Notat

Til:	UNINETT Sigma2 styre AS
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Dato:	04.05.2018
Gjelder:	Sak 27/18: Anskaffelse 2018 - strategi

Anskaffelse 2018 - strategi

1. Gjennomgang av anskaffelsesstrategi
2. Gjennomgang av budsjett
3. Gjennomgang av plan

Forslag til vedtak:
Styret vedtar anskaffelsesstrategi, budsjett og plan for prosjektet

Procurement strategy:
HPC-facility for computational sciences

Content

BACKGROUND AND PURPOSE OF THE PROCUREMENT

UNINETT Sigma2 (Sigma2) is responsible for procuring, managing and administrating the national infrastructure for computational science in Norway, and offers services in High-Performance Computing (HPC-facilities) and data services (NIRD).

Due to the fast-paced technological advancements within HPC-technology and the high maintenance costs of existing facilities, a HPC-facility has a life span of approximately 4-5 years. The purpose of this procurement is to continue the replacement of the Norwegian e-Infrastructure, which commenced with the procurement of *Fram* (A1) in 2016.

In 2015, the Sigma2 Board decided to reduce the number of HPC-facilities in the e-infrastructure from four to two. Phase one of this strategy consisted of the acquisition of the storage system NIRD as well as the first of the two new HPC machines, Fram. The storage system NIRD was put into production 26.07.2017 and Fram was put into production 31.10.2017, thus completing phase one of the overall e-infrastructure changeover.

The objective of this new project is to complete the changeover by acquiring the second of the two HPC-facilities – B1, and thereby replace the remaining two facilities – Abel (Oslo) and Stallo (Tromsø).

The recommendation for this provision (B1) from The Technical Working Group (TWG) is to split the workload into two separate platforms. One for handling large parallel jobs (B1) and one for handling I/O and metadata-intensive load (C1). Hence, instead of expanding and modifying Fram (A1) to handle I/O and metadata intensive load as well as medium size parallel jobs, the recommendation from the TWG is to leave Fram as is, and rather prepare a separate machine with low end type hardware to handle the I/O and Metadata intensive jobs. Thus, the major elements of the procurement project will consist of:

1. B1 - HPC machine for parallel jobs (High end hardware)
2. B1-storage
3. C1 - HPC machine for I/O and Metadata intensive jobs (Low-end hardware that can be procured at a lower cost)
4. C1-storage

Introducing C1 will be both most cost-efficient and better meet user needs compared to use Fram and B1 for those kind of loads.

See chapter 2 for further details. See below for the lay out of the infrastructure:

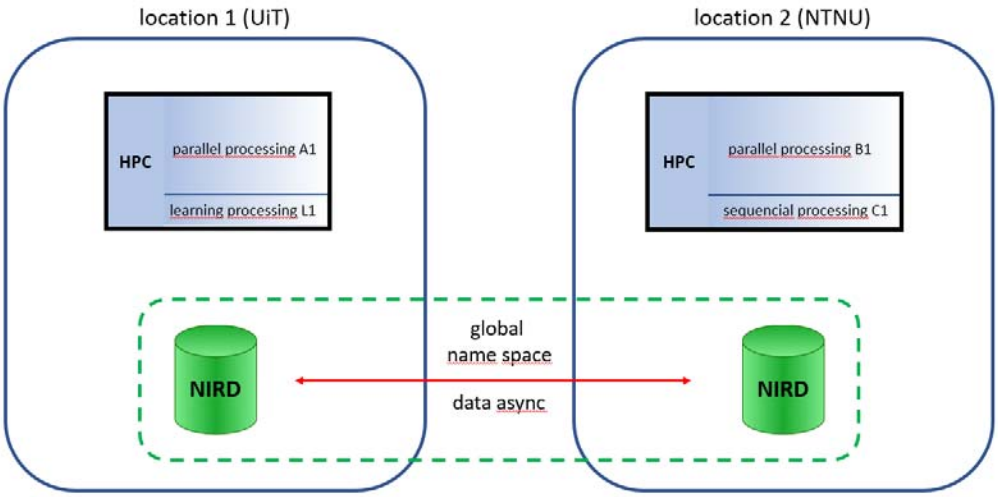


Figure 1 - Two Facility infrastructure

1. GENERAL REQUIREMENTS

1.1. Demand specification

The Technical Working Group has developed a *Technical Solution Strategy* for the future layout and setup of UNINETT Sigma2s HPC-facilities based on an assessment of demand, application usage estimates and user surveys. Below is a brief summary of the conclusions. For detailed analyses, please see the Technical Solution Strategy.

The user surveys shows an increase in demand for HPC resources.

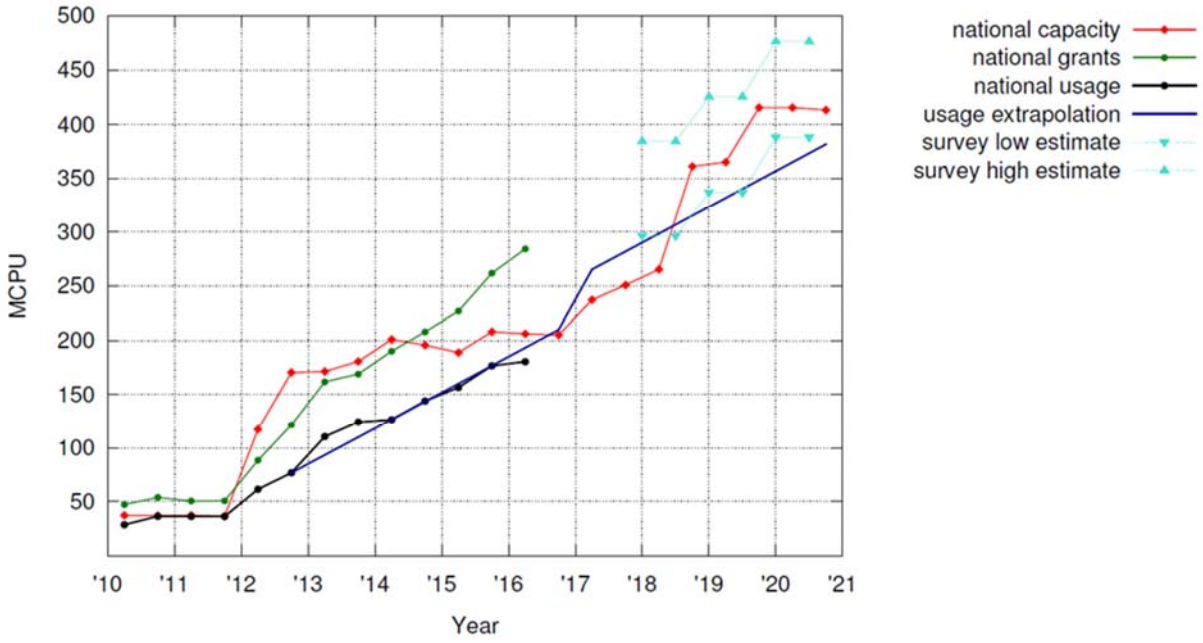


Figure 2 - Development of Demand for HPC resources

Demand for different types of research jobs can be measured in terms of core hours over time, categorized by the number of nodes (up to 64 cores) required to perform the job.

The historical usage shows that ca. 55% of CPU-time is used for smaller jobs requiring less than 256 cores, which supports the approach of investing in two different types of facility – capacity and capability. An analysis regarding metadata usage has been completed and shows that jobs with core count 1-256 require high metadata capacity.

During the procurement process in 2016, *Fram* was initially conceived as a capability facility and should be able to handle the larger parallel jobs. However, Fram's island topology has proved to cause queueing issues when running these larger types of jobs. Moreover, since it was not designed to handle massive numbers of small jobs that require only a single node, the current file system cannot sufficiently cope with the large metadata loads for creating such a large number of files.

The Technical Working Group investigated whether it would be possible to reconfigure the network topology of Fram to be able to better to conduct large parallel jobs or to introduce a new file system to better handle metadata-intensive loads. Although both these two scenarios are possible the Technical Working Group concluded that altering the setup of Fram would entail a great deal of risk and introduce possible service interruptions.

Hence, the Technical Working Group has concluded to advise the board to split the planned B1-facility into two: B1 as a parallel facility with uniform network topology; and C1 as a cluster system with simple interconnect, but dimensioned to handle high metadata load (typically bioinformatics jobs). This is still in accordance with the strategy of reducing the facilities from 4 to 2.

This will lead to the following setup after all three facilities are commissioned:

Fram

- No further compute core expansion of *Fram*
- The budgeted cores for the planned *Fram* expansion reallocated to C1
- All login nodes to be upgraded to have hardware visualization capabilities
- Minimum of 16 GPUs added

B1

- B1 will handle large parallel jobs.
- All login nodes will have hardware visualization capabilities.
- Option add GPU, based on observed demand.
- Option for an upgrade with GPUs based on observed demand.
- Option for an upgrade with additional CPUs.

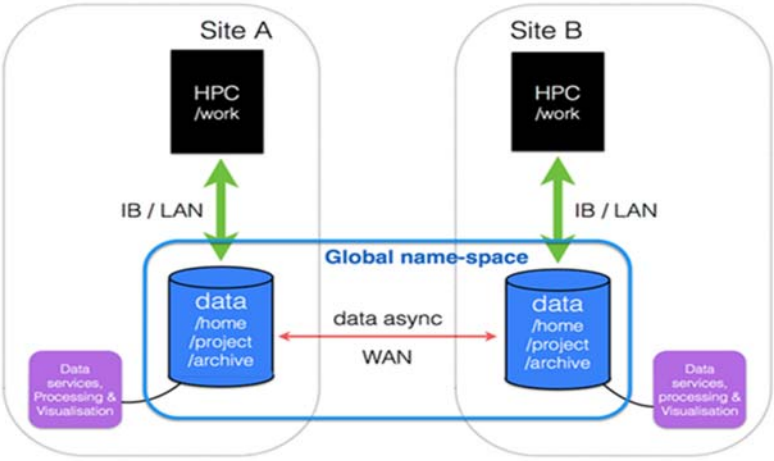
C1

- Will have a file system to handle bioinformatics and other metadata-intensive load.
- All login nodes will have hardware visualization capabilities.
- 8 big-memory nodes with >=1.5 TiB memory to be included.
- 32 GPUs to be included
- The parallel file system on C1 will be able to be expanded - on the storage, I/O capacity and metadata sides
- Additional nodes/cores and GPUs can be added based on demand

1.2. Interdependencies to the storage resources/system (NIRD)

The storage systems associated with the four facilities were initially procured separately from one another, and has been managed as completely separate entities.

