NORDUnet
Nordic Gateway for Research & Education

Arctic Connect R&E

- Boosting Global Research and Education
- Northern Development and Resilience
- Data Economy stimulating European Recovery
- Digital Sovereignty for Europe

Enabling Global Terabit Connectivity for Research, Development, Innovation & Education through the Arctic

Executive Summary

Arctic Connect R&E is a Northern European initiative to acquire a dedicated fiber pair through the Arctic, bringing Research, Development and Innovation (RDI) and Education sectors substantially better connectivity between Europe and Asia and North America.

The RDI & Education sectors are facing a data explosion, which means a rapidly increasing demand for efficient data infrastructures. In addition to addressing the increased capacity need of existing intercontinental collaborations, **Arctic Connect R&E** will spur new innovative collaboration models and support the rapid digital transformation in the RDI & Education fields.

Arctic Connect R&E will be a strategic investment into fundamental digital infrastructure that will support and advance regional development of the Nordics and Northern Europe. Additionally, it will connect all of the European R&E networks and thus support European RDI & Education sectors and European recovery.

The Arctic Connect Subsea Cable System, on which **Arctic Connect R&E** will be implemented, will be the first cable system between these continents taking this shorter route through the Arctic. Europe will play a major role in the Arctic Connect Subsea Cable System project and therefore the project strengthens European digital sovereignty. **Arctic Connect R&E** will be among the first intercontinental fiber pairs in history owned and managed by the research and education communities, which will bring great benefits in terms of cost, bandwidth, latency, and resilience.
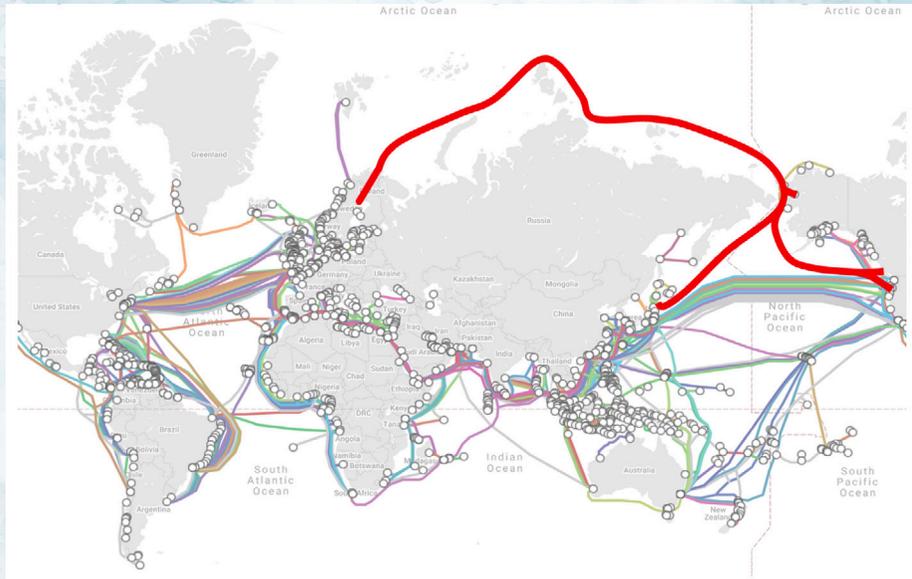
Arctic Connect Subsea Cable System's cable route through the Arctic, showing the uniqueness of the route
(plotted on the TeleGeography's Submarine Cable Map)

Arctic Connect Subsea Cable System - a pioneering project connecting Europe to Asia and North America

The Arctic Connect Subsea Cable System is a joint European, Russian, and Japanese initiative to create a new subsea cable system through the North-East passage in the Arctic Ocean, connecting Northern Europe to Asia and North America. This route is unique and is for the first time used for a submarine cable system. The Arctic Connect Subsea Cable System will bring unprecedented new resilience for Europe's connectivity towards both Asia and North America, and the rest of the world. This dedicated fiber system will have its European cable landing stations in Northern Norway and Finland, with connections further southwards through Finland, Norway, Sweden, and Denmark reaching the rest of Europe.

