52north
exploring horizons

Annual Report 2021

Innovation and Technologies
for Research Data Infrastructures

Preface

2021 was an exciting and challenging year! 52°North concluded work on a number of significant strategic and structural changes. Established in 2006, 52°North GmbH promoted cooperative software development to bridge the gap between research and application. We have developed geospatial open source software to bring open and innovative solutions to our partners, customers, and users from the private and public sector. Over time, support for developing open source software communities and provision of software management tools no longer provided the added value it once did. Fruitful discussions concerning refocusing and rebranding ultimately lead to a shift in the company's mission. We continue to support open source software, but now concentrate on enhancing existing and established open source projects. Our new mission also stresses the support of Open Science, of which Open Data and Open Source Software are two building blocks. These changes are reflected in our new title: "52°North Spatial Information Research GmbH".

Another exciting transition was the handover between our former managing directors, Prof. Dr. Albert Remke and Prof. Dr. Andreas Wytzisk-Arens, and our new management team - Dr. Benedikt Gräler, Dr. Simon Jirka and Matthes Rieke. Regrettably, due to the ongoing pandemic, we had very limited opportunities to personally share and celebrate this important cornerstone with 52°North partners and friends. We hope to make up for this in the near future.

52°North's overall research focus in 2021 was to lay the foundations for research data infrastructures (RDI). In several R&D and professional service projects, our staff unearthed requirements, sketched possible solutions and prototyped different RDI components. These RDIs are designed to integrate data from various, possibly federated, sources in order to enable the analysis of these valuable data sets. This report summarizes these activities as well as those of projects covered by other 52°North expertise.

We are excited for the coming year, innovative project work and vital cooperations with our partners and customers. Please do not hesitate to contact us if you have any questions or ideas you would like to share.

Münster, January 2022

Dr. Benedikt Gräler   *Dr. Simon Jirka*   *Matthes Rieke*

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About 52°North

Spatial Information Research

52°North is a private non-profit R&D organization, located in Münster, Germany. Our mission is to increase the value of geodata and geographic information technologies in science, business and public administration through applied research and knowledge-intensive services.

Our research software engineers have a strong background in applying scientific methods and excellent software engineering practices. They have extensive knowledge regarding state-of-the-art technologies and GeoIT trends, such as cloud native technologies, geoAI or big data analytics. We contribute to research and innovation projects and provide professional services to build operational high-end GeoIT solutions.

52°North stands for Open Science and Open Innovation based on a collaborative open source software development process.

STAFF

21
software engineers,
data scientists,
business
administration,
trainees…

13,93
full time
equivalents

15
permanent
contracts,
6 temporary
employments

Facts and Figures

REGISTERED NAME

52°North Spatial Information Research GmbH
Martin-Luther-King-Weg 24, 48155 Münster, Germany
T +49 251 396371-0, info@52north.org, https://52north.org

FOUNDED

September 2006

SHAREHOLDERS

> University of Münster, Germany
> University of Twente, The Netherlands
> Esri Inc, Redlands, United States of America
> con terra GmbH, Münster, Germany

MANAGEMENT

Dr. Benedikt Gräler

Dr. Simon Jirka

Matthes Rieke

REVENUES

~ 1,2 M €
in total

56%
billable hours spent
on research
projects

44%
billable hours spent
on fully funded R&D
and professional
services

Research and Development

Citizen Science

Environmental
Monitoring

Sustainable
Mobility

Geospatial
Sensing

Disaster
Management

Smart
Cities

SPATIAL
DATA

Efficient
Processing

Data
Analytics

Earth
Observation

Ocean
Science

Precision
Farming
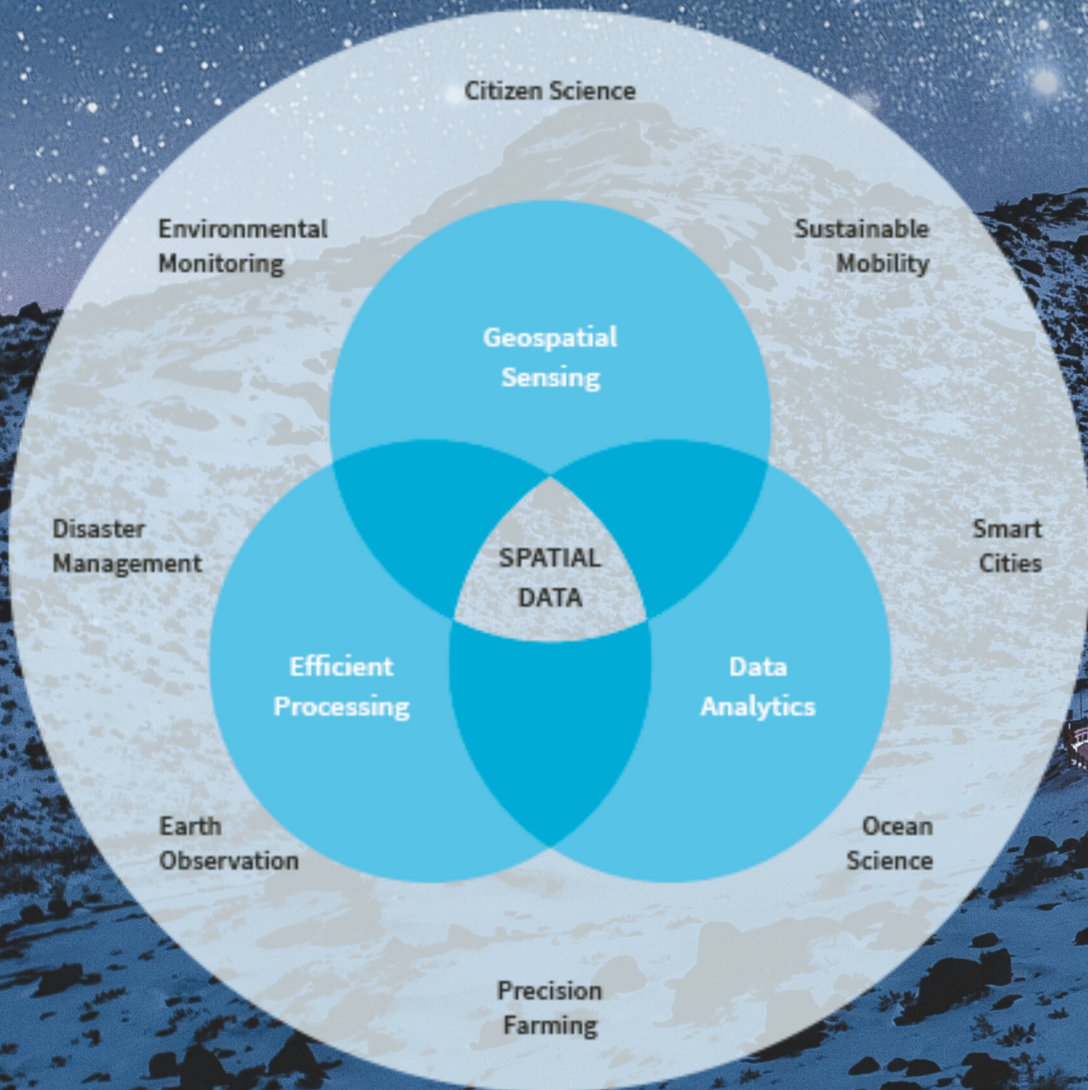
Leveraging the value of Spatial Information by innovating its methods and technologies

Spatial data plays a key role in supporting environmental planning, renewable energy forecasts, disaster management, smart mobility, risk assessment and mitigation and many other application domains. Our goal is to facilitate the availability and use of spatio-temporal data by inn ovating the methods and technologies for creating, managing, sharing, analyzing and visualizing this data.

52°North pursues three interwoven disciplines. Research Data Infrastructures (RDI): The development of RDIs builds upon 52°North's experience in Spatial Data and Spatial Information Infrastructures (SDI/SII). A central component is the provision of Analysis Ready Data (ARD) for subsequent processing and analysis workflows. This is closely linked to Spatial Data Science. Spatial Data Science: The true value of available data sets can only be leveraged if the data is turned into information. Employing classical and modern Machine Learning (ML) approaches, we facilitate this transition. SDI research: This addresses the technical solutions used to bring the RDI and analysis to life. Researching and developing new SDI architectures and concepts on modern IT systems unlocks the true potential of spatial data.

We believe that applied research is best complemented by the development of operational solutions in order to create a tangible added value in practice. This combination turns scientific results into relevant "innovations". 52°North supports the development of operational solutions by offering professional services, such as training and consulting services, software engineering or data analysis. A central idea is the co-development with our project partners, customers or a wider community in order to provide the innovations to the point. In the following chapters, we provide an overview of our research and development activities.

Geospatial Sensing
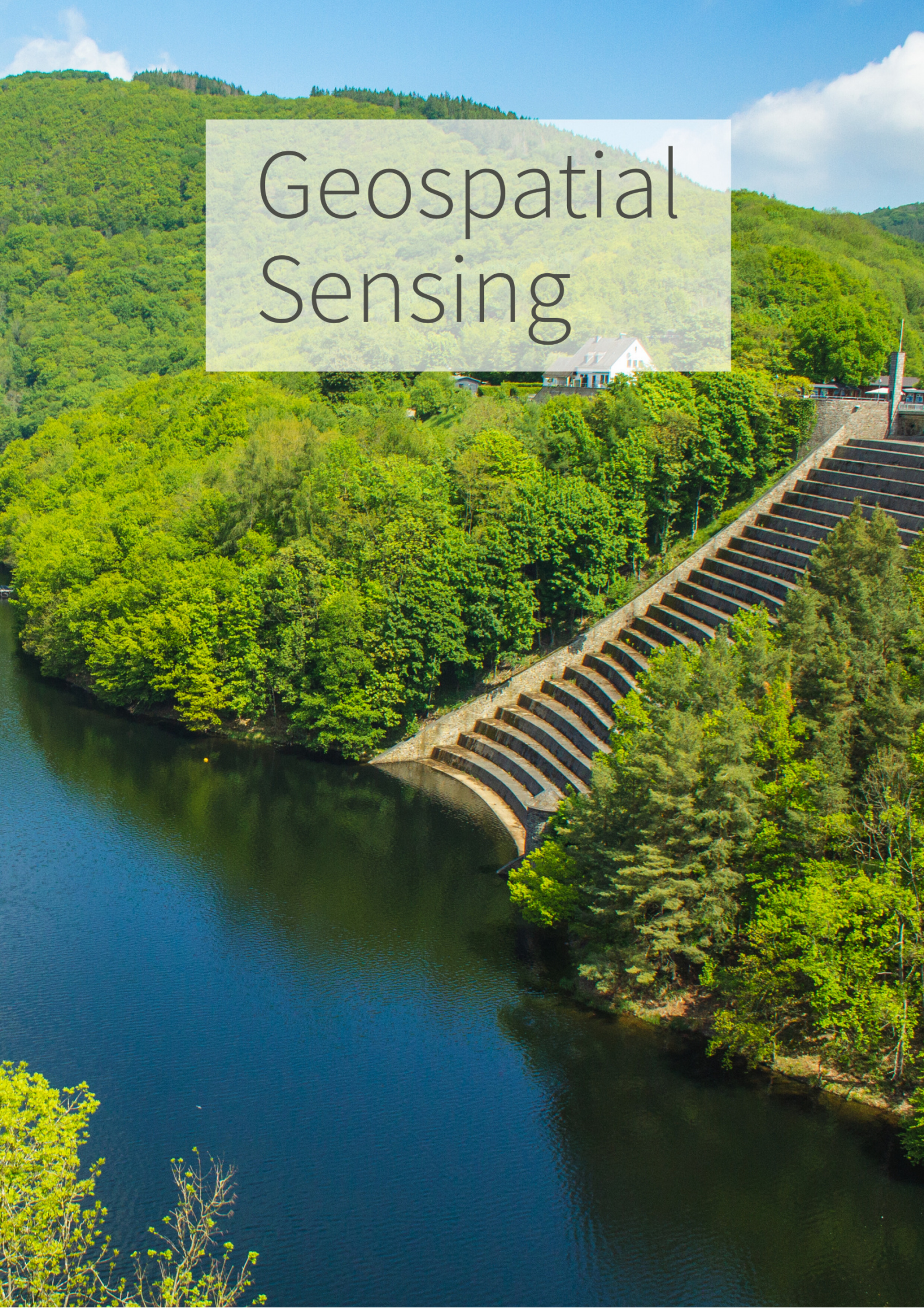
Enabling the efficient flow, management and visualization of sensor data

When speaking of Geospatial Sensing, we refer to all aspects related to capturing, managing, discovering, sharing, and visualizing data that describes the past, current, or future state of the environment. This includes, not only data generated by sensors (e.g., air pollutant concentration and water level measurements), but also information captured by humans (e.g., observations of animals or plants) and predictions calculated through models (e.g., weather models). In the Geospatial Sensing lab, we support our partners and customers along the whole process chain from data capturing to visualisation.

Dr. Simon Jirka heads a team focusing on new approaches and technologies in the field of Geospatial Sensing. Currently, he and his team address the following challenges:

- Connecting to sensor hardware: investigating how to efficiently integrate new sensors into (research) data infrastructures, e.g. using IoT technologies such as MQTT.
- Data storage and management: optimizing data models and supporting the provision of metadata to ensure the correct interpretation of sensor data.
- Research data infrastructures: supporting how to handle sensor data as an important element of research data infrastructures.
- Semantic interoperability: contributing to and promoting the use of vocabularies.
- Data availability to users: advancing data access interfaces and encodings.
- Efficient data delivery: enabling push-based/event-driven communication patterns to ensure a timely delivery of data.
- Access control: developing strategies for controlling the access to (dynamic) sensor data sets/streams.
- Data visualization: improving methods for visualizing and exploring sensor data to enable a better communication of the gathered information.
- Citizen science: easing the set up of citizen observatory initiatives by providing dedicated reusable building blocks.

Our activities also lead to active contributions to international standardization efforts. We drive interoperability aspects through our participation in the Open Geospatial Consortium (OGC) and the European INSPIRE framework.

Simon Jirka

Head of Geospatial Sensing

SeaDataCloud

Handling Near Real-Time Sensor Data in a Marine Research Data Infrastructure

Further developing the pan-European infrastructure for marine and ocean data management

National oceanographic data centers and major research institutes from 34 countries have developed the pan-European SeaDataNet infrastructure. It connects more than 100 marine data centers that provide data discovery and access functionality for researchers. Furthermore, SeaDataNet is a key element supporting the European Marine Observation and Data network (EMODnet), which was initiated by the EU DG-MARE. It also complements the Copernicus Marine Environmental Monitoring Service.

In order to provide more efficient and faster data access for researchers, several upgrades and enhancements to reflect recent technological developments were necessary. These comprise aspects, such as new types of sensors, as well as international IT concepts (e.g., cloud infrastructures) and interoperability standards (e.g., INSPIRE guidelines for observation data). Consequently, SeaDataCloud aimed to improve the current SeaDataNet infrastructure by adopting cloud and high-performance computing technology. SeaDataCloud cooperated with EUDAT, a network of computing infrastructures that develops and operates a common framework for managing scientific data across Europe.

The SeaDataCloud project output resulted in improved access to research data. A comprehensive collection of services and tools developed to cover researchers' specific needs is now available to support marine research and enable the generation of added value products.

52°North investigated new approaches to enhance the SeaDataNet infrastructure with capabilities for handling near real-time observation data. This comprised two main tasks: the development of a SWE Ingestion Service and a SWE Viewing Service.

The SWE Ingestion Service: In order to facilitate the publication of observation data streams, we developed a concept and prototypical implementation of a Web service architecture that comprises a plug-and-play approach for sensor data publication. It includes the description of sensor interfaces, sensor data streams (e.g., delivered through Internet of

Things protocols such as MQTT) and other sensor data repositories (e.g., CSC-based data stores). This was complemented by tools for editing such sensor data stream descriptions (including the semantics of the data) and an interpreter relying on the descriptions for pushing the available data into the SeaDataCloud infrastructure.

The SWE Viewing Service: We explored new approaches for a user-friendly visualization of the previously published sensor data streams. This service covers not only the data display itself, but also new ideas on improving the discoverability of the broad range of published sensor data streams.

In addition, our team participated in networking activities to promote and further test the SeaDataCloud developments and provided feedback to international standardization activities. We completed the project in 2021 with a participation in the IMDIS 2021 conference.
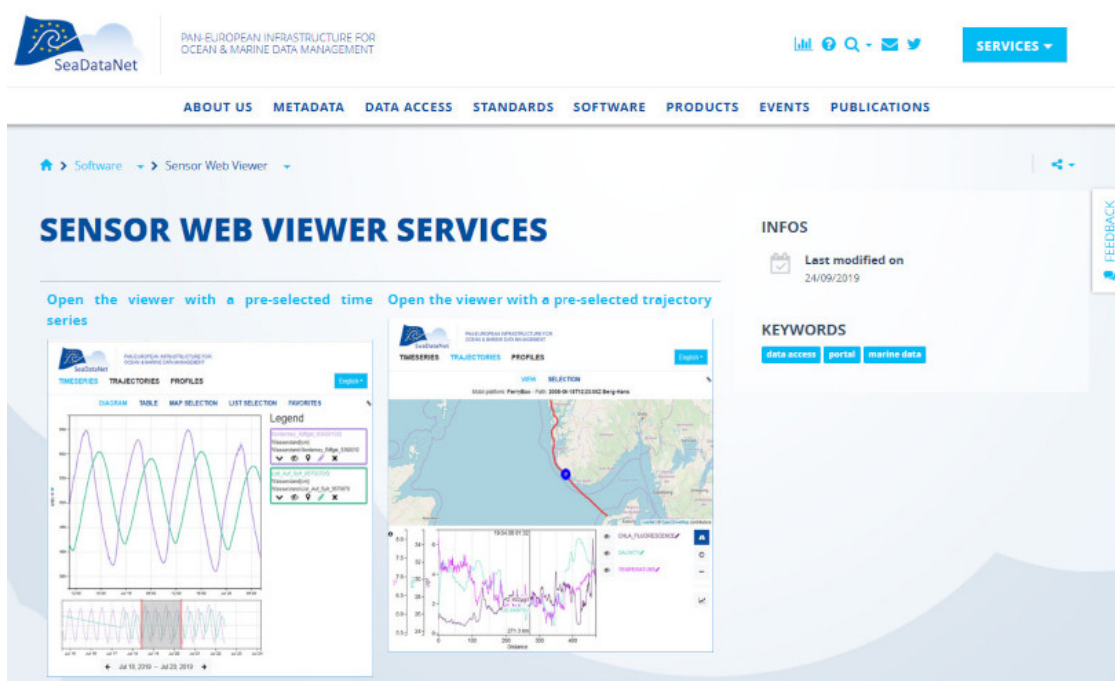
Sensor Web Viewer Services

PARTNERS

- **Coordinator**: Institut Français de Recherche pour l'Exploitation de la Mer (Ifremer), France
- 56 partners and 5 sub-contractors from 32 countries

FUNDING

SeaDataCloud is funded by the Horizon 2020 Framework Programme for Research and Innovation (H2020-INFRAIA-2016-1) of the European Union under grant agreement number 730960.

EMODnet Ingestion

European Marine Observation and Data Network

Marine data ingestion and safekeeping in and for EMODnet

The European Marine Observation and Data Network (EMODnet) brings together more than 160 organizations to improve the harmonized sharing of marine data. As part of the larger EMODnet context, EMODnet Ingestion 2 worked on facilitating the data publication process. This in particular included the EMODnet Data Ingestion Portal, which helps data managers publish their data following open data principles.

52°North's role in EMODnet Ingestion 2 was that of an expert on Sensor Web technologies. Based on results from previous projects, such as SeaDataCloud, we supported the consortium in challenges related to sharing near-real time observation data streams. This included not only the development of best practices and guidance, but also the creation of dedicated demonstrators and show cases.

In 2021, 52°North continued to work with several partners to enable research vessels to share their near-real time tracking data using interoperability standards, such as MQTT and the OGC SensorThings API. We further refined the resulting data publication workflow built on top of the Eurofleets Automatic Reporting System (EARS) and described it in corresponding publications.

