

Evaluation of UNINETT Sigma2

2019

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1. The context of this evaluation

UNINETT Sigma2 AS (Sigma2) has a strategic responsibility for and manages the national e-infrastructure for large-scale data and computational science in Norway. Sigma2 is mandated to provide services for high-performance computing and data storage to individuals and groups involved in research and education at all Norwegian universities and colleges, and other publicly funded organisations and projects. In addition, UNINETT Sigma2 coordinates Norway's participation in Nordic and European e-infrastructure organisations and projects. Sigma2's activities are jointly financed by the Research Council of Norway (RCN) and the Sigma2 consortium partners, which are the universities in Oslo, Bergen, Trondheim and Tromsø (UiO, UiB, NTNU and UiT).

Sigma2 was established as a non-profit company (UNINETT Sigma2 AS) in December 2014, based on an agreement between the five parties, which defines a long-term model with a 5+5-year perspective and an evaluation after the first five-year period. This report presents the evaluation performed in response to the mandate for this evaluation, see Annex 1. The founding agreement also states that the report from the evaluation committee shall provide a basis for the RCN and the four Sigma2 consortium members to decide whether they need to adjust the funding level for the second five-year period, starting 1 January 2020. Furthermore, the evaluation report should point out how Sigma2 could improve its services to strengthen its position as the national provider of e-infrastructure services and boost successful collaboration with Nordic and European e-infrastructures for research and higher education.

2. Summary: Overall findings

2.1 Overall findings

Today, Sigma2 is a well-established and very important element in the Norwegian research infrastructure landscape. Sigma2 provides access to national e-infrastructure – with a focus on high-performance computing and large-scale data storage – in a way that enables Norwegian researchers in computational science to be highly competitive in the international research arena. At an overall level, Sigma2 is currently a well-functioning e-infrastructure that has delivered central services to Norwegian research in an excellent manner during its first five years.

The Sigma2 initiative also provides an excellent foundation for Norwegian research institutions and the Research Council of Norway to meet the future needs of Norwegian researchers. This will, however, require a further shift of focus towards different forms of user support – including providing support to new and emerging user communities – and increasing activities and services directed towards large-scale data storage, handling and analysis. Norwegian universities will also be required to take steps to consolidate and engage in the Sigma2 metacentre organisation and to ensure that their local e-infrastructure strategies are co-developed and consistent with the national Sigma2 strategy.

2.2 General recommendations

The four *recommendations* below present the general findings of the committee, and many of the more detailed recommendations in Section 7 are also summarised in a more general context.

General recommendation-1: Sigma2 (board, central office, metacentre sites) should take further action to enable the Sigma2 national e-infrastructure to be the central resource for

an even wider range of research groups in an even broader range of research fields, for other research infrastructures and large research projects, and in education. Going forward, research communities that do not necessarily include traditional users of large-scale computing and data-driven research will have to be given special focus. A further change of focus from technology and operations towards user and application support will be beneficial to expanding the user spectrum. In connection with this process, the metacentre sites should be empowered to manage contact with users and user/application support for the national e-infrastructure.

General recommendation-2: The universities in the Sigma2 consortium should develop/clarify transparent e-infrastructure strategies that are fully harmonised with the national Sigma2 strategy and clarify the roles of the local computing centres/IT organisations.

General recommendation-3: The Sigma2 central office and the metacentre sites should jointly develop the national competence profile of the Sigma2 e-infrastructure, including the development of a national competence plan, a national plan for user support and for on-boarding new user groups.

General recommendation-4: Extending the scope and range of users of the Sigma2 e-infrastructure will require an expansion of Sigma2's activities and services. Some recent and ongoing actions, e.g. computing hardware being concentrated in a smaller number of sites, will facilitate some of this expansion. However, the growth in needs will be such that it will not be possible to provide the forthcoming e-infrastructure resources required by all potential Norwegian researchers within the current funding framework. Sigma2 will require an increase in its overall funding.

3. Norsk sammendrag/Norwegian summary

3.1 Samlede funn

Sigma2 er i dag et veletablert og svært viktig element i forskningsinfrastrukturlandskapet i Norge. Sigma2 gir tilgang til en nasjonal e-infrastruktur – med hovedvekt på tungregning og storskala datalagring – på en måte som gjør norske forskere innenfor feltet beregningsvitenskap svært konkurransedyktige i det internasjonale forskningsmiljøet. På overordnet nivå er Sigma2 i dag en velfungerende e-infrastruktur som i løpet av sine fem første år har levert viktige tjenester til norsk forskning på en svært god måte.

Med Sigma2-initiativet har norske forskningsinstitusjoner og Norges forskningsråd et utmerket utgangspunkt for å kunne dekke norske forskeres behov også i fremtiden. Dette vil imidlertid kreve at man fokuserer enda mer på andre former for brukerstøtte – herunder støtte til nye og potensielle brukergrupper. Dette krever også en økning av aktivitetene og tjenestene rettet mot storskala datalagring, -behandling og -analyse. Det vil også forutsette at norske universiteter i enda større grad går sammen og deltar i metasenterorganisasjonen for Sigma2 og sikrer at deres lokale e-infrastrukturstrategier utvikles gjennom samarbeid og i samsvar med den nasjonale Sigma2-strategien.

3.2 Anbefalinger

Utvalgets funn presenteres i de fire anbefalingene under, som også sammenfatter mange av de mer detaljerte anbefalingene i avsnitt 7 i en mer generell kontekst.

Anbefaling 1: Sigma2 (styre, hovedkontor, lokale metasentre) bør ta videre grep for å gjøre den nasjonale e-infrastrukturen

Sigma2 til den sentrale ressursen for et enda bredere utvalg forskningsgrupper på enda flere forskningsfelt, for andre forskningsinfrastrukturer og store forskningsprosjekter, og for utdanning. I de kommende årene blir det nødvendig med særlig fokus på forskningsmiljøer som ikke nødvendigvis omfatter de tradisjonelle brukerne av tungregning og datadrevet forskning. En ytterligere forskyvning av fokus, fra hovedsakelig teknologi og drift mot bruker- og programstøtte vil være nyttig for å tilrettelegge for en slik utvidelse av brukerbasen. I denne prosessen bør de lokale metasentrene gis mulighet til å håndtere kontakten med brukerne og bruker-/programstøtten for den nasjonale e-infrastrukturen.

Anbefaling 2: Universitetene i Sigma2-konsortiet bør utvikle/avklare transparente strategier for e-infrastruktur, som er harmonisert med den nasjonale Sigma2-strategien og avklarer rollene til de lokale databehandlingssentrene/IT-organisasjonene.

Anbefaling 3: Hovedkontoret til Sigma2 og de lokale metasenterlokalene bør i samråd utvikle den nasjonale kompetanseprofilen for e-infrastrukturen Sigma2, herunder utviklingen av en nasjonal kompetanseplan, en nasjonal plan for brukerstøtte og for innlemming av nye brukergrupper.

Anbefaling-4: En utvidelse av bruksområdet og en større brukerbase for e-infrastrukturen Sigma2 vil kreve at Sigma2-aktivitetene og -tjenestene utvides. Enkelte nylige og pågående tiltak, f.eks. databehandlingsmaskinvare som er fysisk lokalisert på færre steder vil muliggjøre noe av denne utvidelsen. Behovsveksten vil imidlertid være på et slikt nivå at det ikke vil være mulig å levere nødvendige e-infrastrukturressurser til alle relevante norske forskere med dagens finansieringsramme. Det vil bli nødvendig å øke den samlede finansieringen for Sigma2.

4. How the evaluation was performed

4.1 The mandate

The full mandate of the evaluation is presented in Annex 1 (in Norwegian). The mandate was prepared by the Sigma2 consortium partners (UiO, UiB, NTNU and UiT) and the RCN and dated 5 July 2017. It describes the background and aim of the evaluation and also explicitly lists a large number of points and KPIs that should be evaluated. The detailed evaluation in Section 7 is presented in subsections that are organised in accordance with the structure provided in the mandate.

4.2 The evaluation committee

As specified in the mandate, the members of the evaluation committee were chosen jointly by the Sigma2 consortium partners (UiO, UiB, NTNU and UiT) and the RCN, and the committee was formally appointed by the RCN in October 2018. The committee consisted of:

- Prof. Bolette Sandford Pedersen, Department of Nordic Studies and Linguistics, University of Copenhagen
- Prof. Jeppe Olsen, Department of Chemistry, Aarhus University
- Prof. Sverker Holmgren, Department of Information Technology, Uppsala University (Chair)

Brief biographies of the committee members are presented in Annex 2.

The work of the evaluation committee was supported by Senior Advisor Ulrike Jaekel at the RCN, who provided a secretarial function, organising meetings etc.

4.3 Input provided to the committee and activities during the evaluation

The mandate specifies important background material, including a self-evaluation by Sigma2. Sigma2 has provided an extensive set of background material, including but not limited to the documents mentioned in the mandate. The Sigma2 self-evaluation is a well-written document which has been helpful in the evaluation process. The Sigma2 management has also been very helpful in responding to requests for additional

material and answering follow-up questions on the material provided during the evaluation committee's work.

During the period from 22 January to 29 May 2019, the committee has held four physical meetings in Oslo, generally in connection with the interviews listed below, and a few video meetings. In addition to this, the committee chair has held a few meetings with the committee secretary, e.g. to prepare the interviews.

The mandate specifies that the evaluation committee should conduct interviews with the Sigma2 management, the Sigma2 board, and the managements of the Sigma2 consortium partners and the RCN. As indicated in the mandate, the committee could also conduct additional interviews and surveys. As further described in Annex 3, the evaluation committee conducted six interviews:

- The former and current chairs of the Sigma2 Resource Allocation Committee (RFK)
- The Sigma2 board of directors
- The Sigma2 administration
- The Sigma2 managing director
- Representatives of the Sigma2 metacentre sites at UiB, NTNU, UiO and UiT
- Representatives of the top-level management of the four funding universities and the RCN

Furthermore, the evaluation committee organised an online survey comprising a small set of questions which was distributed by email to over 500 recipients, including all Norwegian universities and colleges, research infrastructures which had previously applied for national research infrastructure funding, national centres of excellence, national centres for research-driven innovation, the Sigma2 metacentre sites and all Sigma2 users.