The Arctic Connect Subsea Cable System is developed, realized, and operated by Cinia Ltd., a Finland-based network and software solutions provider established in 2015, and MegaFon LLC. Cinia owns and operates roughly 15,000 kilometers of fiber network in Northern Europe including subsea cable systems like C-Lion1. MegaFon is the second largest mobile and network operator in Russia.

The Arctic Connect Subsea Cable System consists of separate European and Russian subsystems. Arctic Connect R&E will be implemented on the European subsystem.

Arctic Connect R&E - a fiber pair dedicated to Research & Education

Arctic Connect R&E is an initiative to acquire a dedicated fiber pair for Research & Education on the Arctic Connect Subsea Cable System. It is led by NORDUnet, the pan-Nordic Research & Education Network, and the Nordic National Research & Education Networks, in close collaboration with GÉANT, the pan-European Research & Education network. It will enable Nordic and European RDI and education sectors to build sustainable development, new collaborations and innovations.

Arctic Connect R&E is planned to be one of the anchor customers of the Arctic Connect Subsea Cable System, thereby contributing to the realization of this system.

"The Nordics are in a unique position to pioneer a fiber pair for Nordic and European Research and Education, on a unique route to Asia and North America. This project will enhance the collaboration landscape between partners in The Nordics, Europe, Japan, Canada, and the US, and in addition boost Nordic development and significantly enhance European digital sovereignty."

René Buch (CEO, NORDUnet)

Boosting Research Collaborations

Leveraging investments and boosting existing collaborations

Arctic Connect R&E will leverage substantial investments in world-leading research infrastructures currently under construction in the Nordics, such as the LUMI[1] EuroHPC supercomputer facility and the European Spallation Source (ESS [2]). For LUMI and ESS, **Arctic Connect R&E** will bring unprecedented levels of global connectivity, enabling access to these facilities for intercontinental research collaborations. EISCAT [3] is another example of a research collaboration of great international importance that will benefit from **Arctic Connect R&E**. EISCAT is currently building EISCAT3D, a next generation radar system capable of providing a three-dimensional image of the upper atmosphere. This will be a major step forward for scientific research on near-Earth space and climate. Facilities are currently under construction above the Arctic Circle, spanning Norway, Sweden, and Finland. These major science endeavors all have active partners and collaborators in Asia, especially in Japan, and will directly benefit from **Arctic Connect R&E**.

"Genomics data is expected to accelerate disease research and improve human health. In addition to appropriate data protection measures, this development requires efficient infrastructure. **Arctic Connect R&E** can provide the potentially massive data transfer capacity that is a prerequisite for the intercontinental collaboration in genomics."

Tommi Nyrönen, Director of ELIXIR Finland Node [4]

"LUMI, one of the most competitive supercomputers in the world, will start operating in Kajaani, Finland in 2021. **Arctic Connect R&E** will vastly support the application of LUMI. The enhanced connectivity will improve collaboration between European and Asian research communities and boost the growth of the new data-intensive economy in Europe."

Jukka-Pekka Partanen, Director, CSC Data Center in Kajaani

Enabling new collaborations

Arctic Connect R&E will boost new collaboration initiatives between the continents, such as collaboration in genomic research in the framework of the Global Alliance for Genomics and Health (GA4GH). GA4GH is an international, nonprofit alliance working to enable the responsible, voluntary, and secure sharing of the growing amount of genomic and health-related data generated around the globe. **Arctic Connect R&E** will provide the essential infrastructure for new intercontinental collaborations in the context of GA4GH.

Support for cross-border data sharing

The enhanced connectivity that **Arctic Connect R&E** will bring for Europe, towards Asia and North America, through the Nordics, will bring great benefits for the European Open Science Cloud (EOSC) and other initiatives aiming at cross-border data sharing. Through **Arctic Connect R&E**, unrestrained connectivity will be available for open and collaborative ways of producing and sharing knowledge and data, cornerstones for implementing EOSC.