KEY TECHNOLOGIES

> Sensor Web
> SensorThings API
> MQTT
> Angular

FACTS

Duration:
10/2019 - 10/2021

Website:
https://www.emodnet-ingestion.eu/

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Professional Services
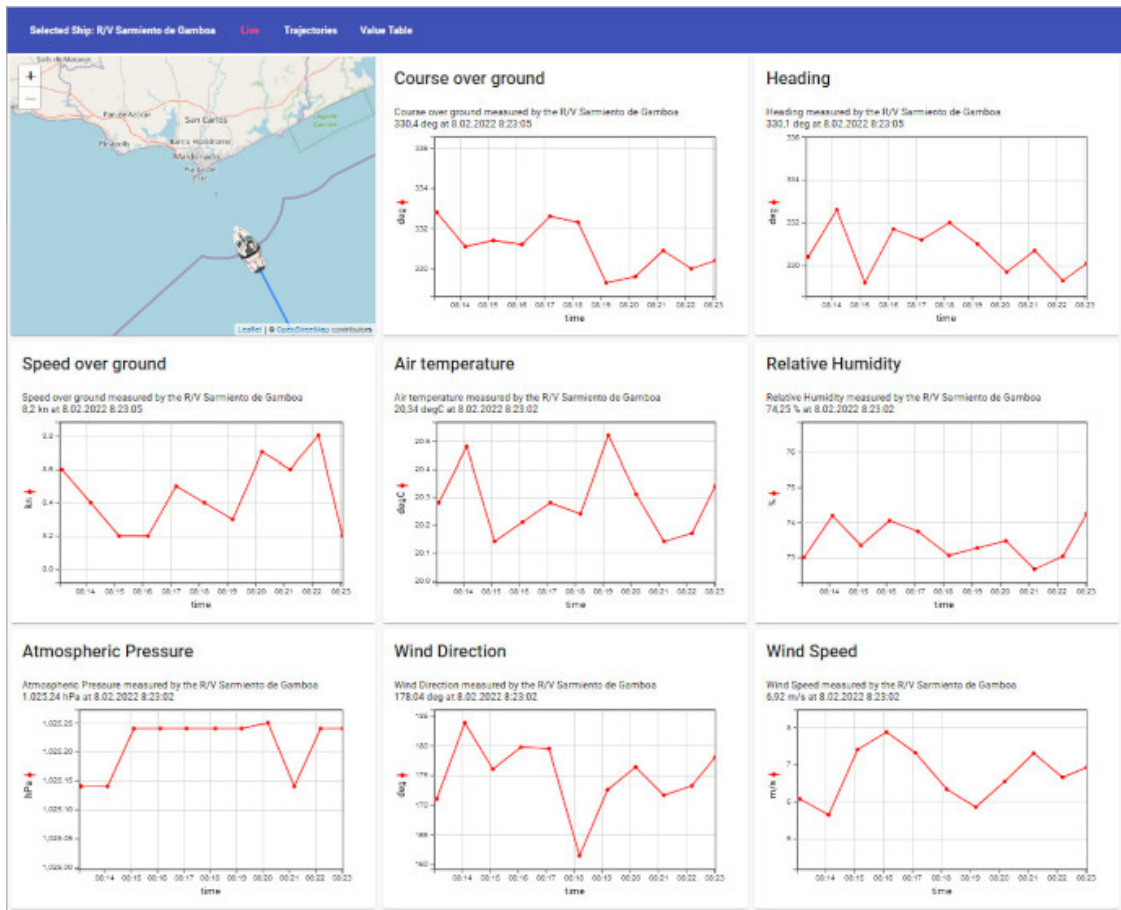
Eurofleets dashboard

PARTNERS

- [44 partners from all over Europe](#)
  52°North is a subcontractor of Maris B.V., The Netherlands

FUNDING

JERICO-S3

Joint European Research Infrastructure of Coastal Observatories

Marine coastal observatories, facilities, expertise and data for Europe

KEY TECHNOLOGIES

> Sensor Web
> OGC Sensor Observation Service (SOS)
> Java
> JavaScript
> Helgoland Sensor Web Viewer
> OGC Sensor Model Language (SensorML)

FACTS

Duration:
02/2020 – 01/2024

Website:
https://www.jerico-ri.eu/

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Research and Development

The Joint European Research Infrastructure for Coastal Observatories (JERICO-RI) is a system of systems strengthening the European network of coastal observatories. It provides a powerful and structured European Research Infrastructure (RI) dedicated to observing and monitoring the complex marine coastal seas. JERICO-RI aims to

- provide services for the delivery of high-quality environmental data
- enable access to solutions and facilities as services for researchers and users
- create product prototypes for EU marine core services and users
- support excellence in marine coastal research to better answer societal and policy needs.

JERICO-S3 (Joint European Research Infrastructure of Coastal Observatories: Science, Service, Sustainability) will provide a state-of-the-art, fit-for-purpose and visionary observational RI, as well as expertise and high-quality data on European coastal and shelf seas. It will significantly enhance the current value and relevance of the JERICO-RI by implementing the science and innovation strategy elaborated in the JERICO-NEXT project.

JERICO-S3 targets a more science-integrative approach to better observe the coastal ecosystem. In turn, this will elevate the scientific excellence of the regional and local ecosystems. The project will implement major user-driven improvements in terms of observing the complexity of coastal seas and continuous observation of the biology, access to facilities, data and services, best practices and performance indicators, as well as innovative monitoring strategies. These will also cover cooperation with other European RIs (EuroARGO, EMSO, AQUACOSM, DANUBIUS, ICOS, EMBRC, LIFEWATCH) and international scientific communities, industry and other stakeholders, and aligning strategy with COPERNICUS/CMEMS, EMODNET and GEO/GEOSS.

52°North focuses on technological innovation activities. We work on the advancement of Sensor Web components, such as the SensorML editor smle, the Helgoland Sensor Web Viewer and data access services based on the OGC SWE standards. Our aim is to improve the usability of interoperable data exchange workflows and concepts for marine sensor data.

In 2021, we mainly focused on the evaluation of new standards that could be potentially relevant for the project. These include, for example, the new OGC API family of standards as well as the SensorThings API 2.0 standard, which is currently under development.

JERICO-RI, Joint European Research Infrastructure for coastal observatories, buoys, gliders, manual sampling, HF-radars, ferryboxes, coastal seabed observatories and coastal floats

PARTNERS

39 partners, including:

- **Coordinator:** Institut français de recherche pour l'exploitation de la mer (Ifremer), France
- Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung (AWI), Germany
- Consiglio Nazionale delle Ricerche (CNR), Italy
- ETT S.p.A., Italy
- European Global Ocean Observing System (EuroGOOS), Belgium
- Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung GmbH (HZG), Germany
- Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGC), Italy
- Plataforma Oceánica de Canarias (PLOCAN), Spain
- Royal Belgian Institute of Natural Sciences, Belgium
- Universitat Politècnica de Catalunya (UPC), Spain

FUNDING

MINKE

Metrology for Integrated Marine Management and Knowledge Transfer Network

KEY TECHNOLOGIES

> 52°North Sensor Web Suite
> ISO/OGC Observations and Measurements (O&M)
> OGC Sensor Model Language (SensorML)
> Internet of Things

FACTS

Duration:
04/2021 - 03/2025

Website:
https://minke.eu/

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Research and Development

Improving the exchange of marine observation data in Europe

The H2020 project MINKE integrates key European marine metrology research infrastructures to propose an innovative framework of 'quality of oceanographic data' for European actors monitoring and managing marine ecosystems. MINKE proposes a new vision for the design of marine monitoring networks. It regards accuracy and completeness as the driving components of quality in data acquisition. This new vision will be framed in a helix model of innovation that incorporates all the elements involved in the monitoring network design:

- context (ocean health): identifying the Essential Ocean variables (EOVs) as the key parameters to monitor
- civil society (NGO, Makers community, Social media and Citizen Science platforms): key actors to ensuring data completeness
- academia: researching new methods to ensure the accuracy and the global quality of the final products, developing tools for integrating the information of top-qualified oceanographic instruments and low-cost instrumentation
- industry: improving the performance of the observations with new instrumentation, data transmission systems and cost-effective technologies
- governments: providing the legal and socio-economic frameworks to develop the proposed network

52°North co-leads a dedicated work package on data harmonization. The core topics of this work package include the evaluation of interoperability standards, the investigation of integration options for the European Open Science Cloud, the handling of uncertainty information, as well as, the link to data aggregation platforms such as EMODNET.

In 2021, our team focused on initializing the work package activities and identifying relevant standards and technologies for the project.

PARTNERS

- **Coordinator:** Consejo Superior de Investigaciones Científicas (CSIC), Spain
- Institut français de recherche pour l'exploitation de la mer (Ifremer), France
- Hellenic Centre for Marine Research (HCMR), Greece
- Consorcio para el diseño, construcción, equipamiento y explotación de la Plataforma Oceánica de Canarias (PLOCAN), Spain
- Universitat Politècnica de Catalunya (UPC), Spain
- Istituto Nazionale di Oceanografia e di Geofisica Sperimentale (OGC), Italy
- Consiglio Nazionale delle Ricerche (CNR), Italy
- Istituto Nazionale di Ricerca Metrologica (INRiM), Italy
- Service hydrographique et océanographique de la Marine (Shom), France
- Norsk institutt for vannforskning (NIVA), Norway
- National Oceanography Centre (NOC), United Kingdom
- Agenzia nazionale per le nuove tecnologie, l'energia e lo sviluppo economico sostenibile (ENEA), Italy
- Physikalisch-Technische Bundesanstalt (PTB), Germany
- Université d'Aix-Marseille, France
- Universidad Católica del Norte, Chile
- Anel.lides Sl, Spain
- Laboratoire national de métrologie et d'essais (LNE), France
- Institut d'Arquitectura Avançada de Catalunya (IAAC), Spain
- Suomen ympäristökeskus (SYKE), Finland
- Joint Programming Initiative Healthy and Productive Seas and Oceans (JPI Oceans), Belgium
- European Multidisciplinary Seafloor and water-column Observatory - European Research Infrastructure Consortium (EMSO ERIC), Italy

FUNDING

Wupperverband Framework Contract

# Developments for the Sensor Web

Supporting the Wupperverband's Sensor Web infrastructure

The Wupper River catchment area covers an area of 813 square kilometers in Germany's North Rhine-Westphalia. The Wupperverband (Wupper Association), responsible for water management in this area, operates a comprehensive network of water monitoring stations that deliver a broad range of hydrological and meteorological parameters.

For more than ten years, the Wupperverband has been operating Sensor Web components to ensure an efficient data management and internal as well as external data exchange. These include a large database for managing the collected observation data, the 52°North Sensor Observation Service implementation, the 52°North Sensor Web REST-API and a customized version of the Helgoland Sensor Web Viewer.

52°North supports the Wupperverband in maintaining and advancing this Sensor Web infrastructure. We regularly update the Sensor Web components as well customize or extend the software modules used.

In 2021, our activities focused on completing the updated Helgoland Sensor Web Viewer. We supported performance optimization of the Sensor Web Server and its underlying database. Our team also continued investigation of Sensor Web access control mechanisms.
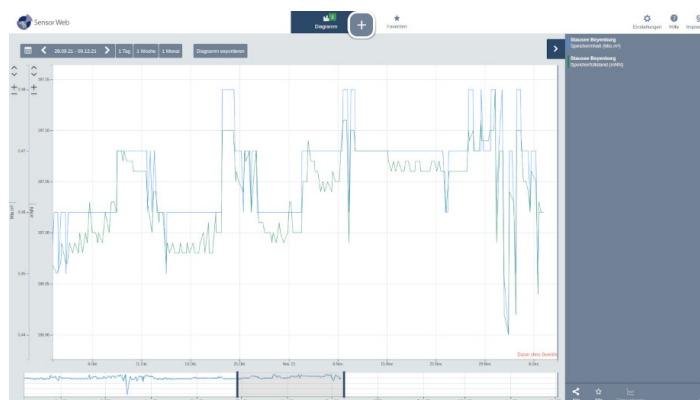
Reservoir content and level as visualized by the Wupperverband Helgoland Sensor Web Viewer

CUSTOMER

- Wupperverband, Germany

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SOS Extensions for Hydrological Data

SOS Extensions for AQUARIUS Data Management System

Enhancing the 52°North SOS server to enable interoperable sharing of hydrological data

AQUARIUS is a hydrological software system developed and sold by Aquatic Informatics. It enables organizations to acquire, process, model, and publish water information. Several regional councils in New Zealand use this system to manage their hydrological data. Some of these councils need to provide an SOS interface in combination with WaterML 2.0 in order to interoperably share the hydrological data collected and simultaneously fulfill corresponding data provision obligations. To address this issue, the 52°North SOS Server uses AQUARIUS as a data source.

52°North's task was to extend its SOS server as a deployable proxy server on top of the AQUARIUS system. To achieve this, we developed the corresponding connectors. We also provided extensions to fulfil the regional councils' specific requirements, such as providing information about detection limits.

Aquatic Informatics funded the implementation to adapt the 52°North SOS server to use AQUARIUS as a data source. We developed the extensions to support information on detection limits under an additional contract with the Otago Regional Council.

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```

XML snippet

CUSTOMER

- Aquatic Informatics ULC, Canada
- Otago Regional Council, New Zealand

Extension of the PEGELONLINE Infrastructure (EDIS)

Investigating new approaches for real-time delivery of hydrological information

KEY TECHNOLOGIES

> 52°North Sensor Web Suite
> SensorThings API
> MQTT
> AMQP
> Containerization
> Angular

FACTS

Duration:
07/2021 - 06/2024

**Contact**:
Simon Jirka
s.jirka@52north.org

Project Type:
Professional Services

The ITZBund is a service center providing IT services to federal agencies in Germany. They operate the PEGELONLINE platform, an important infrastructure that yields a broad range of hydrological measurement data collected along German waterways.

52°North provides consulting to evaluate event-based communication techniques to more efficiently deliver (geospatial) information, such as measurement data, in real-time. Our team specifically considers approaches to reduce the latency of data delivery and minimize server loads using push-based communication protocols such as MQTT and AMQP. In addition to evaluating protocols, we investigate potential approaches to structuring the delivered data, ensuring access control, supporting the development of client applications such as dashboards, and integrating event-based workflows into the existing IT infrastructure.

Our software engineers complement these activities by upgrading PEGELONLINE's existing Sensor Web components. These include the current 52°North SOS implementation as well as the Helgoland Sensor Web Viewer.

The activities in 2021 mainly comprised upgrading the Sensor Web Server and the Helgoland Viewer, evaluating deployment options (e.g., using container technologies), as well as creating the first architectural approaches and prototypes in order to enable event-based data delivery.

EDIS architecture
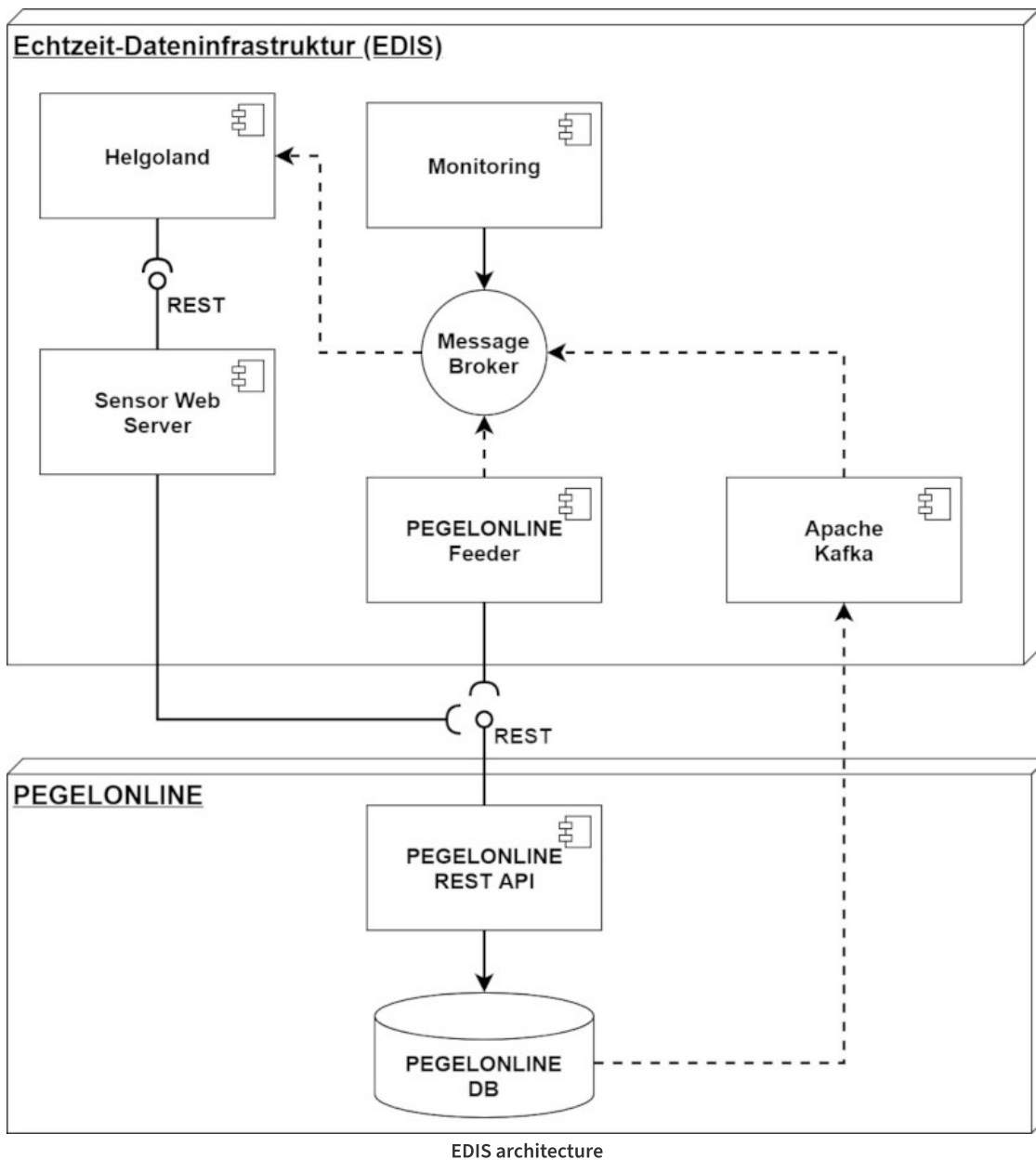
CUSTOMER

- Informationstechnikzentrum Bund (ITZBund), Germany

Cos4Cloud

Co-designed Citizen Observatories Services for the EOS Cloud

Developing interoperable components to support Citizen Science projects via the European Open Science Cloud (EOSC)

Cos4Cloud (Co-designed citizen observatories for the EOS Cloud) aims to design, prototype and implement services that address the Open Science challenges shared by citizen observatories active in the fields of biodiversity and environmental quality monitoring. To support citizen observatories, project work focuses on the development of services that help improve the data and information quality. Technologies used to implement these services include deep machine learning, automatic video recognition, advanced mobile app interfaces, and other cutting-edge technologies based on data models and data protocols validated by traditional science. The new services will provide mechanisms to ensure the visibility and recognition of data contributors and tools to improve networking between various stakeholders. Novel innovative digital services will be developed by integrating Citizen Science products generated by different providers. The consortium implements the services according to open standards to ensure their interoperability. The European Open Science (EOS) Cloud hub provides an agile, fit-for-purpose and sustainable site, including a discovery service, to both traditional and citizen scientists.

Stakeholders in society, government, industry, academia, agencies, and research drive a user-oriented design of the new services by co-designing the service requirements. Cos4Cloud integrates Citizen Science in the European Open Science Cloud, bringing Citizen Science projects as a service to the scientific community and society at large.

52°North contributes to the architecture definition and development of interoperability standards, profiles and best practices. We lead the project work on defining an agile development methodology. Our other contributions include interoperability, conformance and performance testing activities as well as the evaluation of technology readiness levels. Additionally, we support networking, dissemination and international standardization activities.

During 2021, our team extended and refined a fit-for-purpose agile methodology, respecting the individual differences of all partners. It frames the technical development and co-design process throughout the project's lifetime. In addition, we are creating an agile testing plan to

ensure that the developed features and the integration of citizen observatories will feed the overall purpose of the Cos4Cloud project.

Our software engineers also contributed to the service architecture development with a particular focus on interoperability. We contributed to the STA+ extension for the SensorThings API (v1.1). This leverages data modeling and workflows within citizen observatories. The extension not only covers aspects focused on citizen science, but also on observation ownership and relationships, for example, and can be also applied on other domains. We have presented and discussed the STA+ extension closely within the OGC community and will prepare it as a "Best Practice Paper".

Agile methodology - big picture
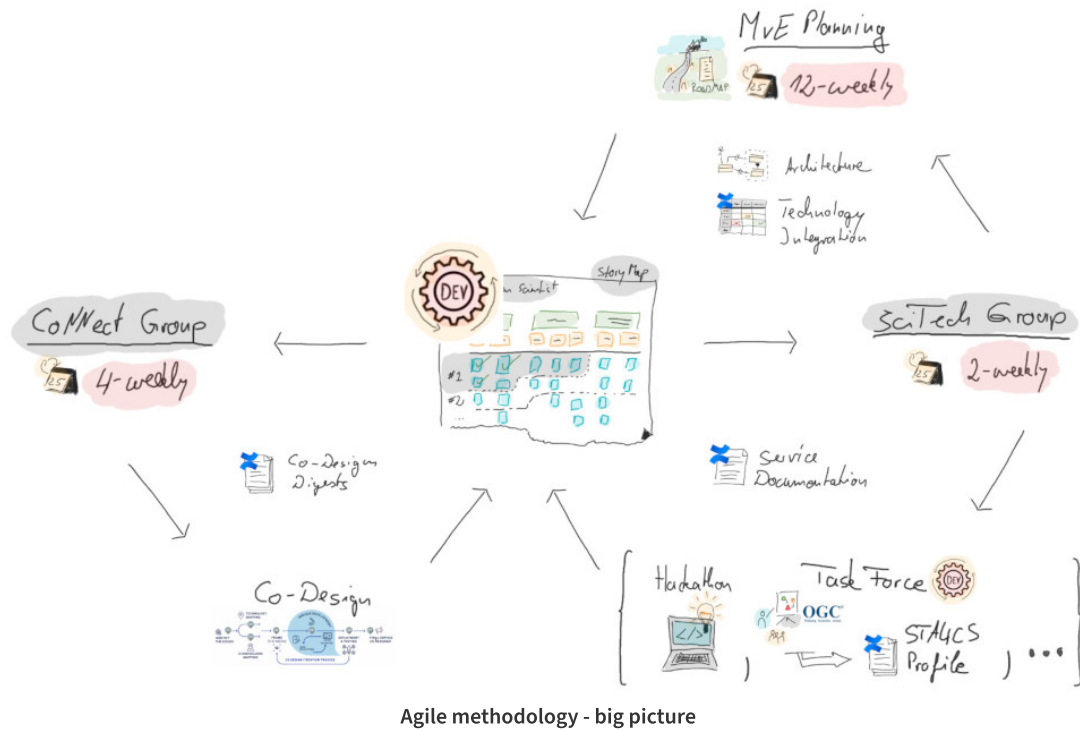
PARTNERS

- **Coordinator**: Consejo Superior de Investigaciones Científicas (CSIC), Spain
- Conservation Education & Research Trust, United Kingdom
- Centro de Investigacion Ecologica y Aplicaciones Forestales, Spain
- Institut national de recherche eninformatique et automatique (INRIA), France
- DYNAIKON LTD, United Kingdom
- Bineo Consulting S.L., Spain
- Norbert Carl Schmidt, The Netherlands
- The Open University, United Kingdom
- Secure Dimensions GmbH, Germany
- Sveriges lantbruksuniversitet (SLB), Sweden
- Ethniko kai Kapodistriako Panepistimio Athinon, Greece
- Verein der Europäischen Bürgerwissenschaften e.V. (ECSA), Germany
- Trébola Organización Ecológica, Colombia
- Science for Change S.L., Spain

FUNDING

Creating Interfaces

Data Management for Citizen Science Projects

Building capacity for integrated governance at the food-water-energy-nexus in cities on the water

Creating Interfaces explores socio-technical interfaces at the food-water-energy (FWE) nexus in cities near water. Aiming to increase urban sustainability, resilience, and quality of life, this project builds local capacity through innovative approaches in knowledge co-creation, governance and exchange.

