summary.

Recommendations

- **Institutional eCommons approach:**
 - *The eCommons approach at the Chalmers University in Sweden is an entirely new e-Infrastructure paradigm adopting a holistic approach for data-driven science integrating all the infrastructures and services required by researchers comprising among others of storage, management, computational analysis of large datasets, and large-scale simulations. **The formalisation and possible automation of the processes and actions involved in the provisioning of such a holistic institutional eCommons approach can act as a paradigm for other national research institutions.***
- **National coordination and combination of top-down and bottom-up initiatives:**
 - *As “one-size fits all” does not usually work across Europe, it is up to each country to identify, adapt and adopt the most suitable approaches for their country to facilitate or improve the coordination among horizontal e-Infrastructures and/or among horizontal and vertical infrastructures.*
 - *In all cases it is recommended that the national ecosystem is based on a “chain of command” organisation, i.e., institutional, (federal-regional) national, (cross-country regional), European interactions, easing also cross-border collaboration.*
 - *Furthermore, the national providers and their structures should be trustable and robust, so that there is a clear notion and sentiment of ownership. In this case, the institutional coordination structure will be using the national and then the regional or European services.*
- **From virtual (distributed) coordination institutions vs. physical (centralised) institutions (legal entities).**
 - *The decision on a virtual (distributed) or physical (centralised) institution, i.e., legal entity, largely depends on the specificities of the country.*
 - *In early phases of coordination, a virtual model may be more appropriate to distribute the knowhow and develop expertise in the country, while in later stages a centralised model appears to be more appropriate reducing the management overhead of functions distribution and potential frictions.*
- **Coordination influence by the national Research Infrastructure roadmaps**
 - *National RI roadmaps and their call for proposals can play a significant role in the coordination of the national research ecosystem.*
 - *The RI roadmap process on one hand records the landscape and contributes towards the avoidance of duplication of efforts.*

- *On the other hand, it also promotes coordination among generic (horizontal) e-Infrastructures and vertical (thematic) research infrastructures via the inclusion of the so-called RI electronic needs - “eNeeds,” inspired by the ESFRI Roadmap process which was initially planned and supported by e-IRG.*
- *The eNeeds can be either fulfilled by the horizontal ones or by a dedicated e-infrastructure or by a mixed approach. A corresponding mixed model of funding both horizontal and thematic infrastructures is also recommended:*
 - *Funding schemes should also be explored, piloted, and installed, which incentivise both the thematic research infrastructures/communities and the e-Infrastructure provider organisations to collectively optimize e-Infrastructure service development and provisioning.*
- *Thematic clusters are a good practice at European level, and their structures should be sustained, constantly representing the end users’ interests.*
- *It is recommended that national roadmap calls include questions on electronic needs (eNeeds”) as obligatory ones, so that coordination between the generic and thematic infrastructures at national level is reinforced.*
- *The alignment of the national process with the ESFRI process appears to be a good practice in several countries and is thus recommended, not only at the level of timeline, but also, if possible, at the level of content and questions. In case of alignment, the national process should precede the ESFRI one to allow time to provide input for new projects at the EU level.*
- *Regional (cross-country) coordination*
 - *Coordination across countries is rather constrained, and it may take a form of looser cross-country collaboration, instead of tighter coordination. Still, there are a few exceptions as the Nordic case, which is highlighted in this document.*
 - *Joint pooling of real resources at a central location, not only for regional purposes, but also at European level, however, is an exception and in such cases cross-country coordination is required.*
- *Open Science strategies at national and also institutional level*
 - *The creation of a national plan or roadmap for Open Science is recommended as a good practice based on the experience of the reported cases. This can be done via a related Task Force among major stakeholders in the country and a corresponding Executive/Editorial Board.*
 - *Each country is encouraged to develop its own national roadmap based on the country’s particularities and conditions, identifying the needs at a national level and possibly also institutional level.*
 - *If appropriate given the national circumstances, the national plan for Open Science can be combined with the national roadmap for RIs.*
 - *Sustainable and coordinated e-Infrastructures at institutional, national and on the European level, are mandatory prerequisites to facilitate Open Science adoption at the end user level.*

1. Introduction

1.1 Background

The e-IRG document *National Nodes - Getting organised; how far are we?*¹ that was published in June 2019, followed up on the e-IRG Roadmap 2016², where two recommendations were directed at national governments and funding agencies, namely that they should reinforce their efforts to:

“1) embrace e-Infrastructure coordination at the national level and build strong national e-Infrastructure building blocks, enabling coherent and efficient participation in European efforts;

2) together analyse and evaluate their national e-Infrastructure funding and governance mechanisms, identify best practices, and provide input to the development of the European e-Infrastructure landscape.”

These recommendations were reiterated in the Council conclusions (28/29 May 2018)³, where (statement 8) reads:

*“**ENCOURAGES Member States** to invite their relevant communities, such as e-Infrastructures, research infrastructures, Research Funding Organisations (RFO's) and Research Performing Organisations (RPO's), **to get organized so as to prepare them for connection to the EOSC and CALLS ON the Commission to make optimal use of ongoing projects, existing expertise and knowledge available via existing initiatives, such as ESFRI, e-IRG, GO FAIR and others”.***

The e-IRG document proactively responded to the Council recommendations and addressed the role of national nodes - including their coordination with thematic Research Infrastructures - in the implementation towards the e-Infrastructure Commons and its instantiation as the European Open Science Cloud (EOSC). It provided a first analysis of the national landscapes, which constitute the building blocks of the European structures, thus acting as **National Open Science Clouds (NOSCs)**. Besides the overview and analysis mainly in terms of governance, funding, access policies, **good practices** in these areas at national or regional level have been identified.