[1] LUMI: https://www.lumi-supercomputer.eu/

[2] ESS: https://europeanspallationsource.se/

[3] EISCAT: https://www.eiscat.se/

[4] ELIXIR: https://www.elixir-finland.org/

Supporting Global Research

Addressing Global Grand Challenges requires wider collaboration and cross-disciplinary research

Research is increasingly global, unfolding in wide international partnerships to solve the grand societal challenges of our time, such as climate change and pandemics. **Arctic Connect R&E** will substantially improve the network backbone for international collaborations and increase the necessary capacity to respond to these grand challenges. This will enable cross-disciplinary and data-intensive research, accelerating global science and improving the quality of research output.

Artificial Intelligence and High Performance Computing to boost competitiveness and well-being

Arctic Connect R&E will contribute to the future leaps in the development of Artificial Intelligence (AI) and Machine Learning (ML), and their usage for the benefit of humanity. Significant advances in High Performance Computing (HPC), combined with the massive increase of data, are key drivers for the current fast development of AI related research and Machine Learning. The convergence of these disciplines creates powerful synergies, instrumental to solve many of the global grand challenges. It can improve healthcare by predicting diseases and making diagnosis more precise. It can make agriculture more efficient, by dramatically improving weather forecasting, and it can be used to monitor the effects of climate change, just to name a few examples.

Arctic Connect R&E will enable the seamless global access to the large data sets needed for these advancements. The network infrastructure has to complement and support this significant development with even higher bandwidth, lower latency, and better reach and with improved network connectivity to other continents. **Arctic Connect R&E** will provide the critical infrastructure needed for efficient intercontinental data transfer.

In addition to enabling access to large data sets, **Arctic Connect R&E** will connect to world class HPC resources. One of the pan-European flagship supercomputers, LUMI, will be located in Finland. LUMI will be one of the world's best-known scientific instruments and leading platforms for Artificial Intelligence.

> "**Arctic Connect R&E** will take connectivity for Research and Education between Europe and Asia and North America to a next level, for the benefit of all European R&E. We are happy to see that the Nordics are taking the responsibility to contribute to making **Arctic Connect R&E** a reality."
>
> Erik Huizer (CEO, GÉANT Association)

Accelerating the Digitization of Education

Improving remote education and training

Arctic Connect R&E supports Higher Education Institutions' intercontinental collaborations by improving remote education and training capabilities. **Arctic Connect R&E** will provide Asian and North American students with better access to Nordic teaching resources at the institutions, unrestricted by time and space. At the same time, **Arctic Connect R&E** will boost European students' possibilities to attend North American and Asian universities' training, academic courses, and curricula. This does not only serve individual students and educators, but can also help in building communities and ecosystems of learning, ultimately turning learning into a an even more collaborative effort.

Next Generation Education

The next generation education will be globalized and go through a digital transformation. It will provide the means for more personalized, flexible and interactive learning models on new digital platforms that meet the requirements of the changing society. Next generation education will use for example 4-dimensional rooms with 3D remote presence of participants combined with the ability to attend teaching flexibly at a suitable time, and hence will short-circuit time and space. This will bring the ability to store learning experiences and enter them at any time. **Arctic Connect R&E** will assist this development, as this development puts massive demands on network capacity and latency.

Northern Development and Resilience - Arctic Connect R&E supporting Gravity North

Unique characteristics of the Nordics bring optimal conditions for, e.g., certain types of research, data center placement, and boosting regional development and activities. We call this Gravity North. **Arctic Connect R&E** will contribute heavily to Gravity North.

Embracing optimal conditions for research disciplines

The northernmost European region provides a unique environment with optimal conditions to conduct research that elsewhere would be very hard. This includes climate research, which involves data harvesting from both near-Earth space and the oceans to gain insight into important climate indicators. **Arctic Connect R&E** enables Nordic organizations to host scientific resources, such as large-scale scientific instruments with a global reach. The resources will be optimally reachable from both Europe, Asia and North America, with lower latency and larger bandwidth than ever before.