A transdisciplinary, international team representing natural and social sciences, humanities, engineering, data and computer sciences, urban planning as well as civil society and business actors conducts research on stakeholder interactions and decision-making in the FWE sectors. It explores data governance and investigates novel approaches to participatory knowledge generation and citizen science along with their implementation. The project helps to answer central questions surrounding the integration of novel citizen-driven knowledge creation into the governance process and urban infrastructure planning procedures. Common research frameworks and a close interdisciplinary and transdisciplinary cooperation provide a basis for comparative analysis and co-production of transformative knowledge.

The development of socio-technical interfaces and decision support tools is driven by the needs of stakeholders, the FWE actors, and members of the public following an Urban Living Lab framework. Users, as co-creators, test and evaluate creative solutions and ideas, e.g. citizen science tools and approaches.

52°North develops interoperable citizen science and decision support workflows for providing data collection and analysis functionality. This is part of different Urban Living Labs and Citizen Science approaches in the three partner cities: Tulcea (Romania), Wilmington (USA) and Slupsk (Poland). We evaluate existing Citizen Science concepts, advance the identified baseline components and contribute our findings to international standardization activities aimed at increased interoperability among Citizen Science projects. According to our partners' specific requirements, we also customize identified tools and frameworks.

KEY TECHNOLOGIES

> JavaScript
> Wq
> PostgreSQL

FACTS

Duration:
05/2018 – 11/2021

Website:
https://creatinginterfaces.eifer.kit.edu/

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Research and Development

52°North's activities in 2021 centered on finalizing the Citizen Science data collection tool for the cities of Slupsk and Tulcea. We also provided support to those partners responsible for the data visualization, helping them to present the data we collected in their visualization tool.
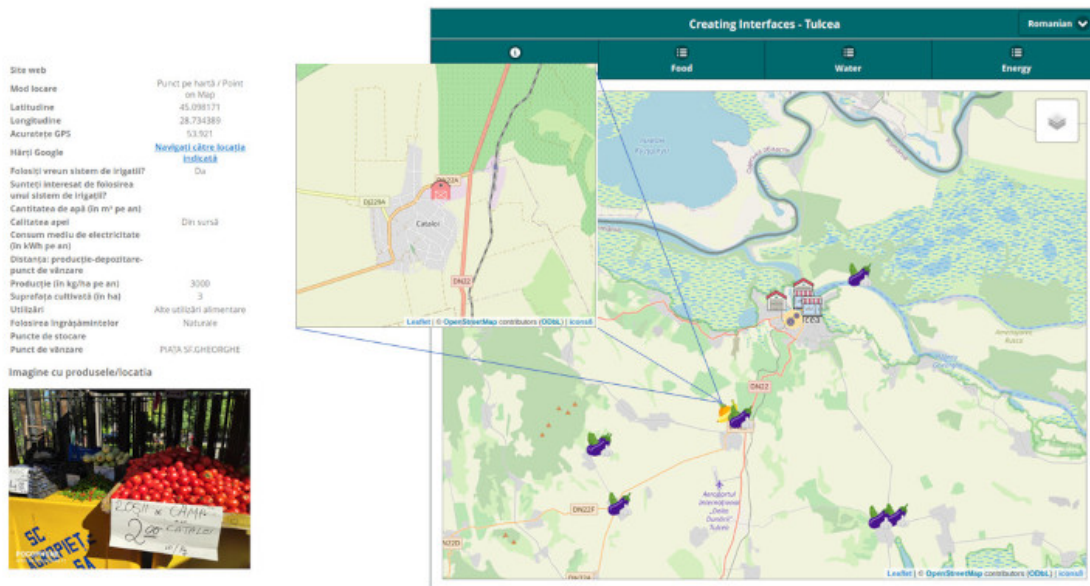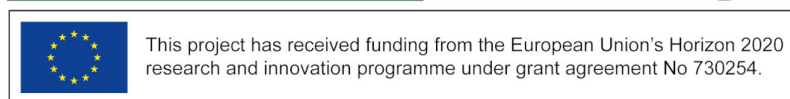

Information on local producers collected near Tulcea, Romania

PARTNERS

- **Coordinator:** EIfER – Europäisches Institut für Energieforschung, Germany
- University of Delaware, School of Public Policy and Administration, USA
- The National Center for Atmospheric Research (NCAR), USA
- University of Warwick, Centre for Interdisciplinary Methodologies, United Kingdom
- Pracownia Zrównoważonego Rozwoju (PZR), Poland
- SweGreen, Sweden,
- Nicolaus Copernicus University Toruń, Institute of Sociology, Poland
- Danube Delta National Institute for Research and Development (DDNI), Romania
- Royal Institute of Technology, Sweden

FUNDING

INSPIRE Data Availability Optimization

Removing Technical Barriers

Studies to optimize the availability of INSPIRE and open data via the UBA metadata catalog

The German Environment Agency (UBA) maintains and provides several databases for their reporting activities and projects. During the INSPIRE directive implementation, they provided environmental data subjected to reporting requirements via their spatial data infrastructure "UBA.gdi". The emergence of new technologies (e.g., OGC API for Features) eases the use of geospatial data significantly. Thus, these two projects investigate current technological approaches that complement the measures implemented in recent years. The goal is to improve the retrieval of UBA's data stocks and remove technical barriers to (re)using the data itself.

con terra and 52°North cooperate to develop solutions and an implementation strategy based on the existing technologies in UBA.gdi. The first project resulted in exemplary implementations that demonstrate feasibility in terms of the INSPIRE Directive requirements and simple data access from the user's perspective. Our developers and software architects investigated how to enhance existing OGC-compliant Web Feature Services to support the new OGC API for Features interface and evaluate an enhancement of the UBA's existing air quality Sensor Observation Service instance with an OGC SensorThings API module. We examined the combined use of OGC API Features and SensorThings API and will use the INSPIRE data theme "Environmental Monitoring Facilities" in a simplified form for an alternative encoding.

In the current follow-up project, 52°North helps advance the prototypes to a stable status. We also investigate the provision of additional data types. Both con terra and 52°North aim to incorporate the project findings into corresponding good practice documentation for the INSPIRE community.

PARTNERS

- con terra GmbH, Germany
  52°North is subcontractor

CUSTOMER

- Umweltbundesamt (Federal Environment Agency of Germany), Germany

FORLIANCE

Geospatial Data Platform Consulting

Supporting the process of developing a suitable system architecture

FORLIANCE developed a Monitoring and Communication Platform to provide clients with digested and analyzed project performance data, thus improving project management and enhancing their climate action reporting. By removing the barriers for transparent data transfer along the supply chain, this platform strengthens the connection between carbon project owners and climate conscious corporates.

52°North supported FORLIANCE in the development of the Monitoring and Communication Platform. We organized a workshop and providied consulting services in 2021. The purpose of the workshop was to systematically gather the relevant requirements and use cases influencing the system design. As a workshop follow up, we analyzed the input and drived recommendations for the design and implementation strategy.

The monitoring tool delivers accurate and real-time data that users without GIS or remote sensing skills can easily analyse.

Find out more about the FORLIANCE Monitoring and Communication Platform.

CUSTOMER

- FORLIANCE GmbH, Germany

KEY TECHNOLOGIES

> GeoNode
> Angular
> Kubernetes
> GeoServer

FACTS

Duration:
10/2021 - 04/2022

Contact:
Simon Jirka
s.jirka@52north.org

Project Type:
Professional Services

University of Manitoba

Managing Geospatial Research Data/ Sensor Data Streams with GeoNode

Customization and extension of a GeoNode instance to support the management of research data and sensor data streams

The Centre for Earth Observation Science at the University of Manitoba operates a data repository that hosts its research data and is used to share research data based on the FAIR principles. This platform is currently undergoing a redevelopment process. It will rely on GeoNode to cover the sharing of spatial data and use the OGC SensorThings API standard for sharing real-time meteorological and water quality data. Special consideration is given to optimizing an initial instance of GeoNode, integrating the data offered via CKAN and SensorThings API instances into GeoNode, and developing user centric data dashboards for meteorological and mooring datasets. 52°North supports the University of Manitoba in this redevelopment process.

Our activities in 2021 mainly focused on establishing a stable, initial setup of GeoNode and developing an approach for integrating metadata about SensorThings API instances.

Exploring layers with Universtiy of Manitoba's GeoNode instance

CUSTOMER

- University of Manitoba, Canada

SDI for JKI

Spatial Data Infrastructure at the Julius Kühn Institute

Managing federated geodata

The goal of this project is to identify, discuss and document the current and future requirements for the geodata infrastructure at the Julius Kühn Institute (JKI). Hence, 52°North supports the JKI in identifying a solution for managing geodata and creating the prerequisites for a short-term implementation of a federated research data infrastructure.

52°North will collect, discuss and document the specific requirements for the spatial data infrastructure in a joint workshop with JKI staff from different teams and organizational units. The following technical aspects, among others, play an important role in the development of the solution approach:

- Dealing with large amounts of data
- Scalability
- Access control
- Metadata description
- Unifying endpoints and data access
- Version control
- Embedding geospatial data in web resources
- Integration into local infrastructure

CUSTOMER

- Julius Kühn Institute, Germany

KEY TECHNOLOGIES

> Research Data Infra-
  structures
> OGC Standards
> GeoNode
> rasdaman

FACTS

Duration:
01/2021 - 12/2021

Contact:
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Project Type:
Professional Services

G.I.B. KomMonitor

Enhancing the KomMonitor Platform

Extending the KomMonitor platform to support requirements of North Rhine-Westphalia's municipalities

The KomMonitor platform supports the management, visualization, and exploration of a broad range of data: socio-demographic, city planning, infrastructure, envirnomental, etc. It was mainly developed by the Bochum University of Applied Sciences in a dedicated research project.

G.I.B. mbH is a state-owned company that supports the North Rhine-Westphalia state government in achieving its goals to promote employment, as well as combat unemployment, poverty and social exclusion. 52°North and the Bochum University of Applied Sciences collaborated to extend KomMonitor according to the needs of North Rhine-Westphalia's municipalities. We developed important enhancements, such as enhanced reporting functionalities, points of interest editing, geo-coding functionality support, and a more sophisticated access control model. These enhancements were funded by the European Social Fund. Our team completed the main developments for this project in 2021.
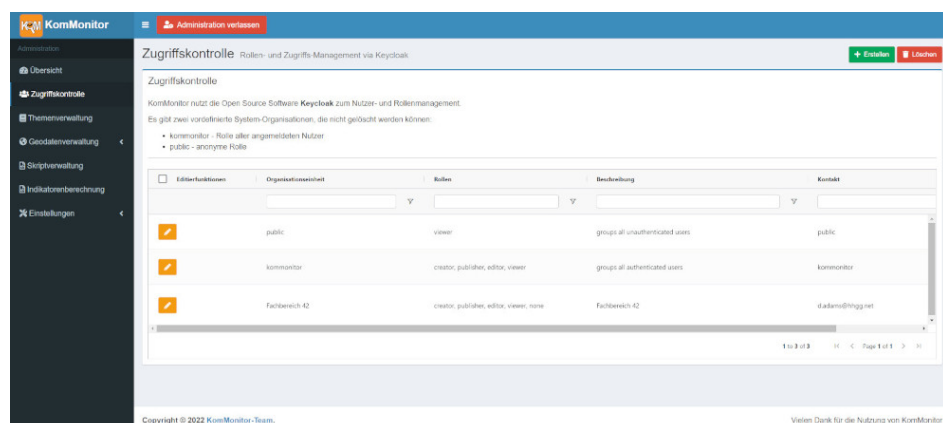
KomMonitor's access management

CUSTOMER

- G.I.B. mbH - Gesellschaft fur innovative Beschäftigungsförderung mbH, Germany

27

CCIKM Portal

Climate Change Information Knowledge Management Portal

Integrating climate change data to better inform about climate change and its impacts

The United Nations Development Programme commissioned the Cologne University of Applied Sciences to develop the "Climate Change Information Knowledge Management Portal for Bangladesh".

One of this project's components is the implementation of a solution for the management and provision of the geodata required for the portal. Two central elements of the system planned are a GeoNode instance for the management of a broad range of spatial data, as well as, an instance of the 52°North OGC SensorThings API implementation to support the handling of timeseries data.

In order to develop this component, 52°North supports the Cologne University of Applied Sciences with consulting and implementation capacities for geodata management, GeoNode and spatial databases. Our team also provides support for the systematic collection of requirements and the derivation of a development plan.

We mainly focused on the requirements analysis in 2021. Additional activities included the architecture design and the creation of a stable, initial instance of GeoNode.
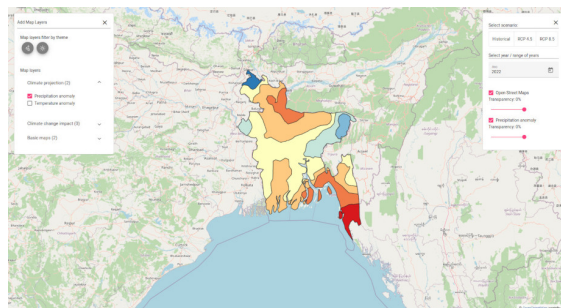
Visualization of map layers based on GeoNode instance

CUSTOMER

- TH Köln - University of Applied Sciences, Germany

data.europa.eu

European Data Portal Managed Services

Enable the sharing of Open Data across Europe

This project facilitates the sharing of open data resources across Europe. The central element of the project is the new data.europa.eu portal, which was launched in the spring of 2021. It integrates the existing European Data Portal and European Union Open Data Portal into a single, coherent core component of the public sector data infrastructure that has been set up by the European Union, its institutions and Member States. Similar to its predecessors, the new portal offers three key pillars:

- Access to public data resources across Europe via a single point of contact: The portal offers over 1 million datasets across 36 countries, 6 EU institutions and 79 other EU bodies and agencies;
- Support to EU institutions and Member States: This includes helping national open data policy owners to build communities of practice, in which they receive training and consultancy to improve, sustain and document data publishing practices;
- Socio-economic benefits: We investigate the socio-economic benefits of re-using public data resources and provide stimuli to foster the use and showcase the value of using open data.

In order to develop and maintain the portal, the Publications Office of the European Union has awarded a six-year framework contract to Capgemini Invent.

52°North cooperates closely with con terra and Fraunhofer FOKUS to develop a component for the map-based visualization of geospatial data. In addition, we contribute to the advancement of the underlying data infrastructure, for example by exploring how to best integrate near-real time data streams.

In 2021, 52°North worked on porting the geospatial data visualization component to a version based on OpenLayers. We also extended it to support an additional type of FIWARE real-time data streams (parking space data). In addition, our team and con terra's contributed to webinars that introduced the use of geospatial data as well as identified new (technology) trends in the provision of geospatial data.
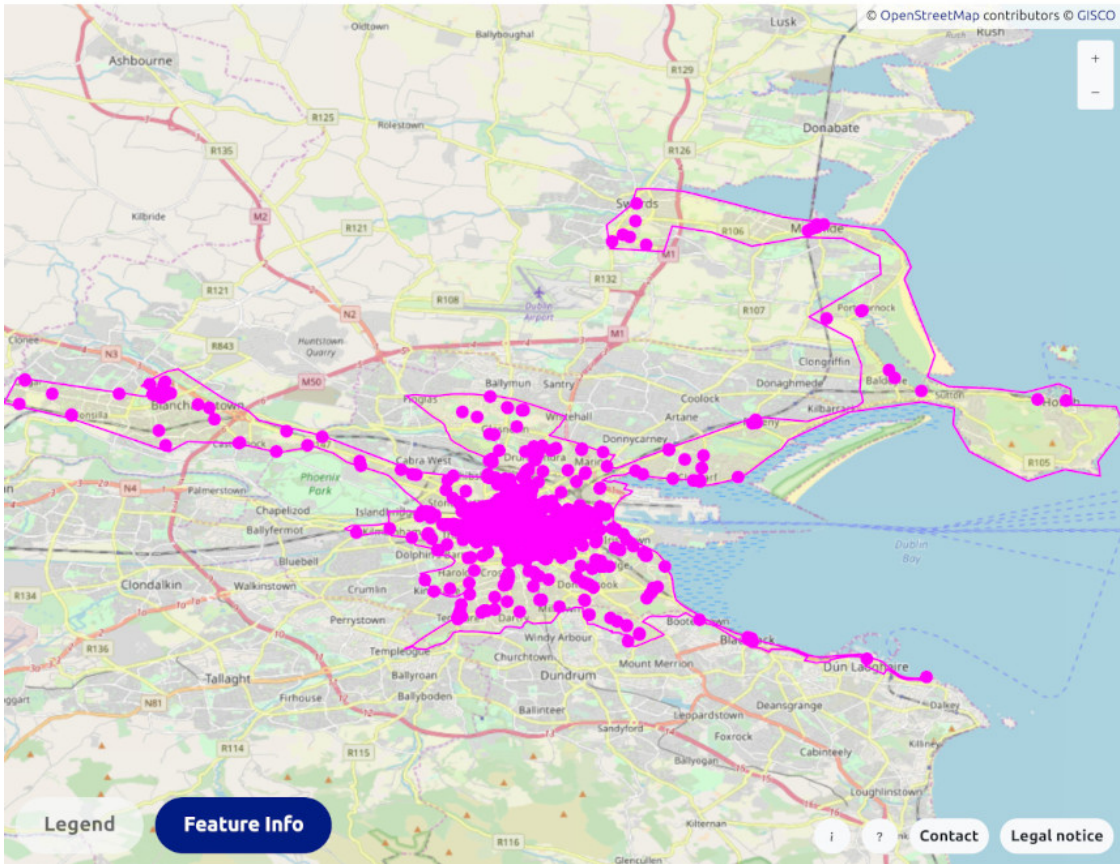
Map view of data from the data.europa.eu portal

CUSTOMER

- Publications Office of the European Union, https://op.europa.eu/
  52°North is subcontractor to Capgemini Invent and con terra

PARTNERS (SELECTION)

- **Main Contractor**: Capgemini Invent, The Netherlands
- INTRASOFT International, Luxembourg
- con terra GmbH, Germany
- Fraunhofer FOKUS, Germany
- Agiledrop Ltd., Slovenia
- OMMAX GmbH, Germany

Efficient Processing of Geospatial Information
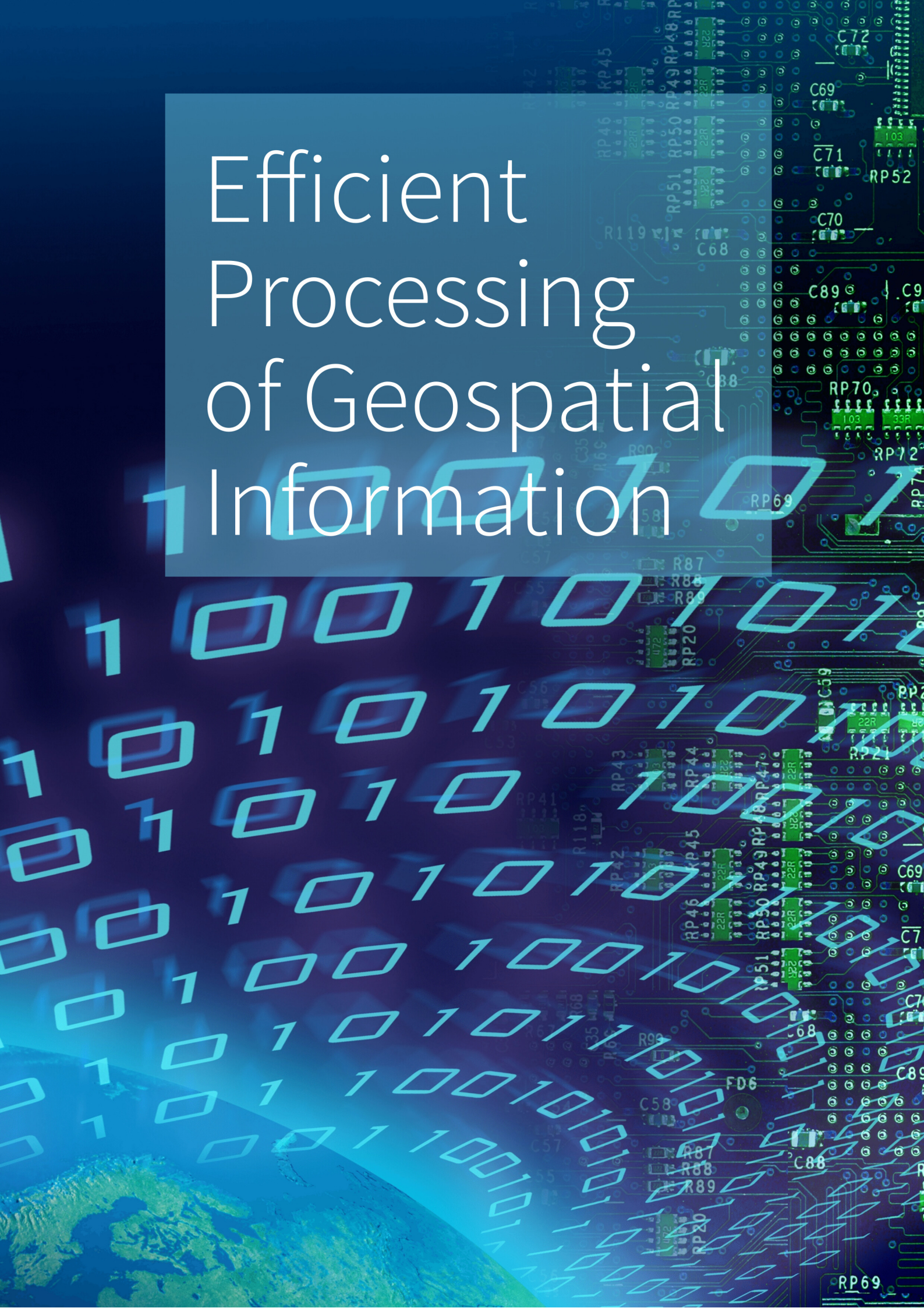
Architectures for heavy duty data processing

Geoprocessing refers to the data processing that is performed to transform, merge, analyze and visualize data from different sources. The increasing volume and variety of data, as well as the velocity of data streams, require new and advanced methods, technologies and architectural designs to cope with these challenges. This is where our Efficient Processing team contributes with research and development (R&D) and professional services (PS).

