Glenna Nordic Cloud

Document identifier:	16-57-02-Glenna-Nordic-Cloud-Final-Report
Date:	**23/11/2016**
Activity:	**Final Report**
Lead Partner:	**CSC**
Document Status:	**FINAL**
Dissemination Level:	**PUBLIC**
Document Link:	https://wiki.neic.no/int/Glenna

Abstract

Final report of the Glenna project Feb 2015 – Aug 2016. The report discusses the results and achievements of the project and gives recommendations for future work.

	Name	Partner/Activity	Date
From	Dan Still	CSC	03.09. 2016
Reviewed by	Michaela Barth	NeIC	03.11. 2016
Approved by	Martin Bech Andreas Hellander Hans A. Eide Magnus Gislason Vera Hansper Michaela Barth	DeIC SNIC UNINETT Sigma2 CSUI CSC NeIC	22.11. 2016

Document Log

Issue	Date	Comment	Author/Partner
0.9	03/09/2016	Draft	Dan Still/CSC
1.0	13/09/2016	Complete version	Dan Still/CSC
1.1	23/11/2016	Final version according to SG comments	Dan Still/CSC

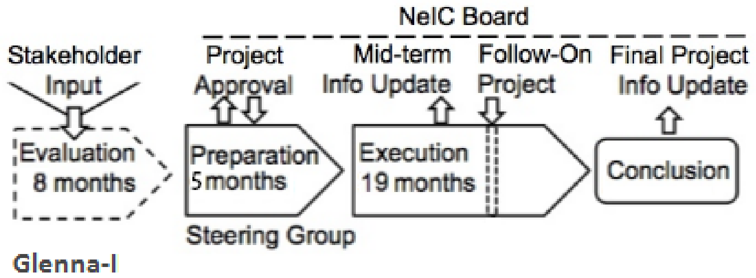
Table of Contents:

Introduction

In 2014 all five Nordic NeIPs signed a collaboration agreement on a common Nordic Cloud project. The project, which was Glenna, started Sept. 2014 and was intended to run for two years.
Glenna (which is an Icelandic name meaning "Opening in the clouds"), set out to try to create a Nordic federated cloud service driven by the needs of Nordic researchers, with a specific focus on enabling knowledge exchange and setting best practices on managing cloud services.
The founders of the project had the vision that sharing cloud resources in the Nordic countries could, if done right, enable easier forms of research collaborations. Instead of moving large amounts of data between countries the analysis could be done closer to the data.
Ideally, having a mechanism for sharing cloud resources would also enable evening out the peaks and valleys between resource demand and capacity at the individual sites. On the technical side, sharing best practices for cloud environment administration would reduce the work needed in each country. Collaboration and information sharing would also have positive implications on security and a wider scope for development.
The Glenna project has also had the ambition to create a fair share marketplace of services for scientific collaboration within the Nordic countries. The results of the Glenna project would support multinational research programs by making it easier to use and fund services provided by national resource centers. A future Nordic cloud would simplify compensation of possible resource usage imbalances between countries and be compensated by a central entity e.g. NeIC or some other organisation. In addition, a Nordic cloud marketplace could cater to projects with external users - e.g. industrial or non-Nordic users.
The Glenna project was also seen as a potential vehicle for interfacing towards European initiatives for Federated cloud infrastructure development and deployment.
In the following sections we will present the results and discuss potential future work.

Description of Glenna Goals and Objectives

The Glenna planning committee started out drafting a project directive to be used as the foundation of the project plan[1]. The project subsequently organized around six work packages, each designed according to the project's objectives. The work packages are listed in Appendix A.



The explicit goal of the Glenna project according to the project directive was to share knowledge and set best practices on managing cloud services and to create a Nordic federated cloud service, driven by the need of the Nordic researchers; with the following objectives:

1. Enable Nordic researchers to run their experiments and manage their data on any Nordic Cloud resource
2. Enable easy access through the Kalmar2[2] federated trust service
3. Share technologies to improve quality and security of cloud services
4. Share user experiences on a Nordic level to improve quality and to increase the available set of services
5. Share cloud administrative work – improving the service availability to the users
6. Enable data sharing (enabling new research) and – increasing overall availability and security of data (avoiding data loss)
7. Create a resource sharing solution to simplifying the usage and sharing of Nordic Cloud resources
8. Enable billing and accounting within the Nordic Cloud – to create a fair sharing of resources and funding. This will also simplify for external funding of research.