In parallel to the *Fram* project in 2016, a global namespace storage solution (NIRD) was procured as well. NIRD is planned to be upgraded with 2x2 PiB in Q4 2018 and 2x3 PiB in Q4 2019. The figure below illustrates the physical location of the storage solution in relation to the two HPC systems.



Figur 2: NIRD

The Technical Working Group has recommended that the B1 and C1 systems shall be dimensioned with a parallel file system of 1.5 PiB and 1 PiB file system capacity respectively.

2. FINANCIAL AND ORGANIZATIONAL IMPACT

2.1. Financial impact

The concentration of active HPC-facilities from four to two is expected to yield a decrease in total cost of ownership (including management, maintenance and user support). It is however expected that this decrease will not be visible until 2020. This is due to the extra operational resources required during the transition period from 4 to 2 main HPC-facilities.

Another aim for this project is to increase total utilization of the HPC-facilities by implementing gradual expansions of processing capacity as opposed to procure systems that initially are over-dimensioned. Through this step-by-step strategy, we can expect to reduce the difference between current processing capacity and current demand. A reduction in the number of machines is also expected to yield an increase in overall utilization. In short, the reduction and new distribution of HPC-facilities is expected to result in a more cost effective solution that yields more research.

An improved advanced user support function is also expected to contribute to an increase in the demand for HPC-services and an increase in the number of users.

2.2. Organizational impact

One of the sub-projects of phase one of the transition from 4 to 2 HPC facilities, was to plan and organize, establish and staff, and finally implement a new operations organization to operate the new infrastructure. This project was completed July 1, 2017. Sigma2 and the metacenter have continuously been monitoring the performance of the organization, which has already resulted in a revision of the organizational structure.

The main basis for the decision to restructure the organization has come from feedback within the organization. The current operations organization is set up to handle Fram, NIRD and the service platform. Additionally an organization for Applications management has been set up an established and this organization came into operation Q1 2018. When B1 and C1 comes into operation, it is expected and indeed planned for an expansion of the operations organization thus enabling it to cope with the additional scope of work.

Prior to B1 and C1, the total Personnel Months (PMs) allocated for operating the systems was as follows:

- Operations Organization: 129 PMs distributed across the four universities + 12 PMs from Sigma2
- Applications Management: 32 PMs distributed across the four universities

Current set up of the operations organization is shown in the figure below.

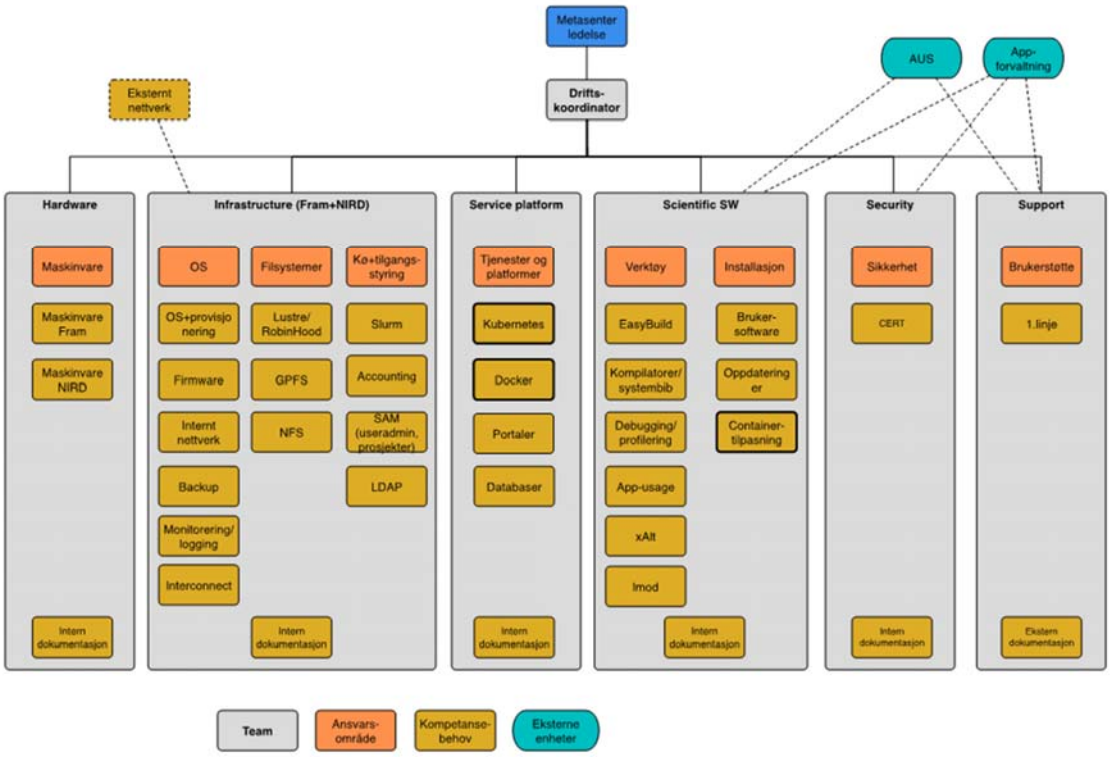


Figure 3 - Operations Organization for FRAM and NIRD

The original HW configuration was that of a A1 machine located in Tromsø and a B1 machine located in Trondheim. The operations organization was planned to expand by 30 PMs when B1 came into production. Whether or not these 30 additional PM will suffice when considering the A1+B1+C1 solution (rather than A1+B1) has yet to be determined, but it is not unlikely that this number has to be revised. The applications management is not expected to be expanded due to these new systems.

As per now the organization is planned to be as follows from when B1 comes into production:

- Operations Organization: 159 PMs distributed across the four universities + 12 PMs from Sigma2 (support)
- Applications Management: 32 PMs distributed across the four universities

2.3. Project and investment Cost

Investment Costs

The E-INFRA 2016 application and corresponding grant from the Norwegian Research Council, consisted of the following investment elements:

1. Fram Expansion
2. B1 HPC Machine
3. NIRD Expansion
4. Service Platform
5. TSD Virtual Platform
6. TSD Compute
7. TSD Storage
8. PRACE Compute

The details of the capacities applied for and corresponding estimated cost, is shown in the table below.

	From E-INFRA 2016 Application Revised - Alternative 1		
Node cost (Ref. A1 Exp.)		Fram Expansion Reduction	**0 %**
Node cost NIRD SP		NIRD Expansion Reduction	**0 %**
Cost Elements	**Volume (Ref. Figure 3.1)**	**Total (VAT Included)**	**Revised Funding Applied for**
A1 Expansion	6912	kr 14 850 000	kr 14 850 000
B1	45000	kr 96 679 688	kr 96 679 688
B1 Expansion	11500	kr 24 707 031	kr 0
NIRD Service Platform	2011	kr 5 498 828	kr 5 498 828
NIRD Expansion	10	kr 14 662 500	kr 14 662 500
TSD Virtual platform	4	kr 1 500 000	kr 1 500 000
TSD Compute	3000	kr 6 445 313	kr 3 500 000
TSD Storage (2 PiB)	2	N/A	kr 2 100 000
PRACE Compute	2	N/A	kr 4 200 000
Total Cost E-INFRA 2016		**kr 171 003 359**	**kr 142 991 016**
Reduction TOTAL		kr 27 893 359	
Reduction amount			kr 28 012 344
Remaining cut to accomplish Offered amount			kr 17 403 647
Redusert omsøkt beløp S2 - %. *Forskningsrådets kutt: 68,3%*			**80 %**
Revidert omsøkt beløp Sigma2			kr 115 097 656
Revidert omsøkt beløp Totalt inkl. 31,7% reduksjon fra NeIC.			**kr 142 403 647**
			78 %

Figure 3 - E-INFRA 2016 Final Grant

The Technical Working Group in collaboration with the Reference Group have, as part of the Technical Solution Strategy, defined the user needs and the specific hardware required to fulfill these needs in the period up and until the next HPC-facility (A2) will be in place. For more details regarding the Technical Working Groups work, its conclusions and the reasoning behind the recommended solution, reference is made to the Technical Solution Strategy (TSS).

One of the recommendations is to split the workload into two separate platforms-one for handling large parallel jobs (B1) and one for handling I/O and metadata-intensive load (C1). Hence, instead of expanding and modifying Fram to handle I/O and metadata intensive load as well as medium size parallel jobs, the recommendation from the TWG is to leave Fram as is, and rather prepare a separate machine with low end type hardware to handle the I/O and Metadata intensive jobs. Thus, the major elements of the procurement project will consist of:

5. B1 - HPC machine for parallel jobs (High end hardware)
6. B1-storage
7. C1 - HPC machine for I/O and Metadata intensive jobs (Low-end hardware that can be procured at a lower cost)
8. C1-storage

Introducing C1 will be both most cost-efficient and better meet user needs compared to use Fram and B1 for those kind of loads.

Based on the projected user needs for the C1 HPC-facility and the fact that this low-end HW can be expanded incrementally, the funding originally meant for the Fram expansion and 5000 of the B1 cores have been re-allocated to C1. This means that the procurement project will consist of two major procurement elements, B1 at approximately 45 000 cores and C1 at approximately 10 000 cores.

The revised investment elements will then be:

1. B1 HPC Machine
2. B1 Storage
3. C1 HPC Machine
4. C1 Storage
5. NIRD Expansion
6. Service Platform
7. TSD Virtual Platform
8. TSD Compute
9. TSD Storage
10. PRACE Compute

The Ans2018 investment cost is shown in the table below.