The committee report has been written jointly by the committee members with final editing by the committee chair. To ensure that all interviewees were given an opportunity to correct any possible misunderstandings that may have occurred during the interviews, a draft of the evaluation report was sent to all interviewees for a fact-check before the final version was produced.

5. Introduction: National e-infrastructure in Norway

Overall, the Norwegian national e-infrastructures for research encompasses equipment, operations and related services for high-performance computing, data storage, software systems and high-capacity networks, as well as tools for efficient workflows and software for simulations and analysis of data. The term “e-infrastructure” also refers to digital registries and databases as well as tools and services for ensuring security and accessibility. Today, the national e-infrastructures for research supply services to more and more research fields that generate and/or use large data volumes and/or employ high-performance computing.

Norway has coordinated most of the national e-infrastructure services for research and higher education through UNINETT AS and its subsidiary UNINETT Sigma2 AS (Sigma2). UNINETT develops and operates Norway’s high-capacity national research and education network. The affiliation to the research network forms the basis for most other services supplied by UNINETT. Sigma2 – which is the topic of study in this evaluation – is responsible for the procurement, operation and further development of generic e-infrastructure services for high-performance computing and data storage at the national level. One of the main arguments for the provision of such national services is that it has the potential to be more cost-effective than parallel structuring of e-infrastructure solutions within the individual subject areas at the different institutions. It should however be noted that the Norwegian e-infrastructure landscape also includes a number of more specific user and data-oriented services provided by national initiatives and research infrastructures within specific domains.

Generic e-infrastructure has an impact on a growing number of scientific fields and research infrastructures. In addition to

providing services to individual researchers and research groups, investments in e-infrastructure should also be assessed in terms of the resources required for other national research infrastructures, as well as for Norwegian participation in ESFRI projects and other European research infrastructure collaborations that rely on e-infrastructure services. Coordinating investment in national generic e-infrastructures provides an opportunity for Norway to tailor investment levels to actual needs and to target activities to areas where the benefits of investments will be greatest. The centralised coordination of measures also provides opportunities for building bridges between infrastructures and subject fields in order to promote multidisciplinary research.

The RCN is a central actor in this coordination effort. It seeks to secure adequate, long-term funding for e-infrastructure within the applicable budgetary constraints and to assist in coordinating investments and mechanisms to ensure that the e-infrastructures are satisfactorily utilised nationally. The RCN does not normally contribute funding for investment in, and operation of, computing resources for data-intensive computing unless the investment has been coordinated with, or comes entirely from, Sigma2. Research groups that require computing resources are advised to contact Sigma2 at the outset in order to clarify whether their needs can be met through existing or planned Sigma2 investments. In connection with applications for new national research infrastructure requiring storage or computing resources, the Research Council expects the project owner to establish a dialogue with Sigma2 on how these needs can be met and to incorporate the costs into the budget for the infrastructure being sought.

6. Introduction: UNINETT Sigma2 AS

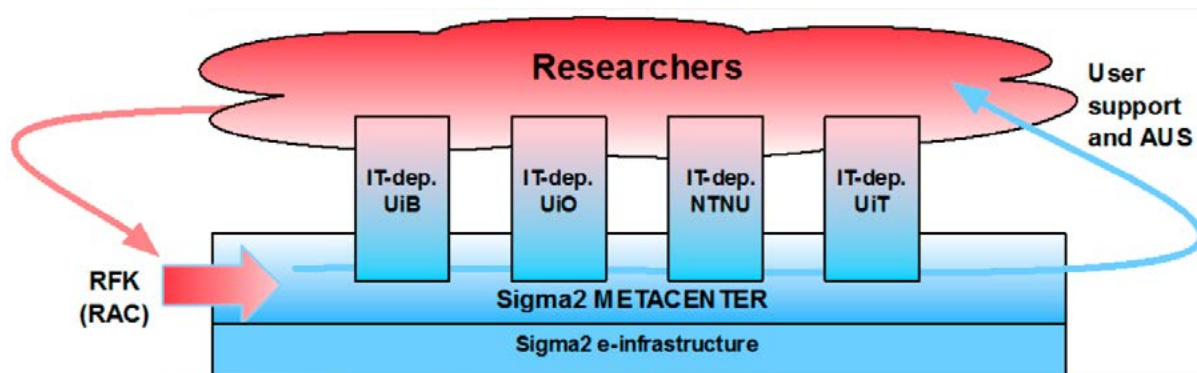
UNINETT Sigma2 AS (Sigma2) became operational on 1 January 2015 as a subsidiary corporation of the UNINETT Group which is owned by UNIT, the Directorate for ICT and joint services in higher education and research under the Norwegian Ministry of Education and Research. Sigma2 is run on a non-profit basis and carries out projects on behalf of the RCN and a consortium consisting of UiB, UiO, UiT and NTNU. The board is chaired by the managing director of UNINETT and consists of four members from the four universities, a legal expert from a national research institute and one external representative from outside Norway. Sigma2 receives basic administrative support from UNINETT, and the main office is co-located with UNINETT in Trondheim. Sigma2 has a small administrative unit (10 FTEs) which is responsible for coordinating the procurement and operation of the Sigma2 e-infrastructure. Gunnar Bøe is the managing director of Sigma2.

Sigma2 is responsible for the procurement, operation and further development of the generic national e-infrastructure for high-performance computing and data storage for research and education in Norway, including services for sensitive data. In addition, Sigma2 offers related services, such as advanced user support (AUS), a platform for data analysis, a tool for making data management plans (DMP) and an archive for research data. Sigma2 also coordinates Norway's participation in international collaborations on e-infrastructure, such as the Nordic e-Infrastructure Collaboration (NeIC), the Partnership for Advanced Computing in Europe (PRACE), the European High-Performance Computing Joint Undertaking (EuroHPC), the European Open Science Cloud (EOSC) and related projects (EOSC Hub and EOSC Nordic), and the European Data Infrastructure (EUDAT Ltd.) consortium.

Sigma2 services are available to individuals and groups involved in research and education at Norwegian universities and colleges, as well as other organisations and publicly funded projects. Services may be sold to commercial entities subject to

government regulations relating to such activities. Applications for computing, storage facilities and user support resources for projects are evaluated by a Resource Allocation Committee (RFK). The RFK is composed of leading Norwegian scientists from relevant user groups who are appointed by the Sigma2 board. The RFK evaluates the proposals and awards access to Sigma2 computing and storage resources twice per year. Proposals for access must demonstrate scientific excellence, scientific need and that the resources requested will be used efficiently. Commercial users, and non-commercial users that require dedicated resources, can also obtain access at a price. Sigma2 services are mainly funded by the RCN and the Sigma2 consortium partners. The company receives basic annual funding through the RCN (NOK 25 mill. per year), as well as funding through service agreements with the four universities that make up the consortium (NOK 50 mill. per year). In addition, Sigma2 can apply for (and has been awarded) competitive funding from national and international funding initiatives. National funding has mainly been allocated through the RCN INFRASTRUKTUR initiative, see Annex 4. A user-contribution model has also been established which means that a small but steadily growing part of the funding comes from larger research projects, as well as non-commercial and commercial users that require dedicated resources.

National coordination and shared, consolidated resources can result in cost and efficiency advantages, but centralisation also entails a risk of a disconnect from the needs of the end-users. The Sigma2 system aims to counter this by retaining support staff and competence at the universities where the research is performed. Qualified staff at the universities provide expertise to ensure that researchers can make optimal use of the resources via a variety of user support services. Together, Sigma2 and the university staff form a pool of competence – the metacentre, corresponding to approximately 25 FTEs in total.



In the period 2016 to 2019, the four national high-performance computing resources acquired in 2012 are being phased out and consolidated into two computational facilities located at NTNU and UiT. Prior to 2015, computational processing resources and data storage solutions for Norwegian research were supplied independently by facilities in separate physical locations at the four universities in the Sigma2 consortium.

In order to meet a growing volume of data and the steady increase in the number of research projects based on data analysis, Sigma2 has initiated a greater degree of integration between the computing facilities and a central data storage – the new National e-Infrastructure for Research Data (NIRD). NIRD, formerly known as NorStore, is now directly connected to the computing facilities, which enables data analysis and visualisation services to be delivered more efficiently. NIRD provides storage resources that are expanded as required, data protection through dual-site storage, support for multiple storage protocols and migration to third-party cloud service providers.

7. Evaluation: Specific findings and recommendations

This section contains specific findings and recommendations, organised according to the structure described in the mandate in Annex 1.

For the explicit key performance indicators mentioned in the mandate, the status is presented in tables in the subsections. The recommendations are also listed in the initial summary section.

7.1 Finances

KPI	STATUS
At least 30% of Sigma2 revenue should come from competitive funding programmes	For the full period 2015-2019, 38% of the revenue originates from competition-based programmes. The fraction has increased during the period and is around 50% in 2019.
The net worth of Sigma2 should not be more than 25% of the turnover, measured as an average over the full period 2015-2019	For 2017 and 2018, the fraction has been 4% and 6%, respectively.

The RCN and the four universities forming the Sigma2 consortium have contributed to Sigma2 with a total annual allocation of NOK 79 million in 2015 and 2016, and NOK 75 million in 2017-2019, which is consistent with the original plan. The second major source of funding for Sigma2 is the RCN national programme INFRASTRUKTUR (see Annex 4), where the funding has increased from NOK 37.5 million in 2016/2017 to NOK 57.9 in 2018/2019. In the past two years, 2018 and 2019, Sigma2 has also received contributions from major users, NeIC and international agencies, corresponding to a total of NOK 18 million in 2019. Thus, whereas the funding provided by the four universities in the consortium and the RCN has not been increased over the period, the income from competition-based programmes has increased significantly. In terms of the total budget in 2019, the fixed allocations from the consortium and the RCN constitutes about 50% of the total revenue, and about 35% of the revenue comes from national competitive funding while the remaining 15% comes from Nordic and international competitive schemes and user payments. For the full period 2015-2019, the revenue from competitive funding corresponds to 38% of the total revenue.