Matthes Rieke leads the Efficient Geoprocessing endeavors at 52°North. He and his team work on:

- Processing Scalability: identifying and realizing requirements for horizontal and vertical scaling of processing algorithms.
- Workflows Chains and Orchestration: designing and automating complex process workflows.
- Earth Observation Data Processing: handling huge amounts of EO data in an efficient and scalable way.
- Fit For Purpose Data: pre-processing, ingestion and provision of raster and vector data to fit the purpose of a specific solution
- Cloud Environments (PaaS, IaaS, SaaS): enabling their possibilities with regards to deployment patterns, handling of input data and processing results.
- Standardization: harmonizing processing interfaces, creating and using interoperable data formats.
- Processing Transparency: strengthening reproducibility, data quality and metadata quality, as well as process discovery.

We address these challenges in a number of R&D and PS projects. Our research partners and customers are from academia and industry covering various application domains, for example, environmental monitoring, emerging market development, climate change, or disaster management. This diversity enables us to develop new approaches that take into account the requirements of many real-world problems and use cases.

Matthes Rieke

Head of Efficient Processing

RIESGOS 2.0

Scenario-based multi-risk assessment in the Andes region

Developing novel concepts and components for multi-risk assessment of natural hazards

RIESGOS 2.0 is the direct successor to the successful RIESGOS project. It addresses challenges of increased risks to society caused by natural hazards, such as volcanic eruptions, earthquakes or tsunamis with a focus on the Andes region in South America. RIESGOS 2.0 aims to effect more efficient risk management based on more reliable information. In particular, the project addresses complex interactions, such as cascading effects of certain hazards and risks, as well as many of the underlying sources of uncertainty.

RIESGOS 2.0 develops novel scientific approaches related to the assessment of different hazards and risks. This includes the analysis of dynamic exposure, vulnerability and the modelling of cascading effects and possible failures.

Modular Web services integrated into a flexible and scalable multi-risk information system demonstrator provide the foundation of the RIESGOS 2.0 software architecture. End-users from civil protection and disaster management authorities receive a tool to simulate and analyze complex multi-risk scenarios.

At 52°North, we are responsible for the conceptual design and implementation of an interoperable architecture for a multi-risk analysis and information system for the Andes region. Our tasks comprise:

- the analysis of requirements
- the design of a message-driven processing architecture that improves the overall flow data and information products
- the implementation of selected web services as instances of the OGC API Processes
- the conceptual design of integrating uncertainty and quality information into the data products of the distributed web services
- a contribution to market analysis and development of exploitation perspectives (focus on the publication as open source software).

Our team focuses on the design of a message-driven processing architecture that allows the dynamic addition of supplementary analytical components. In the first year of the project, the focus will lie on the discussion and evaluation of potential software solutions that support

KEY TECHNOLOGIES

> OGC API Processes
> OGC Web Processing Service
> Java
> Docker

FACTS

Duration:
03/2021 - 02/2024

Website:
https://www.riesgos.de/en/

Contact:
Matthes Rieke
m.rieke@52north.org

Project Type:
Research and Development

such an architecture. The outcomes of this process will lead to the development of prototypes based on 52°North software components, such as the javaPS.
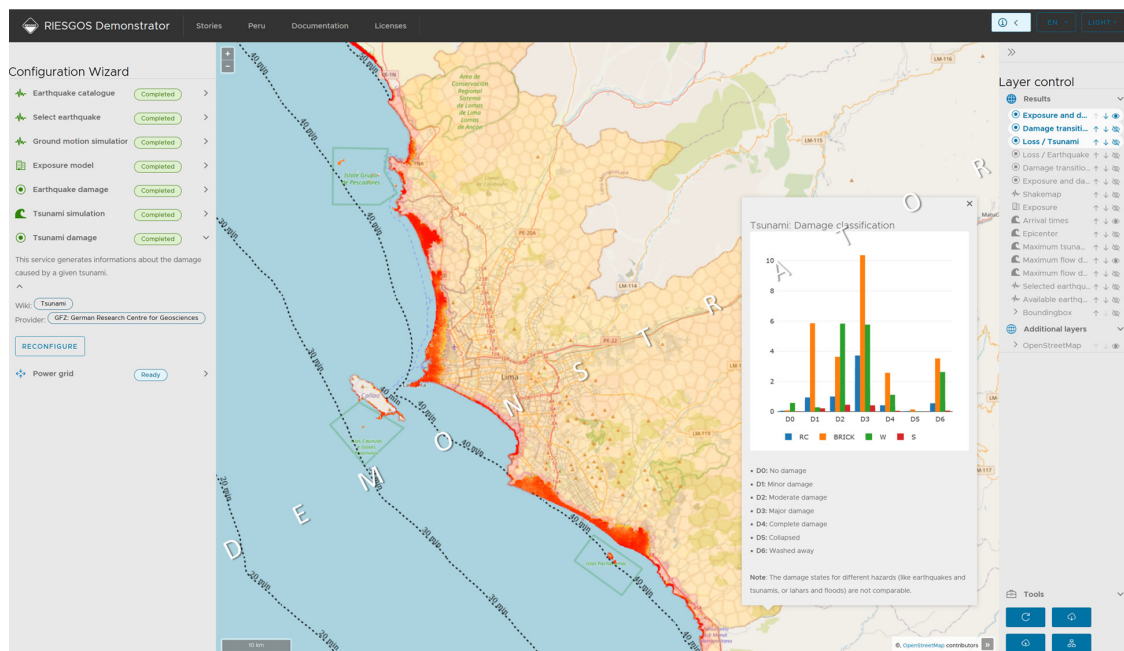
Screenshot of the RIESGOS demonstrator

PARTNERS

- **Coordinator**: Deutsches Zentrum für Luft- und Raumfahrt (DLR), Germany
- Helmholtz-Zentrum Potsdam Deutsches GeoForschungsZentrum (GFZ), Germany
- Alfred-Wegener-Institut (AWI), Germany
- Technische Universität München (TUM), Germany
- geomer GmbH, Germany
- Sachverständigenbüro für Luftbildauswertung und Umweltfragen, Germany
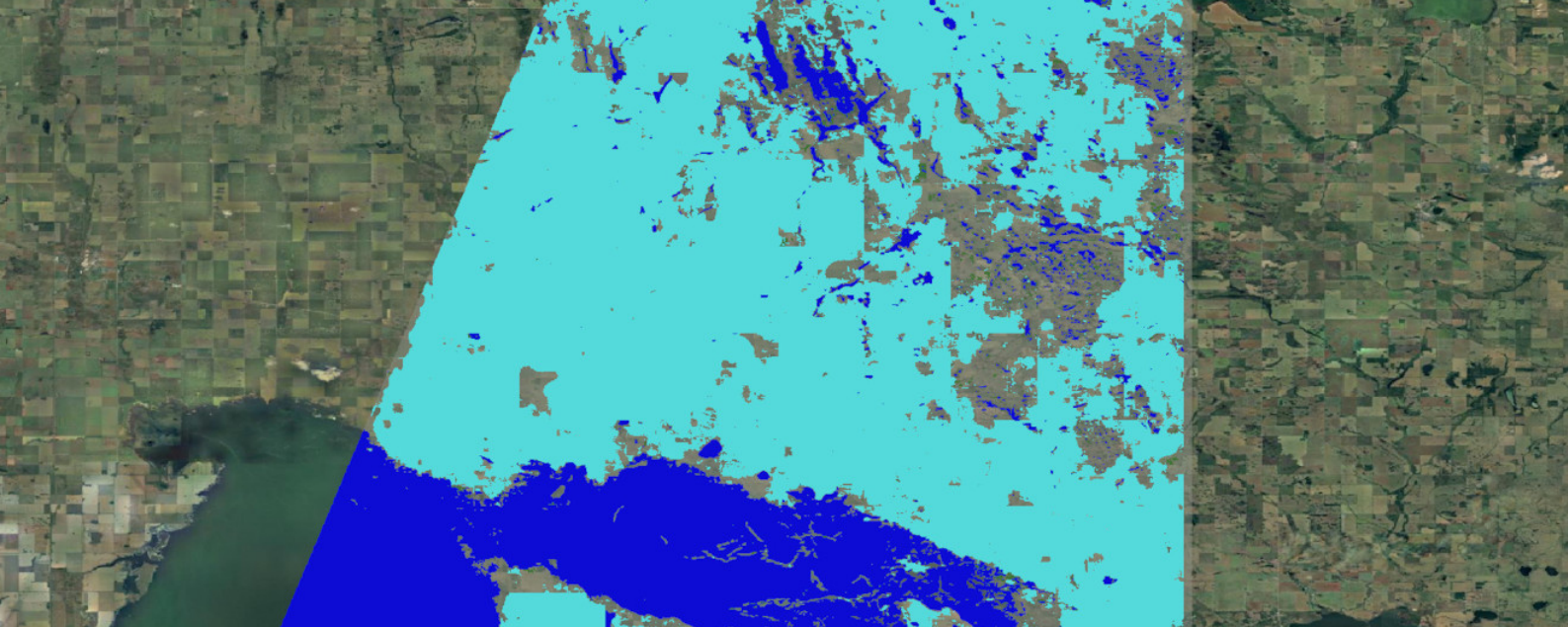- DIALOGIK, Germany

ASSOCIATED PARTNERS

- GIZ GmbH, Germany
- UNOOSA/UN-SPIDER, Germany
- UNESCO, Uruguay
- MunichRE, Germany

FUNDING

OGC Testbed-17

Next Generation of Geospatial Web APIs

Shaping the future of geospatial data technologies

The Open Geospatial Consortium (OGC) Testbed is an annual research and development program that explores geospatial technology from various angles. It takes the OGC standards baseline into account, but at the same time allows for exploration of selected aspects from a different perspective.

"Testbed-17 emphasizes the evaluation of what should be in a specification, how the specification should act, and how specification-based software should respond. Draft specifications and change requests are feeding the OGC Standards Program, where they will be reviewed, revised, and potentially approved as new international open standards that can reach millions of individuals." (OGC Testbed-17 | OGC, 2021)

Land cover prediction
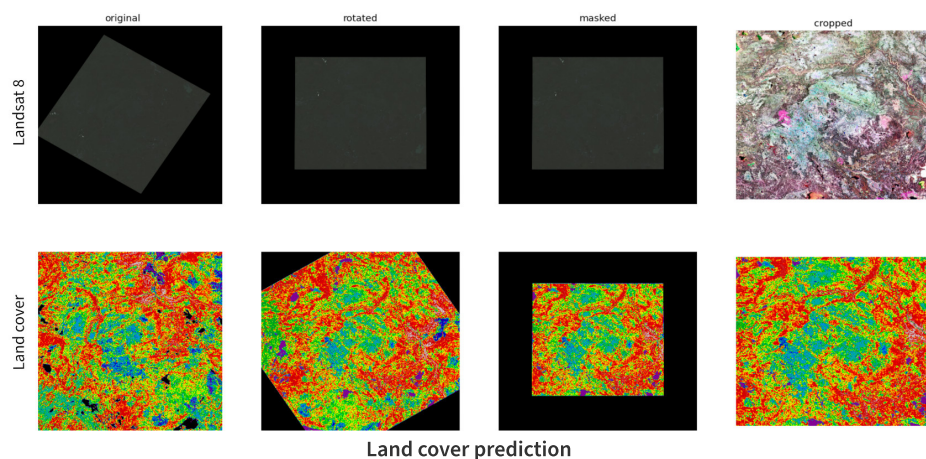
52°North participates in three different tasks of the "Interoperability through APIs" thread: the API Experiments (API), Geo Data Cubes (GDC) and the CITE tasks. The API task aims to provide a set of example code for both server-side and client-side software as well as best practices on how to start developing implementations of OGC APIs. The goal of the GDC task is the neutral definition of a Geo Data Cube (GDC) and a Web API for convenient, interoperable access and exploitation of coverage data. 52°North implemented data bridges for pygeoapi to integrate an Open data Cube instance. Based on these developments, data from an Open Data Cube

can now be served through different OGC APIs. 52°North also developed a Machine Learning client that interacts with the GDC API to retrieve EO data for an automated land cover classification. Finally, the CITE task utilizes the *OGC TEAM Engine* to provide an automated test suite for the upcoming OGC API Processes.

CUSTOMER

- Open Geospatial Consortium (OGC), USA

PARTNERS

- m-click, Germany
- George Mason University, USA
- Skymantics, USA
- Pixalytics, UK
- Solenix, Switzerland
- CubeWerx, Canada
- GeoSolutions, Italy
- GeoLabs, France
- interactive instruments, Germany
- Ecere, Canada
- Wuhan University, China
- MEEO, Italy
- Ethar, USA

FUNDING

OGC Testbed 17 was funded by multiple sponsors, including:

- Natural Resources Canada (NRCan), Canada
- European Space Agency (ESA), France
- US National Aeronautics and Space Administration (NASA), USA

OGC CITE Consulting

Issue Management and Feature Development for OGC's TEAM Engine

Ensuring true interoperability through OGC web service testing

The Open Geospatial Consortium (OGC) sought development support for their *TEAM Engine* (Test, Evaluation, And Measurement Engine), in particular, for maintenance and evolution of the core framework, existing test suites and test suite candidates. The TEAM Engine is a Java-based application for testing web services and other information resources. It executes test suites developed using the popular TestNG framework, OGC Compliance Test Language (CTL) scripts, and possibly other JVM-friendly languages. It is lightweight and easy to run from the command line or as a web application. The TEAM Engine can be used to test almost any type of service or information resource. It is the official test harness used by the OGC's compliance program.

52°North has already participated in activities related to the OGC API Processes test framework as part of the OGC Testbed-17. The software consultancy services continue on this foundation. We exectued this project in close collaboration with OGC and lat/lon as the overall manager of the TEAM Engine.

PARTNERS

- lat/lon GmbH, Germany

CUSTOMER

- Open Geospatial Consortium (OGC), USA

Fraym DMP

Fraym Data Management Platform

Designing geodata management

Fraym "delivers unprecedented, localized information about population characteristics and behaviors" (Fraym | Advanced data on communities around the world, n.d.). The data used ranges from raster and vector data to survey and related reference data. This data and the results of analysis workflows must be stored and managed in a sustainable and similar manner. Since the amount of data Fraym stores exceeded a manually manageable threshold, they needed to create a modern and scalable solution that takes Geo-IT standards into account. The main project goal was to identify, discuss and document the requirements for Fraym's Data Management Platform (DMP) with a particular focus on geo-spatial aspects. 52°North supported and advised Fraym in their development of solutions for storing and managing geo-spatial data required for data analysis workflows.

The initial requirements analysis phase featured a remote User Story Workshop. Based on the user requirements collected at the workshop, 52°North designed an overall architecture for the DMP. Using arc42 as a lightweight, but flexible architecture documentation concept, we identified and designed the DMP's central components to the required level of detail.

The project finalized the implementation phase in 2021. 52°North developed the DMP using cutting-edge technology (e.g. AWS Elastic Kubernetes Service, auto-scaling of underlying business logic components, S3 for data storage). We realized specific solutions that focus on the requirements of data ingestion and metadata management on top of the existing GeoNode and Django framework. A special focus was on the extensibility of the ingestion and metadata framework to enable lightweight adjustments by Fraym staff. Raster data is stored and managed in S3 buckets while vector data is hosted in a PostGIS data based and exposed via GeoServer.

CUSTOMER

- Fraym, USA

KEY TECHNOLOGIES

> User Story Workshop
> Arc42
> GeoNode
> AWS Elastic Kubernetes Service
> S3

FACTS

Duration:
05/2020 - 06/2021

Contact:
Matthes Rieke
m.rieke@52north.org

Project Type:
Professional Services

RDFC with con terra

Research and Development Framework Contract with con terra

Creating synergies for innovation in Geo-IT

Motivated by upcoming challenges in the solution design for future Geo-IT services, con terra requested consulting to identify, evaluate and prototype new architectural patterns. The trend of IT infrastructures moving towards Cloud concepts, such as Kubernetes, demands a shift in software systems and their architectures. This and related aspects were the main driver for the activities in a three-year research and development framework (RDFC).

In 2021, 52°North conducted two pilot projects. We developed architectural patterns and solutions to help con terra build cloud-native solutions and provide guidance for the further development of their technology stack.

The first pilot focused on lightweight server-side processing functionality backed by OpenAPI 3.0 definitions. A team consisting of both con terra and 52°North software developers and architects realized and evaluated different approaches. In particular, we compared an API-first approach using code stub generators with a code-first approach that derives the API definition from the component at runtime. The results led to recommendations on how to implement lightweight Microservices with modern programming languages, such as Python and TypeScript, utilizing geospatial capabilities from Esri ArcGIS and Safe Software FME.

In the second iteration, a team of 52°North and con terra software architects carried out a deeper analysis of Cloud technology. An extensive look into project solutions revealed basic patterns for con terra's enterprise software stack that are relevant in customer environments that use Cloud technologies for deployment and monitoring. The project analysis was complemented by a state-of-the-art analysis of the current Cloud landscape, which will be integrated into the project development strategies by different teams at con terra.
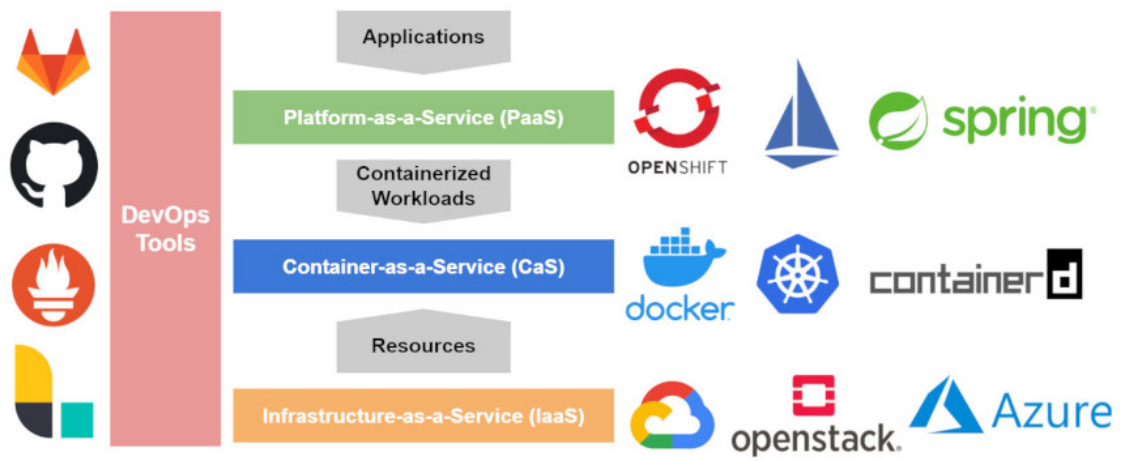
Cloud native stack

CUSTOMER

- con terra GmbH, Germany

EUMETSAT Cloud and Big Data Services

Cloud and Big Data Services Eengineering and Operations Support

EUMETSAT

Designing the next generation of Online Data Access Services for satellite products

Following the EUMETSAT Pathfinder and Earth Observation Web Based Services (EOWS) projects, a consortium consisting of CGI Deutschland, con terra, ask and 52°North successfully bid for the direct successor - *Cloud and Big Data Services engineering and operations support*. EUMETSAT aims to continue the established portfolio of data services featuring innovative data access and discovery capabilities. The operational version of the EUMETSAT Data Store - a scalable and extensible architecture for providing online access to EUMETSAT's products - will be maintained and developed further. Besides the Data Store, additional components play an important role: e.g., a workflow engine for improving the internal data processing pipelines and established services such as the Product Navigator. The consortium is also responsible for the maintenance and operation of the components. Together, con terra and 52°North provide third-level support for specific components of the architecture.