	ANS 2018 Investment Cost				
Node cost (Ref. A1 Exp.)	kr 55 000,00		**Core Cost**	kr 1 718,75	Fram Expansion Reduction
Node cost NIRD SP	kr 70 000,00		**Core cost SP**	kr 2 187,50	NIRD Expansion Reduction
Cost Elements	**Content**	**Volume (Ref. Figure 3.1)**	**Price pr volume**	**Total (VAT Excluded)**	**Total (VAT Included)**
A1 Expansion	Additional Cores	0	kr 1 718,75	kr 0,0	kr 0
B1	Supercomputer (Cores)	45000	kr 1 718,75	kr 77 343 750,0	kr 96 679 688
B1 Lagring	Disk space, PB	1,5	kr 2 306 815,0	kr 3 460 222,5	kr 4 325 278
C1	Cores	10 000	kr 2 187,50	kr 21 875 000,0	kr 27 343 750
C1 Lagring	Disk Space, PB	1	kr 2 306 815,0	kr 2 306 815,0	kr 2 883 519
NIRD Service Platform	Cores (Nodes)	0	kr 2 187,50	kr 0,0	kr 0
NIRD Expansion	Disk space, PB	10	kr 1 173 000,0	kr 11 730 000,0	kr 14 662 500
TSD Virtual platform	Nodes	4	kr 300 000,0	kr 1 200 000,0	kr 1 500 000
TSD Compute	Cores (Nodes)	1629	kr 1 718,8	kr 2 799 843,8	kr 3 499 805
TSD Storage (2 PiB)	Years	1,71	kr 1 230 000,0	kr 2 100 000,0	N/A
PRACE Compute	Years	2	kr 2 100 000,0	kr 4 200 000,0	N/A
Total Cost E-INFRA 2016				**kr 127 015 631,3**	**kr 157 194 539**

Figure 4 - Investment Cost

Project Cost

ANS2018 will be completed by using a mix of personnel from Sigma2 (Project and engineering management), Metasenter and UNINETT personnel (Technical Experts) and consultants from KPMG (Legal and Procurement experts). This is the same methodology for staffing the project as was done for the ANS2016 project.

The project cost has been calculated using an estimate of the projected cost which has been quality-controlled against the actual cost of the ANS2016 Project. The cost due to the delays in the ANS2016 have not been taken into account and the numbers are therefore comparable. For details regarding the project cost, reference is made to the budget of the project.

Organization	Travel Cost	Hours	Hour Cost	Total cost
Sigma2	108 000	3 369	3 739 209	3 847 209
UNINETT	36 000	1 653	2 355 169	2 391 169
Metasenter	363 867	9 041	5 813 343	6 177 210
KPMG	22 000	500	923 600	945 600
Total Project Cost	**529 867**	**14 562**	**12 831 320**	**13 361 188**

Figure 5 - Projected project Cost

The comparable figure (Sum Project Costs) from the ANS2016 project was 13,1 MNOK

2.4. Financing and funding

The financing and funding of the ANS2018 project will be through the E-INFRA 2016 application grant as well as internal Sigma2 funds. The internal Sigma2 funds comprises of base operational funding from the Research Council of Norway and the Universities as well as user contribution (see the Contribution Model). As the contribution model is currently being phased in and there is not yet a complete overview of all the funds that this will entail. A combined finance post called Sigma2 is used

below to illustrate all financing that is not through the competitive funding (E-INFRA Program) from the Research Council of Norway.

The below table shows the complete cost and funding/financing plan for the ANS2018 Project.

Prosjektkostnader	VAT only on certain travel cost	2017	2018	2019	2020
Total Number of Hours	14 562				
Hours, cost	kr 12 831 320				
Travel Cost	kr 529 867				
Total Project Cost	**kr 13 361 188**	**kr 500 000**	**kr 5 144 475**	**kr 5 144 475**	**kr 2 572 238**
Investment Cost	**Including MVA**				
Fram Expansion	kr -		kr -	kr -	kr -
B1	kr 96 679 688	kr -	kr -	kr 96 679 688	
B1 Lagring	kr 4 325 278	kr -	kr -	kr 4 325 278	kr -
C1	kr 27 343 750		kr 6 835 938	kr 20 507 813	kr -
C1 Lagring	kr 2 883 519	kr -	kr 720 880	kr 2 162 639	
NIRD Expansion	kr 14 662 500	kr -	kr 5 790 325	kr 8 872 175	kr -
SP Expansion	kr -	kr -	kr -	kr -	kr -
TSD Virtual platform	kr 1 500 000	kr -	kr 375 000	kr 1 125 000	kr -
TSD Compute	kr 3 499 805	kr -	kr 874 951	kr 2 624 854	kr -
TSD Storage (2 PiB)	kr 2 100 000	kr -	kr 1 050 000	kr 1 050 000	kr -
Prace Compute	kr 4 200 000	kr -	kr 2 100 000	kr 2 100 000	kr -
Sum Investment Cost	**kr 157 194 539**	**kr -**	**kr 17 747 093**	**kr 139 447 446**	**kr -**
Total Cost of Project	**kr 170 555 727**	**kr 500 000**	**kr 22 891 568**	**kr 144 591 921**	**kr 2 572 238**
Financing					
RCN	kr 115 097 656	kr -	kr 17 747 093	kr 97 350 563	kr -
Sigma2	kr 55 458 070	kr 500 000	kr 26 192 916	kr 26 192 916	kr 2 572 238
Total Funding	**kr 170 555 727**	**kr 500 000**	**kr 43 940 010**	**kr 123 543 479**	**kr 2 572 237,53**
Project Cash Flow	0	0	21 048 441	-21 048 441	0

Figure 6 - Total Budget, Funding and Cash Flow

2.5. Managing project deliveries

As part of the procurement project ANS2018, a sub-project will be as established responsible for preparing the system for operation. The main responsibilities will be:

1. Preparation for receipt, receipt and check of system
2. Monitoring of installation and initial testing
3. Perform acceptance testing in collaboration with vendor
4. Installing own platform and prepare for operation
5. Commission system
6. Migration (SW and Users)
7. Run pilot testing in Approval Period
8. Hand over to operations organization

Personnel from the operations organization under supervision from Sigma2 are natural candidates for the Preparation For Operations (PFO) organization. We will also utilize experience from the previous PFO organization, which was responsible for commissioning FRAM.

3. ORGANIZATION AND EXECUTION OF THE PROCUREMENT

3.1. Organization and roles

Resources	Role/ unit	Responsibilities
UNINETT Sigma2 Board	Project Steering Committee	Approval of the procurement strategy and ensuring that the procurements are done in accordance with the approved strategy
Gunnar Bøe, Sigma2	Project owner and responsible procurer	General clarifications regarding the procurement project
Stein Inge Knarbakk, Sigma2	Project manager	Responsible for implementation and execution of the project according to UNINETT project model, in accordance with the approved strategy
Jørn Amundsen (Technical lead), Sigma2 Ole Widar Saastad, UiO Andreas Skau Einar Jensen, NTNU Alexander Oltu, UiB Lorand Szentannai, UiB Steinar Trældal-Henden, UiT	Technical working group	Responsible for technical and functional specifications, qualification criteria, benchmarks and technical needs assessment
Hans Eide, Sigma2 – Leader Gard Thomassen, UiO Roy Dragseth, UiT Jan Christian Meyer, NTNU Csaba Anderlik, UiB	Technical Reference Group	Responsibility for quality control (QC) the TWGs work and propose any improvements if needed. Responsible for ensuring that the universities' strategic interests, as described in the collaboration agreement with Sigma2.
Halvor Oseid, KPMG	Legal advisor	Advice and assistance on legal requirements and public procurement/quality assurance
Martin Rydland, KPMG	Procurement Advisor	General project management/support, preparation of procurement documents etc.

Table 7: Project Organization

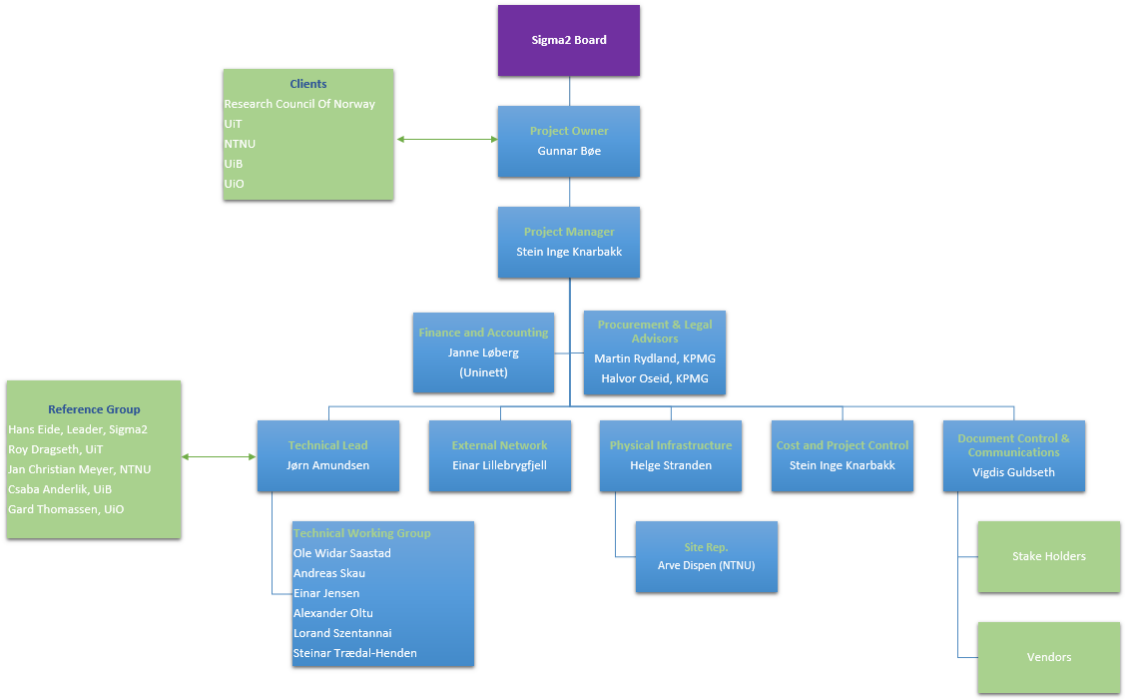


Figure 6 - Project Organogram

3.2. Project progress plan

This procurement has been split into B1 and C1, and they will be conducted as two separate competitions (see chapter 2). Due to the different lead times for administrating the competitions they will be conducted according to different progress plans.

B1:

No.	Activity	Date
M1	Contract notice (Doffin & TED) – Invitation to pre-qualify	05.06.2018
M2	Deadline for return of Pre-Qualification Questionnaires	05.07.2018
M3	Invitation to tender	30.08.2018
M4	Deadline for receipt of Tenders/ Tender due date	15.10.2018
M5	End of negotiations round 1 - Evaluation and ranking - Negotiations - Deadline improved tenders	03.12.2018
M6	End of negotiations round 2 - Evaluation and ranking - Negotiations - Deadline improved tenders	03.01.2019
M7	Contract award	16.01.2019
M8	Standstill period	10 calendar days
M9	Signing of contract	25.01.2018

C1:

No.	Activity	Date
M1	Contract notice (Doffin & TED) – Invitation to pre-qualify	29.05.2018
M2	Deadline for return of Pre-Qualification Questionnaires	29.06.2018
M3	Invitation to tender	13.07.2018
M4	Deadline for receipt of Tenders/ Tender due date	21.08.2018
M5	End of negotiations - Evaluation and ranking - Negotiations - Deadline improved tenders	11.10.2018
M7	Contract award	15.10.2018
M8	Standstill period	10 calendar days
M9	Signing of contract	24.10.2018

All dates after deadline for receipt of tenders are tentative.