Despite the considerable progress achieved in EOSC in its first phase, which finished at the end of 2020, the EOSC Governance has not adequately addressed neither consolidation issues between horizontal European e-Infrastructure providers, nor the requirements of the thematic Research Infrastructures that are treated with lower priority although they are key for EOSC sustainability. Furthermore, EOSC is focusing on establishing a 'web of FAIR data' whilst a diverse set of data processing and analysis capabilities are key in obtaining fundamental objectives of the EOSC as infrastructure facilitating the European Open Science policy. An

¹ e-IRG National Nodes document- Getting organised; how far are we? Implementing the e-Infrastructure Commons and the European Open Science Cloud, 14-06-2019 (erratum date 03-03-2020) <http://e-irg.eu/catalogue/eirg-1006>

² <http://e-irg.eu/documents/10920/12353/Roadmap+2016.pdf>

³ <https://data.consilium.europa.eu/doc/document/ST-9029-2018-INIT/en/pdf>

unjustified separation of data infrastructures and e-Infrastructures in the EOSC Strategic Research and Innovation Agenda (SRIA) v1.0 stands in the way of an integral view on added value for the Research and Innovation area, while a clear definition of whether EOSC incorporates both or a part of the two is not provided.

e-IRG is overlooking the whole e-Infrastructure spectrum, from networking and computing to data and other services (such as middleware, software, and related tools/services), covering not only short-term but also longer-term aspects, advising both Member States and the European Commission. In 2020, e-IRG also via its ministries influenced the new European Research Area policy document⁴, namely the “**Council Conclusions on the new ERA**”⁵ reflecting on the EC Communication “A new ERA for Research and Innovation”⁶. The Council conclusions reinforced the previous message on coordination at national and European level on Research Infrastructures and e-Infrastructures.

ENCOURAGES the Commission and Member States to increase the level of national and European coordination, in particular on research infrastructures and e-infrastructures.

Thus, e-IRG aims to continue to respond to the multi-level coordination challenges, reflecting on the above issues, proposing concrete actions and partnerships, providing integral views, and contributing towards bridging the above gaps. The **e-IRG White Paper 2021** contributes to the vision for an inclusive and holistic e-Infrastructure ecosystem for the European Research Area with resilient and flexible e-infrastructures that serve data interoperability and federation. It bridges the gaps and provides holistic views both within and between MS, working on two main topics:

- Good practices of coordination within and across e-Infrastructures and thematic Research Infrastructures
- "Partnerships" among e-Infrastructures and the cooperation and linking ("interconnectability") between EOSC and EDI (networking/HPC), in particular EuroHPC towards their "convergence".

In the first iteration of the White Paper, the first topic of “Good practices of coordination” are addressed, presenting a set of good paradigms at regional, national, and institutional level, highlighting either integral and holistic views or highlighting specific components, which may be useful for other countries. The good practices section is thus not considered complete or exhaustive. However, the [Annex 2.2 - Full description of institutional, national, and regional approaches](#) comprises some rather detailed description that might help countries on their way implementing coordination activities. The second topic of “Partnerships” will be addressed in the second semester of 2021, while further topics may be included in the next version of the White Paper (see also the next section 1.2). The document may thus be considered a living document with a series of topics and corresponding White Paper instances being addressed over time.

⁴ [New European Research Area: Council adopts conclusions - Consilium \(europa.eu\)](#)

⁵ <https://data.consilium.europa.eu/doc/document/ST-13567-2020-INIT/en/pdf>, 1 December 2020

⁶ <https://data.consilium.europa.eu/doc/document/ST-11400-2020-INIT/en/pdf>, 30 September 2020

2. Good practices of coordination within and across e-Infrastructures and thematic Research Infrastructures

2.1 Policy Area and Goal

As already identified in the introduction, the topic of coordination at national level has been targeted from e-IRG for almost a decade. After the publication of its Roadmap in 2012, e-IRG turned its attention to the organisation of e-Infrastructure at the national level, first publishing its 2013 White Paper⁷, which touched on the need for effective coordination at national and international level across the ecosystem of different organisations, each with their own focus. These messages were taken forward and crystallised in the e-IRG Roadmap 2016, referring to the requirement of coordination at the national level and strong national e-Infrastructure building blocks, to enable coherent and efficient participation in European efforts. For this to be achieved it was deemed necessary, and it was so recommended to the national research ministries and funding agencies to analyse and evaluate their national e-Infrastructure funding and governance mechanisms, identify best practices, and provide input to the development of the European e-Infrastructure landscape. This topic was addressed in the work of the last e-IRG document entitled “National Nodes; getting organised - how far are we?” in 2019, where besides the landscape analysis and comparison of the countries, a set of good practices was highlighted, namely:

- The French National plan for Open Science ([Ouvrir la Science - The national plan for open science](#))
- The Italian Computing and Data Infrastructure (ICDE), (<https://icdi.it/en/>)
- The German National Research Data Infrastructure (NFDI), (<https://www.nfdi.de/enhome-gb>)
- The Nordic collaborations: Nordforsk, NeiC, NORDUnet (<https://www.nordforsk.org>, <https://neic.no>, <http://www.nordu.net>)

In this White Paper a wider set of practices is presented not only at regional and national level, but also examples at institutional level are provided. The regional level refers to regions both within a country (e.g., federal countries such as Germany) and also across countries (e.g., Iberia, Nordic). The above-mentioned good practices are taken further, while new material is identified, especially with regards to coordination paradigms around Europe within e-Infrastructures, across e-Infrastructures and thematic RIs and on open science, covering aspects like ownership/governance, organization (top down/bottom up, distributed/centralised), funding/cost sharing, resource sharing/access policies and the impact of the national RI roadmap in the country organisation. This is also relevant with the establishment of National Open Science Clouds (NOSCs), although e-IRG remit is broader, also covering networking and HPC, among others. Different approaches are analysed, and proposed paths are identified. Thematic area coordination cases are also described.

⁷ <https://zenodo.org/record/4049675>

The goal of this section is thus to identify different practices at institutional, national/regional (intra-country), and regional (cross-country), that can be helpful for other institutions, countries, and regions, depending on their size, complexity, or level of funding. The approaches are analysed, identifying major aspects that influence the coordination and there is a set of paradigms. Realising that each country is unique and “no one size fits all,” still paradigms may be useful for other countries, while related more generic recommendations are also presented that may apply to different cases.