Given that around 50% of Sigma2 revenue comes from long-term (5-year) commitments from the RCN and the consortium,

Sigma2 is able to work with a time-horizon spanning several years. However, the revenue from the long-time commitments have not been adjusted to compensate for increased costs. This inflation-adjusted budget reduction has been compensated by income generated from other sources, including user payments. This implies that the added sources of income have to some degree been used to maintain status quo, rather than to finance new initiatives. This can be seen to affect Sigma2's capability to engage in new activities and extend the use of large-scale computing to additional scientific disciplines. The on-going centralisation of hardware to only two sites will presumably reduce the operating costs somewhat, but whether this cost-reduction can both finance significant increases in the demand for computing and data storage resources and additional contributions to user support is far from certain.

User fees were introduced in 2018 and now make up a sizeable contribution to the total revenue of Sigma2, contributing 5% to the total income in 2019. As these payments are an addition to the long-term basic funding, where a very large fraction of the total budget is tied up in fixed salaries and investments in hardware, they are an important source of funding that enables Sigma2 to invest in new initiatives and strengthen existing initiatives. Only the very largest user groups, typically centres of excellence and large research infrastructure, pay for access to the facilities. These payments are organised as negotiated fixed payments, based on expected consumption of CPU hours and other use of resources, rather than on actual billing of CPU hours. Restricting payments to the very largest user groups and using negotiated payments rather than billing the amount of resources used in a given time-period makes the payments system rather simple. It also does not affect users with small or medium-sized projects. This has led to Sigma2 being able to generate a significant additional source of income without creating a complicated billing system and without impairing access to computational facilities for most of the users. From this point of view, the introduction of user payments has been successful. Whether this billing is affecting the demand for and efficient use of the e-infrastructure services is not apparent, especially as the implemented scheme for payments does not seem to have been set up with such purposes in mind. It is also still too early to judge how – and indeed if – the introduction of user payments is affecting user behaviour.

A large fraction of the Sigma2 revenue goes to staff salaries at the metacentre sites at the four universities that are Sigma2 stakeholders. A minor part of payroll expenses is used to pay a rather small staff at the Sigma2 central office. As an organisation, Sigma2 has a rather small and inexpensive “head” and a rather large “body”. There are probably some historical reasons for the significant number of staff members at the metacentre sites funded by Sigma2. The partner universities which initially had their own independent HPC staff now use a model where the

universities pay Sigma2 which subsequently, through an explicit or tacit agreement, funds the staff at the various sites at a level comparable to that preceding Sigma2. Sigma2 took over the financial and organisational responsibility for sizeable groups of IT experts at the four universities and has only made minor adjustments to the size of the personnel. In terms of joint corporate responsibility, this is an admirable procedure and it also guarantees that essential competence is retained. The decentralised and quite staff-intensive structure of Sigma2 also has a significant potential to be an important asset in the next phase of Sigma2, and it is not at all clear that changing the balance between funding used for staff and investments would benefit the Norwegian research community as a whole. This is further discussed in several sections and recommendations below.

- **Recommendation Finances-1:** If Norway wishes to be at the forefront of countries that use large-scale computing to foster new insights in a broad range of scientific and technical disciplines, including extending the efforts to support even more data-driven research fields, the total funding level for Sigma2 should be increased for the next five-year phase.
- **Recommendation Finances-2:** The decrease in the fraction of long-term funding to competition-based funding for Sigma2 should be stopped. Optimally, the fraction should again be increased towards 70% to guarantee the sustainability of this foundational national research infrastructure.
- **Recommendation Finances-3:** Sigma2 should continue the user fee initiative using the current format and procedures. A separate evaluation of this could be organised in two to three years.

7.2 Organisation

Sigma2 has successfully implemented the national e-infrastructure as described in the background documents that accompanied the introduction of the initiative, and its set-up as a non-profit company has proven appropriate. However, it is evident that there is growing interest in and use of Sigma2 services within Norwegian universities and research institutes that are not part of the current Sigma2 consortium, and it would be beneficial for the national coverage, sustainability and close connections to important user groups to also include such organisations in the Sigma2 consortium.

The established structure where the company Sigma2 interacts with metacentre sites based on the current agreement framework and collaborative setting is also considered appropriate for the next funding period. At an overall level, the division of work between Sigma2 and the participating universities is also appropriate. However, during the first period of Sigma2's existence and the implementation of the new collaborative structure, some issues have emerged that were not fully clarified in the background documents. This includes e.g. specifying the division of work within the Sigma2

metacentre and the details of how the collaboration within Sigma2 is organised. This does not imply that the background work or the implementation work by Sigma2 has not been successful. Rather, it demonstrates the fact that implementing a national e-infrastructure is complex and that the field of e-infrastructure is constantly evolving. The next step is now to further develop and consolidate the metacentre organisation to further improve the effectiveness of the national e-infrastructure system for the benefits of Norwegian research. This should include Sigma2 activities being more strongly established in the research infrastructure/e-infrastructure strategies of the universities and other user institutions (and, if necessary, the development of such strategies).

The contracts governing the collaboration between Sigma2 and the participating universities appear to be appropriate and fulfil the needs of the collaboration.

- **Recommendation Organisation-1:** The RCN and the Norwegian research institutions should consider expanding the Sigma2 consortium to also include the Norwegian universities/research institutes which are currently not members of the consortium but which use – or could be assumed to benefit from using – significant amounts of Sigma2 resources.
- **Recommendation Organisation-2:** The partner universities in the Sigma2 consortium should develop /refine transparent e-infrastructure strategies and coordinate these with the national Sigma2 strategy. In these strategies, the role of the local Sigma2 metacentre sites should be clarified.
- **Recommendation Organisation-3:** The partner universities in the Sigma2 consortium should develop/refine local research-oriented fora for channelling the current and future needs of their research towards the national e-infrastructure in Sigma2.

7.3 Governance and management

KPI	STATUS
Sigma2 has developed and maintains a strategy, including plans which take the users' future needs into account.	Sigma2 has developed appropriate processes for its strategic planning. Sigma2 also regularly updates its strategy with the active participation of the board.
Sigma2 has implemented appropriate project management procedures.	Sigma2 has imported project management procedures from the parent company UNINETT and adapted these to the setting where projects are performed within the metacentre organisation.

Sigma2 has implemented appropriate quality assurance monitoring for operations and service delivery.	The quality of the operations and delivery of Sigma2 services is monitored using appropriate procedures.
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Sigma2 has developed appropriate processes for its strategic planning. Sigma2 also regularly updates its strategy with the active participation of the board. Furthermore, members of the Sigma2 board have initiated a process, supported and formalised by the management of the universities in the Sigma2 consortium and the RCN (*Financing of e-infrastructure towards 2030*), where the future of national e-infrastructure for research in Norway is considered in a wider context. The decisions of the Sigma2 board are in line with the established goals and strategies. The Sigma2 board has executed its formal duties appropriately and has also taken a strong strategic lead in the development of Sigma2. The contact and collaboration between the board and the Sigma2 management appears to be very well functioning and appropriate.

With the exception of one international/Nordic member, the Sigma2 board only has Norwegian members. This is not a problem *per se*, and the members of the board and the Sigma2 management are well-established internationally. However, to further support the strategic work of the board, an international e-infrastructure advisory group with globally leading experts should be formed to provide annual input to the board on Sigma2 developments and plans.

The co-location and contact between Sigma2 and the parent company UNINETT provides informal access to management and administrative competencies naturally found in this much larger organisation. For example, Sigma2 has used established procedures for project administration and project work it has "imported" from the parent company UNINETT, and adapted them to the setting where projects are performed within the metacentre organisation.

The quality of the operations and delivery of Sigma2 services is monitored using appropriate procedures, including re-occurring meetings and scheduled reporting. Professional procedures are implemented for managing changes and events.

Sigma2 is a lean organisation with only around ten employees under central management to form the Sigma2 "central office". The competence profile and individual competencies of this staff appear to be appropriate.

Sigma2 projects are normally performed in a decentralised setting involving the efforts of employees at one or more of the metacentre sites. The formal management of their day-to-day work is not under the control of the Sigma2 management. A decentralised model for project work provides many advantages (use of available competence in the national setting, involvement and buy-in by the metacentre sites etc.). However, there is also a risk of inefficiencies and conflicting priorities affecting the national projects. The metacentre set-up is dependent on a high level of mutual trust and respect being maintained within the organisation.

The operation and further development of Sigma2 is also strongly dependent on appropriate contributions being made by the highly competent staff at the metacentre sites. The introduction of a project-based mode of managing national operations and development in combination with centralising the hardware at fewer sites and an enhanced focus on different forms of user support is a challenging situation which might require the competence profiles of the staff at the individual sites to be further developed.

- **Recommendation Governance-and-Management-1: The Sigma2 board should appoint an international e-infrastructure advisory group of globally leading experts to provide annual input on Sigma2 developments and plans.**
- **Recommendation Governance-and-Management-2: The Sigma2 management and the management of the metacentre sites should work further on minimising the risk of distrust and conflict. Frequent (weekly) virtual meetings where the managers of the metacentre sites and the Sigma2 management discuss operational issues and national projects should be introduced. The option of transferring the employment relationship – probably as a leave-of-absence – of the metacentre site managers to the Sigma2 central organisation should also be considered.**
- **Recommendation Governance-and-Management-3: The Sigma2 management and the management of the metacentre sites should develop a national plan for ensuring access to and further developing national competence within an efficient and effective Sigma2 e-infrastructure. In this process, an overall shift of focus from operations to user and application support and an increased focus on new and emerging user communities should be considered.**

7.4 Contact with stakeholders

KPI	STATUS
Meetings with the universities in the consortium in accordance with the Sigma2 agreement	An annual meeting with each university has been organised. However, the strategic managements of some universities did not participate
Meeting with the RCN in accordance with the Sigma2 agreement	An annual meeting has been organised
Appropriate meetings with relevant user groups	Many meetings have been organised, but the metacentre sites could potentially be more involved (representing the national e-infrastructure)
Appropriate meetings with research institutions that could be candidates for joining the Sigma2 consortium	Appropriate meetings have been organised

According to the annual reports and the self-evaluation, one annual meeting has been held with each of the involved universities as specified in the agreement. It is pointed out, however, that, for some universities, only the IT sections and not the university management have participated in these meetings. This can be seen as problematic. The university management has the overall responsibility for their IT and e-infrastructure strategy and must play a central planning role since it is up to them to ensure that the institution actually has and pursues a digital strategy. To this end, Sigma2 cannot alone be blamed for a potential lack of impact or decision-making competence at some of these meetings, and it seems reasonable to ask that representatives of the university management who are well informed regarding the e-infrastructure strategy of the particular institution participate at these meetings. As documented in the activity reports provided to the evaluation committee, annual meetings have also been held with the RCN.