3.3. Accounting for future demand in HPC

Due to the fast-paced technological advancements within HPC-technology and the high maintenance costs of existing facilities, a HPC-facility has a life span of approximately 4-5 years. This has been a central prerequisite for the 2016 *Fram* Procurement Strategy, and the broader strategy for e-Infrastructure in Norway.

Given the different types of jobs the three systems (Fram, B1 and C1) will be conducting, it is important that the tender documentations includes precise options for later capacity increases and coverage of future demands. The scope for options and possibility to change the contract will be prepared in preparing the tender documentation.

Options for capacity increases for B1 and C1 should only be applicable within a two-year period after the go-live date.

4. MARKET SITUATION AND POTENTIAL SUPPLIERS

4.1. The market for HPC in general, processors, interconnect and memory

The *National strategy for use of cloud services* and *Digitaliseringsrundskrivet* states "Når det ikke foreligger spesielle hindringer for å ta i bruk skytjenester, og slike tjenester gir den mest hensiktsmessige og kostnadseffektive løsningen, bør en velge slike tjenester.". The technical working group has evaluated cloud solutions and in the Technical Solution Strategy the working group has recommended an on premise HPC-solution rather than a cloud solution, hence this chapter will only deal with the market for on premise HPC-solution.

HPC-facilities generally consist of processors, network and memory. There are many potential suppliers with the ability to deliver these components. However, it is the overall complexity (architecture, topology, etc.) which determines whether or not the components can be delivered stand-alone, and configured using in-house know-how, or whether a technical solution needs to be proposed by a supplier.

As described in chapter 2, the complexity of the B1 and C1 facilities is vastly different which might influence the number of potential suppliers for the two facilities.

There is a wide array of smaller companies that can deliver solutions where they function as an integrator, relying heavily on third party hardware producers. However, only a select number of suppliers can deliver complete turnkey solutions of complex HPC-facilities where the company provides the main value of the contract.

Regardless, it is important that the winning supplier has broad experience in supplying HPC-systems. Below follows a chart of the top 10 vendors in percentage of system share as of November 2017.[1]

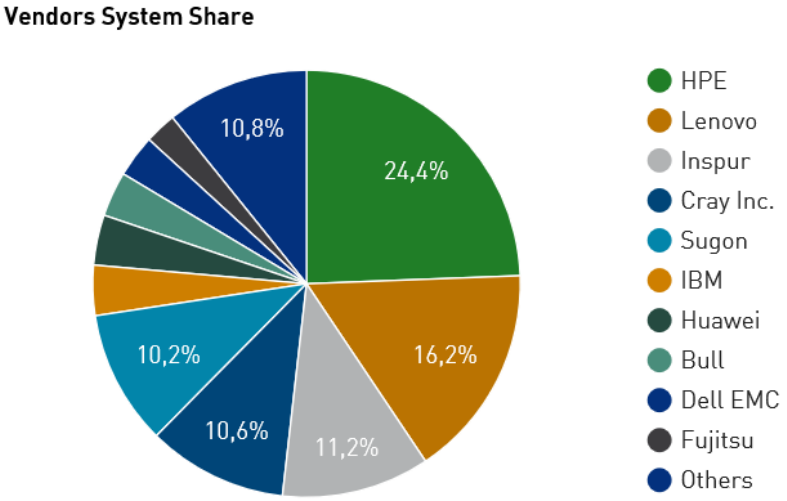


Figure 9: Top 10 vendors of HPC by percentage of total system share. Source: www.top500.org.

Generally, the current market for processors consists of a few large suppliers:

- Intel Xeon (x86-64) - the largest supplier and has until recently had near–monopoly..
- AMD launched a new series of processors in 2017 with a performance comparable to Intel.
- IBM Power processors has been used at NTNU until a few years ago.
- ARM, known for producing microprocessors for cellphones, tablets and embedded systems, has recently introduced a series of new solutions in the HPC market. The systems delivered by ARM are cost-effective and delivers a solution that is well adapted for handling bioinformatics and complicated applications.

Regarding interconnect there are several solutions available, with InfiniBand (Mellanox), OmniPath (Intel), BXI (Bull/Atos) and Aries (Cray) being the most well-known. In addition to these four there are also a few less known solutions on the market.

Memory capacity is considered off-the-shelf products. For the kind of storage required on B1 it is necessary to incorporate a file system with high capacity (performance) such as e.g. LUSTRE or BeeGFS. IBMs GPFS is also a potential solution, although the licenses for this are relatively expensive. The Metacentre has first-hand experience with all three of the above-mentioned systems.

[1] https://www.top500.org/statistics/list/

4.2. Review of potential suppliers

When procuring the HPC system FRAM in 2016, Sigma2 received tenders from the following nine suppliers:

- Atea (Nextron & Supermicro)
- Dell
- Fujitsu
- GO Virtual (Huawei)
- HPE
- IT-partner Tromsø (Lenovo)
- Cray
- Megware

Since then, the market for HPC systems has developed, and there has been a significant increase in the number of potential suppliers. As a comparison, Linköping University recently completed a procurement of a HPC-facility comparable in size to the *Fram*, B1 and C1 facilities combined, receiving tenders from the following suppliers:

- ClusterVision
- NEC
- Go Virtual
- Dell
- Megware
- Atos IT Solutions and Services
- Cray
- Super Micro Computing
- Penguin Computing
- Dawning Information Industry (Beijing) Co., Ltd
- HPE
- IBM
- Atea

It is likely that we will receive tenders from a similar amount of suppliers as the above.

Specifically regarding B1:

Using data on suppliers for the top 500 HPC systems in the world (the top500 list), and our experience from previous procurements we have tried to identify the potential suppliers that will compete for the delivery of B1. This list does not include integrators, as it is only the main systems manufacturers that are recorded in the data. Using the most recent data from November 2017, we have imposed the following filters to identify potential suppliers:

- Excluding the 50 lowest ranked systems because they are less relevant to the specifications required for B1
- Excluding the 50 highest ranked systems because they are less relevant to the specifications required for B1
- Only include systems installed within the last two years (2016 and 2017)
- Excluding less experienced suppliers who have provided four or less systems
- Excluding suppliers who historically have only operated in China

This leaves us with seven suppliers listed in alphabetical order:

- Bull
- Cray Inc.
- Dell EMC
- HPE
- Huawei
- Lenovo
- Penguin

The analysis does not include collaborations between companies. Further, it should be noted that predicting which companies who will be interested in tendering is difficult, as timing and capacity on the supplier side often determines whether or not they decide to deliver a tender. Anyway, there should be a sufficient number of suppliers to secure a good competition.

From the Fram procurement, it has become evident that it is important that the judicial party to the agreement, is the party which delivers the most value to the contract in question. It is not beneficial for Sigma2 to have a smaller service/sales company as the legal party to the agreement. The B1-procurement will limit the availability for such supplier constellations through requiring that the potential contract party must be planning to provide minimum 50 % of the contract value themselves.

5. Tendering rules and procedures

UNINETT Sigma2 is subject to the regulations regarding public procurement. Both B1 and C1 tenders are above the threshold of 1.75 MNOK and will be conducted in accordance with the Norwegian Regulations for public procurement (FOA).

5.1. B1 and C1 as separate or joint competitions

As described in chapter 2, B1 and C1 are of different complexity, targets different markets and have different lead times. Hence, it must be considered whether B1 and C1 should be procured as separate or joint competitions. These alternatives carry different benefits.

The two contracts can be awarded as two parts of the same competition or be conducted separately. There are several benefits to conducting the two competitions separately. It would be beneficial to implement and install the C1-facility as early as possible. This is because most of the heavy metadata load runs on the HPC-facility Abel at UiO, an old machine which has high maintenance costs as well as a support agreement between Sigma2 and UiO. By installing C1 at an earlier date, Abel would be able to be decommissioned sooner.

Although awarding the contract for both B1 and C1 to the same supplier would reduce administrative work with the competition, the markets for B1 and C1 are different and linking the two in this way might lead to having to choose a suboptimal solution for one to ensure the other.

It is recommended to award B1 and C1 as two separate contracts under the same competition.

5.2. Tendering procedure

Principles

Given the expected value and form of this procurement there are three potential tendering procedures to choose from; open procedure, negotiated procedure or competitive dialogue.

The main principle is that public procurements are to be conducted using an open or restricted procedure, following § 13-1. The regulations for public procurement were revised in 2017, and is now more lenient toward using alternative procedures such as negotiation. In consultation memorandum no. 2 related to the change in the regulations, the following is stated regarding negotiated procedures:

"Departementet antar at vilkårene vil omfatte de aller fleste anskaffelser der oppdragsgiveren vil ha et legitimt behov for å gjennomføre forhandlinger, dvs. der hvor forhandlinger er nødvendig for å sikre at oppdragsgivers behov blir oppfylt".

The opportunity to use competitive dialogue has also been extended in the new regulations. Historically the use of this procedure was restricted to particularly complex contracts. Today however the buyer is free to choose between negotiated procedure and competitive dialogue as long as the subjected terms in FOA § 13-2 are fulfilled.

In short, the conditions for using procedures where the buyer uses active communication with the tenderers during the competition has been significantly extended. It is further assumed that one or more of the subjected terms in FOA § 13-2 subparagraph a) – e) are fulfilled for this procurement. For example, subparagraph a) states that negotiated procedure can be used if the buyers needs cannot be fulfilled unless there are made substantial adaptations to existing products or solutions. Further on subparagraph c) states that the nature of an acquisition, it's complexity, it's legal and financial composition or the associated risk can make it necessary to engage in negotiations with suppliers. The terms in FOA §13-2 are alternative, not cumulative, meaning that only one of the terms in subparagraph a) – e) needs to be fulfilled.

The tendering process when using negotiations or competitive dialogue are roughly the same as for a standard open procedure. For negotiations in particular, the main principle is that all aspects of the procurement can be subject to negotiations, including price and cost. It should however be noted that award criteria and absolute requirements may not be subject to dialogue. With regards to competitive dialogue, it is important to note that when the buyer has identified solutions that fit criteria and demands, the dialogue must be terminated and that the rest of the process should be continued as a standard open procedure with submission of final tenders. See also FOA § 23-10 for general rules and guidance on conducting negotiations and competitive dialogue.