2.2 Context: Current practices - achievements and limitations

2.2.1 Introduction

The following cases have been identified at institutional, national, and regional levels (both intra and cross-country), detailed presentations can be found in [Annex 2.2 - Full description of institutional, national, and regional approaches](#):

- **Institutional level**
 - The Chalmers eCommons is a recently initiated university-wide initiative to further empower researchers and innovators at Chalmers University in Sweden by providing support and collaborative projects for the full range of digital aspects of research. This acts as an e-Infrastructure Commons inside a single institution, and this may pioneer other similar approaches in other institutions across Europe.
 - The Danish eInfrastructure Collaboration (DeiC) is also an example of an institutional approach, which is dominant at national level. Thus, this is relevant not only as an institutional approach, but also -and mainly- at national level (see also below).
- **National and intra-country regional level**
 - Austria:
 - Austrian universities and research initiatives, including the Austrian NREN, are implementing the national organisation *Austrian EOSC initiative*, which will facilitate the coordination of activities related to Open Science and FAIR data policies. ACONET, the Austrian NREN, will act as the Austrian mandated organisation towards EOSC, whereas the Austrian EOSC initiative will be active nationally and reach out across borders towards other EOSC nodes.
 - Croatia:
 - Coordination among e-Infrastructures inside the country towards a National Open Science Cloud (NOSC) is being explored, initially as an umbrella initiative via a Memorandum of Understanding, similar to the Italian ICDI approach, which can be further pursued as a new legal entity.

- Denmark:
 - The Danish national collaboration on e-Infrastructures (DeiC) is moving from a virtual coordination structure to a physical coordination structure, i.e., a single organisation as a separate legal entity. DeiC will act as the main interface towards international activities such as EOSC. Still, outsourcing key activities to universities and research centres is planned (e.g., on HPC) in an effort to spread the knowledge and use the resources across the country, despite the managerial overhead.
- France:
 - France is in the progress of aligning its policies regarding Open Science, research infrastructures, e-Infrastructure landscape, and its participation in EOSC and GAIA-X. Relevant policy regulations and initiatives are identified, including the National Plan for Open Science, which was one of the first initiatives for Open Science in Europe paving the way for other countries to create similar plans. In this paper, the contribution is taken further from the e-IRG National Nodes document, while other paradigms are also sketched including one on Artificial Intelligence.
- Germany:
 - The National Research Data Infrastructure (NFDI) combines a top-down and bottom-up approach, initiated by recommendations from the Council for Information Infrastructures (RifII) a joint funding scheme from the *Bund* and the *Länder* was agreed that a national infrastructure is built to provide systematic access to research data and cooperate with European and international research data infrastructures. The NFDI is structured as a network of domain specific consortia.
- Greece:
 - A bottom-up Open Science Task Force composed of 25 national academic research institutions, research infrastructures, national nodes and Open Science initiatives provided input to the national Open Science Strategy, which aims to establish a national Open Science Initiative (HOSI). One goal of the initiative is to facilitate coordination among the stakeholders and sustain the national development.
- Hungary:
 - There is a national laboratories support program with 18 laboratories for disciplinary research with support from the Research Support Organisation (NRDIO), with strong emphasis on FAIR data. Related coordination and policies are identified that can act as a paradigm.
- Italy:
 - The Italian e-Infrastructures landscape in view of Horizon Europe is presented, including the NREN and the main HPC centre in Italy, while the Italian Computing and Data Infrastructure (ICDI) that was initially highlighted in the e-IRG National Nodes document is taken further, acting as a good practice of bottom-up collaboration.

- Netherlands:
 - SURF has been in a process of merging e-Infrastructures, i.e., the NREN, procurement of services and computing and data infrastructures are now in one organization. SURF is a cooperative and brings relevant institutions (in research and education) together. The Dutch approach is that organisation at national level with a centralised/common effort through collaboration is pursued first, aiming at a strong national infrastructure that is rooted in local infrastructures. As such, the country is in a good position to connect to the European and global level. Thus, an integral approach at national level, gathering the main e-Infrastructures components, is presented.
- Portugal:
 - In Portugal, the most prominent aspect of a vision for an inclusive and holistic e-Infrastructure ecosystem for the European Research Area stems from the Portuguese Roadmap of Research Infrastructures, coordinated by FCT. In parallel and connected with the e-Infrastructures roadmap, the political initiative INCoDe 2030, establishes strategic relevant orientations regarding digital competences complementary to e-Infrastructures, such as the topics of Advanced Computing, Artificial Intelligence and, more broadly, the development of digital skills. This program has double guardianship, initially from science, and lately also from the economic sector. These two programs can act as a paradigm for a strategic vision for both digital infrastructures and related competences and related areas, inspiring other countries.
- Spain:
 - There are several initiatives at national and regional level, highlighting good collaboration practices, namely:
 - Singular Scientific Technological Infrastructures (ICTS in Spanish) initiative⁸. This shows coordination at the level of policy agencies across communities.
 - IBERGRID⁹ is a federation of distributed computing facilities from Spain and Portugal. Given the fact that it affects both the national organisation and the regional (with Portugal), there is material for both inside the country and under the regional approaches.
 - The Spanish Network for e-Science¹⁰ is a coordination network across ICT infrastructures, policy agencies and researcher communities, acting as a paradigm of coordination across both horizontal (generic) and vertical (thematic) infrastructures.

⁸

https://www.ciencia.gob.es/portal/site/MICINN/menuitem.eed4570ef37d2c8fbaa777b9026041a0/?vgnnextoid=928d5ef3677c4610VqnVCM1000001d04140aRCRD&lang_chosen=en