A considerable number of user meetings with current and potential users has taken place. The main aim of the user group meetings has been to ensure that particular research areas and institutions are well covered, and that future user requirements are clearly identified in collaboration with the users and potential users.

With respect to contact with potential new users, the impression from the interview with the metacentre site representatives in particular is that there is still room for improvement. “Small” potential projects, i.e. user groups who are not potentially going to use constant and large amounts of

CPU time are subject to a long response time when they approach Sigma2. To this end, some metacentre sites report that the general application processing time for “smaller” users for digital facilities and CPU time has increased after the establishment of Sigma2. The user survey performed by the evaluation committee likewise indicates room for improvement with respect to contact with potential new users. Non-users generally report very little awareness and knowledge of Sigma2.

The general impression is that the level of activity regarding contact with stakeholders has been high, although it is hard to estimate to what extent all relevant current and potential users are satisfactorily involved. There has been a very high level of activity during the five years, and Sigma2 appears to have shown a thorough interest in basing its work on the users’ needs and collaborating closely with relevant partners and stakeholders. However, the metacentre sites’ reports of extended waiting times for approaching small and new projects should be addressed. Experts from the metacentre sites can also probably play a greater role in the contact with stakeholders, representing the national Sigma2 e-infrastructure (and not their home institution).

The Sigma2 infrastructure set-up is distributed over a number of geographically widespread institutions, and the meeting frequency and stakeholders’ participation and commitment at such meetings has proven to be a crucial success indicator for the impact of the infrastructure. Based on the reporting (in particular the activity reports) and interviews, Sigma2 appears to have fulfilled its responsibility to set up and organise a large number of such formal meetings with relevant stakeholders.

- **Recommendation Contact-with-Stakeholders-1:** The universities in the Sigma2 consortium should take further action to increase the commitment made by the university managements with respect to actively participating in Sigma2 stakeholder meetings and other issues related to Sigma2.
- **Recommendation Contact-with-Stakeholders-2:** The Sigma2 metacentre sites should take further action to increase awareness of the national Sigma2 e-infrastructure among research communities in order to further improve its connection to ongoing research. To this end, it is recommended that best-practice is applied from the universities best prepared to reach their users – also users in emerging fields.
- **Recommendation Contact-with-Stakeholders-3:** The Sigma2 metacentre sites should increase the focus on introducing new projects and research groups to the national Sigma2 infrastructure. This could e.g. be projects in the humanities and social sciences.
- **Recommendation Contact-with-Stakeholders-4:** The metacentre sites and the Sigma2 central organisation should jointly contribute to channelling researchers’ upcoming needs into the Sigma2 strategy and plans, e.g. by working together with the local research-oriented fora described in Recommendation-Organisation-3.

7.5 Investments and procurement of services

KPI	STATUS
Sigma2 has carried out market and needs analyses	Sigma2 has carried out needs analyses based mainly on surveys among existing users. When preparing procurements, market analyses have been performed
Sigma2 has developed plans for investments based on the market and needs analyses, and used these for procurements	Plans for investments have been developed
The unit costs and energy efficiencies for the procured resources are consistent with the market analyses	Not evaluated

Sigma2 has developed a process for planning investments by regularly updating an investment strategy based mainly on surveys among existing users. The requirement to prepare well-founded applications for competitive funding to RCN also seems to have contributed to this process. Surveys among existing Sigma2 users are a relevant means of gaining input for investment strategies, but there is also a risk that the resulting needs analysis becomes conservative and does not include the needs of potential future Sigma2 users.

In an international context and comparison, the Sigma2 procurements have provided good value for money. The HPC installations in Norway are of a good international standard, without being in either the absolute top or bottom HPC-ranking in Europe or internationally. Whether the procurements have resulted in the absolute best deals is very difficult to judge, and such procurements generally differ so much in detail and conditions that objective comparisons are practically impossible. However, there are different opinions on this issue within the Sigma2 metacentre, including the opinion that the existing competence within the organisation has not been fully used in the recent procurement processes. A central, national process for procurements with full use of all available competence and commitments and buy-in from all the Sigma2 partners is a national asset that should be safeguarded and further developed.

In an international context, Sigma2 has managed to fulfil the needs of the Norwegian computational science community – as expressed in the applications to the RfK – in what seems to be an almost unprecedented way. The match between the resources researchers applied for and the resources provided is almost perfect, with only a small oversubscription. However, care should be taken not to over-interpret this to conclude that the resources provided fulfil all the needs of Norwegian

research. International experience also shows that the situation can potentially, to some extent at least, be explained by the fact that applicants are aware of the amount of available resources and limit their research ambitions accordingly. There may also be some potential applicants who do not submit applications at all since they believe that the resources provided are not appropriate for their needs.

- **Recommendation Investments-2: Sigma2 should increase its efforts to plan and execute the procurement of computer and storage systems involving the full expertise of the metacentre organisation, working as a team to arrive at the most suitable and cost-efficient solution irrespective of the location of the resources.**

7.6 Accessibility to computational resources and data

KPI	STATUS
The principles and conditions for using Sigma2 resources are transparent	The work of the resource allocation committee is transparent and described in a public mandate. A limited amount (< 5%) of resources is used for block-allocations as decided by the Sigma2 board.
Sigma2 has a data policy and a data management plan	Sigma2 does not have an explicit data policy but leaves this to the user projects. It is assumed that the user projects adhere to the data policy of their institution. This can be considered appropriate for an e-infrastructure like Sigma2. Sigma2 provides a tool for data management plans but does not require the use of such a plan. Again, this is left to the user projects to consider as appropriate.

The transparency of the resource allocation process is ensured through the resource allocation committee (RfK), which has a public mandate describing the main principles of allocation. During the interview with RfK, the committee satisfactorily demonstrated that it undertakes the responsibility of transparency and fair judgement in the best way that it can. In some cases, however, it can be difficult to assess the scientific quality of the projects applied for, and assessments must thus largely rely on second-hand judgement in terms of already granted projects and accepted publications. It also became clear from the interview with the RfK that not all resource allocations are handled via the committee: a limited amount of

resources and some service platforms and portals are decided by the Sigma2 board.

The interviews and the user survey performed by the evaluation committee also indicated that although formal transparency is sought through websites and committees, there seems to be a problem with accessibility for new users. Potential new users do not seem to have access to relevant information about Sigma2.

Sigma2 has taken some action to simplify access for potential new users, but there still seems to be a perceived problem with regard to obtaining relevant knowledge as well as a lack of flexibility with respect to taking in “smaller” research projects with moderate needs in terms of resources and CPU time. These actions should be intensified, and the staff at the metacentre sites are an important resource in this work.

The material provided indicates that the data stored in the Sigma2 Research Data Archive is freely accessible. This is in agreement with the European Charter and the access policy of the Research Council. The archive supports provisioning of metadata according to the Dublin Core standard; there is the DOI-Metadata association and also support for machine readable metadata harvesting (OAI-PMH). Access to the data can either be provided through a web interface <https://archive.sigma2.no/> or by using various file transfer protocols. Sigma2 does not have its own data policy plan but relies on the policy of each project, although it complies with standards for metadata and exchange of metadata.

The evaluation committee does not consider the lack of a data policy plan in Sigma2 to be problematic as such since it is deemed appropriate that data policy responsibility lies with the individual research projects and their principal investigators. This naturally requires the projects using the infrastructure to be very well planned and managed, and to have their own well-grounded data policy. This is a process that could be supported by the Sigma2 metacentre sites.

- **Recommendation Accessibility-1: Sigma2 should take further action to fully document and openly publish all allocations of Sigma2 resources, including those not decided by the resource allocation committee.**
- **Recommendation Accessibility-2: Sigma2 should be more active towards potential new users, including users from “untraditional”, emerging and smaller research fields; Sigma2 is encouraged to increase flexibility and speed with respect to the inclusion of new groups; in general procedures have to be adjusted to new user needs. The metacentre sites should play a central role in this process.**
- **Recommendation Accessibility-3: Sigma2 should take more responsibility for encouraging and supporting research projects with respect to establishing sound data policies. Again, the metacentre sites should play a central role in this process.**

7.7 The resource allocation committee (RFK)

KPI	STATUS
Sigma2 has produced a mandate for the RFK	A public mandate is available
The RFK has a balanced composition with respect to central research areas, geographical location and gender	The composition of the RFK is balanced
An appropriate fraction of the allocated resources are also used	The overall usage of allocated resources is appropriate

The work of the research allocation committee has been assessed based on the interviews with the current and former chairs of the RFK, material providing statistics on grants divided into different scientific subfields, the RFK’s annual reports to the board of UNINETT Sigma2 which provide statistics on the various grants, the degree of user satisfaction and statistics on the number of publications that acknowledge the support of the facilities provided by Sigma2 and the ranking of these publications in the Norwegian classification system. The evaluation does not include input from groups that have not been successful in obtaining funding for computing or advanced user support.

According to the information obtained from all the available sources, the work of the RFK is considered to be objective and fair, based on good scientific standards and in compliance with the guidelines defined by the board of Sigma2. The composition of the RFK has been updated continuously to include experts within emerging fields of HPC, including the humanities and life sciences, and it has thus not been dominated by experts within the fields of physics and chemistry which were the first users of HPC. It is also evident from the list of the current RFK that gender balance has been considered in the selection of the committee members, without sacrificing the requirement that the members of the RFK are renowned scientists.