Preliminary recommendation for choice of tendering procedure:

B1:

Procurements of large-scale IT-solutions is just that, solutions, and not "off-the-shelf" standardized products or services. This means that it usually is quite demanding to define or specify the exact requirements for the desired solution. In addition, technological development of computer processors occurs at a fast pace, making acquired knowledge and competency about the subject rapidly outdated. Experience from similar procurements has also shown that it is beneficial to have ongoing dialogue with suppliers during the tendering process, in order to make sure that needs and requirements can be verified and modified if necessary.

We note that during the procurement of Fram in 2016, one of the tenderers was able to substantially improve their proposal through proposing a different network topology for their solution. Without this dialogue, the tenderer would not have been able to revise their proposal to provide a better solution to Sigma2.

It should also be taken into account that procurement of HPC-systems happens relatively seldom. This suggests that the supplier will normally be the party with the best prerequisites and competency to

assess what is the best solution for different situations. This indicates that one should consider tendering procedures that enables the utilization of supplier expertise.

The need to select vendors that has broad experience in supplying HPC systems, stresses the importance of staying in touch with the supplier market both before and during the procurement. This suggests negotiations as the most reasonable tendering procedure for this procurement based on a predefined requirement specification.

C1:

Although C1 consists of more low-end components, the tenderers will still provide Sigma2 with a technical solution. This solution will require some level of dialogue with the tenderers.

Conclusion

Based on the above-mentioned aspects it is concluded that there is legal basis to conduct both B1 and C1 as negotiated procedures or competitive dialogue, and it is also our preliminary assumption that a negotiated procedure is the best-suited option.

5.3. Contract terms and conditions

General provisions

The Norwegian Government's Standard Terms and Conditions (Statens Standardavtaler – SSA) are developed for procurement within the public sector and is well suited for procuring different kinds of IT-systems and consultancy assistance. The contracts, terms and conditions are available in both Norwegian and English at www.anskaffelser.no.

The standard terms and conditions were revised and made available for use on July 2, 2015. Part of the aim in these revisions was to make the terms more balanced in relation to rights and responsibilities between customer and service provider. The terms and conditions are still considered customer-oriented, but at the same time, many suppliers are accustomed to including the risks associated with the terms in their prices. The standard terms also has appendices, which make it easier to incorporate clauses and specific terms.

We propose using the SSA for these tenders. Since this procurement predominantly relates to the procurement of a Hardware *solution*, the SSA-K is the most relevant draft contract, as it is predominantly used for Hardware or Software that has an "off-the-shelf" component, including where the supplier assembles different components together in a solution that meets the customer's needs. Because the supplier will assemble a system based on different components, and hence deliver a "solution" this should not affect the decision to use a negotiated tendering procedure.

5.4. Corporate social responsibility

Environmental impact and energy efficiency

Environmental impact should be minimized and the procurement will to a large degree follow the Energy Star recommendations for enterprise servers. See www.energystar.gov

The HPC-machine B1 with servers will be installed in a data hall at the Norwegian University for Science and Technology in Trondheim, which have excellent facilities for re-use of heat generated from the HPC-facility.

Ethical trade

The United Nations Convention on the Rights of the Child article 32 and ILO convention § 138 will be included in the terms and conditions for this procurement.

Wages and working conditions

The terms and conditions for this contract shall ensure that the contractor and any of its subcontractors' employees do not receive wages or have working conditions that are inferior to those stipulated in the Regulations relating to Generalized Collective Wage Agreements. The terms and agreements in the contract will be according to the Regulations No. 112 of 8 February 2008 relating to Wages and Working Conditions under Government Contracts

6. RISK ANALYSIS AND CRITICAL SUCCESS FACTORS

6.1. Risk analysis and mitigation measures

A risk assessment (RA) was conducted during the E-INFRA 2016 (ANS2018) application process and it's result and conclusions is still recognized as valid. The RA identified and rated the relevant risks for the project. A 5x5, Very Low to Very High, Risk matrix was utilized for ranking the risks. Consequently, mitigating actions were identified, before a final risk ranking was performed to conclude residual risk. The results are shown below. The conclusion is that provided mitigating actions are implemented, project risk level is considered acceptable. For better readability, both the Risk Matrix and the Risk Assessment are attached in full size as attachment 8.1

Impact
(What is the impact given the event occurs)

Likelihood (What is the likelihood that the event will occur)	Very Low 1	Low 2	Medium 3	High 4	Very High 5
Very Low 1	1	2	3	4	5
Low 2	2	4	6	8	10
Medium 3	3	6	9	12	15
High 4	4	8	12	16	20
Very High 5	5	10	15	20	25

Type	Rating	Mitigating Actions
Low Risks	Risk ≤ 5	Not required
Moderate Risks	6 < Risk < 12	To be monitored through execution
High Risks	Risk ≥ 12	Required; risk not acceptable

Figure 10 - Risk Matrix

Basic Project Risk Assessment - Sigma2 HPC and Storage - Phase 2

Risk #	Event	Consequence	Likelihood	Impact	Initial Risk	Mitigating Action/Measure	Likelihood	Impact	Residual Risk
1	"Over specifying" product. No / Too few vendors able to fulfil requirements and withdraws from the competition or is excluded	Cost increase, delays (possibly major)	3	5	15	1. Discuss requirements with market to ensure it is able to comply 2. Stick to available & proven technology	2	5	10
2	Changes to technical requirements & specification after tender issue	Added cost, delays, possible cancellation and re-start of tendering process & legal issues	3	4	12	1. Ensure that spec is complete before tender issue 2. Avoid adding "Nice to haves" after tender issue	2	4	8
3	Scope increase	Cost increase & delays	2	3	6	1. Define Scope and product and prepare specifications & requirements in close cooperation with customer/users. 2. If scope increase is to be implemented, extension of schedule to be agreed with client (red. Impact)	1	2	2
4	Lack of Funding	Reduced capability/capacity (Quality) of product and consequently services	2	5	10	1. Prepare detailed description of current and future needs and associated cost and ensure this is clearly conveyed to investors	1	5	5
5	Scope Change => Not complying with user needs	Reduced ability to cover user needs and meet the goals of the project.	2	4	8	1. Mini survey. 2. Verify requirements before procurement process 3. Technology Watch	1	4	4
6	Change of price or accuracy of calculations (Se lack of funding)	Reduced capability/capacity (Possibly Quality) of product and consequently services =>	3	4	12	1. Market research 2. Apply for Additional funding from partners	3	3	9
7	Lack of Resources for specifications and procurement	Delay and cost increase	2	3	6	1. Keep resources providers informed about plans and resource requirements 2. Hire required relevant resources	1	3	3
8	Change of technology (e.g. not x86)	Additional cost (Development , adjustment, competency, support), Delay	2	4	8	1. Technology watch 2. Competency building 3. Pre-studies 4. Partnering with other providers	2	3	6

Figure 11 - Risk Assessment

6.2. Critical success factors

- New HPC facility (C1 / B1) in production no later than 13.12.2019
- Earlier start up C1 in production (compared to mods to Fram and multitask B1)
- the transition from four to two facilities.
- Operating cost reduction of 20 % after transition. This must be measured for the first year of full operational production after changeover and compared to the last year of full production before the changeover (2016)
- Ensure predictable and as low as possible maintenance cost for the life span of the facilities.

7. Attachments

7.1. Risk Matrix and Risk Assessment

7.2. Project Organogram

7.3. Project Schedule (B1 & C1)

7.4. Project Budget

Impact

(What is the impact given the event occurs)

Likelihood (What is the likelihood that the event will occur)	Very Low 1	Low 2	Medium 3	High 4	Very High 5
Very Low 1	1	2	3	4	5
Low 2	2	4	6	8	10
Medium 3	3	6	9	12	15
High 4	4	8	12	16	20
Very High 5	5	10	15	20	25