⁹ <http://www.ibergrid.eu/>

¹⁰ <https://www.e-ciencia.es>

- The Spanish Network for Supercomputing¹¹ is a network of supercomputing centres in Spain, mainly showing coordination across horizontal e-Infrastructures
- Sweden:
 - There is ongoing work to come up with a new structure on RIs/e-Infrastructures. A joint structure such as the one in the Netherlands as one integrated organisation is being considered. A report from a corresponding group will be delivered on 31 May 2021. If in time, the outputs will be included in the White Paper.
- **Regional approaches**
 - Nordic collaboration:
 - The Nordic countries, including Denmark, Finland, Iceland, Norway, and Sweden, as well as the three autonomous areas, the Faroe Islands, Greenland and the Åland Islands, have a long-standing history of collaboration in science and research. There exist today many strong and extensive collaborations among Nordic researchers, institutions, and research infrastructures that are based on common values and goals for research, as well as long-term established trust. As a result of these, there have over the years been established structures and frameworks among the Nordic countries that foster easy collaboration among them, also regarding a more aligned participation in international initiatives.
 - NordForsk was established in 2005 as a formal organization under the Nordic Council of Ministers to provide funding for and facilitate Nordic cooperation on research and research infrastructures within common Nordic priority topics across the borders of the Nordic countries. One of the strategic priorities for NordForsk is the Nordic research infrastructure cooperation which aims to enable an increased joint Nordic use and access to research infrastructures at the national, Nordic, and international level.
 - The Nordic e-infrastructure Collaboration (NeIC) is hosted by NordForsk since it was established in 2012 and it is NordForsk's main tool to implement the Nordic eScience Action Plan. NeIC has the operational responsibility for the Nordic distributed Tier-1 facility that is part of the Worldwide LHC Computing Grid (WLCG) and provides computing and storage for CERN. NeIC furthermore has an important role to jointly or collaboratively explore, evaluate, develop, and deploy innovative e-infrastructure services in response to the Nordic strategic priorities and the needs of the national e-infrastructure providers, their users and selected ESFRI projects of joint Nordic interest. More recently, NeIC also coordinates projects for e-infrastructure collaboration in the Nordic region that are also funded by the European Commission, such as the EOSC Nordic project.

¹¹ <https://www.res.es/en/about>

- With all roles, NeIC is becoming an intersection point between national, Nordic, and international research infrastructure strategies that heavily depend on collaborations among Nordic e-infrastructures.
- NORDUnet is Nordic a collaboration between the National Research and Education Networks (NRENs) of the five Nordic countries Denmark (DeiC), Iceland (RHnet), Norway (Uninett), Sweden (SUNET), and Finland (Funet). The NORDUnet collaboration started with the first NORDUnet Conference in 1980, and from there on evolved into a dedicated Nordic network during the NordForsk funded NORDUNET program (1986 to 1992). Since 1993 NORDUnet is organized as a limited liability company with the ministries of the five Nordic member countries as equal shareholders. The organization provides a common Nordic world-class network infrastructure and a collaboration platform for developing and facilitating other common e-infrastructure services. The NORDUnet collaboration benefits its member countries also in the context of wider international project participation. NORDUnet is an active participant in the European NREN collaboration GÉANT, as well as the Global Research and Education Network (GREN) through its membership in the intercontinental NREN collaborations Advanced North Atlantic (ANA) and the Asia Pacific Europe Ring (AER).
- IBERGRID: The Iberian Distributed Computing Infrastructure (IBERGRID) is a joint Spanish-Portuguese initiative federating the respective national computing resources with a lightweight, bottom-up coordination, the general coordination is ensured by representatives of both countries. IBERGRID facilitates resource allocation through Virtual Organisations and serves generic thematic VOs as well as ESFRI ERICs.

2.2.2 Current practices: advances vs. limitations

1. A holistic e-Infrastructure Commons approach at institutional level:

The Chalmers e-Commons adopts a *holistic approach*, which is based on a data-centric perspective, *covering all phases of the research data life cycle*, from planning, management, and large-scale computing/analysis in active projects, to long-term preservation, data sharing and data publishing. Furthermore, the e-Commons provides access to a span of local, national, and international e-Infrastructure resources and services for large-scale computing and data storage/management, *reducing fragmentation and acting as a one stop shop for its users*. Chalmers e-Commons coordinates the Chalmers university participation in national e-Infrastructures such as the national computing (SNIC) and data (SND) infrastructures, as well as in European initiatives like EOSC and access to computing resources in EuroHPC.

2. National e-Infrastructure and Open Science coordination approaches: a combination of bottom-up and top-down

There are several national approaches of e-Infrastructure coordination that combine the top-down (ministerial/funding agency) with the bottom-up (research organisations led) control/influence.

Ownership/Members/Governance/Purpose

Owners/Initiators

In some cases, the owner or at least the coordination initiator is the Ministry of Science, but the role of coordination of all national initiatives for Open Science and infrastructures is designated to key e-Infrastructure or Open Science actors (such as the Croatian Open Science Cloud HR-OOZ case and the Danish DeiC) and in other cases the coordination is initiated and driven by the key e-Infrastructure or Open Science actors, followed by the ministry (either as full members or observers) such as the Italian case of ICDI.

Members

Members of the collaboration are usually the key policy-making institution (Ministry of Science), the main research funding institution (Science Foundation), the main e-Infrastructure providers (NREN, National Computing Centres, National Data Service and Centres), the EOSC mandated organisation in the country, the main research performing organizations including thematic Research Infrastructures (e.g. national components of ESFRI RIs or ERICs), the OpenAIRE National Open Access Desk (NOAD), the RDA National Nodes, related main library coordination entities or institutional entities and possibly other major universities.

Type of agreement: informal Forum or MoU.

The initial agreement is usually based either on a forum among the involved members that meets regularly to discuss and resolve coordination issues based on priorities (such as the Greek case of the Open Science Task Force) or a lightweight Memorandum of Understanding, where the main coordination objectives and agenda points are described and agreed in advance. In case the initial consensual agreement is successful it can also lead into a formalisation of the agreement with a legal act, such as the creation of a new legal entity (such as it is being considered in Italy with ICDI).

Governance

The coordination is usually governed by a board composed of all forum or MoU members, while usually there is a one leading entity (coordinator) or two leading entities, usually co-chairing the board meetings. This does not preclude other setups, depending on the level of the bottom-up vs. top-down control. Expert groups (e.g., DeiC) and advisory bodies are usually complementing the governance (e.g., Austria, Greece).

Range between top-down and bottom-up

Obviously, these cases can be either more leaning towards bottom-up or top-down or be rather balanced, while the state may be dynamic and evolve over time towards one or the other direction. In particular, in case of a successful coordination, such as the ICDI paradigm which already operates for a couple of years, a formalisation of the relationship via a legal form (creation of a legal entity) is considered. A legal formalisation may lead to a more top-down controlled approach (e.g., in case of dependency on ministerial funding) or continue to be bottom-up controlled via membership fees by its member-organisations or a mix of the two with funding from both of these sources.