As part of the evolutionary development, 52°North will be responsible for the EUMETSAT Data Store User Interface, the workflow engine and the Product Navigator components. The Data Store is designed to provide an easy-to-use web interface for end users in order to identify EO products of interest. It comprises a search interface with spatial, temporal and thematic filters. Users are able to examine the details (e.g., the spatial footprint, sensing time, satellite instruments used) and start the download of single or multiple products. The Product Navigator, jointly developed by con terra and 52°North, is the central entry point to access EUMETSAT's Earth Observation product types and services. The landing page refers users to interesting highlights, product types or data.

The team concentrated on taking over the operational and maintenance responsibilities, by which the analysis of architectural concepts for the EUMETSAT service infrastructure played an important role. Furthermore, an evolution of the Data Store focused on the integration of Sentinel-3 data. At the end of 2021, we initiated a new acitivity for the next evolution of the Product Navigator. This includes an holistic approach to information and data discovery.
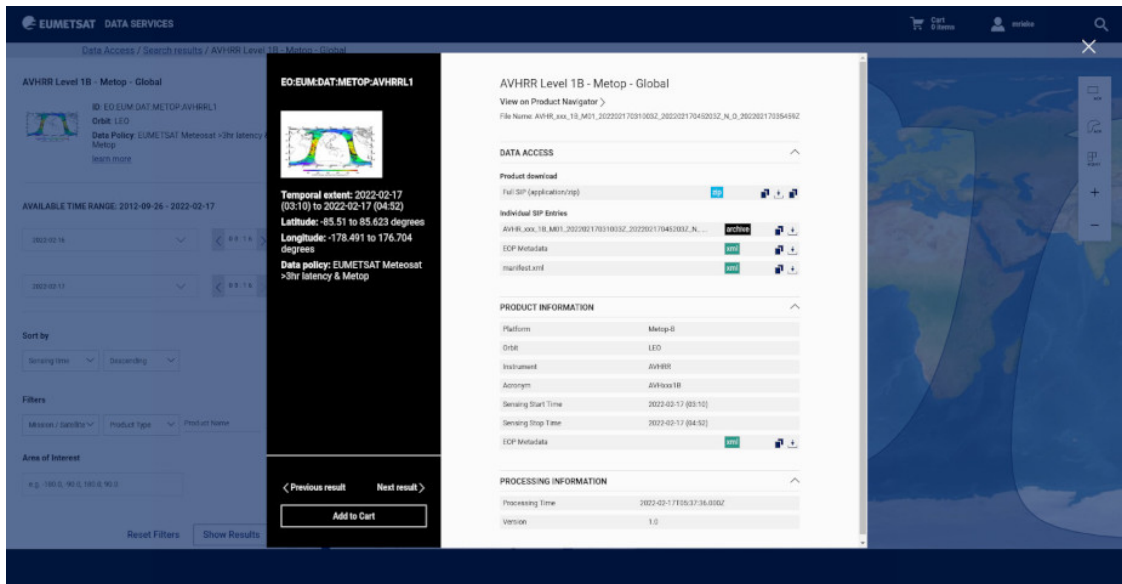
EUMETSAT data services

CUSTOMER

- EUMETSAT, Germany

PARTNERS

- CGI Deutschland B.V. & Co. KG
- con terra GmbH
- ask – Innovative Visualisierungslösungen GmbH

DVFO LHS

Digital Traffic Flow Optimization for the State Capital Stuttgart

Enhancing enviroCar to support digital traffic flow optimization

As part of their "Digital Traffic Flow Optimization" project, the state capital of Stuttgart intends to set up an environmentally sensitive traffic management system. This system will include existing components and those currently under development in the overall architecture. It will aslo supplement further components and integrate various vehicle, traffic and environmental data to form a new overall system.

52°North supports SSP Consult by providing services to enable the use of the enviroCar platform for its purposes in the project. We provide operational and technical support for the platform and software as well as software development and consulting services. Software developments include:

- Detection of extreme accelerations and decelerations
- Continuous provision of measurement data
- Support of software development, data preparation and data analysis.
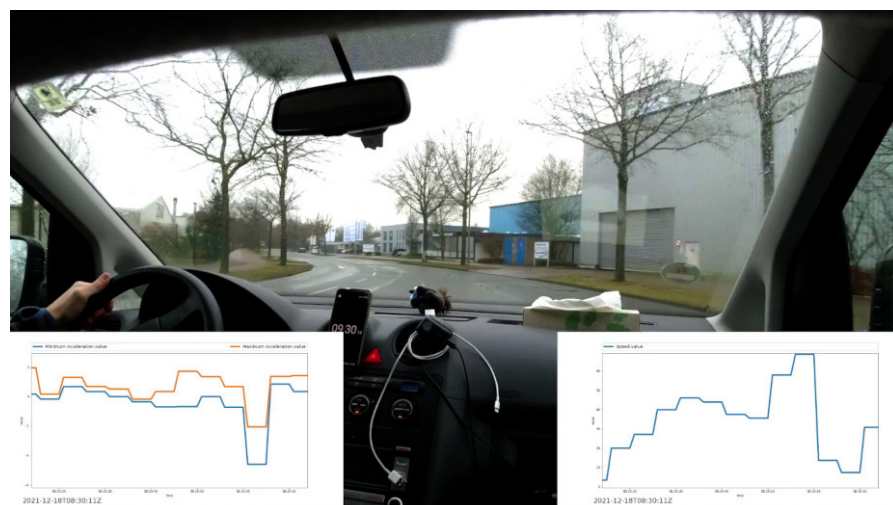
Capturing vehicle accelerations with enviroCar

PARTNERS

- GEVAS software GmbH, Germany
- PRISMA solutions EDV-Dienstleistungen GmbH, Germany
- Trafficon - Traffic Consultants GmbH, Germany
- SSP Consult Beratende Ingeniuere GmbH, Germany
- IVU Umwelt GmbH, Germany

CUSTOMER

- SSP Consult Beratende Ingeniuere GmbH, Germany

FUNDING

SPONSORED BY THE

SIMPORT

Sovereign and Intuitive Management of Personal Location Information

Raising awareness for privacy in location information

The majority of cell phone users are unaware of how their cell phone's GPS location history can lead to deep conclusions about their activities, place of residence, inclinations, beliefs or social networks. The SIMPORT project aims to raise awareness as well as design and implement measures to better protect the privacy of location information.

The consortium members work to develop guidelines and software modules to confidentially handle personal location information on a mobile device. They cooperate with partners from the industry to create open source software components to enable digital sovereignty with regard to personal location information. Users of these components can clearly visualize possible conclusions about their personal location information and better assess the advantages and disadvantages of passing on this information. Consequently, users know of the risks precisely when they have to decide whether or not they want to share their personal data.

In close cooperation with computer science and the social sciences, the researchers analyze how to improve awareness of risks and opportunities and to develop fine-grained control options for the transfer of personal location information. This strengthens the competence and sovereignty of smartphone users when deciding about their personal data.

52°North has long-term experience with location-based services from the developments of the enviroCar ecosystem. Our team evaluates possible prototypes of SIMPORT components in the enviroCar system. In addition, we contribute expertise in collaborative software development processes.

KEY TECHNOLOGIES
> Location based services
> Android

FACTS

Duration:
07/2020 - 06/2023

Website:
https://simport.net/

Contact:
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Project Type:
Research & Development

SIMPORT app

PARTNERS

- Institute for Geoinformatics, University of Münster, Germany
- FH Münster, Germany
- HERE Deutschland, Germany
- re:edu, Germany
- Universität Osnabrück, Germany

FUNDING

Spatio-Temporal Data Analytics

Developing analytical tools to address real world problems

The constant increase in volume and variety of data available generates a large potential for answering a range of questions. To understand these data and derive answers, we need analytical tools to model relationships emerging from them. Dr. Benedikt Gräler, leading the activities within the Spatio-Temporal Data Analytics realm, and his team develop data-driven solutions to real world problems.

Exploring and researching analytical tools from linear statistics, recent multivariate distributions to modern machine learning (ML) and artificial intelligence (AI) approaches, we develop appropriate solutions for the problem at hand given the data available. A prerequisite is a solid data and business understanding. We use and contribute to open source tools where possible and encourage Citizen Science.

We address different R&D and PS projects covering a range of topics. The challenge of making Earth Observation time series accessible and providing unified processing and analysis tools has been and remains an engineering task for solving several open questions. The meaningful integration of heterogeneous data sources (from geospatial observations to official statistics) and the adoption of ML and AI algorithms to the special characteristics of spatial and spatio-temporal data are central themes of forthcoming tasks. A general ambition is to develop tools that are of great value for the end users. Therefore, a co-design approach often helps to unearth the relevant questions within a project and to empower us to provide meaningful solutions.

Benedikt Gräler

Head of Spatio-Temporal Data Analytics

KI:STE

AI Strategy for Earth System Data

AI for the analysis of Earth Observation data
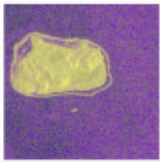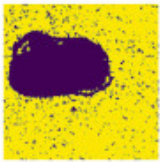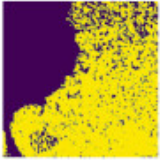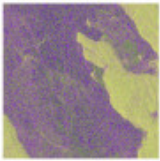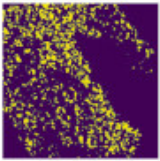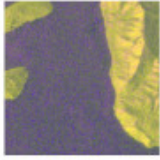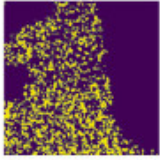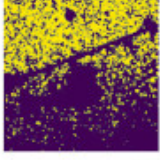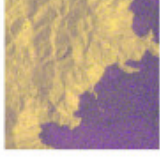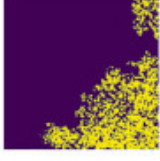
Artificial intelligence (AI) methods experience rapid development and increasing use in the context of environmental data. However, this often happens in isolated solutions. Environmental and earth system sciences have yet to establish the systemic use of modern AI methods. In particular, discrepancy exists between the requirements of a solid and technically sound environmental data analysis and the applicability of modern AI methods such as Deep Learning for researchers.

The KI:STE project strives to facilitate and evaluate the use of AI for remote sensing Earth Observation data for a range of applications. The fields studied in the project range from air quality to clouds and radiation, to snow and ice propagating, as well as water that drives vegetation, then closing the loop with air quality. A core focus is not only to adopt and apply AI concepts to these areas, but also to train several PhD students and build an e-learning platform. This will ease and facilitate access to the algorithms and tools developed for a wider audience – from scientists to practitioners.

52°North develops the Spatial Research Data Infrastructure (SRDI) that will supply the AI processing platform with data. A requirement analysis provides the basis for defining and developing interfaces for data acquisition and provision. The platform must react flexibly to the requirements of the AI algorithm requesting data in order to be able to provide the data in a format optimized for the required processing. We work on the SRDI in close collaboration with the Ambrosys GmbH.

During 2021, Ambrosys and our team conducted the requirements analysis for the KI:STE data and machine learning platform based on detailed interviews with the KI:STE PhD students. 52°North developers also contributed a use case on the classification of water surfaces based on SAR images. Our approach builds on a two step iterative process using U-Nets to classify water in EO scenes within the visible and NIR spectra. These are then used as input for the SAR image training. As a result, the approach can be used to detect flooded areas in an emergency scenario. We implemented first data bridges for the Mantik platform and Ambrosys has presented a first show case of the Mantik platform.

Water surface classification results

PARTNERS

- Forschungszentrum Jülich GmbH, Germany
- Jülich Supercomputing Centre (JSC) und Institut für Bio- und Geowissenschaften – Agrosphäre (IBG-3), Germany
- Universität zu Köln, Institut für Geophysik und Meteorologie, Germany
- Universität Bonn, Institut für Geodäsie und Geoinformatik, Germany
- RWTH Aachen, Aachen Institute for Advanced Study in Computational Engineering Science, Germany
- Ambrosys GmbH Gesellschaft für Management komplexer Systeme, Germany

FUNDING

I-CISK

Co-Design to Reveal the Value of Climate Services

Innovating climate services by integrating scientific and local knowledge

Climate Services (CS) are crucial in empowering citizens, stakeholders and decision-makers in defining resilient pathways to adapt to climate change and extreme events. Despite advances in scientific data and knowledge (e.g. Copernicus, GEOSS), current CS fail to achieve their full value proposition to end users. Challenges include incorporation of social and behavioral factors, local needs, knowledge and the customs of end users. I-CISK develops a next generation of end user CS, which follow a social and behaviorally informed approach to co-producing services that meet climate information needs at a relevant spatial and temporal scale. It takes a trans-disciplinary approach to developing CS by working with stakeholders in 7 Living Labs established in climate hotspots in Europe, it's neighbors, and Africa, to address climate change and extremes (droughts, floods and heatwaves) faced by agriculture, forestry, tourism, energy, health, and the humanitarian sectors. With end users, I-CISK will co-design, co-create, co-implement, and co-evaluate pre-operational CS that provide a step change in integrating local knowledge, perceptions and preferences with scientific knowledge. This co-production framework is unique as it (i) links climate impact and adaptation at different temporal scales from (sub)-seasonal forecasts through to climate scale projections, and (ii) explicitly considers the human climate feedbacks of adaptation and options in a multi-timescale, multi-sector, and multi-hazard setting. The novel CS will be built on a highly customizable cloud-based web platform that I-CISK develops; freely available, and easily replicable. The I-CISK co-production framework, supported by online open courses, guidelines, business stories and strategic dissemination, will catalyze the production and adoption of CS that integrate end-user local knowledge with scientific knowledge, contribute to improved decisions and policies, and a flourishing market for end-user CS.

With its recent start in November 2021, the project kicked off the first phase of requirement analysis. 52°North leads this phase and the specification of the climate service platform jointly with GECO. The focus of 52°North tasks lies in the development of front-end components to combine new CS for end-users. Hence, 52°North will be involved in the co-design process driven from the Living Labs. Our team will also contribute to the discussions and developments to assess, manage and present the uncertainties that are an inherent component of climate models.

Co-design pattern in I-CISK
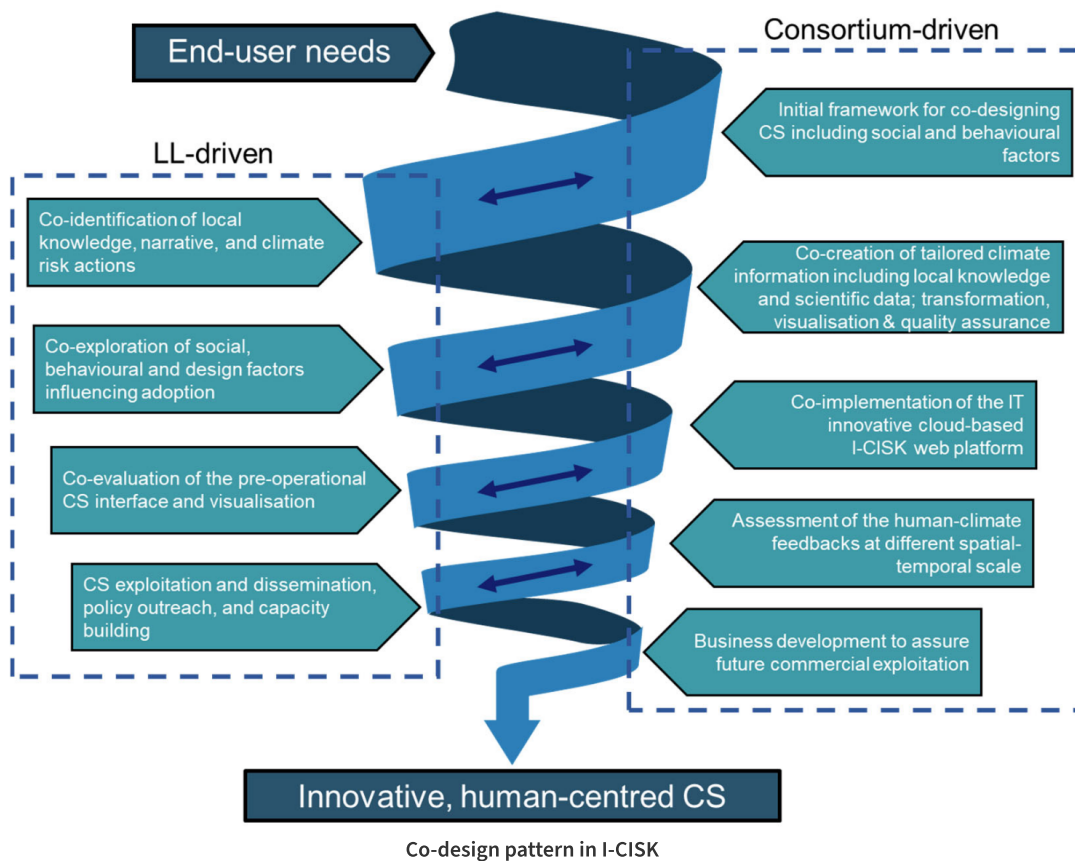
PARTNERS

- **Coordinator**, IHE Delft Institute for Water Education, The Netherlands
- European Centre for Medium-Range Weather Forecasts (ECMWF), UK
- Swedish Meteorological and Hydrological Institute (SMHI), Sweden
- VU Foundation, Then Netherlands
- CREAF, Spain
- Uppsala University, Sweden
- The Netherlands Red Cross, The Netherlands
- GECOsistema, Italy
- Caucasus Environmental NGO Network (CENN), Georgia
- Universidad Computense de Madrid, Spain
- IDEAS Science Ltd., Hungary
- EMVIS S.A., Greece

FUNDING

MariGeoRoute

MariData GeoPlatform and Routing

Comprehensive technologies for energy management of ships

MariData is a project funded by BMWI that aims to enable a deterministic analysis of a ship's energy demand based on environmental and physical conditions. It sensibly delineates the energy demands of various sources to provide tools for an energy optimized ship routing and management. This leads to suggested routing alternatives, speed and trim adjustments or additional services on the ship hull.

MariGeoRoute is a subproject addressing the challenges related to needs arising from the various data demands, such as nautical maps, weather records and forecasts raging from wind and temperature to wave heights and currents. 52°North develops an integrated data store, the GeoPlatform, which will provide data for on shore services as well as for the ships at sea. It needs to sensibly subset and preprocess the data to reduce data load. We will also develop approaches based on machine learning (ML) to model the energy demand based on the data collected and derived from the consortial partners. A routing service developed by 52°North will use the data accessible in the GeoPlatform to provide routing alternatives along the smallest energy demands under constraints of nautical limitations, ship safety and delivery schedules.

In 2021, 52°North completed a detailed and extended requirements analysis of the entire MariData system, including the Decision Support System onboard and the GeoPlatform deployed in the cloud. We evaluated the first concepts and options according to their suitability. Our team also developed and deployed several modules constituting the entire GeoPlatform. An environmental data retrieval Web Application to support the research partners allows for the retrieval of various recorded environmental data sets across different data providers in a unified interface. Specifying the spatial and temporal extent along with the set of desired variables suffices to retrieve an integrated multi variable space-time cube as a single NetCDF-file. We designed the API integration that delivers the energy demand based on a set of surrogate models, as well as, developed and discussed the provision of the route-optimized data cubes with the MariData consortium.