Boosting regional development of Northern Europe

Arctic Connect R&E supports the sustainable regional development of Northern Europe, particularly the regions of Kainuu, Finnish Lapland, Norrbotten, and Troms and Finnmark. Improving the preconditions of these Northern areas is fully in line with the aim of EU's regional development policy. **Arctic Connect R&E**

will contribute to placing the Nordics more in the center of the global Internet infrastructure, boosting IT-development and business opportunities in the region.

Leveraging opportunities for data center investments

Arctic Connect R&E adds to the attractiveness of the region for data center investments by providing world-class intercontinental connectivity. The Northern European region provides an attractive environment for hosting energy-intensive, large-scale data centers that have a minimal carbon footprint, which helps to combat climate change. This is possible thanks to the continuous availability of sustainable and low-cost hydropower energy, and a cool climate enabling easy and energy-efficient cooling solutions with the potential to reuse the waste heat. Other regional benefits include stable geological conditions, long-term political stability as well as multiple geographic options for suitable locations for data centers.

Creating increased digital activity in the Nordics

Arctic Connect R&E is instrumental in gaining substantially more data transit traffic between Europe and the rest of the world through and from the Nordics. This will increase investments in Nordic network infrastructure and in turn benefit data driven scientific and innovation activities in the Nordics, including activities that generate new data such as sensor networks for scientific purposes. These benefits can be leveraged to support the development of Europe as a whole, where the Nordic region would be an important hub along this digital highway between Europe, Asia, and North America.

The Data Economy stimulating European Recovery

The COVID-19 pandemic has had a profound impact on the global economy. European economic recovery will require substantial investments in the data economy. Data is the new fuel for economic development: According to the European Data Strategy, the value of the EU data economy is projected to increase from €301 billion (2.4% of EU GDP) in 2018, to €829 billion (5.8% of EU GDP) in 2025. This extensive growth puts a high demand on the connectivity capacity for research, innovation and education sectors. **Arctic Connect R&E** is a driver for long-term sustainable economic development, due to its vital role in meeting demand for handling large amounts of data.

Economic benefits through increased RDI activities

The international education and data-intensive research collaborations between Europe, Asia, and North America are rapidly growing. **Arctic Connect R&E** will be able to meet the continuously growing connectivity needs between these regions, which requires strategic planning well before the increased need is a reality. Intensified collaborations and new collaboration projects between the continents will support the creation of new innovations, which brings clear benefits to the economies.

Economic benefits will be further actualized through developments in science, new innovations and improved capabilities of industry to participate in research collaborations. For example, the European industries' access to LUMI EuroHPC resources combined with connectivity to Asia and North America leverages the industries' opportunities to create intercontinental research collaboration and to join RDI collaboration projects.

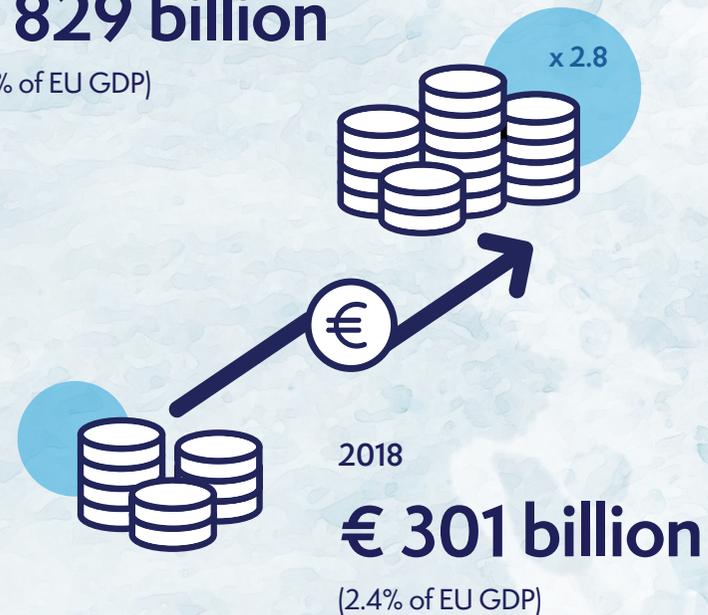### Arctic Connect R&E bringing cost-efficiency