Another interesting example of a combination of top-down and bottom-up coordination is the German National Data Infrastructure (NFDI). In this case the funding for the NFDI call for proposals is provided by the federal ministry of education and research (BMBF), while the call is open to bottom-up coordinated consortia that -if successful- will effectively run their work programme controlled by the ministry.

Purpose/Scope

In the vast majority of cases, the main purpose of coordination is around publicly funded research infrastructures/Open Science, not dealing with other areas (e.g., industry, public sector). The coordination may span different areas of e-Infrastructures or Open Science or both. In some cases, this only covers Open Science (e.g., the Greek Task Force of Open Science). There are also cases of coordination of activities only in the area of e-Infrastructures (e.g., Spanish Network of Supercomputing - RES). And finally, there are cases coordinating both e-Infrastructures and Open Science which are optimal, as the fragmentation is reduced (Croatian HR-OOZ and Italian ICDI).

Exemplary points for such coordination include:

- Setting up managerial coordination structures, between horizontal (generic) providers and across horizontal and vertical (thematic) infrastructures, as well as for the coordination of the participation to the European initiatives. As a concrete country example, Spain has multiple levels of coordination, such as the Spanish network for supercomputing (RES) among the 13 supercomputing centres in Spain and the Spanish network for e-Science, a coordination network across ICT infrastructures, policy agencies and researcher communities. Furthermore, there is a federation and related coordination of distributed computing facilities at the regional level, i.e., Spain and Portugal, called IBERGRID. Another traditional and long-lasting regional collaboration and coordination paradigm is the one of the Nordic countries. The NordForsk organization under the Nordic Council of Ministers provides funding and facilitates Nordic cooperation on research and research infrastructures, while concrete coordination structures are the NORDUnet regional research network and the Nordic e-Infrastructure Collaboration (NeIC), covering broader e-Infrastructure needs for strategic priorities or thematic areas (such as high energy physics and ESFRI RI projects/ERICs). There are several other examples of national coordination via dedicated legal entities such as SURF, which is a “cooperative

association,” and its member institutions can work on the coordination based on their priorities.

Regarding coordination among generic (horizontal) e-Infrastructures and vertical (thematic) research infrastructures there is strong push in the related calls for proposals in several countries. This is mainly achieved via the inclusion of the so-called “electronic needs” or “eNeeds”) by the Research Infrastructures which may be fulfilled by the horizontal ones. So, the funders/policy makers oblige the two groups to talk to each other and coordinate things. Of course, there may be cases where the horizontal infrastructures can cover the needs of the RI, but also others where a dedicated e-infrastructure is better suited to the new or existing thematic RI. Examples of such a roadmap process can be found in several countries such as France, Poland, the Netherlands, Sweden and in several cases the “eNeeds” are obligatory. It is reminded that e-IRG prepared for ESFRI the first set of the eNeeds questions for the ESFRI Roadmap 2018¹² with a guiding e-IRG document¹³, which were later updated further on by ESFRI and its later-constituted DIGIT working group.

- Documenting a National Action Plan for Open Science to coordinate and harmonize activities related to Open Science, Research Data Management and “FAIRification” of national data and services. A concrete example for this case is France, which was one of the first countries to come up with such a national plan for Open Science, while other countries such as Greece came up with a similar plan.
- Providing consultations and support to the Ministry of Science in defining national positions related to the EU activities, including EOSC, EuroHPC and other sectoral ones.
- Coordinating and harmonizing the activities related to participation in European and international initiatives on e-Infrastructures and Open Science and applying on Horizon Europe calls and other EU funding programmes

Funding/Cost sharing/Business models

In the hybrid top-down bottom-up model, usually the funding comes from either the state budget, or membership contributions -from the members of the e-Infrastructure provider entity, e.g., German case of NREN (DFN), or pay-per-use fees, or both. In the case of a mixed model of both state budget and membership fees (e.g., Danish DeiC and Dutch SURF) this provides diversity and flexibility. Further costs can be shared among participating members. Although for national ministries and funding agencies the costs are recorded as actual budgets (in cash), at European level there is also the concept of in-kind contributions (e.g., EOSC partnership MoU), where each country provides resources not only in cash, but also in-kind contributions (people, resources share, training centres, etc.). This concept may be also used at national level for coordination purposes among the relevant members.

Sustainability depends on continued support by the state budget or the diversity of funding, including national, regional, and European. Cases where a change of government resulted in change in the financial and strategic support of a key e-Infrastructure player are diminishing over the years.

¹² <http://roadmap2018.esfri.eu>

¹³ <https://zenodo.org/record/4063465>

Resource sharing and access policies

For rivalrous resources such as computing (HTC and HPC), in most cases there are resource sharing policies. These can be either based on the participating members of the e-Infrastructure providers, e.g., according to their financial contributions or based on scientific excellence/peer review. Furthermore, some percentage of the resources can be reserved or provided ad-hoc given strategic priorities or urgent needs (e.g., Covid-19). Access is mainly provided to the academic and research communities, while there are a few cases where industry/SMEs can also get access to a small share of resources (either for research/innovation purposes for free or against payment). In addition, services are in most cases free at the point of use for the end users, and the costs are covered either centrally by the provider itself or via the end-user's organisations membership contributions or usage fees. Access to resources from other countries is usually limited and depends mainly on the source of funding or programme.

Other variations: fully bottom-up or top-down.

Variations of this case are either top-down or bottom-up only paradigms or dominated by one of the two, however both of these are less balanced and have corresponding disadvantages. The top-down cases are fully controlled (or driven) by ministries/research councils (e.g., Danish DeiC, France, Portugal, NORDIC Nordforsk), while the bottom-up only cases are only driven by the institutes (e.g., Dutch SURF). Still, despite the lack of balance, in both cases there are corresponding advantages and disadvantages. Advantages for top-down include the possible dedicated support/funding from the ministry and endorsement, while disadvantages include the lack of independence or flexibility. On the other hand, advantages for the bottom-up case include the independence/flexibility and disadvantages include the possible lack of dedicated funding and endorsement.

A combination of top-down (ministerial/funding agency) with the bottom-up (research organisations led) control/influence of national e-Infrastructures' coordination appears to be an effective and balanced approach in all reported cases. The top-down and bottom-up influences vary along with exact scope of coordination that can be around horizontal e-Infrastructures only, between horizontal and vertical infrastructures and around research data management and open science. For rivalrous resources such as HTC and HPC computing sharing and usage policies span from access via scientific excellence/peer review, according to the members contributions or based on ad-hoc strategic priorities or needs.