Traditionally cloud computing is often categorized in terms of service models. The project directive did not limit the project to a specific selected set of models but, in practice, work in

[1] https://wiki.neic.no/wiki/Glenna#Documents

[2] www.kalmar2.org

Glenna has focused on IaaS (Infrastructure as a Service), SaaS (Software as a Service) and PaaS (Platform as a Service).
The working group initially identified a set of services in different countries and has focused on enabling these services for academic use throughout the Nordics.
We believe that the selected infrastructures in Glenna will show how already existing services could be successfully provided as a foundation for a Nordic research e-infrastructure. Instead of nationally restricted stand-alone infrastructures, the Glenna project shows the way towards a solution of integrated platforms that are nationally maintained but deliver services to end users in all the Nordic countries.
During the course of the project there were a number of changes to the project plan, due to competence changes in the working group and reacting to new requirements and opportunities. The most significant was the addition of WP1 cloud storage. Furthermore, openly formulated T4.2 was integrated into T4.1. T3.6 Knowledge sharing between the participating centers was moved to WP3 from the original WP1. T2.4 was deemed no longer relevant since the services participating all have their own interfaces.

Project Progress and Results

Given the objectives, the working group set out to investigate the status of cloud computing at the participating centers in early 2015. Most of the countries had national cloud initiatives on-going or were in a start-up phase and particularly the IaaS OpenStack initiatives SNIC Science Cloud (SSC) in Sweden, UH-Sky in Norway and cPouta in Finland were expected to provide potential to function as future platforms and basis for further collaboration. Later on the Danish DeIC data service and Icelandic Seafile initiative were added to the set along with the Lifeportal bioinformatics (SaaS) service at UiO, Norway and the Pouta blueprints framework at CSC, Finland.
As was to be expected, the maturity of the national cloud initiatives varied and Glenna turned out to be an ambitious project considering the fact that all of the national cloud initiatives mentioned above were under heavy development.
Nonetheless, the sharing aspect of Glenna (objectives 3, 4 and 5) has served the national initiatives well. Glenna staff has had an active channel for collaboration and discussing technical issues and the Glenna team has worked together on proposing requirements and policies for operating a cloud infrastructure.
NeIC funding has also been instrumental in enhancing the development of the services by enabling individuals at the centers to explicitly work on cloud related technologies.To put this in concrete terms we claim that the CSC cPouta IaaS service has improved 20% more than it otherwise would have, due to the Glenna channelled funding and the talented, Glenna funded individuals, working on cPouta. Similar claims can be made for the other countries although explicit percentages can be hard to estimate. In the case of the SSC, national base funding is not really covering front-line development, while it certainly can add to a more sustainable infrastructure.

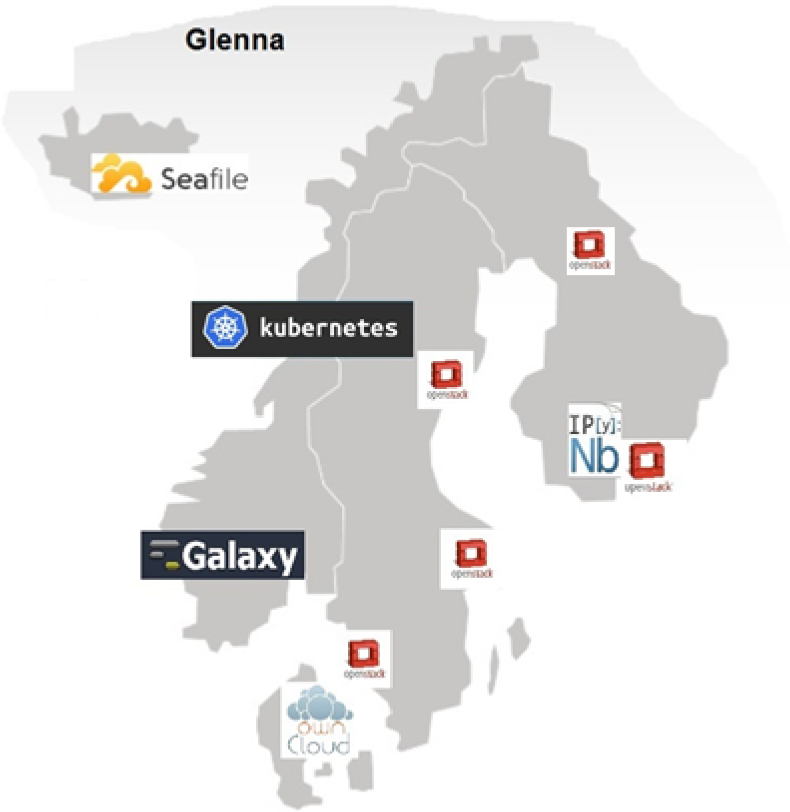
Since single-sign-on (SSO) is an important component of Glenna, funding has forced the centers to take an active look at implementing SSO in their clouds, something that otherwise would not have taken a high priority.
Furthermore sharing experiences has a “trust building” component attached and in the Glenna case a concrete (unplanned) outcome is exemplified by the letter of intent signed between SNIC on behalf of SSC and CSC which is a document formalizing future Finnish-Swedish collaboration beyond the horizon of the Glenna project.
In practice the intention is to explore what CSC could do for the SSC and vice versa and in the process aim for cost efficiency in development.
Objective 4 has received attention in the form of two use cases, the first one formed together with a consortium of the Norwegian, Swedish and Finnish met offices Met.No, SMHI and FMI and the second a consortium formed by researchers at Uppsala University, Helsinki University and the University of Iceland.