Type	**Rating**	**Mitigating Actions**
Low Risks	Risk ≤ 5	Not required
Moderate Risks	6 < Risk < 12	To be monitored through execution
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Basic Project Risk Assessment - Sigma2 HPC and Storage - Phase 2									
Risk #	Event	Consequence	Likelihood	Impact	Initial Risk	Mitigating Action/Measure	Likelihood	Impact	Residual Risk
1	"Over specifying" product. No / Too few vendors able to fulfil requirements and withdraws from the competition or is excluded	Cost increase, delays (possibly major)	3	5	15	1. Discuss requirements with market to ensure it is able to comply 2. Stick to available & proven technology	2	5	10
2	Changes to technical requirements & specification after tender issue	Added cost, delays, possible cancellation and re-start of tendering process & legal issues	3	4	12	1. Ensure that spec is complete before tender issue 2. Avoid adding "Nice to haves" after tender issue	2	4	8
3	Scope increase	Cost increase & delays	2	3	6	1. Define Scope and product and prepare specifications & requirements in close cooperation with customer/users. 2. If scope increase is to be implemented, extension of schedule to be agreed with client (red. Impact)	1	2	2
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5	Scope Change => Not complying with user needs	Reduced ability to cover user needs and meet the goals of the project.	2	4	8	1. Mini survey. 2. Verify requirements before procurement process 3. Technology Watch	1	4	4
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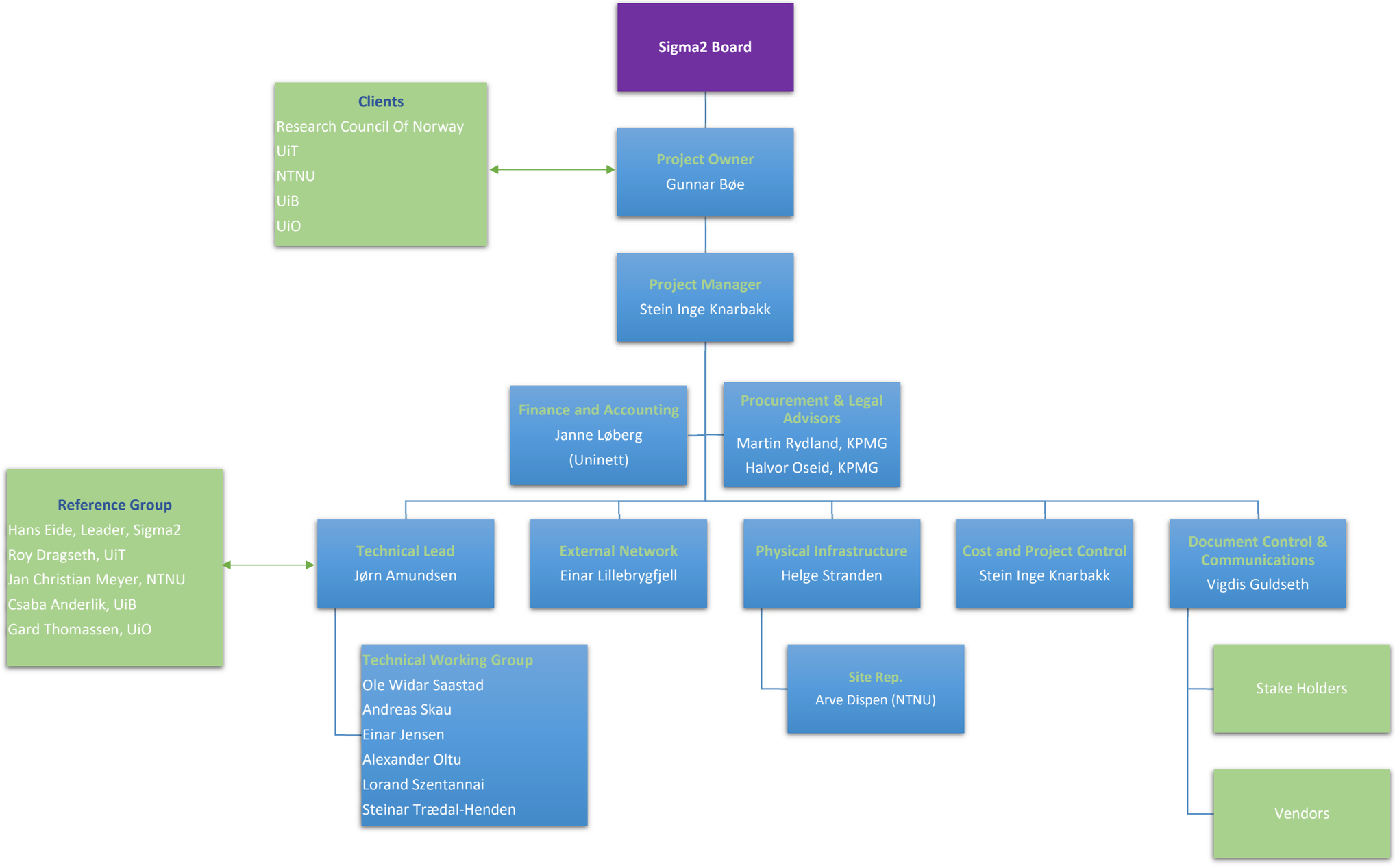
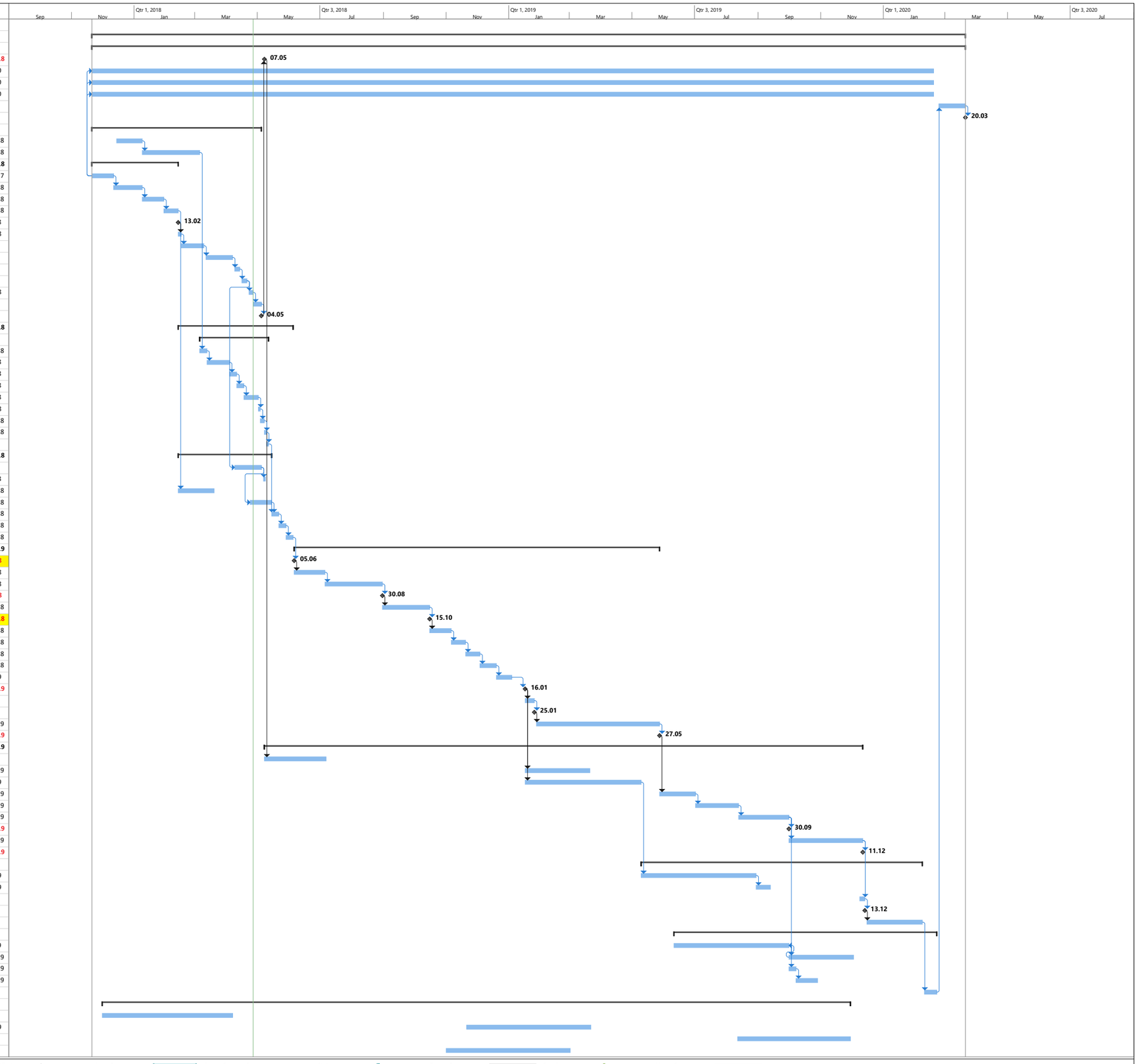
7	Lack of Resources for specifications and procurement	Delay and cost increase	2	3	6	1. Keep resources providers informed about plans and resource requirements 2. Hire required relevant resources	1	3	3
8	Change of technology (e.g. not x86)	Additional cost (Development , adjustment, competency, support), Delay	2	4	8	1. Technology watch 2. Competency building 3. Pre-studies 4. Partnering with other providers	2	3	6


Sigma2 Board
Clients
Research Council Of Norway
UiT
NTNU
UiB
UiO
Project Owner
Gunnar Bøe
Project Manager
Stein Inge Knarbakk
Finance and Accounting
Janne Løberg
(Uninett)
Procurement & Legal Advisors
Martin Rydland, KPMG
Halvor Oseid, KPMG
Reference Group
Hans Eide, Leader, Sigma2
Roy Dragseth, UiT
Jan Christian Meyer, NTNU
Csaba Anderlik, UiB
Gard Thomassen, UiO
Technical Lead
Jørn Amundsen
External Network
Einar Lillebrygfjell
Physical Infrastructure
Helge Stranden
Cost and Project Control
Stein Inge Knarbakk
Document Control & Communications
Vigdis Guldseth
Technical Working Group
Ole Widar Saastad
Andreas Skau
Einar Jensen
Alexander Oltu
Lorand Szentannai
Steinar Trædal-Henden
Site Rep.
Arve Dispen (NTNU)
Stake Holders
Vendors