KEY TECHNOLOGIES

> Open Data Cube
> GeoNode
> Geoserver
> Python
> Django
> pygeoapi
> Java
> JavaScript
> Kubernetes

FACTS

Duration:
12/2020 – 11/2023

Website:
http://maridata.org/

Contact:
Benedikt Gräler
b.graeler@52north.org

Project Type:
Research and Development
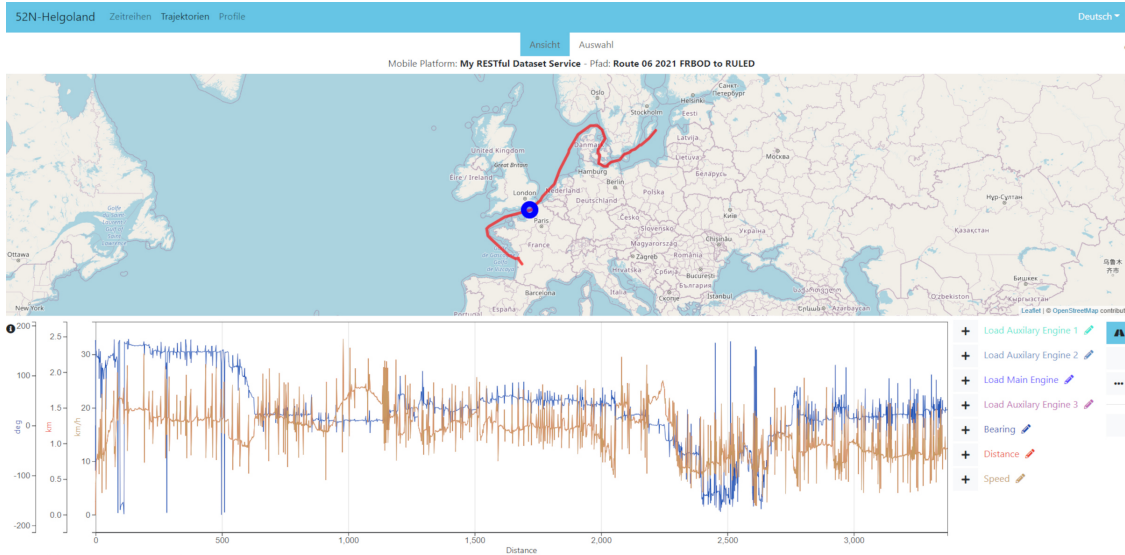
Speed-distance-bearing trajectories

PARTNERS

- Hamburgische Schiffbau-Versuchsanstalt GmbH (HSVA)
- AVL Deutschland GmbH
- DST – Entwicklungszentrum für Schiffstechnik und Transportsysteme e.V.
- Friendship Systems AG
- Technische Universität Berlin
- Technische Universität Hamburg
- Universität zu Lübeck
- Maritimes Zentrum der Hochschule Flensburg
- Carl Büttner Shipmanagement
- AVL Software and Functions

FUNDING
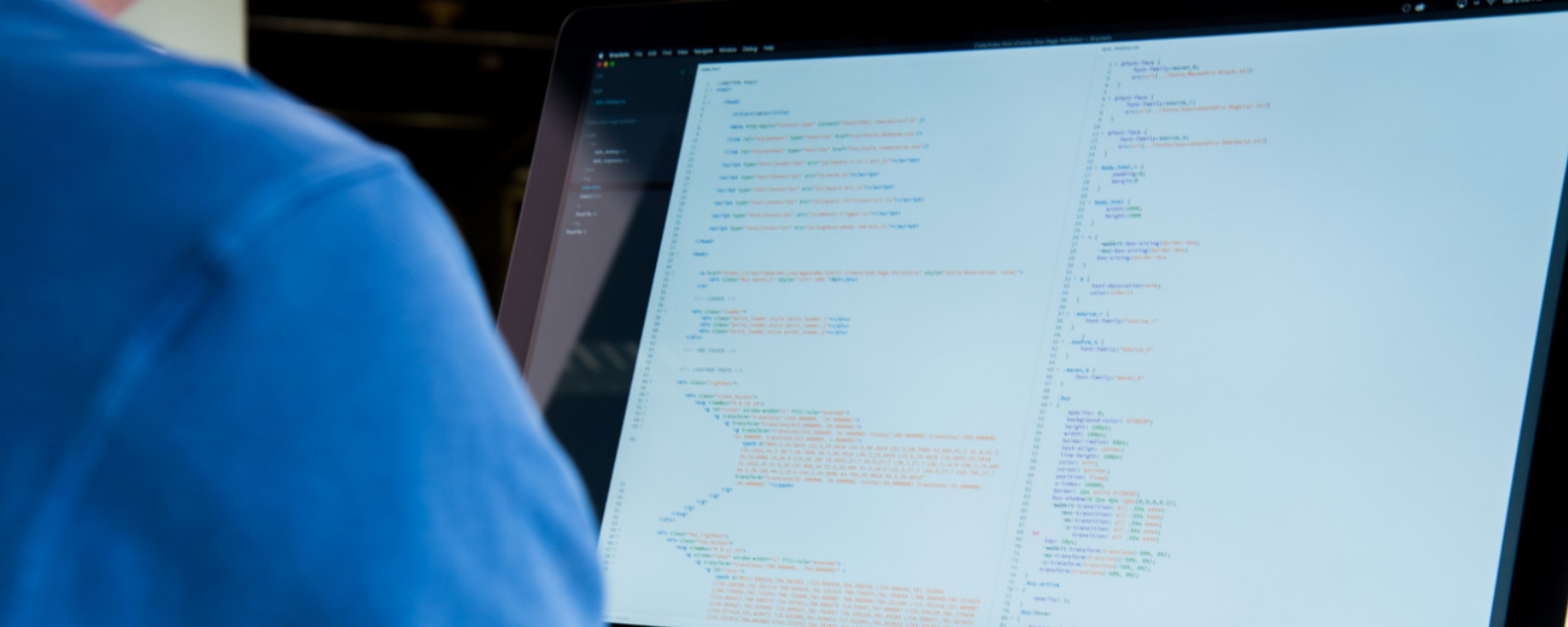
RCon-STDA

Spatio-Temporal Data and Analytics

Filling the gap for irregular spatio-temporal data in R

The existing R package sftime is a suite of modern spatial and spatio-temporal data representations in R. However, it did not include irregular spatio-temporal data. In this project, 52°North and the Institute for Geoinformatics jointly develops the R package sftime to a mature state to close this gap. The geostatistical modelling package gstat and the spatial copula modelling package spcopula are also modified to support the new data representation classes of sf, stars and sftime. All packages will receive vignettes with worked out, full-fledged case studies, and results will be published on the r-spatial.org blog.

In 2021, our developers further implemented the agreed upon design of the sftime classes and the entire package. The implementation enables the user to store, plot and subset data. We also completed first adaptations to the analytics packages.

PARTNERS

- Institute for Geoinformatics, University of Münster, Germany

CUSTOMER

- ISC, R consortium

BZgA Survey Evalaution Tool

Toolbox Improvements

Improving the user interface and user experience

The Federal Center for Health Education (BZgA) runs educational campaigns for a multitude of health topics. A central measure in these campaigns are public websites tailored to different target audiences. In order to evaluate these websites, standardized questionnaires for regular user studies are put forward and, subsequently, their results must be assessed.

A complete toolbox to ease and standardize the entire website evaluation process is available as a standalone R-Shiny application. 52°North builds upon this previously developed questionnaire evaluation toolbox. We also incorporate several questionnaire updates into the evaluation application. In addition, our team focuses on improving the user interface and user experience.
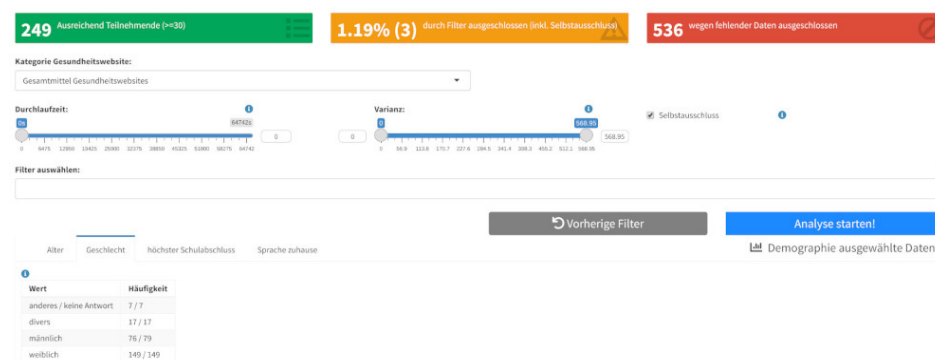
BZgA's evaluation tool showing synthetic test data

CUSTOMER

- BZgA - Federal Center for Health Education, Germany

Software Projects

Helgoland Sensor Web Viewer

Arctic Sea

Helgoland Toolbox

Open Source Projects Contributions

wps-ng-client

enviroCar suite

SOS

sos4R
and sos4py

STA

Developing innovative technologies to advance spatial information infrastructures

52°North fosters applied research in the geospatial domain by managing and supporting the collaborative development of geospatial open source software. Our software is published under Open Source Initiative (OSI) approved open source licenses and hosted at GitHub. We also contribute to major Open Source Software solutions by applying our expertise to expand, improve and use this software for our research and customers.

Helgoland
API

javaPS

Arctic Sea

Backbone for OGC Services, Clients and Middleware

Easing the development of OGC related services, clients and middleware

Arctic Sea is 52°North's framework for developing OGC services, clients and middleware sharing concepts for encoding and decoding of different formats and encoding, workflows and configuration. This stack of projects eases the development of OGC related services, such as 52°North's implementation of the OGC SOS and WPS, as well as clients and middleware. It compromises the following modules.

Iceland: Iceland is a service framework that enables the development of OGC RPC (remote procedure call) based services. It features bindings for KVP, POX, SOAP, as well as JSON-based bindings. Iceland facilitates the rapid development of modular services that use Faroe for easy configuration and Svalbard for request parsing and response generation.

Svalbard: Svalbard consists of various decoders and encoders for OGC models (e.g., SensorML, O&M and SWE Common), service interfaces (like SOS and WPS) and a framework for developing these. This enables the creation of decoupled and reusable encoders and decoders for various encodings (e.g., XML, JSON or NetCDF). The object models used are found in Shetland and shared across 52°North components.

Faroe: Faroe is a configuration API currently featuring a JSON and an SQLite backend. It enables the injection and automatic configuration of settings of various types in classes, including a Spring BeanPostprocessor.

Shetland: Shetland consists of classes for OGC models like SensorML, O&M and SWE Common and various service requests and responses. These are shared across different service implementations.

Jan Mayen: Jan Mayen contains various utility classes shared throughout Arctic Sea.
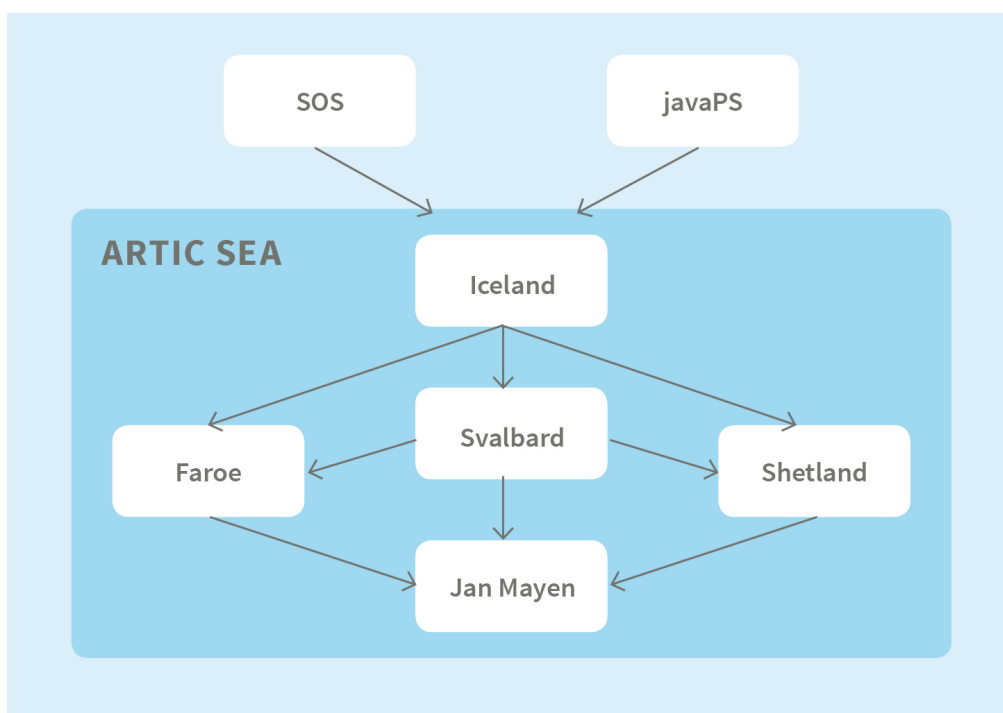
Arctic Sea modules

In 2021, our software engineers published several bug fixes and small improvements. Most notable is the support for the "qualifier" and censoredReason" in the WaterML 2.0 and TimeseriesML 1.0 encodings. We actively maintain the versions on Maven Central.

BENEFITS

- The middleware component provides a robust layer to easily create web services compliant to OGC standards.
- The configuration API enables harmonized management of service properties
- Centralized XML encoding and decoding reduces boilerplate code and increases stability

FIELDS OF APPLICATION

Building blocks for OGC Web Services, OGC clients, processing of OGC schema data formats (GML, O&M, SensorML, …)

PROJECT REFERENCES

- NeXOS
- COLABIS
- SeaDataCloud
- ODIP II
- ConnectinGEO
- GeoViQua
- WaCoDiS
- MuDak-WRM
- BRIDGES

DOWNLOAD

GitHub: https://github.com/52North/arctic-sea

Maven Central: https://search.maven.org/search?q=g:org.n52.arctic-sea
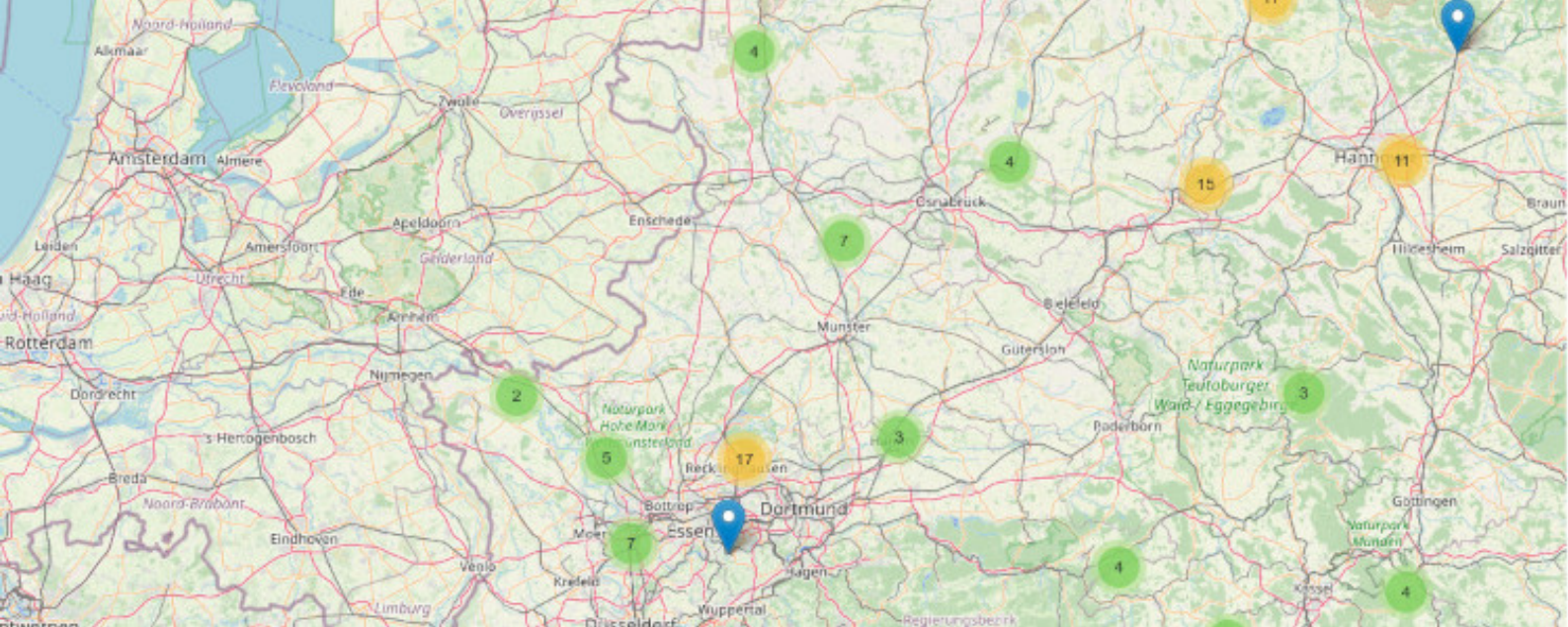
Helgoland Sensor Web Viewer

Web-Based Visualization of Observation Data

Enabling exploration, analysis and visualization of sensor web data

The 52°North Helgoland Sensor Web Viewer is a lightweight web application that enables the exploration, visualization, and analysis of Sensor Web data in various fields of use, e.g., hydrology, meteorology, environmental monitoring.

It enables users to:

- Explore stations or mobile sensor platforms in a map
- Select time series data via a list selection
- Visualize and navigate through time series data, trajectory data, profile measurements
- Create favorites of selected time series
- Export visualized data as CSV files.

The Helgoland Sensor Web Viewer can connect to different Sensor Web endpoints (via the 52°North Helgoland API). These endpoints provide a thin access layer to sensor data (e.g., offered by SOS servers' databases) via a RESTful Web binding with different output formats. In addition to the Sensor Web endpoints, the Viewer can also connect to different OGC SensorThings APIs.

Our Sensor Web Viewer is based on the Helgoland Toolbox. It integrates the different toolbox modules into a viewing application that can be easily customized according to the requirements of specific users.

52°North's software engineers focused on evaluating approaches to visualize real-time data streams and code base maintenance in 2021.
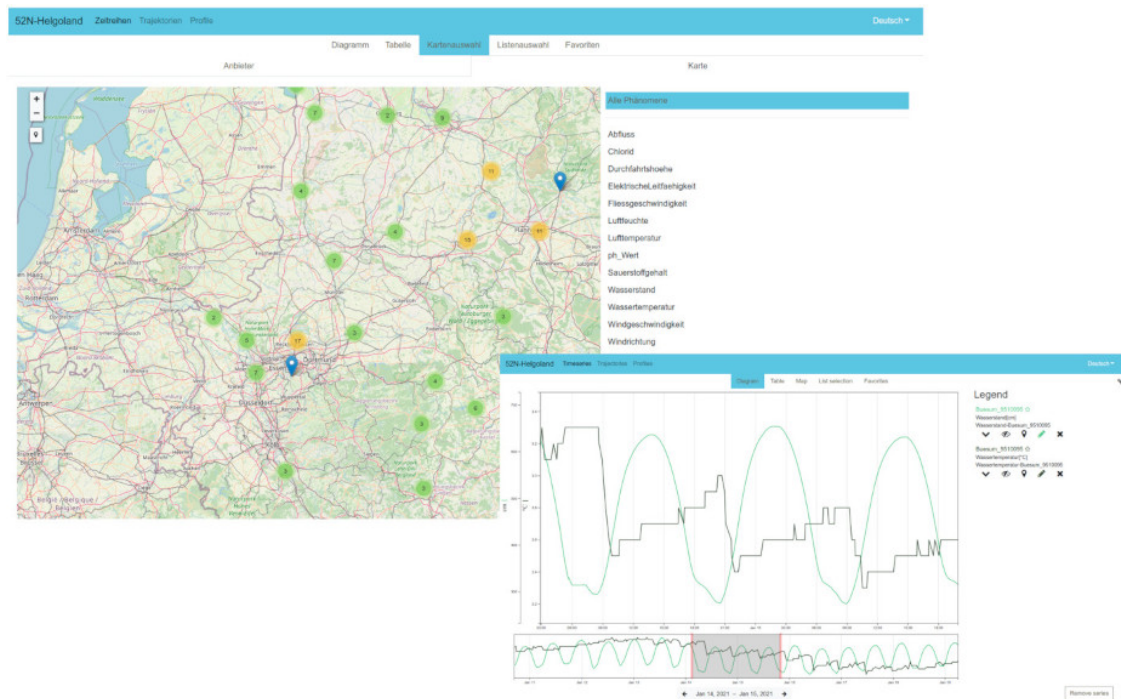
Helgoland Sensor Web Viewer

BENEFITS

- Lightweight, Web-based visualization of observation data
- Exploration of Sensor Web data sources (SOS, SensorThings API)
- Support of different types of observation data (time series, trajectories, profiles)
- Data download (CSV)

FIELDS OF APPLICATION

Hydrology, air quality, marine sciences, environmental monitoring

PROJECT REFERENCES

- Federal Maritime and Hydrographic Agency (BSH), Germany
- Wupperverband, Germany
- SeaDataCloud
- WaCoDiS
- MuDak-WRM

DOWNLOAD

GitHub: https://github.com/52North/helgoland

Helgoland Toolbox

Tools for Building Web Applications

Providing reusable components for building (Sensor Web) client applications

52°North created the Helgoland Toolbox to facilitate the reuse of developments for Sensor Web client applications. It provides a range of modules that offer functionalities for building Web applications dealing with dynamic spatio-temporal data.

The Helgoland Toolbox modules are used to build the 52°North Helgoland Sensor Web Viewer. We also built additional applications (e.g., the BelAir app, smle, or the developments resulting from the TaMIS project) upon this library.

The most important functional modules comprise:

- Core
  - Communication with the APIs (Helgoland API and OGC SensorThings API)
  - Important common services (local storage, time)
  - Central interfaces and abstract classes
- Caching
  - Request Caching with Angular Interceptors
- d3
  - Trajectory Graph component
  - Time series Graph component
- Depiction
  - Legend entries
  - Table view of data
- Map
  - Controls (Geo-Search, Locate, Zoom, Extent)
  - Map Selector component

- Selectors
    - List Selector for observation data
    - Service Selector for data sources.