Early on it became evident that in order to address objective 1), federated SSO would be a prime target of the Glenna activities. As indicated by objective 2) the vehicle chosen to deliver results was the Kalmar2 which is a confederation of the academic identity federations in the five Nordic countries. For the Glenna cloud services SSO is provided through Kalmar2 and at the present moment (Sept 2016) two services, the data.deic.dk data cloud and Lifeportal are fully accessible from institutions in the Nordic countries provided the institutions (IdP) allows access to the services. Here the project had the lucky opportunity to stand on the shoulders of giants: Some of those services have been developed nationally with considerate amount of time and funding, so opening them up to a broader Nordic usage makes perfect sense in order to enlarge the user space and to potentiate research gain.

More services are on their way, SNIC cloud resources, UH Sky resources and CSC cPouta resources are accessible on a national level but are not yet made available for cross border access. In Iceland UI is also considering federated SSO to the university cloud data service. The current services are listed and described on the web page:

https://neic.nordforsk.org/activities/glenna/

The map below indicates the geographical location of the services.



Given the project’s objectives, this web page can be characterized as the primary deliverable. The working group has high hopes that future projects and activities will enhance the list of available services.
Furthermore each Glenna work package has produced deliverables. The full set can be found at:

https://wiki.neic.no/wiki/Glenna

The working group believes Glenna has a strong foundation in the areas representing cloud storage (WP1), VM management and IaaS configuration (WP3) and SaaS and PaaS development (WP4).
However the final target, i.e. objective 8) “Enable billing and accounting within the Nordic Cloud”, remained elusive due to the immaturity of the national cloud initiatives and this is reflected in the areas that deal with federations and billing and accounting (WP2 and WP5). In the beginning of the project only the CSC cPouta IaaS cloud could be said to represent a production quality service, and none of the infrastructures addressed during the project (including cPouta) could provide even rudimentary billing functionality. Obviously the lack of monitoring and accounting functionality has impacted the opportunities for Glenna resource sharing policies, but one of the working groups key messages is that a key issue a future contractual framework within the Nordics will have to address, is the issue of adequate

service levels. The project presents a contractual template for how such a service level agreement (SLA) could look like in Glenna (WP5 deliverable 5.1).
The rationale is that user support services will be critical to the resource sharing programs performance and effectiveness providing access to shared resources and therefore the centers will be required to provide user support services of high quality defined in an SLA. Regarding cloud resource sharing the Nordic Cloud working group conclusion is that

1. The production services will be provided by the national centers or other service providers
2. The services, which are intended to be shared, are acquired centrally and contractually bound to a single entity (e.g. NeIC or affiliated entity).

The Glenna team remains very optimistic regarding the sharing of cloud resources in the Nordics. As more services come online and are easily accessible, there will be an increased momentum towards collaboration.
Here it is important to note that developing and funding these services is very expensive. The combined net worth (R&D and operations) of just the current Glenna services likely exceed 50 million NOK which may be a conservative estimate. Running them professionally requires a team of dedicated experts and in terms of Nordic cloud expertise, the Glenna experience is that of severe scarcity at the centers, due to heavy demand from industry. Sharing resources would obviously be very valuable, but requires addressing political hurdles such as VAT issues etc.
The need for resource sharing is clearly demonstrated in the Meteo use case where a fully functional weather code (AROME) has been scaled down for a single CPU, but retaining its functionality (MUSC). The code has been cloudified in a collaboration between Glenna team members (WP3) and experts at FMI, SMHI and Met.No with development of the code using CSC's cPouta and final testing and evaluation in Met.No:s private OpenStack cloud. Another case is the cloudification work of the LHC ALICE software now installed on CSC's cPouta OpenStack cloud. The ALICE software used to run as a grid implementation on a dedicated Linux cluster but currently runs on virtual machines in cPouta.

The use case provides a good example of how a collaboration can be set up and actually achieve a working solution suitable for research use in the Nordics and elsewhere. Resource sharing will continue as a NeIC activity in the form of the Dellingr project.

A overall breakdown of the project cost according to invoices received by the NeIC office as of November 2016 can be found in Appendix B.