Arctic Connect R&E is a strategic investment for the Nordic countries and Europe, with an expected life time of up to 30 years. Without **Arctic Connect R&E**, we will see an increased cost for connectivity, using the less advantageous traditional cable routes, year over year, due to the data explosion. **Arctic Connect R&E** is therefore not only the right network development step to do for the Nordics, it is also right for the European community as a whole.
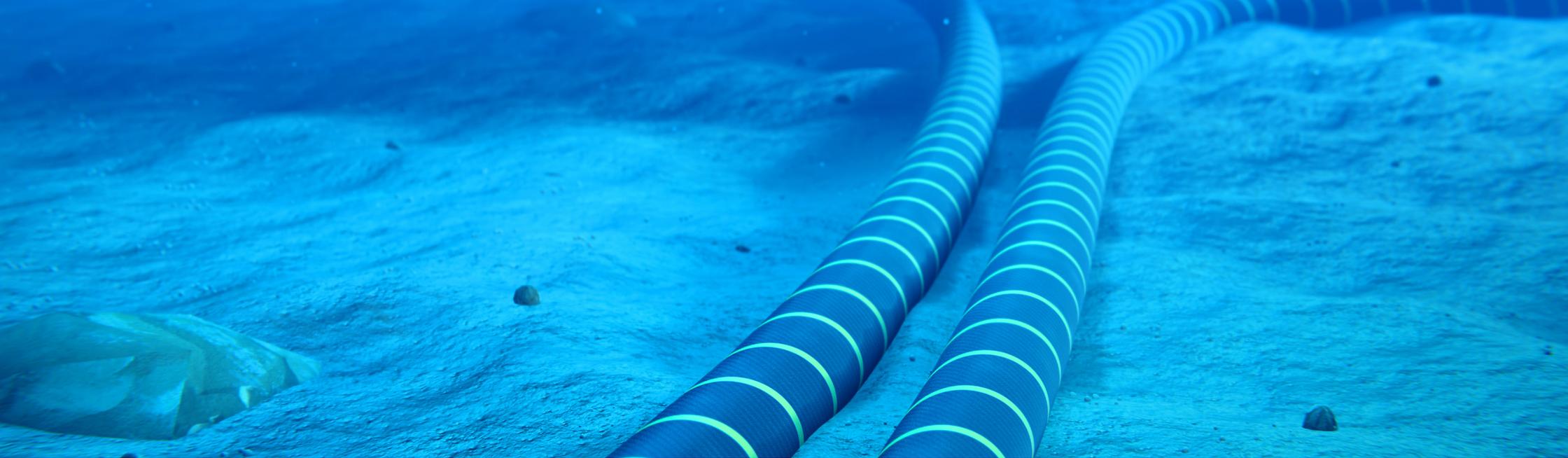
The value of data economy (EU27) [1]

2025

€ 829 billion

(5.8% of EU GDP)

x 2.8

2018

€ 301 billion

(2.4% of EU GDP)

[1] https://ec.europa.eu/info/strategy/priorities-2019-2024/europe-fit-digital-age/european-data-strategy

Digital Sovereignty for Europe

Promoting European Digital Sovereignty, European leadership and strategic autonomy in the digital field are among the top priorities on the EU agenda. The aim is to develop a competitive, secure, inclusive and ethical digital economy with world-class connectivity, based on European-led initiatives, under European control, while still promoting international collaboration in the field.