For allocations of computational resources, the ratio between the number of granted and requested CPU hours is rather high, and the RFK has been in the fortunate position to have generally been able to support applications containing original science together with reasonable requests for CPU time and/or support. When the total use of the computational resources is divided into the different scientific disciplines, differences can be observed between Norway and many other European countries. In particular, the fields that dominated the early use of HPC, chemistry, physics and engineering, have a larger share of the total use in Norway than in many other countries, whereas the life sciences have a smaller share of the resource in Norway. As a large fraction of the requested resources have been granted, these differences are probably due to differences between

Norway and other countries in the relative prominence of different research fields, rather than a bias on the part of the RFK.

With respect to the impartiality of the RFK, there are no obvious reasons for concern, but there are some points that are worth addressing. As in any other small country, there are a number of very competent researchers who play a role in the organisation of HPC at the national level and at the same time are major recipients of resources in the form of allocations of computer time, storage and user support. It is the committee's understanding that applications from these groups are treated in the same way as all other applications, with due consideration given to RFK members' conflicts of interests and that the RCN procedures for handling potential conflicts of interests are used. However, in other countries, such applications are often sent for international evaluation to ensure a completely impartial evaluation and to eliminate any potential for criticism.

With respect to advanced user support, the evaluation committee is aware that the number of applications with excellent scientific and management plans has been rather limited, and that the use of this resource has been less than the RFK and Sigma2 had hoped for. A single advanced user support project uses about half of the resources allocated to advanced user support. As most other requests for advanced user support have also been granted, this large allocation, however, does not seem to have affected other applications.

- **Recommendation RFK-1: The RFK should consider making more use of international evaluations, in particular for applications for large amounts of computer or personnel resources.**
- **Recommendation RFK-2: Sigma2 should take further action to develop and provide information about the advanced user support programme. The metacentre sites should play a central role in this process.**

7.8 User satisfaction

KPI (ON THE BASIS OF THE USER SURVEYS, SCALE 1-6)	STATUS (2018)
User satisfaction for storage services > 4.5	4.9
User satisfaction for computing services > 4.5	4.9
User satisfaction for user support > 4.5	5.1
User satisfaction for documentation > 4.5	4.6
Number of users participating in training within the Sigma2 metacentre	Not evaluated (information not available)
Average resolution time for issues submitted to the Sigma2 helpdesk	13 hours – Seems appropriate but the KPI may not be very relevant

The self-evaluation indicates that the documentation on the different services was not satisfactory in the beginning of the evaluation period but that progress has been made and that the goals are now being met. This is generally a good development. General user satisfaction can be summed up as being rather high and increasing over the years with an average score of 5.07 in 2017 (scores ranging from 1-6) which generally seems very satisfactory.

The user questionnaires indicate that the importance of commercial software has decreased over the evaluation period whereas the importance of self-developed software is increasing. This can be considered a positive sign where users are more satisfied with the facilities and training provided by Sigma2.

With respect to training, users generally request more specialist training for new users as well as training in specific research software tools and packages and specific programming languages. Furthermore, it appears that CPU and memory-intensive simulations have become less important over the years in relation to data intensive computing. The availability of computing resources and reliability, and high overall processing speed are by far the most important requirements.

An additional user survey performed in 2019 on the initiative of the evaluation committee generally reports high satisfaction from primary users who refer to excellent facilities and good support.

Fairly extensive material consisting of the three user surveys during the period has been provided to evaluate Sigma2 user satisfaction (2015, 2016 and 2017). In general, as summed up in the 2017 user survey, there is greatest satisfaction with the

quality of support provided by the technical staff and the response time to queries and problems, indicating that the users are in general satisfied with the user support provided. The user surveys indicate that the survey respondents overall are very satisfied with the Sigma2 user support, both in terms of services provided to project managers as well as regular users. The additional user survey from 2019 underlines this attitude. It is clear that the main responsibility for user support lies with the Sigma2 metacentre sites, and their competent staff should be commended for their efforts in this area.

However, it appears that the information and documentation Sigma2 provides on its website and other sources could still be further improved, and that information could be better disseminated, particularly to potential new users. More responsibility could be given to the metacentre sites in this respect, since they are closest to the research communities.

To what extent the user requirements mentioned above can be fully met by Sigma2 in future remains to be seen. Broadly covering software development and training needs is very demanding in a rapidly shifting domain, and where the data landscape is also changing very fast.

Furthermore, as indicated in the 2019 user survey, current non-users of Sigma2 are generally remarkably unaware of the possibilities provided by the Sigma2 e-infrastructure.

7.9 Support for other research infrastructures

Sigma2 has been aware of several ESFRI and other research infrastructures, and meetings have been held between the metacentre sites and the participants in these initiatives. However, these efforts appear to lack direction and coordination. One of the reasons for this is a lack of coordinated strategic direction from the universities in the Sigma2 consortium, the RCN and the Sigma2 board. Another reason seems to reflect one of the weaknesses in the current organisation of Sigma2, where most of the personnel are located at the metacentre sites which operate as rather independent units. As the sites employ a substantial staff, they have the volume and economy needed to carry out such efforts on behalf of Sigma2.

- **Recommendation-Research-Infrastructures-1:** Sigma2 should, based on strategic decisions by the Sigma2 board and Norwegian research institutions, develop a strategy for supporting national research infrastructures and Norwegian participation in international research infrastructures by providing generic e-infrastructure for computing and data storage. The metacentre sites should play an important role in the implementation of this strategy.

7.10 Relevance of Sigma2 services in education

In this section we analyse how Sigma2 services have supported education at the participating universities. Since no statistics or questionnaires have been conducted to shed light on this aspect, all interviewed groups were asked questions regarding their views on Sigma2 services in education in order to analyse the challenges and prospects in this area.

Generally speaking, it has not been regarded as Sigma2's responsibility to ensure use of the services in education, although, according to Sigma2's own self-evaluation, it has been possible from the start to apply the e-infrastructure in teaching.

It has become clear from the interviews that there is no consensus within the Sigma2 metacentre regarding the importance of this issue. The metacentre sites report in particular that they are interested in and have always supported good contact with the education communities, but they find that this contact has not been supported, prioritised or even approved to a significant extent by the Sigma2 management and board.

The Sigma2 e-infrastructure has yet to formally support education activities to a considerable extent. Sigma2 has not had a responsibility to promote Sigma2 services to the wider education community, this is instead the responsibility of each site. However, it seems that the local strategies for leveraging the national e-infrastructure should be clearer on this point. The Sigma2 metacentre sites have tried to help researchers who wanted to use the Sigma2 infrastructure as part of their education activities, but Sigma2 does not provide a dedicated programme, and it could encourage the metacentre sites more in this enterprise.

From a future perspective, ensuring that coming generations of researchers are well educated in the use of e-infrastructure as an integral part of their career will be essential. It is to be expected that general awareness of e-infrastructures will increase and that teachers will soon demand such education-related access to Sigma2.

- **Recommendation-Education-1:** The metacentre sites should be mandated on behalf of Sigma2 to become actively involved in education activities in a way that enables easy and flexible procedures to be established for introducing e-infrastructure services in relevant study programmes.

7.11 Operations

KPI	STATUS (2018)
Average service availability > 95%	Availability has been > 95% (in general >> 95%)
Average utilisation of the computational resources	85%
Average utilisation of the storage resources	81%
Average time to resolve malfunctions	Not evaluated – not very relevant given the high availability
PUE for the computer facilities	=< 1.4 (lower in new facilities)
Operating cost per core-hour for the computational services	0.07
Operating cost per TiB/year for the storage services	1090

In the period 2015-2018, all the HPC installations (Abel, Hexagon, Stallo, Vilje and Fram) have been accessible more than 95% of the time and the target accessibility has therefore been met. A more detailed look at the individual installations and time-periods reveals that the availability of the HPC resources in general has been about 99% or more, with a few exceptions: Vilje in 2015 had an availability of 97.6%, Abel had an availability of 95.6% in 2018, and Fram had an availability of 96.6% in the same year. All in all, the systems have been very stable, and a major part of the downtime has been in connection with either the initial or final phase of an installation. It is clear that the operation of the Sigma2 resources is highly professional and performed by highly competent staff at the metacentre sites.

The storage facilities have had an availability of 99% or more with the exception of 2016 where the availability was only 95.55%. The latter figure is too low for a well-running storage facility, but the problems that may have caused the downtime have been eliminated.

Total usage of the installations has fluctuated between 84 and 89%, which results in a good compromise between accessibility and efficiency: a much greater usage would lead to long queue-times especially for jobs requiring many cores and a much smaller usage would obviously indicate unused resources. The usage of storage facilities increased from 35% of the total capacity in 2015 to 81% in 2018. A significant increase in the storage capacity is either required imminently or has already been realised.

Although it is difficult to compare the operating costs at different local and national facilities, as differences in hardware, maintenance and service level may vary, the reported operating costs of NOK 0.07 per executed core-hour and NOK 1,090 per TB storage year may be considered competitive for a medium-sized national installation with excellent availability and reliability.

The housing PUE over the years for Abel and Hexagon has been 1.3 and 1.4, respectively, which must be considered good. Furthermore, the housing PUE for Stallo and Vilje has been 1.15 and 1.01, which is extremely good, and among the very best in an international scale. The new Fram installation is reusing some of the heating, which leads to a PUE of 0.66 when this reuse is taken into account and 1.26 without including the reuse.

7.12 Participation in international activities and initiatives

KPI	STATUS
Fraction of the H2020 applications with Sigma2 participation that have been graded above the threshold	100%
Cost/benefit of services that are provided via international collaboration	Not evaluated in detail, but the services complement the national services
User satisfaction with the international services	Not evaluated, no data available

Sigma2 has carefully chosen to participate in a few H2020 projects, linked to the initiatives PRACE, EUDAT and EOSCHub, which can be deemed to provide additional value to Norwegian researchers and where Sigma2 can contribute to developments at the European level.