Work Package Review

In Glenna WP1 - cloud storage - work has focused on providing a “dropbox” type cloud storage component for cloud using the DeIC ownCloud based service data.deic.dk, as the platform of choice. The service is primarily intended for working with and sharing active research data as well as for safe-keeping of large datasets. Such data can be put in an area that is specifically not synced, i.e. not copied to desktops, laptops and mobile devices by the sync client. Instead the data can be accessed and manipulated via the web interface, file transfer clients or the command line.
Work in WP1 has focused on enabling federated Nordic-wide access via Kalmar2 to the service and on improving the overall functionality. The service is built with open-source software from the ground up: FreeBSD, ZFS, Apache, PHP, ownCloud+apps.
DeIC is actively engaged in community efforts on developing such apps, and some are available as previews of things to come - including apps for getting large amounts of data into the system and tagging with metadata. The servers are attached directly to the 10-Gigabit backbone of "Forskningsnettet", i.e. wired up/download speeds from Danish academic institutions are in principle those of a USB hard drive.

The work in WP2 - Federated resources - has focused around enabling the Nordic researchers to run their experiments and manage their data on Nordic Cloud resources through the Kalmar2 federated trust service. The group has been particularly successful collaborating with UiO and DeIC personnel in enabling Kalmar2 as an option for access to the UiO Lifeportal bioinformatics service and the DeIC datacloud. Also the Blueprints service at CSC is accessible through federated AAI but at this point, only for Finnish HAKA users.
To understand the Nordic AAI landscape better the working group set out to collect information on the candidate services
https://wiki.neic.no/int/Glenna/WP2_Federation_of_Resources

The project’s primary contribution to the Nordic computing landscape is a number of cloud services ”loosely” linked to the web page:

https://neic.nordforsk.org/activities/glenna/

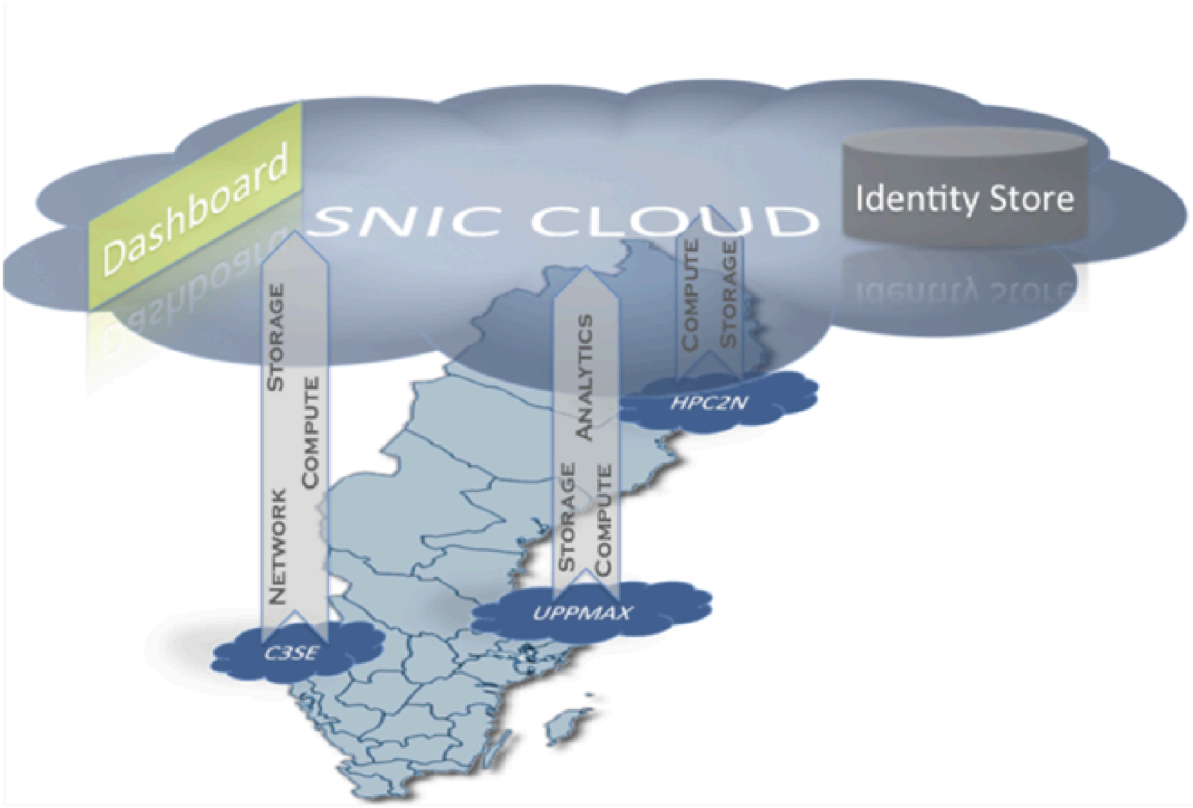
These services are different in nature (SaaS, IaaS, PaaS) but can all be accessed by federated SSO.