3. From virtual (distributed) coordination institutions to fully integrated (centralised) institutions (legal entities)

Coordination of main e-Infrastructure provider organisations can also be categorised based on the level of centralisation or distribution of activities/functions. In the first case (centralised model) there is a legal entity with a large number of FTEs operating centrally, while in the other extreme there is a virtual organisation (e.g., Danish DeiC first phase or Italian ICDI) distributing all the tasks to other entities (universities and/or research centres). Obviously, there are also mixed cases. As an example, the Greek NREN "GRNET" started with a small central team and a virtual Network Operating Centre (VNOC) distributing the responsibilities of functions to organisations

with relevant expertise via a tender, with the small central team managing, reviewing, and evaluating the VNOG activities. Over the course of the years the model became increasingly centralised. SURF in the Netherlands has also gathered centrally the procurement, networking, computing, and data services merging its three companies (SURFmarket, SURFnet and SURFsara) into one (SURF BV) and all staff were also placed in the BV (under a cooperative, governed by its members: mostly research performing organizations). DeiC (and possibly ICDI) is moving away from the virtual organisation towards a legal entity with a physical centralised organisation and approach, although some functions will still be outsourced to its members. Centralisation or distribution of functions may also depend on the size of the country and the number of players (e-IRG document “National Nodes - Getting organised; how far are we?”¹⁴) or other inherent or historical reasons in each organisation, country, or region.

Each model has its advantages and disadvantages. Outsourcing the work to other entities (e.g., universities or research centres) has the advantage of spreading the knowledge/know-how/competences inside the country. On the other hand, higher distribution of responsibilities comes with a high overhead of coordination given the distributed responsibilities and in cases the coordination is not smooth it can also lead to conflicts. On the other hand, centralised coordination of at least networking, computing (HTC/HPC) and storage resources/services (such as CSC in Finland, GRNET in Greece and SURF in the Netherlands to name a few) may come with lower coordination overhead (depending also on the size). In some cases, however there is a risk that the knowledge is not spread around the country evenly, and sometimes these organisations become excessively powerful. When the leading e-Infrastructure provider is governed by its member institution (such as SURF), this is not a problem, as the members have the ultimate decision power, and they use it. The knowledge very often also comes from members and the leading entity has to propagate it inside the country.

There are currently discussions in some countries whether private entities should also take part in research e-Infrastructures, such as SMEs or specialised industrial entities with research and innovation activities, for example as part of their Recovery and Resilience Facility funds after the Covid-19 pandemic or around Covid-19-related activities.

The best path for coordination and possible integration of different functions in the country is dependent on the particularities of the country (e.g., size and number of players), but some country paradigms can also inspire other countries, with virtual (distributed) organisations or physical (centralised) organisations or a combination of the two.

4. Coordination influence by the national Research Infrastructure Roadmap: from light to strong

Another possible axis of coordination in different countries is the national roadmap for Research Infrastructures, including e-Infrastructures. The national roadmaps are major milestones for the national research system mapping the national landscape and coming up with a list of infrastructures either of national or of European/international relevance. The infrastructures may either be supported financially (both for capital and operational expenditures) or related short- or medium-term projects may be assigned to the approved infrastructures. In most cases, the

¹⁴ <https://zenodo.org/record/3608075>

national RI roadmaps are updated frequently (every few years) and may be possibly aligned with the ESFRI Roadmap process. Initially, ESFRI updated its Roadmap every two years (first cycle: 2006, 2008, 2010) focusing mainly on new priorities, while in the second cycle (2016, 2018, 2021) ESFRI, on one hand identified new priorities, while on the other produced an evaluation methodology of previously accepted projects and followed up the progress of the projects in the Roadmap.

As identified in point 2 (on national coordination), coordination among generic (horizontal) e-Infrastructures and vertical (thematic) research infrastructures is incentivised in the related Roadmap calls for proposals mainly via the inclusion of the so-called RI “eNeeds”. These can be either fulfilled by the horizontal ones or by a dedicated e-infrastructure or by a mixed approach. In most cases the “eNeeds” questions and proposal section are obligatory.

In particular, France is one of the countries having a strong national RI roadmap, with major strategic decisions (funding and EU participation) being based on such a roadmap. Open Science is a key area in the roadmap, but also the roadmap is used at a generic level to have a good mapping of the landscape and avoid duplication of efforts. Similarly, Poland and Portugal have also similar strong coordination influence by their national roadmaps. In several other countries, the influence may be much lighter, without key decisions on funding, rather producing related short-lived projects, which would need further rounds of funding (as with European projects).

The national roadmap for Research Infrastructures, including e-Infrastructures can be another coordination focus inside a country. The national infrastructure roadmaps are major milestones for the national research system mapping the national landscape and identifying a list of infrastructures of either national or international relevance. The infrastructures that enter the national roadmap are in most cases supported financially (both for capital and operational expenditures) and/or related national funded projects may be supported. The national roadmaps may also be aligned with the ESFRI European Roadmap process and updated every few years.

5. Regional (cross-country) Coordination

The amount of cross-country regional coordination depends on the specific case. There are coordination paradigms with deep-rooted and long-lasting relationships such as the Nordic countries, while there are other examples of less instinctive relationships, such as the Iber one (Spain and Portugal). Even less homogeneous one is the paradigm of South-eastern Europe, Eastern Mediterranean and some of the Caucasus countries. However, given the fact that several of these countries are non-EU (and not even Associated) countries, and rather third countries it is more a collaborative approach (rather than coordination) in an effort to come closer to the European affairs, rather an actual coordination of Research Infrastructures including e-Infrastructures. In this paper, there is a dedicated contribution from the Nordic countries and also on IBERGRID.

Nordic e-infrastructure collaborations have over the years established successful frameworks, organizational structures and joint funding models that have facilitated the development and provisioning of joint Nordic e-infrastructure services. In many cases, these Nordic collaborations have been expanded to function beyond their initial core tasks and have become platforms for an

aligned Nordic participation into wider international e-infrastructure collaborations. Common factors for these developments appear to be the establishment of long-term organizational trust, common values in developing e-infrastructure services and a willingness to fund and achieve results that contribute to a dynamic development and increase Nordic competencies and competitiveness on the international level.