Sigma2 staff and staff from the metacentre sites have actively participated in and followed up the e-infrastructure development activities in NeIC. The Sigma2 management is also represented on the NeIC Board. NeIC also delivers services to the Nordic WLCG Tier-1 (CERN) collaboration, but the Norwegian part of this activity is not managed or operated by Sigma2.

Recently, NeIC submitted and was awarded a grant for the project “ESOC-Nordic”, where Sigma2 is one of the consortium members. The project aims to foster and advance the take-up of the EOSC at the Nordic level by coordinating the EOSC-relevant initiatives taking place in Finland, Sweden, Norway, Denmark, Iceland, Estonia, Latvia, Lithuania, Netherlands and Germany. This project has the potential to be a very important entry point for Sigma2 and Norwegian research to the rapidly growing ESOC efforts.

Sigma2 facilitates the use of PRACE for Norwegian researchers, and several Norwegian researchers have been granted PRACE allocations in cases where the national Sigma2 resources have not been sufficient. The allocations on national resources and the PRACE resources are to a great extent complementary. Sigma2 has also contributed to the development of EUDAT CDI (EUDAT Collaborative Data Infrastructure), which can be assumed to be an important player in the emerging development of EOSC.

8. Concluding remarks

The evaluation committee wishes to express a big thanks to the participants in the interviews for providing clear answers to the questions and being willing to take part in open and clarifying discussions. The committee also thanks the Sigma2 management for gathering and providing a significant amount of background material, including the self-evaluation, and for responding to follow-up questions on this material. Finally, the committee would like to thank Ulrike Jaekel and other staff at the RCN for excellent secretarial support, including detailed internal notes from all the meetings, and for organising the practical arrangements in connection with the committee's work.

As a final comment, the committee notes that the mandate for the evaluation can be seen as unusually detailed. This structured approach has helped the committee during its work on the evaluation and also when preparing the report. However, a very detailed mandate could potentially also lead to important observations being left out since they are perceived as inappropriate to the mandate. One way of handling this would be to also include more open-ended questions/points in the mandate. Furthermore, a detailed mandate prepared a long time before the evaluation is conducted could pick out details which, though relevant at the time of the mandate's preparation, may have changed meaning or even appear to have been selected in an ad-hoc manner at the time of evaluation.

Annex 1 : Mandate

Mandat for evaluering av UNINETT Sigma2 AS

05.07.2017

Formålet med evalueringen av UNINETT Sigma2 AS (Sigma2) er todelt:

Primært skal evalueringen gi Forskningsrådet og de fire universitetene UiB, UiO, NTNU og UIT – Norges arktiske universitet en uavhengig vurdering av virksomheten til Sigma2 i forhold til effektivitet, effekt, resultater og måloppnåelse. Dette vil gi de fem organisasjonene grunnlag for å vurdere finansiering og organisering av nasjonal e-infrastruktur for forskning og høyere utdanning for perioden 1.1.2025 – 31.12.2029.

Sekundært skal evalueringen gi Sigma2 grunnlag for å levere bedre tjenester og styrke sin posisjon som nasjonal leverandør av e-infrastruktur tjenester og deltager i det nordiske og europeiske samarbeidet om e-infrastruktur for forskning.

Evalueringsutvalgets oppgaver

Vi ber evalueringsutvalget om å evaluere punktene som er listet under. Evalueringsutvalget bes i tillegg om å gi en oppsummering av områder hvor Sigma2 bør forbedre eller endre sin virksomhet.

Utvalget skal gi selvstendige kvalitative vurderinger på alle vurderingspunktene. For noen av punktene er det i tillegg angitt indikatorer for måloppnåelse, og i enkelte tilfeller også måltall for disse. Indikatorne dekker ikke alene de punktene utvalget er bedt om å evaluere, og det er ikke ønskelig at alle punktene evalueres ved bruk av indikatorer. Det er ønskelig at evalueringsutvalget kvalitativt vurderer situasjonen i Norge opp mot sammenlignbare land i Norden og Europa i den grad dette lar seg gjøre.

Økonomi

Det skal vurderes:

- om inntektene til Sigma2 fra Forskningsrådet og de deltagende universitetene er i samsvar med planene som ble lagt ved etablering av selskapet (jamfør tall skissert i [6] og [7]).
- hvordan utviklingen av andre inntekter (brukerbetaling/salg, prosjektinntekter, konkurranseutsatt finansiering) har vært
- hvordan innføring av brukerbetaling har påvirket brukeratferd og etterspørsel av tjenestene
- i hvilken grad brukerbetaling har bidratt til å øke finansieringsgrunnlaget til Sigma2
- i hvilken grad innføring av brukerbetaling har bidratt til god bruk av e-infrastrukturen
- om de totale inntektene er på et fornuftig nivå i forhold til å dekke nåværende og antatt fremtidige behov
- om langsiktig finansiering har ført til gode investeringer og styring av virksomheten
- om fordeling av tilgjengelige midler på de ulike aktivitetene (beregningstjenester, lagringstjenester, basis brukerstøtte og avansert brukerstøtte) er hensiktsmessig
- om virksomheten drives slik at den er økonomisk bærekraftig på kort og lang sikt

Indikatorer for måloppnåelse:

- Minimum 30 % av inntektene til Sigma2 kommer fra konkurranseutsatt finansiering, brukerbetaling/salg og prosjektinntekter, målt som et snitt over evalueringsperioden
- Egenkapitalen skal ikke være mer enn 25 % av årsomsetningen, målt som et snitt over evalueringsperioden

Organisering

Det skal vurderes i hvilken grad

- organisering av nasjonal e-infrastruktur gjennom et selskap har gitt de resultatene som var ønskelig ved opprettelsen av selskapet (jamfør dokumenter under listet under

”Underlagsmateriale for opprettelsen av UNINETT Sigma2 AS”) og fremdeles vurderes som hensiktsmessig for neste periode

- organisering og fordeling av arbeidet mellom Sigma2 og de deltagende universitetene er hensiktsmessig
- avtaleverket som regulerer samhandlingen mellom universitetene og selskapet har fungert etter hensikten, eller om det bør gjennomføres en justering

Styring og ledelse

Det skal vurderes i hvilken grad Sigma2

- har formålstjenlige strategiske planer for sin virksomhet og fulgt opp disse
- har fattet beslutninger om investeringer og drift i tråd med mål og strategier
- har basert prosjektarbeidet på etablert metodikk
- benytter relevant metodikk for kvalitetssikring av drift og tjenesteleveranser
- har tilgang på nødvendig kompetanse, internt og gjennom avtalene med universitetene og har en strategi for å sikre tilgang til kompetanse for å møte fremtidige behov

Evalueringsutvalget bes også om å vurdere samarbeidet mellom administrasjon og styret for Sigma2, herunder hvordan styret har utført sitt arbeid og dekket lovpålagte oppgaver.

Indikatorer for måloppnåelse:

- Sigma2 har utarbeidet og vedlikeholder en strategi for sitt arbeid, inkludert strategiske planer fremover rundt brukernes behov for fremtidige arkitekturer for HPC
- Sigma2 har implementert en prosjektmetodikk
- Sigma2 har utviklet metodikk for kvalitetssikring av drift og tjenesteleveranser Sigma2 har utviklet en kompetansestrategi og benytter denne aktivt i samarbeidet med universitetene

Kontakt med interessentene

Det skal vurderes i hvilken grad Sigma2 har evnet å forankre sitt arbeid hos

- ledelse og IT-organisasjoner ved de deltagende universitetene
- brukergrupper
- Norges forskningsråd
- Virksomheter som er kandidater til å bli med i samarbeidet

Indikatorer for måloppnåelse:

- Gjennomført kundemøter med universitetene i henhold til avtale
- Gjennomført et årlig avtalefestet oppfølgingsmøte med Forskningsrådet
- Gjennomført brukermøter slik at sentrale fagområder og institusjoner er godt dekket i perioden evalueringen omfatter og for å sikre at fremtidige brukerbehov blir kartlagt sammen med brukermiljøene
- Gjennomført egne møter med virksomheter som er kandidater til å bli med i samarbeidet, spesifikt NMBU og UiS.

Investeringer og kjøp av tjenester

Det skal vurderes i hvilken grad investeringer og kjøp av tjenester

- har vært forankret i investeringsplaner som er basert på behovs- og markedsanalyser
- har gitt god verdi for pengene
- har vært rett dimensjonert og dekket nasjonale behovene som lå til grunn for anskaffelsene - både isolert og samlet for alle anskaffelsene som er gjort i perioden (analyse av søkt/ etterspurte tjenester sammenlignet med tildelte tjenester)

Indikatorer for måloppnåelse:

- Sigma2 har gjennomført markedsanalyser og behovsanalyser
- Sigma2 har utarbeidet investeringsplaner basert på markeds- og behovsanalysene og fulgt disse ved anskaffelser
- Enhetskostnader og energieffektivitet for anskaffelsene (målt mot tall fra markedsanalyser)

Tilgjengelighet av infrastruktur og data

Det skal vurderes i hvilken grad

Sigma2 følger beste praksis for tilgang til forskningsinfrastrukturer, jamfør det europeiske Charter for Access to Research Infrastructures.

Sigma2 legger til rette for at prinsipper og retningslinjer i Forskningsrådets policy for tilgjengeliggjøring av forskningsdata følges

Sigma2 har etablert en datahåndteringsplan hvor det fremgår i) hvordan dataene som er lagret og arkivert på infrastrukturen sikres, tilgjengeliggjøres og vedlikeholdes og ii) rettigheter til databaser og eventuelle restriksjoner på aksess og bruk av data.

Indikatorer for måloppnåelse:

- Prinsipper og betingelser for bruk av Sigma2 sine tjenester er transparente
- Sigma2 har en data policy og en datahåndteringsplan

Ressursfordelingskomiteen

Det skal vurderes i hvilken grad

- mandat og retningslinjer er fulgt opp av komiteen
- mandatet og retningslinjene bidrar til effektiv, transparent og vitenskapelig basert fordeling av ressurser
- komiteens sammensetning er hensiktsmessig
- komiteen har evnet å velge ut de beste prosjektene, herunder kvaliteten på seleksjon av avanserte brukerstøtteprosjekter

Indikatorer for måloppnåelse:

- Sigma2 har utarbeidet et mandat for komiteens arbeid
- Komiteen har representanter fra de sentrale fagområdene, god geografisk spredning og kjønnsbalanse
- Andel av tildelte ressurser som ble benyttet.