It should be pointed out that the services all have a long history that precede the Glenna project. The project’s efforts have focused on enabling access to the services.

Work in WP3 - VM management - focused on tools for configuration management and automated building and mechanisms for creating customised cloud images. In 2015 we worked quite closely with the PM of the UH IaaS project in Norway giving the working group valuable information on how the project had configured the UH IaaS cloud.

https://wiki.neic.no/w/int/img_auth.php/6/60/UH_IaaS_Documentation_0.1.0_Norcams.pdf

The Swedish SNIC Cloud project has provided valuable input on how to configure OpenStack for federated access. SNIC Cloud has a distributed architecture with OpenStack instances in Gothenburg, Uppsala and Umeå (depicted below)



Security was also a particular area of interest in WP3. As with any infrastructure, OpenStack based cloud deployments are vulnerable to security threats. The OpenStack security guideline identifies four elements in the security domain - users, applications, servers or networks that share common trust requirements and expectations within a system, where applications, servers and networks are categorized as virtual infrastructure.

Information about the security mechanisms of the participating cloud service providers using a questionnaire was collected from the participating centers. The questionnaire addressed the following domains -

- User and Access Control
- Network and System Environment

- Logs, Data and Backup
- Virtual Machines
- System and Service Security Process and Standards

https://wiki.neic.no/w/int/img_auth.php/7/75/Summary_of_the_responses_to_the_Security_Analysis_Questionnaire.pdf

The work in WP4 - SaaS and PaaS development - has concentrated on evaluation of technological platforms suitable for data analytics. Although a well defined, single production service for large scale data analytics is not in place (and this may or may not be desired considering the very rapid movement on the technology side) selfservice stacks developed in the WP are now available for users in the Nordics in need of Hadoop or Spark clusters, deployed easily as virtual private resources in the SNIC Science Cloud, cPouta, and more generally any Kubernetes cluster.

The following services have been developed and are/can be offered to Nordic scientists (see below for background) if support for their continuous maintenance/development is maintained:

1. Self Service automated deployment of virtual private Spark clusters over Kubernetes developed at UNINETT Sigma:

https://github.com/UNINETT/kubernetesapps

These can also be deployed in the SNIC Science Cloud and cPouta using the following tools:

https://github.com/SNICScienceCloud/catalystcloudorchestration
https://github.com/SNICScienceCloud/kubernetesapps (fork of Gurvinder Sing's code adapted for SSC)

2. OpenStack Sahara (Official OpenStack Data Processing as a Service):
Deployed by admins in SSC. Available in SSC, consumable from the OpenStack Horizon Dashboard. See https://cloud.snic.se, and usage guides https://wiki.openstack.org/wiki/Sahara.

3. cPouta Blueprints (https://pb.csc.fi) :
Inhouse developed Software as a Service from CSC to i.e. provision
Jupyter notebooks for easy development and sharing of code/interfacing to Spark Clusters.
https://github.com/CSCITCenterforScience/Poutablueprints

These developed resources can form the backbone of future Nordic collaboration on

Data-intensive computing, data analytics and sharing/presentation of results. The ecosystem is rapidly evolving and while Apache Spark (after thorough technical considerations during the WP) currently has emerged as the most likely candidate for a production resource, continuous technical evaluation will be needed also in the future. Work is in progress to provide Kubernetes as a Service (prerequisite to the services developed at UNINETTSigma) in SSC and cPouta. There, OpenShift should also be considered an alternative, and some work evaluating it has been conducted at CSC.

Work in WP5 - billing and accounting policies - focused on policies, SLA design and discussions on resource sharing and future billing and accounting procedures based on the Implementation in the Swedish SUPR and SAMS for the SNIC Science Cloud.

A well-defined SLA is a cornerstone for a successful relationship between the service provider and the customer and if services as the ones listed above in the Nordics will be provided outside the national borders a contractual framework will have to be established in order to ensure a predefined level service quality.

https://wiki.neic.no/w/int/img_auth.php/f/fe/NeIC-Glenna-WP5-1.pdf

https://wiki.neic.no/w/int/img_auth.php/6/64/NeIC-Glenna-WP5-4-1.pdf

Resource sharing conclusions:

- For resource sharing, the participating centers need to come together and cooperate in two broad areas:
  (a) Developing the collection of services
  (b) Developing the mechanisms for easy access to the services

- Developing the shared resources is of great importance and central to the concept of resource sharing. In developing the shared resources, the focus is first on eliminating duplication in the development of new services to the extent possible.
- Thereafter, the initial focus should be on the selection and definition of services, which the participating centers agree to share, and later on funding and developing this services.
- In conclusion: the efforts of the participating centers in developing the shared resources should be directed in two distinct directions: 1) rationalization of the services to be provided, and 2) development of the services.