Today, Europe's essential connectivity to both Asia and North America is dependent on non-European cable systems, which puts Europe in a vulnerable position. The Arctic Connect Subsea Cable System will fundamentally change the telecommunication landscape with the construction of the first Arctic subsea cable system, which is fully diverse from existing cable corridors and independently routed through the Arctic region. This will significantly increase European digital sovereignty and influence in the increasingly critical global communications infrastructure.

For the research and education sectors, the rapid digital transformation means increased need for international data transfer. However, the concurrent data explosion in all sectors puts R&E in a vulnerable position. Having a fiber pair in full control of the R&E community would strengthen the digital sovereignty of these vital sectors in Europe, so they are not at the mercy of non-European connectivity providers.

Green benefits and the environment [1]

Arctic Connect R&E contributes to the targets of the European Commission's ambitious Green Deal initiative. In addition to supporting existing research initiatives and significantly enabling new opportunities in the field of climate and environmental research, **Arctic Connect R&E** will have direct climate impacts by reducing the need to travel, enhancing remote participation in education and research events.

Additionally to climate benefits, studies show that laying subsea cables on the seabed does not harm the environment. Subsea cable installation is environmentally a low impact process. Especially in the deep oceans, the cable is simply put on the ocean floor. In more shallow waters, most importantly where fishing happens or where ships put out their anchors, the cable is buried to reduce damage to the cable from fishing nets or dragging anchors.

[1] https://www.un.org/Depts/los/global_reporting/WOA_RPROC/Chapter_19.pdf

40 Years of Nordic Research and Education Network collaboration

Arctic Connect R&E builds on the Nordic Research and Education Network (NREN) collaboration, which has an extensive history of delivering network services for R&E in the Nordics. Each of the five Nordic countries has a well-established and active NREN, jointly serving the national R&E Communities in the Nordics:

- Denmark: DeiC

- Finland: Funet (operated by CSC - IT Center for Science Ltd.)

- Iceland: RHnet

- Norway: Uninett (owned by Unit, Directorate under the Ministry of Education)

- Sweden: SUNET (part of the Swedish National Research Council)

The international arm of the five Nordic NRENs is NORDUnet, established as a project in 1980, as a granted programme by the Nordic Council of Ministers in 1985, and as a company limited by shares in 1993. Since its inception, NORDUnet has been owned by the Nordic NRENs and is delivering services to the Nordic NRENs, and is the joint collaboration platform for IT related services for the Nordic R&E Community.

For decades, NORDUnet and Nordic NRENs have built up vast experience in running advanced, state-of-the-art fiber and optical network infrastructures, both within the Nordic region and internationally. The involvement of staff at NORDUnet and the Nordic NRENs runs all the way from designing, selecting equipment vendors, building, to operating these fiber infrastructures, for the R&E Communities in the Nordics.

Arctic Connect R&E will have a great impact on the Global Research and Education Network, which is essential for global research and education. NORDUnet has already been a driving force behind the AsiaPacific Europe Ring and the Advanced North Atlantic collaboration, two initiatives aimed at fostering collaboration between NRENs to do joined, aligned investments in and the running of intercontinental bandwidth for R&E. Bandwidth between Europe and Asia is expensive due to the limited number of options. **Arctic Connect R&E** will bring a new low latency route towards Asia and North America, at an attractive price point.

The path towards a successful implementation

Arctic Connect R&E is dependent on the timeline and planning of the Arctic Connect Subsea Cable System project, and is currently as follows:

- Marine survey: Phase 1 in 2020 (completed) and Phase 2 in 2021

- Start of service: 2023 / 2024

Contacting the Arctic Connect R&E project coordinator

NORDUnet A/S, established in 1993 and based in Kastrup, Denmark, is the collaborative organization owned by the five Nordic NRENs, i.e. Uninett (Norway), SUNET (Sweden), CSC/Funet (Finland), DeiC (Denmark), and RHnet (Iceland). NORDUnet acts as the primary contact for the **Arctic Connect R&E** Project on behalf of the five Nordic NRENs and other R&E partners in Europe, Asia, and North America.

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