Despite the will for cross-country coordination in such cases (Nordic and Iber), and the recommendations or functionality on resources sharing (e.g., by the Nordic e-Infrastructure Collaboration in the Nordic countries), the decision on resource sharing stays with the national authorities. There are also a few cases though, where a central pool of resources is prepared which can be then managed by the regional (or even European) bodies.

Cross-country regional approaches are rather special and isolated (such as the Nordic case) and furthermore funding, resource access and sharing are based on national decisions. Thus, coordination across countries is rather constrained, and it may take a form of looser cross-country collaboration, instead of real and tighter coordination. Joint pooling of real resources at a central location, not only for regional but also at European level, however, is an exception and in such cases cross-country coordination is required.

6. Open Science plans at national and also institutional level

Already in the e-IRG National Nodes document in 2019 the French national plan for advancing Open Science was highlighted. The plan is concentrated around 3 primary areas: Open Access to publications, research data “FAIRness” (Findable, Accessible, Interoperable, Reusable) and strong links with a sustainable European and international Open Science initiative (EOSC). The support for the Research Data Alliance (RDA) and OpenAIRE initiatives was also highlighted, as well as data-related skills, certifications, and policies not only at national, but also at institutional level. The Netherlands national program for Open Science was constituted even earlier (2017)¹⁵, which foresaw that for all educational institutions and research domains, open access publishing and optimal reuse of research data will be the norm by 2020, with a motto “open, if possible, closed if it must”. The same approach was also taken up by the EU in its Open Science policy¹⁶, in which the Commission requires beneficiaries of research and innovation funding to make their publications available in open access and make their data “as open as possible and as closed, as necessary.” In 2019 the Swedish National Roadmap for the European Research Area 2019–2020¹⁷ was adopted, identifying a set of priorities and corresponding key actions for the various actors in the national research and innovation system to support a strong ERA, a main priority of which was Open Science. The main elements of the roadmap in this priority included open research data, openly accessible publications, open-source code, open educational resources, and citizen science. Key stakeholders in the country around publications, such as the National Library of Sweden was tasked to coordinate the work on promoting open access and assess the

¹⁵ <https://www.openscience.nl/en/national-platform-open-science/national-plan-open-science>

¹⁶ https://ec.europa.eu/info/research-and-innovation/strategy/goals-research-and-innovation-policy/open-science_en

¹⁷ [swedish-national-roadmap-for-era-2019-2020.pdf \(government.se\)](https://www.government.se/press-releases/2019/04/swedish-national-roadmap-for-era-2019-2020)

“FAIRness” of research data as part of the national ecosystem. Recently the Swedish universities agreed to adopt an Open Science approach at *institutional level*.

In 2019, the Swiss State Secretariat for Education, Research, and Innovation (SERI) commissioned Swiss universities to extend the National Strategy on Open Access to Open Research Data and to coordinate stakeholder activities in partnership with the Swiss National Science Foundation (SNSF), the Swiss NREN SWITCH and the Swiss Data Science Centre (SDSC). A project group was thus put together to develop the Open Research Data strategy and Open Research Data action plan for the Swiss universities Open Science delegation¹⁸.

Following the French paradigm and similar to the Swedish case, Greece formed an Open Science Task Force, a bottom-up initiative that brought together the major Open Science stakeholders in the country and was gradually supported by the General Secretariat of Research and Technology (related Ministerial branch). The National Open Science Plan for Greece^{19,20} was published in 2020 after a year of frequent meetings and editing rounds by an editorial board, and revisions by all members. The plan gathered a series of goals, policies, and actions for the adoption of Open Science at national level and also highlighted the necessary links at European level. It focuses on open access to scientific publications, research data and research software produced by publicly funded research institutions. Furthermore, it highlights the role of research infrastructures as key data providers and consumers and their role for high quality data provision, promotion of the open science culture and for innovation. It should be noted that organisations part of the Task Force declared the adoption of the document at *institutional level* and the uptake of actions along the lines of the plan. Indicative areas covered by in the plan are again Open Access to Scientific Publications, Research Data Management and Sharing, Research Software Development and Management, Open Science as part of national Research Infrastructures ecosystem and Integration and alignment with the European Open Science and Innovation Ecosystem.

A broader roadmap for digital transformation on “Shaping digital transformation in science” was developed by the “Digital Information” Initiative by the Alliance of Science Organizations²¹ in Germany for 2018 - 2022. The mission statement describes the main goals of the initiative, identifies the fields of action and priorities for the digital transformation. Such priorities around Open Access, Open Science and research data include among others the scientific publication system, digital tools, software and services, digital collections of data, federated e-infrastructure, digital learning, teaching, and networking, digitally literate staff, good practices, and related legislation.

The Landscape Working Group of the EOSC Executive Board surveyed and documented the landscape of infrastructures, initiatives, and policies across Europe related to EOSC²² including Open Science. The Country Sheets Analysis²³ goes deeper into the country data, complementing

¹⁸ [About us - Swiss Universities](#)

¹⁹ <https://zenodo.org/record/3908953> (Greek version)

²⁰ <https://zenodo.org/record/4656150> (English translation)

²¹ <https://www.allianzinitiative.de/publikationen-positionen/>

²² [Landscape of EOSC-related infrastructures and initiatives - Publications Office of the EU \(europa.eu\)](#)

²³ [Country sheets analysis - Publications Office of the EU \(europa.eu\)](#)

the work being conducted by the INFRA-EOSC-5B projects²⁴, which are assessing the landscape at the local level.

Once again, it should be clear that each country's research and innovation system has its own unique character. Still, the creation of a national plan or roadmap for Open Science is a good practice. So, each country is encouraged to develop its own national roadmap, based on the country's particularities and conditions, identifying the needs at a national level and possibly also institutional level, and setting out corresponding initiatives or task forces for such a development. Depending on the circumstances, it may be possible to combine the national plan for Open Science with the national roadmap for RIs.