WP6 activities have included workshops and training sessions, documentation and general dissemination of the project's achievements. Target audiences were scientific communities, (biomedic, meteorology, high energy physics), potential users of IaaS and big data analytics services as well as the general public in the Nordic countries. Marketing material includes project web site, flyers, background documentation, social media and press releases.

Workshops and Presentations 2016

- Glenna Workshop at Kastrup Airport on March 15th, 2016.
- Glenna Analytics WorkShop at CSC Finland on May 19th 2016.

- ECMWF Cloud Session May 2016
- DataCloud Nordic 2016 in Stockholm,
- ECMWF HPC’16 conference (meteorology U.K. event) October 2016
- Nordunet 2016 Conference (Helsinki)

Use Cases

In 2014-2015 letters of interest were submitted to NeIC proposing interesting research topics for starting new collaborative activities.

Two of the proposals were in line with the Glenna objectives and are presented below.

Meteo MUSC Use Case
Lisa Bengtsson, Swedish Meteorological and Hydrological Institute (SMHI)
Nico Budewitz, Norwegian Meteorological Institute (Met.No)
Niko Sokka, Finnish Meteorological Institute (FMI)

HARMONIE is a jointly developed atmospheric model system number developed by a number of European countries, including all the Nordic countries, which is used in these countries both as an operational weather prediction model and as a climate simulation model. MUSC (Modèle Simple Unifie Colonne) is the HARMONIE model system single column model. At present, MUSC is maintaining the international HIRLAM and ALADIN consortium of co-operation and it is also available for general research purposes.

In recent years, MUSC software has been widely used in development of the HARMONIE model parameterizations both at meteorological institutions, and in academia. The operational weather prediction model at the Nordic Meteorological Institutes HARMONIE AROME is one of MUSC's full-scale three-dimensional equivalents.

In order to be fully compatible with the corresponding full-length HARMONIE model MUSC software includes a three-dimensional model of the entire source code, about two million source code lines written in different programming languages, as well as a number of dependencies on external scientific computing and system libraries. Research and educational use of MUSC i.e. installing the software for traditional server platforms have often proven to be a quite laborious and time-consuming task. It has been found that in a typical user scenario, where a scientist or a university student installed MUSC on a workstation system, too much time was spent on the installation and configuration of the system. MUSC-runs of the reference results in a variety of platforms has been challenging due to differences in numerical computing platforms resulting in different outcomes. Also laborious input and output file transfers to distribute the output results among researchers were needed.

The results of the MUSC cloudification has greatly improved overall performance in the installation and configuration as using a cloud image leaves more time for actual research. This has also eliminated platform induced differences making inter-comparison between different user experiments straightforward. Input data sets are available in the cloud storage i.e. no tedious data transfers.

This use case paves the way towards an open science type of use of the HARMONIE system, which in turn addresses the growing need to access this system due to emerging open NWP data in Nordics. It also demonstrates a way to improve the whole HARMONIE system.

Scientific Application as a Service (SaaaS) Use Case

A Hellander, S. Toor, P. Eeerola, H. Jonsson, T. Linden
Uppsala University, University of Iceland, Helsinki University

The case aims to better understand how scientific applications should be designed and implemented for secure and efficient execution in hybrid cloud environments.
Questions included:

- How to design Master/Slave hybrid setups where VMs reside in or migrate between different clouds?
- Where should the multi-cloud logic reside in such hybrid cloud applications - at the application or IaaS level?
- How to build elastic scientific applications in a sensible manner?
- Can runtime tools be developed to understand application performance in (hybrid) cloud environments?

Glenna resources have been used to
(a) develop and host an OpenStack-enabled trial deployment of StochSS:
https://try.stochss.org
(b) look at hybrid deployments for master-slave setups, a detailed discussion of which can be found in the paper MOLNs: A Cloud Platform for Interactive, Reproducible, and Scalable Spatial Stochastic Computational Experiments in Systems Biology Using PyURDME.

A case-study of “cloudification” of a legacy application, EON, has also been conducted. The findings are discussed here.

Glenna - Lessons Learned

The Glenna project has been hampered by staffing issues from the start. Personnel turnover has been significant, for example, in Sweden over just a few months in the summer of 2015 the project lost all personnel (to industry) including the steering group member. Similar situations have occurred in Denmark, Norway and Finland and almost 100% were replaced due to the pull from lucrative jobs in the commercial sector.
The steering group has also replaced three of its five members within 20 months.
The project has managed to navigate these challenges by having the luck of keeping a baseline of highly talented individuals, albeit a changing one, and by the efforts of the Glenna steering group and the NeIC coordinator assigned to the project.

Recommendation: There are no reasons to believe the pull of the job market will subside in the near future and a future follow-up Glenna project will have to account for this fact.