In 2021, 52°North software engineers focused on a refactoring process to better support the integration of heterogeneous data sources and real-time data streams (e.g. via MQTT). We complemented this with regular code maintenance and upgrades of used libraries.
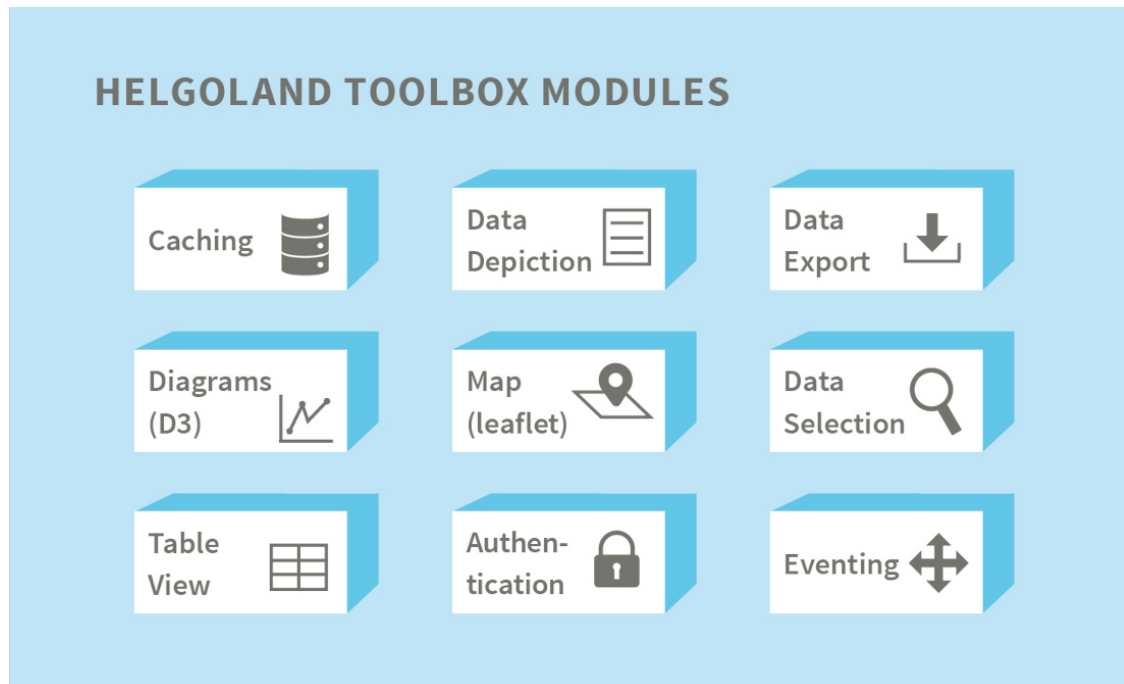
BENEFITS

- Reusable components for building client applications
- Modules for visualizing different types of sensor data (time series, trajectories, profiles)
- Mapping modules
- Different components for data selection

FIELDS OF APPLICATION

Hydrology, air quality, marine sciences, environmental monitoring

PROJECT REFERENCES

- EMODnet Data Ingestion Portal
- SeaDataCloud
- Federal Maritime and Hydrographic Agency (BSH)
- Wupperverband
- WaCoDiS
- MuDak-WRM
- mVIZ

DOWNLOAD

GitHub: https://github.com/52North/helgoland-toolbox
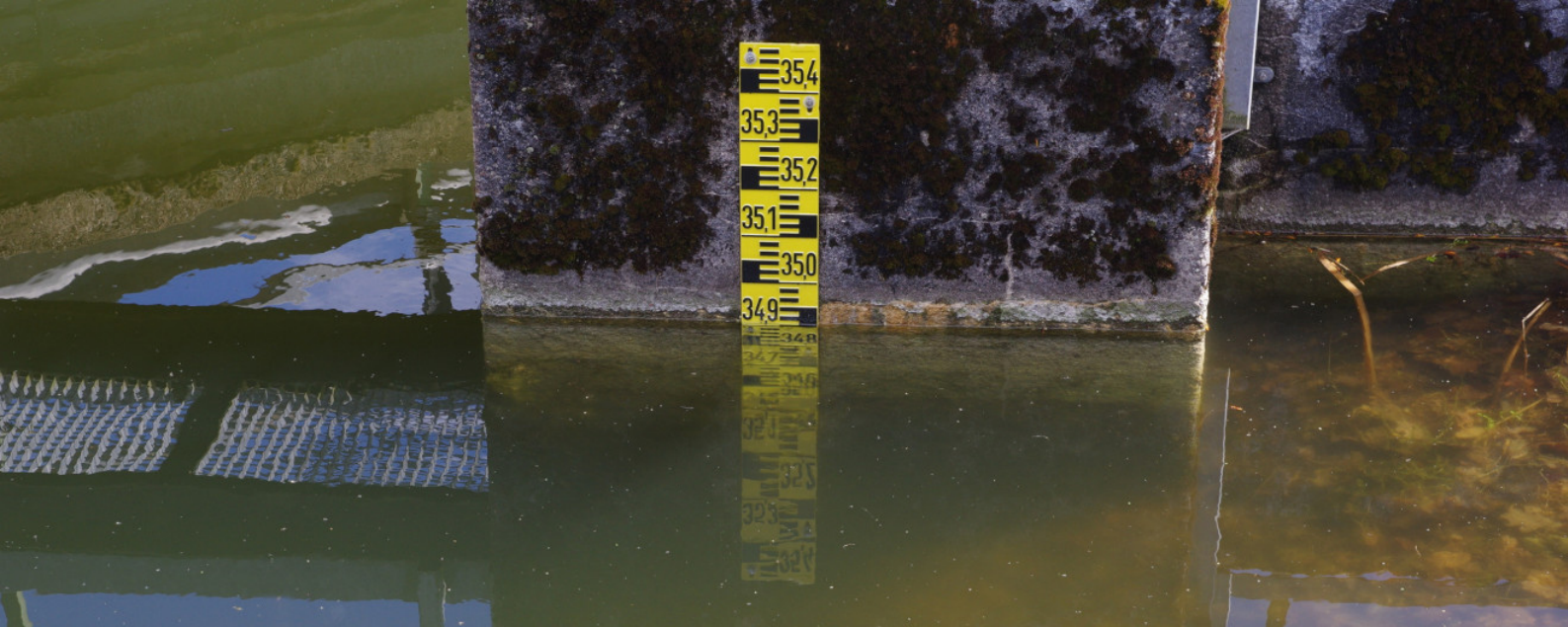
sos4R and sos4py

R and Python clients for OGC SOS

Easing access to environmental time series data from an OGC Sensor Observation Service

sos4R is an extension of the R environment for statistical computing and visualization. The user can apply it to query data from standardized SOS instances (with specific consideration of the OGC SOS 2.0 Hydrology Profile) using simple R function calls. It provides a convenience layer for R users to integrate observation data from SOS servers compliant with the SOS standard, but without any knowledge about the underlying OGC Sensor Web Enablement standards.

The package sos4py follows the same idea in a python environment. Since sos4py is a relatively new development, it does not yet provide the same range of functionalities as sos4R does.

```
In [20]:    1  x1 = fluggs_obs[(fluggs_obs['site']==sites[0])]['time_stamp'].to_numpy()
            2  y1 = fluggs_obs[(fluggs_obs['site']==sites[0])]['value'].to_numpy()
            3
            4  x2 = fluggs_obs[(fluggs_obs['site']==sites[1])]['time_stamp'].to_numpy()
            5  y2 = fluggs_obs[(fluggs_obs['site']==sites[1])]['value'].to_numpy()
            6
            7  plt.figure(figsize=(12,5))
            8  plt.plot(x1,y1,label=sites[0])
            9  plt.plot(x2,y2,label=sites[1])
           10  plt.xlabel('Time')
           11  plt.ylabel(fluggs_obs['phenomenon'][0] + " " + fluggs_obs['procedure'][0] + " in " + fluggs_obs['unit'][0])
           12  plt.legend()
           13  plt.show()
```
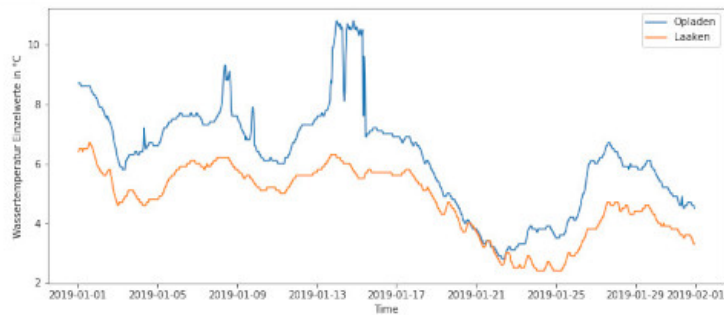

Jupyter notebook illustrating the use of sos4py

BENEFITS

- Easier access to environmental time series data
- Automatic generation of SOS requests
- Result handling and parsing into standard R objects
- Convenience API: Data Science oriented functions to load data

FIELDS OF APPLICATION

Hydrology, air quality, any other kind of processing of (in situ) observation data

PROJECT REFERENCES

- MuDak-WRM
- NIWA

DOWNLOAD

GitHub: https://github.com/52north/sos4R, https://github.com/52North/sos4py

SOS

Sensor Observation Service

Standardized, Web-based upload, management and download of (in situ) sensor data and metadata

The 52°North Sensor Observation Service (SOS) provides an interoperable web-based interface for inserting and querying sensor data and sensor descriptions. It aggregates observations from live in situ sensors as well as historical data sets (time series data).

It enables users to:

- Publish georeferenced (in situ) observation data
- Access georeferenced measurement data in a standardized format (ISO/OGC Observation and Measurements, OGC WaterML 2.0 OGC TimeseriesML 1.0, INSPIRE O&M Specialized Observations, NetCDF)
- Insert and retrieve sensor descriptions (encoded in OGC SensorML, OGC WaterML 2.0)
- Publish measurement data (near real-time, as well as archived data)
- Offer Download Services for observation data that are compliant with the INSPIRE regulations.

A major development in 2021 was the improvement of the common database model harmonization. The model provides observation data via the OGC SOS, Helgoland API, and SensorThings API interfaces. In addition, we continued to optimize the SOS's performance and stability.

Our team also focuses on providing data from the Aqatic Informatics Aquarius Time Series by using the SOS as a proxy. This proxy solution will be part of the upcoming 6.x line.
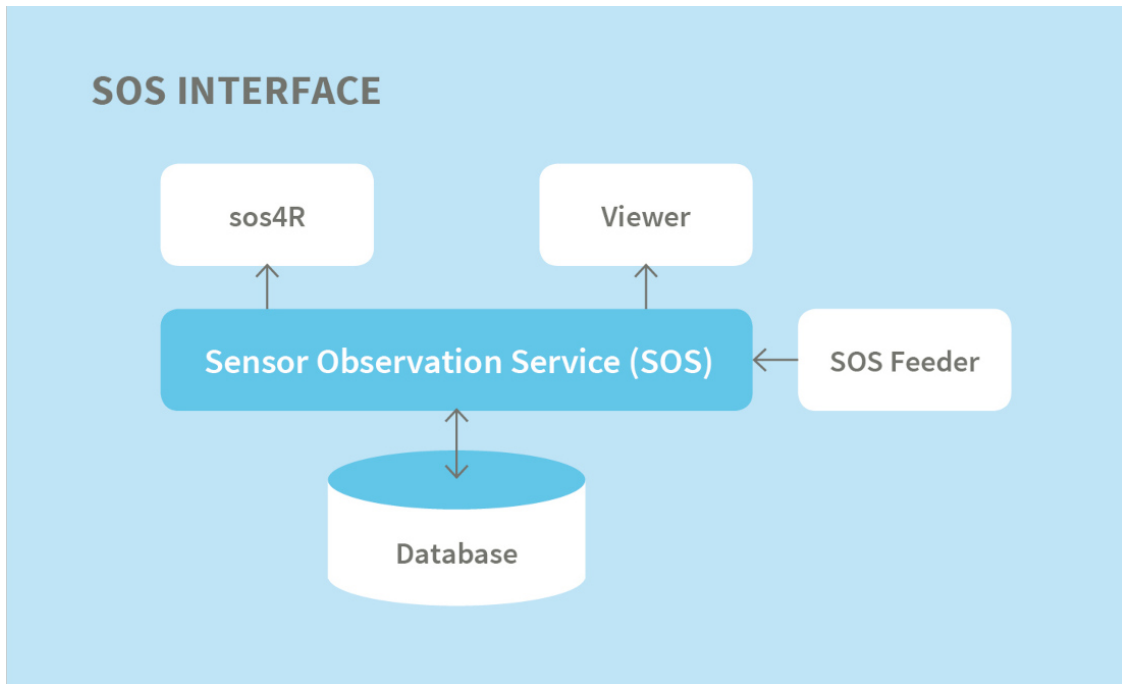
BENEFITS

- Full implementation of the OGC Sensor Observation Service 2.0 standard
- INSPIRE compliance (SOS as INSPIRE Download Service)
- Dedicated support for hydrological applications via the OGC SOS 2.0 Hydrology Profile
- Support of the European e-reporting workflows for ambient air quality
- Highly efficient data transfer via the optional EXI (Efficient XML Interchange) support
- Flexible integration into existing IT infrastructures (coupling to existing databases, several options for data publication)
- Comprehensive ecosystem of supporting tools and applications (Helgoland Sensor Web Viewer, sos4R, SOS importer)
- Additional data management functionality beyond the SOS standard

FIELDS OF APPLICATION

Hydrology, air quality (e-reporting), environmental monitoring, ocean sciences, tracking

PROJECT REFERENCES

- SeaDataCloud
- MariData
- Cos4Cloud
- Aquatic Informatics
- Otago Regional Council
- Wupperverband
- Federal Maritime and Hydrographic Agency (BSH)
- … and many more

DOWNLOAD

GitHub: https://github.com/52North/SOS
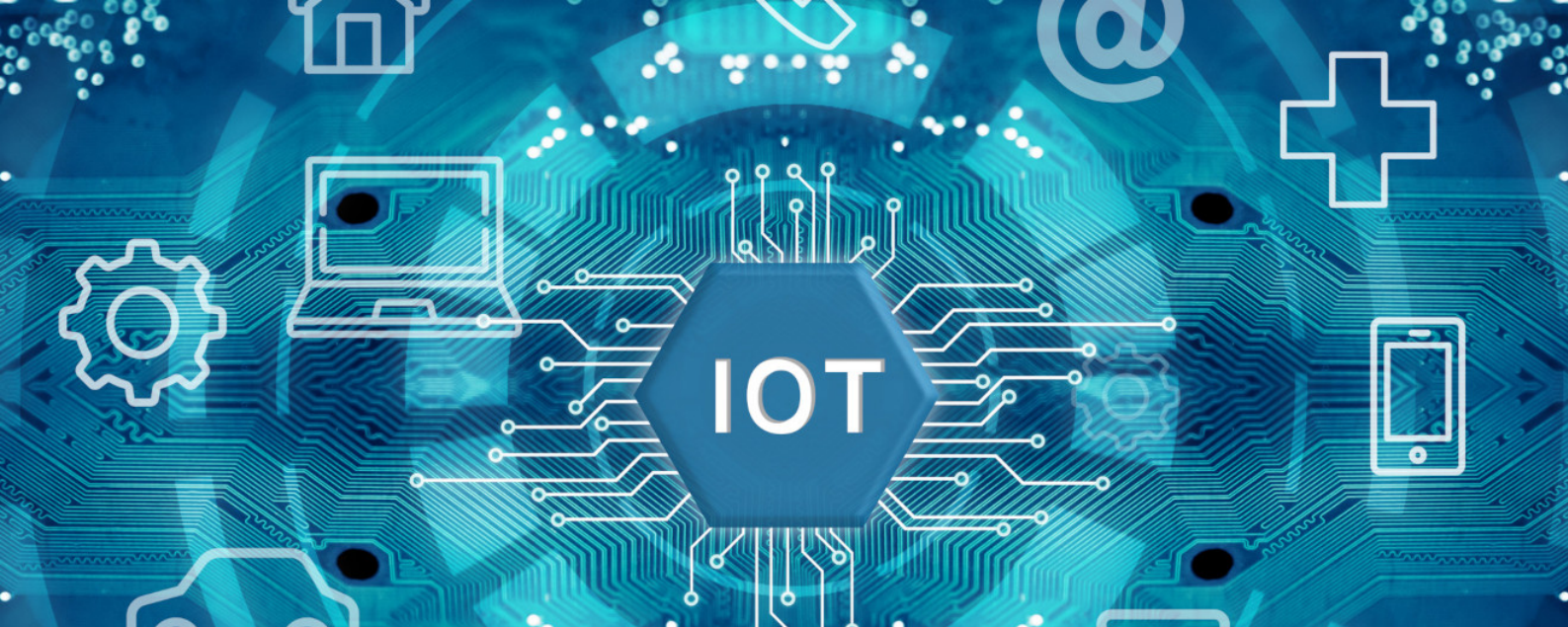
STA

SensorThings API

Efficient access to sensor data via the OGC SensorThings API

The STA module complements the 52°North Sensor Web Server with support for the "OGC SensorThings API Version 1.1 Part 1: Sensing" specification. It provides support for the following Conformance Classes (tested for standard compliance):

- Sensing Core
- Create-Update-Delete
- Filtering Extension
- Observation Creation via MQTT
- Receiving Updates via MQTT.

52°North's software development activities in 2021 focused on code base maintenance and performance optimizations. Additionally, we continue our work on the following challenges:

Citizen Science Extension: Together with our Cos4Cloud project partners, we identified a need for guidance on how to use the STA for Citizen Science data. Our team collaborated with CREAF and Secure Dimensions to design and implement a prototypical extension to the official standard to support this new data.

Access control: A widening adoption of the STA specification, along with an increasing amount of data to be managed, creates a need for fine-grained access control. The specification itself specifically excludes this topic, delegating it to other components in the infrastructure. To address this challenge, we investigated the use of technologies, such as OpenID Connect and Keycloak, to control access to STA instances. This resulted in an extended STA implementation, which the Wupperverband and the Cos4Cloud project partners currently evaluate.

SENSORTHINGS API MODULE
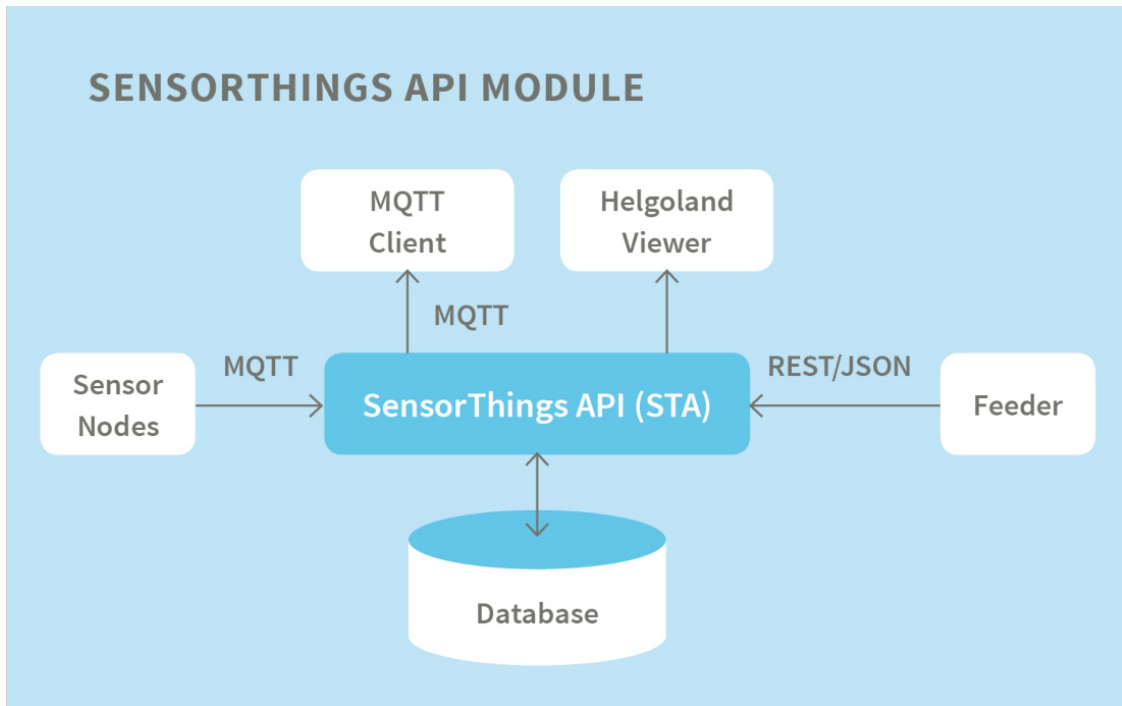
BENEFITS

- Robust implementation making use of the broad 52°North experience with Sensor Web data models
- Easy integration into the 52°North Sensor Web Server (joint database layer)
- MQTT for data publication and delivery
- Interlinking between SOS, STA and Helgoland API (e.g., data publication via STA, data retrieval via SOS and Helgoland API)

FIELDS OF APPLICATION

Hydrology, air quality (e-reporting), environmental monitoring, ocean sciences, tracking

PROJECT REFERENCES

- Wupperverband
- Cos4Cloud
- AQSens
- EMODnet/Eurofleets
- Federal Maritime and Hydrographic Agency (BSH)
- WaCoDiS