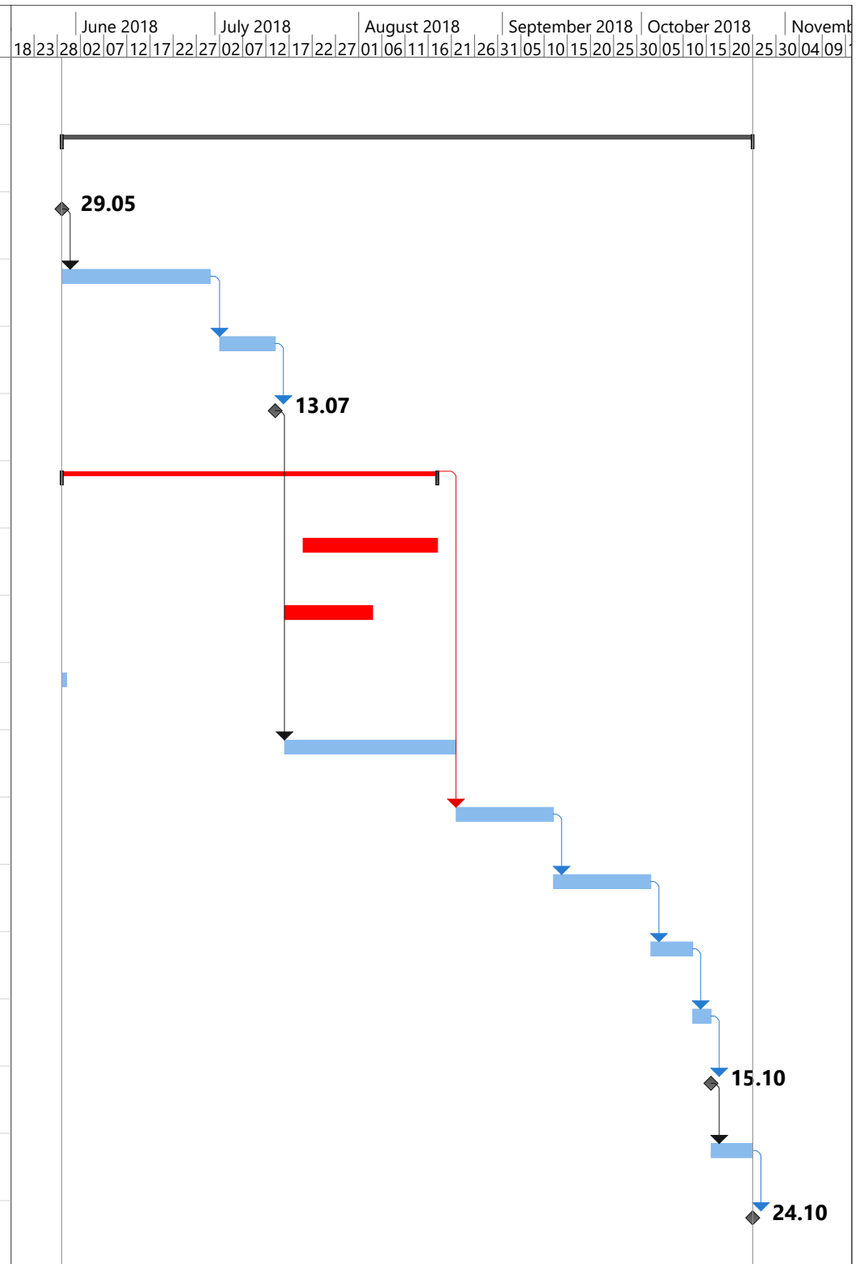
ID	Task Mode	Task Name	Duration	Start	Finish
1					
2		**Project Plan - HPC B1, TSD and Expansion A1 and NIRD**	**540 days**	**Tue 21.11.17**	**Fri 20.03.20**
3		**WP1 - Management**	**540 days**	**Tue 21.11.17**	**Fri 20.03.20**
4		**Project Start**	**0 days**	**Mon 07.05.18**	**Mon 07.05.18**
5		Project Management and Organization	517 days	Tue 21.11.17	Tue 18.02.20
6		Schedule & Detailed Planning	517 days	Tue 21.11.17	Tue 18.02.20
7		Project Follow up and coordination	517 days	Tue 21.11.17	Tue 18.02.20
8		Project Close Out	20 days	Mon 24.02.20	Fri 20.03.20
9		**Project Closed**	**0 days**	**Fri 20.03.20**	**Fri 20.03.20**
10		**WP2 - Requirements for HPC B1 and TSD (Pre-Project)**	**108 days**	**Tue 21.11.17**	**Fri 04.05.18**
11		Agreement with Procurement and legal Consultants	12 days	Fri 15.12.17	Mon 08.01.18
12		Procurement Strategy Preparations	40 days	Tue 09.01.18	Mon 05.03.18
13		**Prepare and execute study of requirements**	**55 days**	**Tue 21.11.17**	**Mon 12.02.18**
14		Survey of potential HPC vendors incl. Cloud	15 days	Tue 21.11.17	Mon 11.12.17
15		Comparison of TCO for Traditional on premise HPC and Cloud HPC	15 days	Tue 12.12.17	Mon 08.01.18
16		Mapping of user needs and requirements, incl. User Survey	15 days	Tue 09.01.18	Mon 29.01.18
17		Gather and collate input from requirements capture	10 days	Tue 30.01.18	Mon 12.02.18
18		Technical Working Group Workshop	0 days	Tue 13.02.18	Tue 13.02.18
19		Technical Solution Strategy (TSS)	3 days	Tue 13.02.18	Thu 15.02.18
20		Reference group TSS Review I	16 days	Fri 16.02.18	Fri 09.03.18
21		Incoorporate Reference Group input and Prepare TSS Complete document	14 days	Mon 12.03.18	Fri 06.04.18
22		Reference group review II	5 days	Mon 09.04.18	Fri 13.04.18
23		TSS Full Document Complete - final review and approval - Metacenter Leads	5 days	Mon 16.04.18	Fri 20.04.18
24		Complete Procurement Strategy	4 days	Mon 23.04.18	Thu 26.04.18
25		Board review of Procurement Strategy	6 days	Fri 27.04.18	Fri 04.05.18
26		**Board Approval of Procurement Strategy**	**0 days**	**Fri 04.05.18**	**Fri 04.05.18**
27		**WP3 - Tender Specifications and Requirements**	**74 days**	**Tue 13.02.18**	**Mon 04.06.18**
28		**Specify legal and commercial requirements (KPMG & SIK)**	**43 days**	**Tue 06.03.18**	**Fri 11.05.18**
29		Rules of the competition	5 days	Tue 06.03.18	Mon 12.03.18
30		Contract SSA-K 2015 English	10 days	Tue 13.03.18	Tue 03.04.18
31		Appendix 4 - Project and Progress Plan	5 days	Wed 04.04.18	Tue 10.04.18
32		Appendix 6 - Administrative Provisions	5 days	Wed 11.04.18	Tue 17.04.18
33		Appendix 7 - Total Price and Pricing Provisions	10 days	Wed 18.04.18	Tue 01.05.18
34		Appendix 8 - Changes to the General Contractual Wording	2 days	Wed 02.05.18	Thu 03.05.18
35		Appendix 9 - Changes Subsequent to the Formation of the Agreement	2 days	Fri 04.05.18	Mon 07.05.18
36		Appendix 10 - License Terms and Conditions for Standard and Free Software	2 days	Tue 08.05.18	Wed 09.05.18
37		Appendix 11 - Maintenance Agreement (Inkluderes som krav i Appendix 1)	2 days	Thu 10.05.18	Fri 11.05.18
38		**Specify detailed technical requirements (TWG)**	**59 days**	**Tue 13.02.18**	**Mon 14.05.18**
39		Appendix 1 - Customer Requirement Specification	20 days	Mon 09.04.18	Fri 04.05.18
40		Appendix 2 - Contractor Solution Specification	2 days	Mon 07.05.18	Tue 08.05.18
41		Appendix 3 - Customer Technical Platform	25 days	Tue 13.02.18	Mon 19.03.18
42		Appendix 5 - Testing and Approval	15 days	Tue 24.04.18	Mon 14.05.18
43		Prepare complete tender document - Draft	5 days	Tue 15.05.18	Mon 21.05.18
44		Final Tender document - for Issue	5 days	Tue 22.05.18	Mon 28.05.18
45		Finalize tender documentation in KGV	5 days	Tue 29.05.18	Mon 04.06.18
46		**WP4 - Tender & Procurement Process**	**216 days**	**Tue 05.06.18**	**Mon 27.05.19**
47		**Contract Notice (Doffin & TED) - Invitation to Pre-Qualify**	**0 days**	**Tue 05.06.18**	**Tue 05.06.18**
48		Return of Pre-Qualification Questionnaires	22 days	Wed 06.06.18	Thu 05.07.18
49		Evaluation and Pre-Qualification of Vendors	15 days	Fri 06.07.18	Thu 30.08.18
50		**Invitation To Tender (ITT) - Issue Full Tender Documentation**	**0 days**	**Thu 30.08.18**	**Thu 30.08.18**
51		Receipt of Tenders	32 days	Fri 31.08.18	Mon 15.10.18
52		**Deadline for receipt of Tenders**	**0 days**	**Mon 15.10.18**	**Mon 15.10.18**
53		Evaluation and ranking	15 days	Tue 16.10.18	Mon 05.11.18
54		Negotiations Round 1 (Desktop - No meetings)	10 days	Tue 06.11.18	Mon 19.11.18
55		Deadline Improved Tender (Last tenderer)	10 days	Tue 20.11.18	Mon 03.12.18
56		Negotiations Round 2 - c/w Meetings	12 days	Tue 04.12.18	Wed 19.12.18
57		Deadline Improved Tender 2	4 days	Thu 20.12.18	Thu 03.01.19
58		**Contract Award**	**0 days**	**Wed 16.01.19**	**Wed 16.01.19**
59		Stand Still Period	7 days	Thu 17.01.19	Fri 25.01.19
60		**Contract Signing**	**0 days**	**Fri 25.01.19**	**Fri 25.01.19**
61		Construction & Vendor Follow Up (Delivery Time)	80 days	Mon 28.01.19	Mon 27.05.19
62		**Delivery of HW at Site**	**0 days**	**Mon 27.05.19**	**Mon 27.05.19**
63		**WP5 - Installation, Acceptance Testing, Approval and Commissioning**	**359 days**	**Tue 08.05.18**	**Wed 11.12.19**
64		Prepare Test Requirements and procedures	44 days	Tue 08.05.18	Fri 06.07.18
65		Prepare Installation Procedures (Vendor)	45 days	Thu 17.01.19	Wed 20.03.19
66		Prepare commissioning Procedures	75 days	Thu 17.01.19	Thu 09.05.19
67		Installation and Testing of HW	25 days	Tue 28.05.19	Mon 01.07.19
68		Installation of Own Platform	10 days	Tue 02.07.19	Mon 12.08.19
69		Acceptance Testing	35 days	Tue 13.08.19	Mon 30.09.19
70		**Acceptance Testing Complete and Approved**	**0 days**	**Mon 30.09.19**	**Mon 30.09.19**
71		Approval Period (Contract Completion)	52 days	Tue 01.10.19	Wed 11.12.19
72		**Approval period complete**	**0 days**	**Wed 11.12.19**	**Wed 11.12.19**
73		**WP6 - Preparation for & Verification of Operation**	**176 days**	**Fri 10.05.19**	**Fri 07.02.20**
74		Preparation for operation specification	60 days	Fri 10.05.19	Thu 29.08.19
75		Prepare Hand over Documentation	10 days	Fri 30.08.19	Thu 12.09.19
76		Execute Hand Over to Operations	5 days	Mon 09.12.19	Fri 13.12.19
77		**Start Production**	**0 days**	**Fri 13.12.19**	**Fri 13.12.19**
78		Production Verification (Internal Quality Assurance, normal production)	40 days	Mon 16.12.19	Fri 07.02.20
79		**WP7 - Migration & Decommissioning Activities**	**164 days**	**Tue 11.06.19**	**Fri 21.02.20**
80		Prepare migration procedure document	60 days	Tue 11.06.19	Tue 01.10.19
81		Execute Migration	45 days	Tue 01.10.19	Mon 02.12.19
82		Prepare Decommissioning Schedule	5 days	Tue 01.10.19	Mon 07.10.19
83		Prepare Decommissioning procedure	15 days	Tue 08.10.19	Mon 28.10.19
84		Execute Decommissioning Abel og Stallo	10 days	Mon 10.02.20	Fri 21.02.20
85		**WP8 - Expansion Fram & NIRD**	**452 days**	**Fri 01.12.17**	**Fri 29.11.19**
86		NIRD Expansion Phase 1	80 days	Fri 01.12.17	Fri 06.04.18
87		NIRD Expansion Phase 2	80 days	Wed 21.11.18	Thu 21.03.19
88		NIRD Expansion Phase 3	80 days	Mon 12.08.19	Fri 29.11.19
89		FRAM Expansion	80 days	Thu 01.11.18	Fri 01.03.19