During the Glenna planning phase the national e-infrastructure providers gave input in the form of desirable areas of interest for the project plan and this input was subsequently used as the basis for the Glenna work packages (WP). The notion was that it would be easier to progress in individual WP:s with expertise tailored towards the WP task area, but staffing shortages is very challenging for this model of work since individual WPs will from time to time have too few participants. Cloud computing is a fast changing environment and work performed early on has a tendency to get dated in a two year effort.

Recommendation: For added flexibility, a future project should look at defining individual deliverables and assign personnel accordingly.

On the positive side the Glenna project has really managed to open up services of significant value to the Nordic research community. The NeIC funding has really forced the national provider in a new direction by the impact of collaboration and the set of shared objectives. Provision of services that are really usable by scientists in the Nordics is not a new thing but in terms of cloud services the team believes we have broken important ground and in particular in the area of big data, analytics and IaaS we believe we have a really unique offering.
The Glenna project will be prolonged until the end of 2016 and during the final four months the team intends to focus on disseminating the results.

The collaborative aspect is very powerful and spawns new opportunities that otherwise would not occur and the cost saving aspect in development should not be overlooked. Running and developing cloud services is very expensive. The Glenna project provides a model for how development and potential future resource sharing can be achieved.

Recommendation: continue collaboration - the value of future knowledge transfer and cost savings will well be worth the investment.

Appendix A: Glenna Work Packages and Deliverables

Note: Please note, that many of those deliverables were already due early in the project and might therefore no longer be relevant.

WP1 Cloud Storage:

- **Subtasks merged into:'** NeIC-Glenna-WP1_part_1.pdf NeIC-Glenna-WP1_part_2.pdf (Aug 2016)
- Full doc: https://data.deic.dk/shared/1076d5d5354a5a36e84b5f39f177ee10

- **T1.1 - Integration**
  - Integration of storage facility in federated resources (Kalmar2) Tailored access through Glenna portal or equiv.
  - Identity management and accounting/billing according to Glenna scheme.
  - EUDAT2020 collaboration: B2Drop technology transfer and follow-up.
- **T1.2 - Performance**
  - Performance optimization.
  - By horizontal scaling (sharding) obtain improved bandwidth and lower latency.
- **T1.3 - Evaluation of staging**
  - Evaluation of techniques for staging to Glenna compute resources.
  - Evaluation of techniques for enhanced access to resources and seamless integration through identity recognition, authentication and automated data transfer pre and post computation.
- **T1.4 - Subsystem evaluation**
  - Performance measurements.
  - Effects of sharding and other means of scaling.

WP2 Federated Resources:

- **T2.1 - Federation management requirement specification. Task defining the requirements for federation management**
- NeIC-Glenna-WP2-1.pdf (Sept 2015)
- Collection of materials of WP2: Federation of Resources: https://wiki.neic.no/int/Glenna/WP2_Federation_of_Resources
- **T2.2 - Architectural design of the federation management support**
- NeIC-Glenna-WP2-2.pdf (Nov 2015)
- **T2.3 - Federation management and identity management. Develop the technology for managing federation of clouds, solve issues related to billing and account management**
- NeIC-Glenna-WP2-3.pdf (March 2016)
- WP2-3.odt
- **T2.4 - (Not Relevant, merged into T2.6) Provisioning interfaces. Providing web-based user interfaces to allow access to the Glenna platform**

- **T2.5 - Managing security policies within the federations. The task will develop strategies for the enforcement of federated security policies, and provide implementation solutions**
- NeIC-Glenna-WP2-5.pdf (Dec 2015)
- **T2.6 - Resource provisioning. The purpose of this task is to provide components for resource provisioning selecting resource providers capable of fulfilling user needs**
- NeIC-Glenna-WP2-6.pdf (Aug 2016)

WP3 VM Mgmt (security, image banks, configuration mgmt, automated building):