Brukertilfredshet

Det skal vurderes i hvilken grad brukerne i den primære brukergruppen er tilfreds med:

- Tjenestene innenfor beregninger, lagring, avansert brukerstøtte, opplæring og helpdesk
- Mekanismene for fordeling av ressurser
- Sigma2 sin evne til å tilby helhetlige tjenester, det vil si om brukerne får alle e-infrastruktur tjenester de har behov for fra Sigma2 (egenproduserte eller innkjøpte), eller om de også må finne andre løsninger
- Sigma2 sin evne til å kartlegge nye behov hos eksisterende brukerne og behov hos nye brukerne og utvikle tjenester basert på dette
- prosjektene innen avansert brukerstøtte har ført til mer effektiv bruk av e-infrastruktur i forskergruppene som har deltatt i prosjektene (effektivisering av programvare, nye muligheter innen forskningen, mer effektiv arbeidsform for forskerne)

Det er ønskelig å se på trender i brukertilfredsheten samt status på evalueringstidspunktet.

Det er også ønskelig å se på i hvilken grad det er forskningsmiljøer som velger ikke å benytte de nasjonale ressursene, men i stedet satser på andre løsninger.

Indikatorer for måloppnåelse basert på brukerundersøkelsen (hvor 1 = svært dårlig og 6 = utmerket):

- Gjennomsnittlig brukertilfredshet med lagringsløsninger. Måltall: > 4.5
- Gjennomsnittlig brukertilfredshet med beregningsløsning. Måltall: > 4.5
- Gjennomsnittlig brukertilfredshet med brukerstøtte. Måltall: > 4.5
- Gjennomsnittlig brukertilfredshet med informasjon og dokumentasjon. Måltall: > 4.5
- Antall brukere som har deltatt på kurs i regi av Sigma2 og universitetene.
- Gjennomsnittlig tid for løsning av henvendelser til helpdesk.

Støtte til forskningsinfrastrukturer

Det skal vurderes i hvilken grad Sigma2 har etablert samarbeid med og dekket behov for e-infrastruktur hos

- forskningsinfrastrukturer finansiert gjennom Nasjonal satsing på forskningsinfrastruktur
- ESFRI-prosjekter hvor Norge har en sentral rolle (vertskap eller nasjonal node)

Tjenestenes relevans for utdanning

Det skal vurderes hvilken grad

- tjenestene fra Sigma2 har støttet opp om utdanning ved de deltagende universitetene, der dette måtte være relevant.

Drift

Kvaliteten av driften skal vurderes ut fra

- Tilgjengelighet av tjenestene
- Utnyttelsesgrad for anleggene
- Driftskostnad (inkluderer housing, systemdrift og basis brukerstøtte)
- Kvalitetsparametere som er angitt i leveranseavtaler og serviceavtaler for anleggene

Det er ønskelig å se på trender i utviklingen av driftskvalitet og driftsøkonomi samt status på evalueringstidspunktet.

Indikatorer for måloppnåelse:

- Gjennomsnittlig tilgjengelighet for tjenestene. Måltall: > 95 % av tiden
- Gjennomsnittlig utnyttelsesgrad for beregningstjenestene
- Gjennomsnittlig utnyttelsesgrad for lagringstjenestene
- Gjennomsnittlig feilrettingstid.
- Power Usage Effektivens (PUE) for datahallene som benyttes.
- Driftskostnad per levert kjernetime.
- Driftskostnad per levert TiB per år.

Internasjonal virksomhet

Følgende punkter skal vurderes:

- Sigma2 sin deltagelse i Horisont 2020 prosjekter og antall søknader som har kommet over threshold
- Sigma2 sin oppfølging av NeIC og i hvilken grad tjenestene fra NeIC dekker behov hos norske brukermiljøer
- I hvilken grad Sigma2 leverer tjenester til og tilbyr norske brukere tjenester fra det europeiske e-infrastruktur landskapet (f.eks. PRACE, EGI, EUDAT) og i hvilken grad tjenester fra de europeiske leverandørene dekker behov hos norske brukere.
- I hvilken grad de nordiske og europeiske tjenestene og tjenestene fra Sigma2 kompletterer hverandre

Indikatorer på måloppnåelse:

- Andelen av Horisont 2020 søknader med deltagelse fra Sigma2 som kommer over threshold.
- Kost/nytte av tjenestene som tilbys gjennom internasjonalt samarbeid.
- Gjennomsnittlig brukertilfredshet med de internasjonale tjenestene. Måltall: > 4.5 (må måles gjennom Sigma2 sin brukerundersøkelse (1 = svært dårlig og 6 = utmerket))

Underlagsmateriale for evalueringen

Kontrakter og avtaler

1. Vedtekter for Sigma2
2. Kontrakter mellom Sigma2 og Forskningsrådet
3. Samarbeidsavtale mellom Sigma2, NTNU, UiB, UiO og UiT Norges arktiske universitet om nasjonal e-infrastruktur
4. Leveranseavtaler mellom Sigma2 og underleverandører, herunder leveranseavtaler med universitetene om drift av anlegg og avansert brukerstøtte

Underlagsmateriale for opprettelsen av UNINETT Sigma2 AS

5. Referat fra møte mellom rektorene ved NTNU, UiB, UiO og UiT 20.11.2013
6. Beskrivelse av ny organisasjon for e-infrastruktur for forskning og høyere utdanning, utarbeidet av arbeidsgruppe med medlemmer fra NTNU, UiB, UiO, UiT og Forskningsrådet, 06.11.2013
7. Finansiering og organisering av nasjonal e-infrastruktur for forskning og høyere utdanning, rapport fra Dæhlen-utvalget, 14.05.2012.

Strategier og planer

8. Sigma2 sin strategi
9. Sigma2 sine strategiske planer fremover

Bruks- og driftsstatistikk

10. Statistikk over søknadsvolum og bruk av ressursene i perioden 1.1.2015 – 30.6.2018. Statistikken skal inneholde søknadsvolum til RFK, innvilgelsesprosenter, utnyttelse av tildelte ressurser, fordeling på fagområder og institusjoner og trender bruksmønsteret.
11. Statistikk over tilgjengelighet og utnyttelse av anleggene

Egenvurdering

12. Sigma2 vil bli bedt om å gjøre en egenvurdering. Mal med spørsmål til bruk i egenvurderingen vil bli utarbeidet av oppdragsgiverne i samarbeid med evalueringsutvalget.

Intervjuer

13. Evalueringsutvalget skal gjennomføre intervjuer med ledelse og styret i Sigma2 og representanter for oppdragsgiverne.
14. Evalueringsutvalget kan gjennomføre intervjuer med ressursfordelingskomiteen og brukere.
15. Evalueringsutvalget kan gjennomføre intervjuer med forskere som har behov for tjenester innen e-infrastruktur, men ikke fikk tilgang til tjenestene, ikke får dekket sine behov gjennom Sigma2, eller velger å benytte andre tjenester.

Brukerundersøkelser

16. Årlige brukerundersøkelser utført av Sigma2

Årsrapporter

17. Årsrapporter fra Sigma2
18. Årlig rapportering fra Sigma2 til Forskningsrådet.
19. Årlig rapportering fra ressursfordelingskomiteen.

VISION AND GOALS OF UNINETT SIGMA2

The vision of Sigma2 is to provide a permanent, predictable and cost-efficient e-infrastructure with access based on scientific quality in order to maximize the impact and return of scientific research.

Cost efficient development, procurement, coordination and operation of the national e-infrastructure for research and education is the main focus for Sigma2.

The main goals for the company's core service activities are:

- Procure, operate and develop a critical national infrastructure
- Promote e-infrastructure to new research communities
- Lead and coordinate participation in international cooperation within the e-infrastructure area
- Provide an attractive and sustainable e-infrastructure for all research communities, with the following characteristics:
 - High reliability and availability
 - Cost effectiveness
 - Predictable access
 - Interoperability within the national e-infrastructure (Notur/NorStore) and between national and international infrastructures (e.g. PRACE, EUDAT)
- Provide joint HPC and Big Data applications

In order to fulfil vision and goals the focus will be on development and delivery of effective, relevant and user-focused services. This requires a thorough understanding of the user needs which will be achieved by a proactive collaboration with the different user communities and Research Infrastructures (RI).

Annex 2: The evaluation committee

Sverker Holmgren is a professor of Scientific Computing at Uppsala University (UU), Sweden, where he is head of the Computational Science research programme. At UU, he is currently a member of the UU Council for Research Infrastructure and head of a project on UU support for research data management. He has previously held the office of chair of the European e-Infrastructure Reflection Group (e-IRG) for four years. Holmgren also held the office of Director of the Swedish National Infrastructure for Computing (SNIC) for six years, and, prior to this, he was Director of the UU computing centre UPPMAX for five years. He has served as the Dean of Mathematics and Computer Science at UU for six years.

Bolette Sandford Pedersen is a professor of Language Technology at the University of Copenhagen, Denmark, where she is head of the Centre for Language Technology. She is deputy head of the Department of Nordic Studies and Linguistics, and a member of the Digital Humanities Strategic Board at the Faculty of Humanities. As part of her research on language resources for technology, she participates in the activities of CLARIN – the European Research Infrastructure for Language Resources and Technology.

Jeppe Olsen is a professor of Chemistry at the University of Aarhus. His research focuses on the development and application of methods and algorithms for describing the electronic structure of atoms, molecules and nano-structures. He has published more than 200 papers and co-authored a textbook on electronic structure theory. For his research, Jeppe Olsen has used computers in all Scandinavian countries, as well state-of-the-art computers in the USA. Jeppe Olsen has been involved in the organisation of computer facilities in Denmark for several decades and has also been a member of numerous boards and committees tasked with evaluating proposals for and performance of research infrastructures in Europe and USA.