2.3 Good practices - Proposed approaches

In the previous section a set of 6 areas of good practices has been identified covering mainly national approaches, but also institutional and regional (cross-country) ones. These areas along with the relevant paradigms that can inspire other countries (or institutions) are summarised in this section along with appropriate actions (if applicable), while a set of related recommendations is proposed in the next section.

A holistic e-Infrastructure Commons approach at institutional level

Coordination of e-Infrastructures at institution level can be considered as an Institutional Open Science Commons, linking to the National Open Science Commons, and through this also to the European Open Science Cloud commons. This allows researchers to focus more on their work and less on finding resources from different infrastructures inside the country and beyond. It should be clear that the national ecosystem should be based on a "chain of command," i.e., institutional, (federal-regional), national, (cross-country, regional), European. A trustful relationship between the institutions and their national providers and their structures is of utmost importance for a successful implementation. In this case, the institutional coordination structure will be using the national and then the regional or European services.

The eCommons at Chalmers University is an entirely new e-Infrastructure adopting a holistic approach for data driven science comprising storage, dissemination, management, and analysis of large datasets and large-scale simulations. The eCommons merge existing e-Infrastructures at Chalmers University to provide support throughout the whole research data life cycle and manage questions concerning storage, data management plans, archiving, and how to make research data FAIR. The Chalmers eCommons will be the interface to national e-Infrastructures such as SND (data), SNIC (computing), Sunet (network), and also international infrastructures such as the European Open Science Cloud. Established by the president of Chalmers University the eCommons is firmly located in the University's organisation and has a clear mandate. *Although there may be other cases where informal coordination in some of the areas is developed, **the formalisation and possible automation of the processes and actions as part of an***

²⁴ [EOSC Regional Projects | EOSC Secretariat](#)

institutional eCommons approach can function as a paradigm for national research institutions.

National e-Infrastructure and Open Science coordination approaches: a combination of bottom-up and top-down

A combination of top-down (ministerial/funding agency) with the bottom-up (research organisations led) control/influence of national e-Infrastructures' coordination appears to be an effective and balanced approach in all reported cases. The top-down and bottom-up influences vary along with exact scope of coordination that can be around horizontal e-Infrastructures only, between horizontal and vertical infrastructures, and around research data management and open science. For rivalrous resources such as HTC and HPC computing sharing and usage policies span from access via scientific excellence/peer review, according to the members contributions or based on ad-hoc strategic priorities or emergency needs.

*A series of paradigms were presented either initiated from the bottom-up and then supported from the top-down (e.g., Italian ICDI) or the other way, i.e., initiated from the top-down and then embraced and driven by the bottom-up (e.g., German NFDI). Multiple other paradigms have been presented that may or may not fit other countries, as the different countries are largely particular. **Thus, as not “one-size fits all,” it is up to each country that does not have formal or informal coordination among horizontal e-Infrastructures and/or among horizontal and vertical infrastructures to identify, adapt and adopt the most suitable approaches for their country.***

Virtual (distributed) coordination institutions vs. physical (centralised) institutions (legal entities)

The best path for coordination and possible integration of different functions in a country is dependent on the particularities of the country (e.g., size and number of players), but some country paradigms can also inspire other countries, with virtual (distributed) organisations or physical (centralised) organisations or a combination of the two.

*The Danish DeiC started as a virtual organisation outsourcing the functions to the member universities, while ultimately a new legal entity is to be created gathering some of the functions centrally, while others will remain distributed to its members. SURF in the Netherlands has also gathered centrally the procurement, networking computing and data services merging its three companies (SURFmarket, SURFnet and SURFsara) into one (SURF BV) governed by members in the cooperative. **The decision on a virtual (distributed) or physical (centralised) institution, i.e., legal entity, again largely depends on the specificities of the country. Still, it appears that in early phases of coordination a virtual model may be more appropriate to distribute the knowhow and develop expertise in the country, while in later stages a centralised model appears to be more appropriate reducing the management overhead of functions distribution and potential frictions.***

Coordination influence by the national Research Infrastructure Roadmap

The national roadmap for Research Infrastructures, including e-Infrastructures can be another coordination focus inside a country. The national infrastructure roadmaps are major milestones for the national research system mapping the national landscape and identifying a list of infrastructures of either national or international relevance. The infrastructures that enter the national roadmap are in most cases supported financially (both for capital and operational expenditures) and/or related national funded projects may be supported. The national roadmaps may also be aligned with the ESFRI European Roadmap process and updated every few years.

*Several paradigms of such a roadmap process have been presented such as France, Poland, the Netherlands, Sweden. **National roadmaps via their call for proposals on one hand record the landscape and contribute towards the avoidance of duplication of efforts and on the other hand also promote coordination among generic (horizontal) e-Infrastructures and vertical (thematic) research infrastructures via the inclusion of the so-called RI electronic needs - “eNeeds.” These can be either fulfilled by the horizontal ones or by a dedicated e-infrastructure or by a mixed approach. Inspired by the ESFRI Roadmap process, national roadmaps calls can include eNeeds questions as obligatory ones, so that the coordination is reinforced. A further good practice is the alignment with the ESFRI process (if possible, at the level of timeline and also questions and content), while the national process may be able to come before the ESFRI one and provide input for new projects at the EU level.***

Regional (cross-country) coordination

Cross-country regional approaches are rather special and isolated and furthermore funding, resource access and sharing are based on national decisions. Such cases are evident in the Nordic countries and the Iber ones (Spain and Portugal). Looser links appear in the Eastern countries or the South-eastern ones, which may take the form of collaboration.

Coordination across countries is thus rather bounded, and it may take a form of cross-country collaboration, instead of real coordination. Joint pooling of real resources at a central location, not only for regional purposes, but also at European level, however, is an exception and in such cases cross-country coordination is required.

Open Science plans at national and also institutional level

*Each country's research and innovation system has its own unique character. Still, **the creation of a national plan or roadmap for Open Science appears to be a good practice in all reported cases. So, each country is encouraged to develop its own national roadmap, based on the country's particularities and conditions, identifying the needs at a national level and possibly also institutional level, and setting out corresponding initiatives or task forces for such a development. Depending on the circumstances, it may be possible to combine the national plan for Open Science with the national roadmap for RIs.***

Colophon

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