Project: Draft 26 08 2016 kladd
Date: Fri 27.04.18

Task · Split · Milestone · Summary · Project Summary · Inactive Task · Inactive Milestone · Inactive Summary · Manual Task · Duration-only · Manual Summary Rollup · Manual Summary · Start-only · Finish-only · External Tasks · External Milestone · Deadline · Progress · Manual Progress

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1							
2		**Schedule for C1**	**107 days?**	**Tue 29.05.18**	**Wed 24.10.18**		
3		Contract notice	0 days	Tue 29.05.18	Tue 29.05.18		
4		Deadline for receipt of Pre Qual	24 days	Tue 29.05.18	Fri 29.06.18	3	
5		Evaluation of Pre-Qualification Qty	10 days	Mon 02.07.18	Fri 13.07.18	4	
6		Issue ITT	0 days	Fri 13.07.18	Fri 13.07.18	5	
7		**Summer vacation**	**59 days?**	**Tue 29.05.18**	**Fri 17.08.18**		
8		Jørn	21 days	Fri 20.07.18	Fri 17.08.18		
9		Andreas	15 days	Mon 16.07.18	Fri 03.08.18		
10		Steinar	1 day?	Tue 29.05.18	Tue 29.05.18		
11		Receipt of Tenders	27 days	Mon 16.07.18	Tue 21.08.18	6	
12		Evaluation and ranking	15 days	Wed 22.08.18	Tue 11.09.18	7FS+2 days	
13		Negotiations	15 days	Wed 12.09.18	Tue 02.10.18	12	
14		Receipt of revised tenders	7 days	Wed 03.10.18	Thu 11.10.18	13	
15		Final Evaluation and ranking	2 days	Fri 12.10.18	Mon 15.10.18	14	
16		Contract Award	0 days	Mon 15.10.18	Mon 15.10.18	15	
17		Stand Still period	7 days	Tue 16.10.18	Wed 24.10.18	16	
18		Signing of Contract	0 days	Wed 24.10.18	Wed 24.10.18	17	



Project: ANS 2018 - C1 proposa
Date: Fri 27.04.18

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

Prosjektkostnader	VAT only on certain travel cost	2017	2018	2019	2020
Total Number of Hours	14 562				
Hours, cost	kr 12 831 320				
Travel Cost	kr 529 867				
Total Project Cost	**kr 13 361 188**	**kr 500 000**	**kr 5 144 475**	**kr 5 144 475**	**kr 2 572 238**
Investment Cost	**Including MVA**				
Fram Expansion	kr -		kr -	kr -	kr -
B1	kr 96 679 688	kr -	kr -	kr 96 679 688	
B1 Lagring	kr 4 325 278	kr -	kr -	kr 4 325 278	kr -
C1	kr 27 343 750		kr 6 835 938	kr 20 507 813	kr -
C1 Lagring	kr 2 883 519	kr -	kr 720 880	kr 2 162 639	
NIRD Expansion	kr 14 662 500	kr -	kr 5 790 325	kr 8 872 175	kr -
SP Expansion	kr -	kr -	kr -	kr -	kr -
TSD Virtual platform	kr 1 500 000	kr -	kr 375 000	kr 1 125 000	kr -
TSD Compute	kr 3 499 805	kr -	kr 874 951	kr 2 624 854	kr -
TSD Storage (2 PiB)	kr 2 100 000	kr -	kr 1 050 000	kr 1 050 000	kr -
Prace Compute	kr 4 200 000	kr -	kr 2 100 000	kr 2 100 000	kr -
Sum Investment Cost	**kr 157 194 539**	**kr -**	**kr 17 747 093**	**kr 139 447 446**	**kr -**
Total Cost of Project	**kr 170 555 727**	**kr 500 000**	**kr 22 891 568**	**kr 144 591 921**	**kr 2 572 238**
Financing					
RCN	kr 115 097 656	kr -	kr 17 747 093	kr 97 350 563	kr -
Sigma2	kr 55 458 070	kr 500 000	kr 26 192 916	kr 26 192 916	kr 2 572 238
Total Funding	**kr 170 555 727**	**kr 500 000**	**kr 43 940 010**	**kr 123 543 479**	**kr 2 572 237,53**
Project Cash Flow	**0**	0	21 048 441	-21 048 441	0

	ANS 2018 Investment Cost				
Node cost (Ref. A1 Exp.)	kr 55 000,00		**Core Cost**	kr 1 718,75	Fram Expansion Reduction
Node cost NIRD SP	kr 70 000,00		**Core cost SP**	kr 2 187,50	NIRD Expansion Reduction
Cost Elements	**Content**	**Volume (Ref. Figure 3.1)**	**Price pr volume**	**Total (VAT Excluded)**	**Total (VAT Included)**
A1 Expansion	Additional Cores	0	kr 1 718,75	kr 0,0	kr 0
B1	Supercomputer (Cores)	45000	kr 1 718,75	kr 77 343 750,0	kr 96 679 688
B1 Lagring	Disk space, PB	1,5	kr 2 306 815,0	kr 3 460 222,5	kr 4 325 278
C1	Cores	10 000	kr 2 187,50	kr 21 875 000,0	kr 27 343 750
C1 Lagring	Disk Space, PB	1	kr 2 306 815,0	kr 2 306 815,0	kr 2 883 519
NIRD Service Platform	Cores (Nodes)	0	kr 2 187,50	kr 0,0	kr 0
NIRD Expansion	Disk space, PB	10	kr 1 173 000,0	kr 11 730 000,0	kr 14 662 500
TSD Virtual platform	Nodes	4	kr 300 000,0	kr 1 200 000,0	kr 1 500 000
TSD Compute	Cores (Nodes)	1629	kr 1 718,8	kr 2 799 843,8	kr 3 499 805
TSD Storage (2 PiB)	Years	1,71	kr 1 230 000,0	kr 2 100 000,0	N/A
PRACE Compute	Years	2	kr 2 100 000,0	kr 4 200 000,0	N/A
Total Cost E-INFRA 2016				**kr 127 015 631,3**	**kr 157 194 539**

From Research Council	kr	115 097 656,25
From Sigma2	kr	49 551 503,00
Total Financing	kr	164 649 159,25

Activity level	Correction factor
Intense	1,0
Medium	0,8
Low	0,5

Til budsjett - Sigma2		
	Dager pr uke Snitt	Timer
Jørn	1,8	13,3
Arild + SIK	2,5	18,8
Gunnar	0,4	3,0
Hans	0,4	2,9
Vigdis	0,1	1,0
Sum	4,9	36,5

Estimert til ca 1 time pr uke

Ref. Janne 24.04.2018			
EU Regi at det skal være 142,5 timer pr PM			
I Norge skal det være 150 timer pr PM			
Ny Ekstern PM timepris:		643	
		Intern	Ekstern
Timepris Sigma2		870	1110
Uninett			1425

	Perioder							Kostnader				
	Konsept	Spesifikasjoner og anbuds dokumenter	Vendor tender prep (Summer vacation)	Evaluering av anbud og forhandlinger	Delivery time, vendor follow up	FAT, installasjon, Acceptance Testing	Preparation for operation, Pilots and decom activities					
	01.01.18 - 28.02.18	01.03.18 - 02.07.18	03.07.18 - 09.09.18	10.09.18 - 27.11.18	28.11.18 - 31.12.18	01.01.19 - 12.07.19	13.07.19 - 24.10.19	Total Reisekost	Totalt Timer	Unit Cost	Total timekostnad	Total Kostnad inkludert reise
Weeks	8	16	9	12	5	26	24					
Sigma2												
Gunnar Bøe	19	48	14	36	8	79	58	kr 24 000	262	1110	290 990	314 990
Stein Inge Knarbakk	120	300	84	225	47	488	360	kr 24 000	1626	1110	1 804 416	1 828 416
Jørn Amundsen	85	213	60	160	33	346	255	kr 24 000	1151	1110	1 277 675	1 301 675
Hans Eide	12	46	13	35	7	75	55	kr 24 000	243	1110	270 001	294 001
Vigdis Guldseth	6	16	5	12	3	26	19	kr 12 000	87	1110	96 126	108 126
Sum Sigma2	**243**	**624**	**175**	**468**	**97**	**1013**	**748**	**kr 108 000**	**3 369**	-	**3 739 209**	**3 847 209**
Uninett												
Helge Stranden	116	233	131	175	56	659	132	kr 24 000	1501	1425	2 139 424	2 163 424
Einar Lillebrygfjell	2	5	3	4	2	120	17	kr 12 000	151	1425	215 745	227 745
Sum Uninett	**119**	**238**	**134**	**178**	**57**	**779**	**149**	**kr 36 000**	**1 653**	-	**2 355 169**	**2 391 169**
Metasenter												
UiO	Total varighet, uker	100,0	Timer pr uke	22,9	Totalt antall timer	2291,4		kr 158 277	2291	643	1 473 374	1 631 651
Ole Widar Saastad												
Andreas B. Skau												
Gard Thomassen												
NTNU	Total varighet, uker	100,0	Timer pr uke	20,7	Totalt antall timer	2066,6		kr 90 967	2067	643	1 328 800	1 419 767
Einar Jensen												
Jan Christian Meyer												
Arne Dag Fidjestøl												
UiB	Total varighet, uker	100,0	Timer pr uke	19,9	Totalt antall timer	1989,1		kr 102 978	1989	643	1 279 017	1 381 995
Alexander Oltu												
Lorand Szentannai												
Csaba Anderlik												
UiT	Total varighet, uker	100,0	Timer pr uke	26,9	Totalt antall timer	2693,9		kr 11 646	2694	643	1 732 152	1 743 797
Steinar Trædahl-Henden												
Roy Dragseth												
Sum Metasenteret								**kr 363 867**	**9 041**	-	**5 813 343**	**6 177 210**
KPMG												
Martin Rydland								kr 10 000	200	1719	343 800	353 800
Knut Kavli								kr 6 000	150	1719	257 850	263 850
Halvor Oseid								kr 6 000	100	2063	206 300	212 300
Christine Strøm Sandtangen								kr 0	50	2313	115 650	115 650
Sum KPMG								**kr 22 000**	**500**	-	**923 600**	**945 600**
Total Project Cost								**kr 529 867**	**14 562**	-	**12 831 320**	**13 361 188**

Reisekostnad for Sigma2/Uninett er meget enkelt stipulert til 8 reiser for key personell til 3000 pr tur og 4 turer for mindre involverte