Annex 3: List of activities during the evaluation

A3.1 List of interviews conducted by the Sigma2 evaluation committee

1. The former and current chairs of the Sigma2 RFK
2. The Sigma2 board of directors
3. The Sigma2 administration
4. The Sigma2 managing director
5. Representatives of the Sigma2 metacentre sites at UiB, NTNU, UiO and UiT
6. Representatives of the top-level management of the four funding universities and the RCN
7. Online survey for Sigma2 users and non-users

The evaluation committee made a set of questions available to each interviewee approximately one week before the interview took place. During the interviews, there was a fairly informal atmosphere between the evaluation committee and the interviewees. The evaluation committee encouraged the interviewees to raise any other relevant issues or concerns that were not included in the discussion of the set of questions. The minutes of each interview were only used by the evaluation committee and were not further distributed, including to the interviewees. This was done to maintain a degree of confidentiality in relation to the content discussed between the interviewees and the evaluation committee. To ensure that all the interviewees were given an opportunity to correct any possible misunderstandings that may have occurred during the interviews, a draft of the evaluation report was sent to all the interviewees for a fact-check.

1. Interview by the Sigma2 evaluation committee with the former and current Sigma2 RFK chair

Date: 22 January 2019, from 13:30 – 15:00.

Place: Research Council of Norway (RCN), Drammensveien 288, Lysaker, Norway.

Present:

<i>Knut Børve</i>	(University of Bergen; the former RFK chair)
<i>Lex Nederbragt</i>	(University of Oslo; the current RFK chair)
<i>Sverker Holmgren</i>	(Uppsala University; chair of evaluation committee)
<i>Bolette Sandford Pedersen</i>	(Copenhagen University; evaluation committee)
<i>Jeppe Olsen</i>	(Aarhus University; evaluation committee)
<i>Ulrike Jaekel</i>	(RCN; evaluation committee secretary)

2. Interview by the Sigma2 evaluation committee with the Sigma2 board of directors

Date: 14 March 2019, from 09:00 – 11:00.

Place: Radisson Blue Airport Hotel Oslo Gardermoen.

Present:

<i>Tom Are Røtting</i>	(UNINETT; chairman of the Sigma2 board)
<i>Kenneth Ruud</i>	(UiT; Sigma2 board member)
<i>Terse Løvås/Skype</i>	(NTNU; Sigma2 board member)
<i>Nathalie Reuter/Skype</i>	(UiB; Sigma2 board member)
<i>Øyvind Hennestad</i>	(SINTEF; external board member)
<i>Sverker Holmgren</i>	(Uppsala University; chair of evaluation committee)
<i>Bolette Sandford Pedersen</i>	(Copenhagen University; evaluation committee)
<i>Jeppe Olsen</i>	(Aarhus University; evaluation committee)
<i>Helene Aaneruud</i>	(RCN; secretarial support)
<i>Ulrike Jaekel</i>	(RCN; evaluation committee secretary)

3. Interview by the Sigma2 evaluation committee with the Sigma2 administration

Date: 14 March 2019, from 11:00 – 13:00.

Place: Radisson Blue Airport Hotel Oslo Gardermoen.

Present:

<i>Maria Francesca Iozzi</i>	(Sigma2; Data storage and Service platform)
<i>Hans Eide</i>	(Sigma2; Advanced User Support)
<i>Jørn Aslak Amundsen</i>	(Sigma2; HPC services)
<i>Sverker Holmgren</i>	(Uppsala University; chair of the evaluation committee)
<i>Bolette Sandford Pedersen</i>	(Copenhagen University; evaluation committee)
<i>Jeppe Olsen</i>	(Aarhus University; evaluation committee)
<i>Helene Aaneruud</i>	(RCN; secretarial support)
<i>Ulrike Jaekel</i>	(RCN; evaluation committees secretary)

4. Interview by the Sigma2 evaluation committee with the Sigma2 managing director

Date: 14 March 2019, from 16:00 – 17:30.

Place: Radisson Blue Airport Hotel Oslo Gardermoen.

Present:

<i>Gunnar Bøe</i>	(Sigma2; managing director)
<i>Sverker Holmgren</i>	(Uppsala University; chair of the evaluation committee)
<i>Bolette Sandford Pedersen</i>	(Copenhagen University; evaluation committee)
<i>Jeppe Olsen</i>	(Aarhus University; evaluation committee)
<i>Helene Aaneruud</i>	(RCN; secretarial support)
<i>Ulrike Jaekel</i>	(RCN; evaluation committees secretary)

5. Interview by the Sigma2 evaluation committee with representatives of the Sigma2 metacentre sites at UiB, NTNU, UiO and UiT

Date: 11 April 2019, from 12:00 – 14:00.

Place: The Research Council of Norway, Drammensveien 288, Lysaker, Norway.

Present:

<i>Roy Dragseth</i>	(UiT)
<i>Arne Dag Fidjestøl</i>	(NTNU)
<i>Einar Næss Jensen</i>	(NTNU)
<i>Csaba Anderlik</i>	(UiB)
<i>Lorand Janos Szentannai</i>	(UiB)
<i>Gard Sundby Thomassen</i>	(UiO)
<i>Jon K. Nilsen</i>	(UiO).
<i>Sverker Holmgren</i>	(Uppsala University; chair of the evaluation committee)
<i>Bolette Sandford Pedersen</i>	(Copenhagen University; evaluation committee)
<i>Jeppe Olsen</i>	(Aarhus University; evaluation committee)
<i>Ulrike Jaekel</i>	(RCN; evaluation committee secretary)

6. Interview by the Sigma2 evaluation committee with representatives of the top-level management of the four funding universities and the RCN

Date: 29 May 2019, 08:45 – 15:00; the interviews were conducted per organisation.

Place: The Research Council of Norway, Drammensveien 288, Lysaker, Norway.

Present:

<i>Solveig Flock</i>	(RCN)
<i>Helge Dahle</i>	(UiB)
<i>Tore Burheim</i>	(UiB)
<i>Jan Walde Johnsen</i>	(UiB)
<i>Anne Borg</i>	(NTNU)
<i>Svein Stølen</i>	(UiO)
<i>Stig Ørsje</i>	(UiT)
<i>Sverker Holmgren</i>	(Uppsala University; chair of the evaluation committee)
<i>Bolette Sandford Pedersen</i>	(Copenhagen University; evaluation committee)
<i>Jeppe Olsen</i>	(Aarhus University; evaluation committee)
<i>Helene Aaneruud</i>	(RCN; secretarial support)
<i>Ulrike Jaekel</i>	(RCN; evaluation committees secretary)

A3.2 Online survey for Sigma2 users and non-users

An online survey was distributed by email to over 500 recipients, including all Norwegian universities and colleges, research infrastructures which had previously applied to the FORINFRA funding scheme, the centres of excellence, centres for research-driven innovation, the Sigma2 metacentre sites and all Sigma2 users.

The survey received 110 responses in the period from 10 April – 17 May 2019.

The online survey was hosted on the RCN website and consisted of the following questions:

Question 1: What is your background?

- Name, institution, position
- Please identify your field of research:
 - Biology and biomedical sciences
 - Humanities and social sciences (please specify)
 - Physics
 - Chemistry
 - Material science
 - Geosciences

- Mathematics
- Informatics
- Engineering
- Other (please specify):

Question 2: In your research, which type of e-infrastructure services do you mainly rely on or need (multiple answers possible)

- High-Performance Computing (HPC)
- Large-scale data storage
- Other services (please specify):

Question 3. Do you use e-infrastructure services provided by UNINETT Sigma2 today?

Yes/No

2.A: If Yes: In your view, what is the benefit of using UNINETT Sigma2? (100 words)

2.B: If No: In your view, could UNINETT Sigma2 improve their services such that you would become a user of them? In what way would they have to improve their services? (100 words)

Annex 4: The INFRASTRUKTUR financing initiative

Since 2009, the RCN has had a dedicated national financing initiative for research infrastructure (INFRASTRUKTUR). The initiative is funded by the Ministry of Education and Research with the aim of providing Norwegian researchers and students with access to the infrastructure required to carry out research of high international quality, achieve a high degree of institutional cooperation and national task distribution, expand international cooperation and ensure open access to the use and reuse of research data. The RCN is mandated to make decisions regarding investments in research infrastructure of national importance that fulfil the following criteria:

- The infrastructure is of broad national interest
- The infrastructure will be available in only one or a few locations in Norway
- The infrastructure lays a foundation for internationally cutting-edge research
- The infrastructure will be made accessible to relevant researchers and industries

Furthermore, Norway takes part in over 30 European collaborations on research infrastructure and pays annual membership fees to use these facilities. Decisions regarding international research cooperation involving major, long-term commitments in the form of investments and membership dues are taken at the ministerial level.

Funding for national research facilities involving investments that exceed NOK 200 million will be dealt with at the ministerial

or government level, in many cases after consultation with the Research Council. The INFRASTRUKTUR initiative primarily targets the renewal of Norwegian research infrastructure. The RCN has a restrictive policy concerning funding of operating costs of research infrastructures which are as far as possible to be covered by the projects that use it. Thus, the RCN requires applicants seeking funding to establish research infrastructure to include plans for how to achieve sustainable operation of the infrastructure. User fees from the R&D projects using the infrastructure should ideally be an integral part of financing its operation. Expenses related to the use of research infrastructure are therefore approved costs in all applications for research funding from the various RCN programmes and funding schemes. In special cases, support for operating costs for new or existing research infrastructure of national importance may be provided under the INFRASTRUKTUR initiative.

After each major INFRASTRUKTUR funding announcement, the RCN administration will assess which projects shall be highlighted on the national roadmap. The roadmap contains infrastructures that are of broad national interest, unique in the national infrastructure landscape, of strategic importance for international collaboration and for the national public sector, research and higher education and industry. Infrastructures that include Norwegian contributions in ESFRI projects are also given special focus in the roadmap because these have key roles for Norwegian collaboration with international research.

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September 2019

Photo: Adobe Stock

Design: Melkeveien Designkontor AS

ISBN: 978-82-12-03803-5 (PDF)

This publication can be downloaded at
www.forskningsradet.no/publikasjoner