- **Subtasks below merged into:'** NeIC-Glenna-WP3.pdf (Aug 2016)
- https://data.deic.dk/shared/27cbdbc8690bb5a90185d9ab4b693d91
  - except **T3.5 Glenna_Security_Questionnaire**: please see results below
- **T3.1 Design and implement tools for configuration management and automated building**
- Norcams: UH-IaaS Norway Documentation 0.1.0 pdf
- UH Sky repository at GitHub https://github.com/norcams/himlar
- CSC internal docs https://wiki.csc.fi/wiki/CloudComputing/CCCPDeploymentProcess
- Glenna WP3 ReadtheDocs http://glenna-nordic-cloud-environment.readthedocs.org/en/latest/
- **T3.2 Create customized image banks or "image stores" which can be dynamically provisioned**
- Diskimage Builder in cPouta .doc
- **T3.3 - Controlling Access in Virtual Infrastructures. access control for the core Glenna infrastructure. It includes secure access to virtual machines and technologies for securing hypervisor and guest OS:s.**
- Security of Virtual Infrastructure .doc
- **T3.4 - Security architecture and specification. Develop the specification and architecture of the security components in Glenna.**
- Glenna Architecture: .pdf
- Glenna Cloud Security Control Matrix: .doc
- **T3.5 - Security Analysis, Test and Evaluation. This task will carry out the necessary analysis, testing and evaluation of the security mechanisms for Glenna.**
- Glenna_Security_Questionnaire :
- https://docs.google.com/forms/d/1ImwkmZhGfOyId2-SIXPbLJIAyt2CCfkCRrkMcPiiiFY/viewform?edit_requested=true
- Security_Analysis_Questionnaire_for_Cloud_Service_Providers_in_Glenna_Google_Forms.pdf
- Summary of Responses to the Security Analysis Questionnaire :
- Summary of the responses to the Security Analysis Questionnaire.pdf
- **T3.6 - Knowledge sharing between the participating centers (moved to WP3 by SG decision, June 2015)**
- *Please consult meeting minutes, ws materials newsletters etc.*

WP4 SaaS and PaaS development (initial focus on data analytics (Hadoop, Spark))

- **Subtasks below merged into:'** NeIC-Glenna-WP4.pdf (Aug 2016)
- https://data.deic.dk/shared/0257c5d24c0722649c36f27016f4a7f0
- T4.1 - Data Analytics (DA) as a service, including development (PaaS) services.
- T4.1.1 - DA Technology Roadmap - deciding on open source data analytics stacks for data analytics pipelines. Investigate options for SaaS and PaaS solutions for the Glenna infrastructure, building on Glenna partners experiences with e.g. Spark, Mesos, Hadoop 2.x. Experiences include user interactions and easy-to-use UI and visualization. Investigate data storage solution to support data locality objective to process large data sets.
- T4.1.2 – Draft Architecture - preparing a draft architecture for the DA services, and defining needed pilots for evaluation
- T4.1.3 – Validating and updating the architecture through PoCs - testing the architecture in an agile way, with users. Deciding on list of base services to deliver.
- T4.1.4 - Roll out of base services, and update of roadmap.
- T4.2 - Candidate (to be decided during year one) area to deliver as SaaS and PaaS, building on the experiences from T4.1.
- T4.3 - Pilot a PoC service to enable sharing data as well as data processing pipeline among researchers from Glenna Partners.
- T4.4 - Management and maintenance of above SaaS and PaaS solutions.

WP5 Policy / SLA / Legal:

- **T5.1 - Requirements for SLAs in Clouds. This task will define the requirements needed for SLA management in Glenna.** (Aug 2016)
- Glenna draft service description: .doc
- NeIC-Glenna-WP5-1.pdf (Aug 2016)
- **T5.2 - Definition of Quality of Service. This task will define QoS parameters at different levels stack. Availability, Performance, and security requirements for the infrastructure components will be defined, covering network, compute and storage**
- NeIC-Glenna-WP5-2.pdf (Feb 2016)
- **T5.3 - Monitoring. The purpose of this task is to develop a monitoring solution to measure performance relative to the agreed Glenna SLA levels**
- NeIC-Glenna-WP5-3.pdf (Nov 2015)
- **T5.4: - Billing and Accounting. This task will formulate a policy and design components for accounting and charging of the resources used across the Glenna service providers**
- Introduction and Recommendations: NeIC-Glenna-WP5-4.pdf (Apr 2016)
- SUPR/SAMS Integration: NeIC-Glenna-WP5-4-1.pdf (Apr 2016)

Use Case: Meteo MUSC

- Partners: Finnish Meteorological Institute (FMI), Norwegian Meteorological Institute (Met.No), Swedish Meteorological and Hydrological Institute (SMHI)

- FMI: CloudMUSC_Usage_by_Niko_Sokka.pdf
- Met.No: Report_by_Nico_Budewitz.pdf
- SMHI: Clouds_in_the_cloud_by_Lisa_Bengtsson.pdf

Use Case: SaaaS

- UseCase-OpenstackEON.pdf

Appendix B: Project Cost Estimate

Glenna Cost Estimate* NeIC				
*All costs may not have been billed as of Nov 2016				
Year	**Salary**	**Travel/meeting**	**Use Case Costs**	**Total cost**
2014	kr 116,715.00	kr 5,172.00		kr 121,887.00
2015	kr 2,214,565.00	kr 102,472.00		kr 2,317,037.00
2016	kr 1,729,071.00	kr 150,535.00	kr 262,500.00	kr 2,142,106.00
Total	kr 4,060,351.00	kr 258,179.00	kr 262,500.00	**kr 4,581,030.00**

All costs are given in Norwegian crowns.