DOWNLOAD

GitHub: https://github.com/52North/sensorweb-server-sta
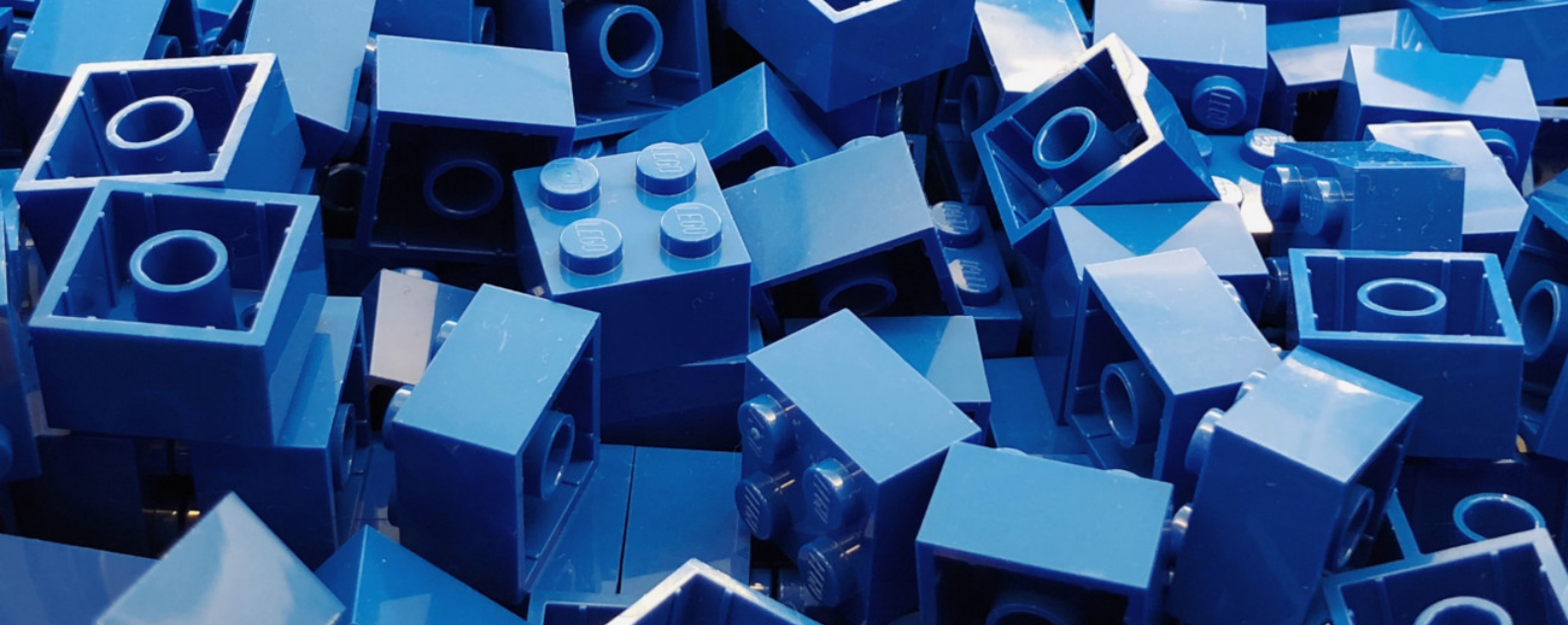
Helgoland API

Lightweight Access Layer to Sensor Data

Supporting the efficient implementation of Sensor Web clients

This lightweight API provides a complementary lightweight access layer to sensor data via a RESTful Web binding. It offers an additional mechanism for data access, which has been optimized to reflect our experience gained during the development of Sensor Web client applications. Thus, it can be considered a convenience layer that facilitates the use of Sensor Web servers.

The API provides a thin access layer offering several functionalities:

- Pre-rendering of time series data (e.g., for embedding pre-rendered diagrams into Web sites)
- Generalization of sensor data sets for reducing the transmitted data volume
- Support of different types of observation data: time series, profiles, trajectories, samplings
- Overlaying of data from multiple data sets
- Conversion of raw data to other formats such as CSV, PDF and PNG
- Comprehensive functionality for exploring, discovering, filtering and accessing observation data.

The REST API can be deployed in two modes: as a 52°North Sensor Web Server module residing on an observation database, or in a proxy mode so that external data sources can be integrated into Sensor Web environments.

Our development efforts in 2021 focused on maintenance and data model harmonization with SOS and STA. In addition, special consideration was given to performance improvements.

DEPLOYMENT OF THE HELGOLAND API
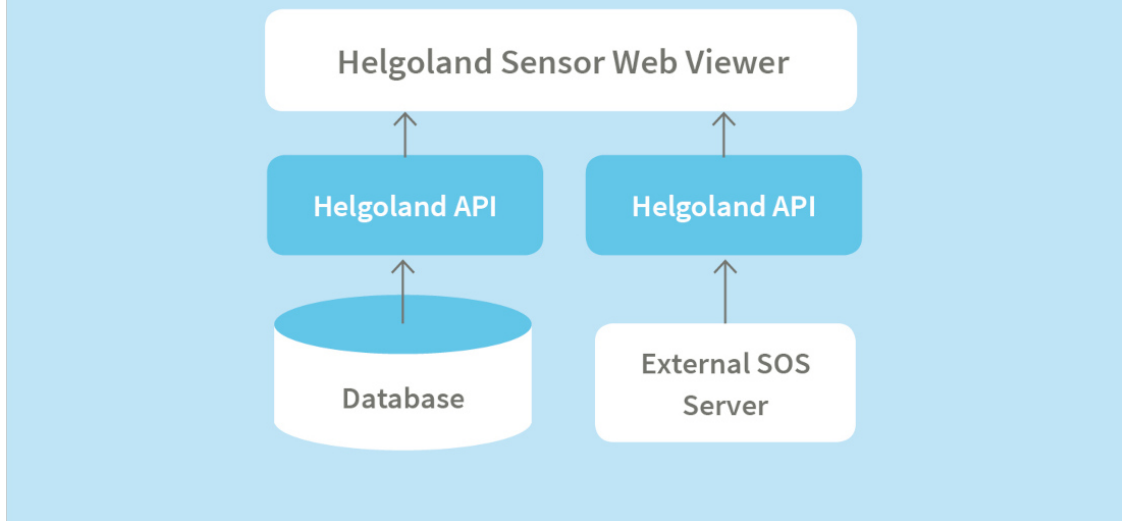
BENEFITS

- Lightweight protocol and encoding
- Convenience functionality for client developers to increase their efficiency
- Functionality going beyond the available standard interfaces (e.g., data generalization, rendering functionality, data conversion)

FIELDS OF APPLICATION

Hydrology, air quality (e-reporting), environmental monitoring, ocean sciences, tracking

PROJECT REFERENCES

- SeaDataCloud
- WaCoDiS
- MuDak-WRM
- IRCEL-CELINE BelAir
- NIWA
- Wupperverband
- Federal Maritime and Hydrographic Agency (BSH)
- … and many more

DOWNLOAD

GitHub: https://github.com/52North/sensorweb-server-helgoland

javaPS

Next Generation Standardized Web-based Geoprocessing

Interoperable processing framework for web applications/distributed workflow systems

KEY TECHNOLOGIES

> Java
> Spring
> Arctic Sea
> OpenAPI

FACTS

Contact:
Benjamin Pross
b.pross@52north.org

License:
Apache License, Version 2.0

JavaPS enables a standardized deployment of geo-processes on the web. One of its main goals is to provide an interoperable processing framework for web applications or distributed workflow systems. Therefore, it fully supports the OGC Web Processing Service 2.0 interface specification. True interoperability only succeeds when transmission data models are well-defined and supported. javaPS supports a broad range of standardized formats and de-facto industry standards including, but not limited to OGC GML (versions 2.x to 3.2.1), GeoJSON, Esri Shapefile, GeoTIFF or KML. In addition, GeoServer (WMS or WFS) enables the dissemination of processing results. This allows a seamless integration into existing Spatial Data Infrastructures.

javaPS evolved from the longstanding 52°North WPS implementation, but uses modern frameworks such as Spring, 52°North Arctic Sea or Guava. It features a pluggable architecture for processes and data encodings.
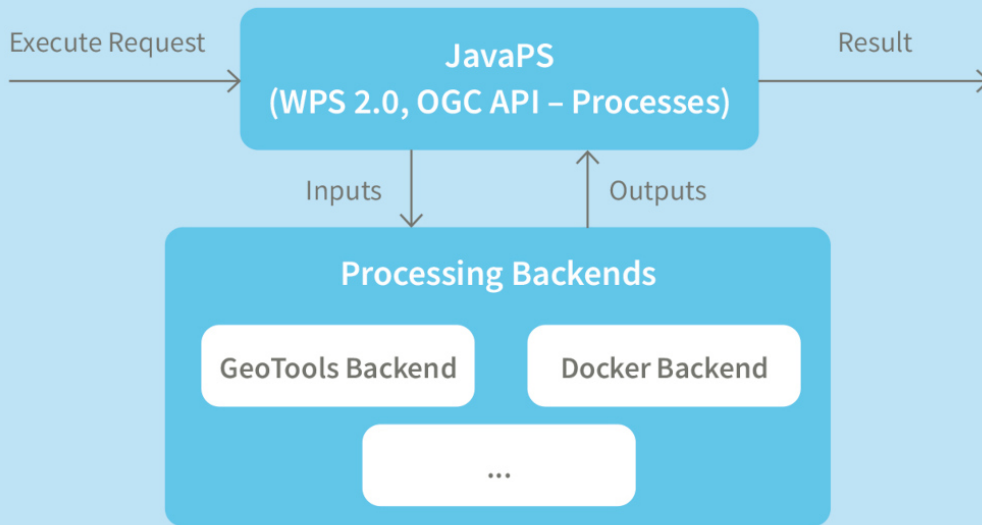
BENEFITS

- Abstraction of (existing) processing tools
- Support for the majority of standardized geo-data formats
- Lightweight API, following the latest state of the draft OGC API Processes standard

FIELDS OF APPLICATION

Web-based processing, automated workflows, Earth Observation, Data Analytics

PROJECT REFERENCES

- RIESGOS 2.0
- OGC Testbed 17
- OGC Testbed 16
- OGC Testbed 15
- OGC Routing Pilot
- WaCoDiS

DOWNLOAD

GitHub: https://github.com/52North/javaps
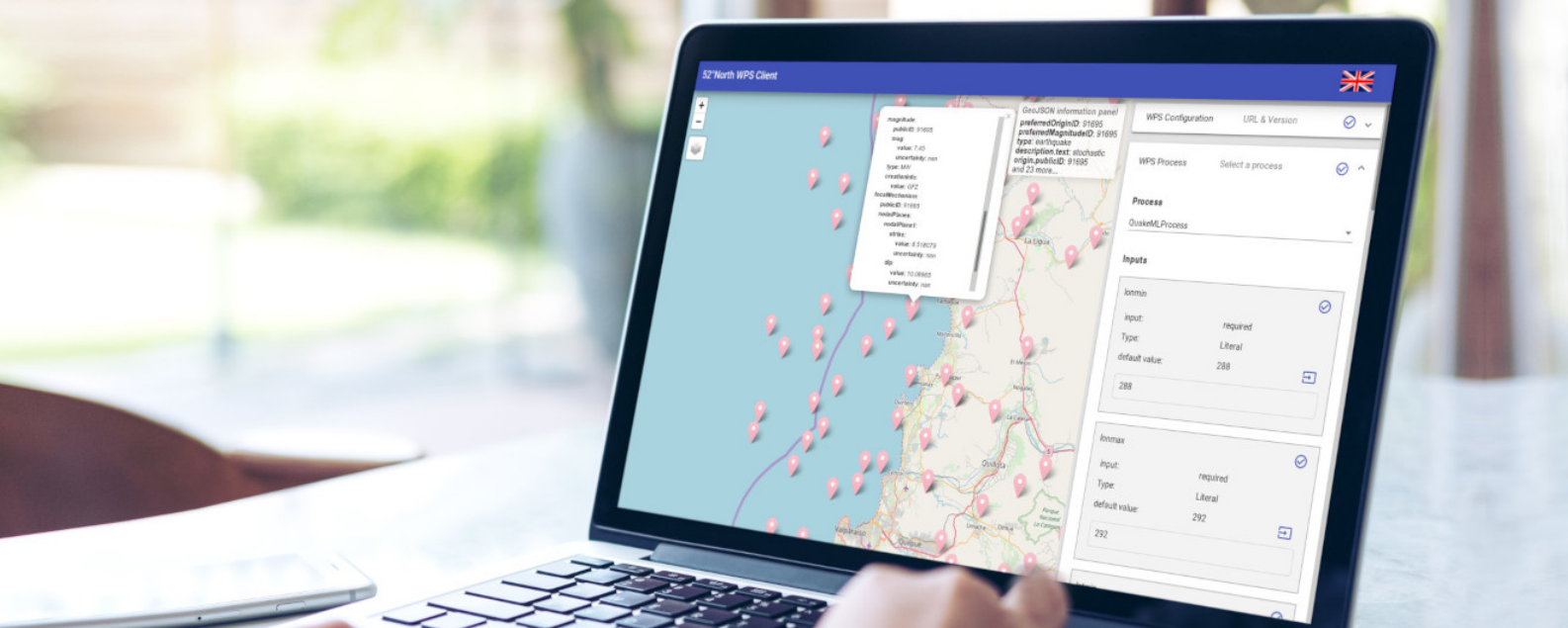
wps-ng-client

Modern Web Application for Geoprocessing

Providing an extensible lightweight single page application for web browsers

A map centered design forms the foundation of this software component. It provides a lightweight single page application for modern web browsers. We wrote the application on top of the Angular framework and its UI counterpart Angular Material. This makes it easily extensible due to its component-based architecture.

Under the hood, the application uses the 52°North wps-js library, which is responsible for the interaction with the WPS backend. It guarantees a clear separation of concerns and the application can focus on the UI/UX aspects and the visualization of input and output data. The wizard-style execution of WPS processes guides the user through all the relevant steps and provides convenient functions (e.g., auto-fill parameters with default values) that create an intuitive user experience.

The wps-ng-client architecture catalyzes the creation of individual web applications for specific use cases or scenarios. As the central UI element, the map enables developers to easily create context and associate the user with a scenario's relevant information and how to use the available processes.

The current version supports a variety of input formats (e.g., different geometry types) and offers and improved process result visualizations. We have tested the client with different WPS implementations (e.g., 52°North WPS, 52°North javaPS and PyWPS) to ensure its robust function.
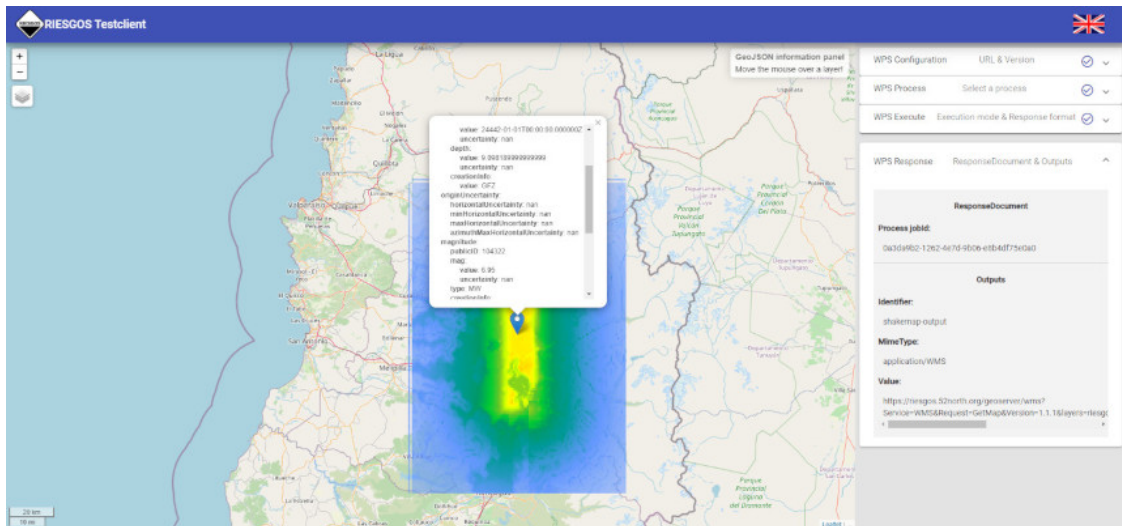
wps-ng-client interacting with the RIESGOS WPS to produce earthquake intensity maps

BENEFITS

- Visualization of web processes' inputs and outputs
- Support for all major browsers due to the Angular framework
- Wizard-style process execution eases the interaction with WPS backends
- Lightweight component architecture makes the software easily extensible

FIELDS OF APPLICATION

Web-based processing, automated workflows, Earth Observation, Data Analytics

PROJECT REFERENCES

- RIESGOS
- MuDak-WRM
- OGC Testbed 15
- CITRAM

DOWNLOAD

GitHub: https://github.com/52North/wps-ng-client

enviroCar suite

XFCD Mobile Data Collection, Analysis, and Management

Collecting, analyzing, managing and sharing vehicle sensor data

The enviroCar suite provides a platform to collect, manage, analyze and share Extended Floating Car Data (XFCD). It comprises several individual software packages.

enviroCar Mobile Android App: enviroCar Mobile is an Android application for smartphones that can be used to collect Extended Floating Car Data (XFCD). The app communicates with an OBD2 Bluetooth adapter while the user drives, which enables read access to data from the vehicle's engine control. The app records this data and the smartphone's GPS position. The driver can view statistics about his drives and publish his data as open data by uploading tracks to the enviroCar server. It is then available under the ODbL license for further analysis and use. Users can also view and analyze the data via the enviroCar website. enviroCar Mobile is one of the enviroCar Citizen Science platform's components.

enviroCar Server: The enviroCar server's central tasks are the enviroCar platform user management and the management of the XFCD data provided as Open Data by the enviroCar drivers. To ensure data privacy, the server anonymizes the recorded tracks external access. The enviroCar server's RESTful API offers the possibility to access statistics as well as space and time related subsets of the data in different formats.

enviroCarPy: The enviroCarPy Python package is a lean extension that wraps the enviroCar REST API to ease access to the data. It allows users to query and download XFCD data via the enviroCar Rest-API.
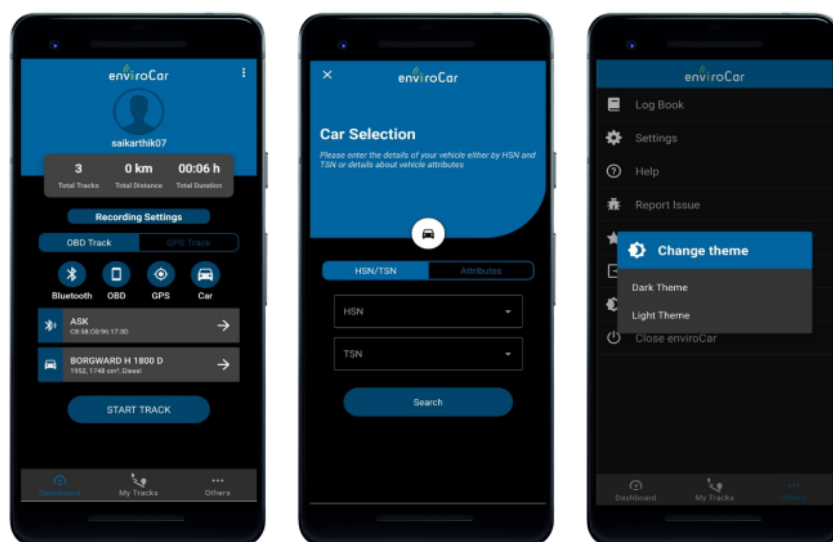
enviroCar dark theme

BENEFITS

- Easy collection of Extended Floating Car Data
- Optional automation of data collection and upload
- Estimation of fuel consumption and CO2 emissions
- Publishing anonymized track data as Open Data
- Map-based visualization of track data and track statistics
- User management support
- XFCD data management
- Open API for data export:JSON, CSV, SHP
- Linked Data/RDF API
- Publishing anonymized tracks via Apache Kafka
- GDPR compliance
- Easier access to enviroCar data for an analysis in Python
- Several Jupyter notebooks with examples of use-cases

FIELDS OF APPLICATION

The enviroCar suite supports the collection, analysis, sharing and management of XFCD data in an open Citizen Science community. This community of scientists, traffic engineers, public administration staff and citizens work together to gain better road traffic information to reduce the environmental impact of motorized traffic and to improve road safety. The enviroCar app can be used free of charge. The data is also available free of charge, as open data to the general public.

PROJECT REFERENCES

- DVFO LHS
- CITRAM
- enviroCar

DOWNLOADS

GitHub: https://github.com/enviroCar/enviroCar-app

GitHub: https://github.com/enviroCar/envirocar-py

GitHub: https://github.com/enviroCar/enviroCar-server

Open Source Projects Contributions

Contributing to Open Source Software Projects

Enhancing open source software

52°North's software research engineers not only develop 52°North software, but also contribute to a number of other open source software packages. These contributions take the form of anything from discussions and bug reports to bug fixing and code development.

Major contributions

pygeoapi-odc-provider

The pygeoapi-odc-provider is a standalone Python library. Our 52°North team prototypically implemented this library during the OGC Testbed-17 Geo Data Cube project. It offers a provider plugin for pygeoapi to use Open Data Cube instances as a data resource. pygeoapi makes the data from the ODC available via OGC APIs.

52°North server architecture
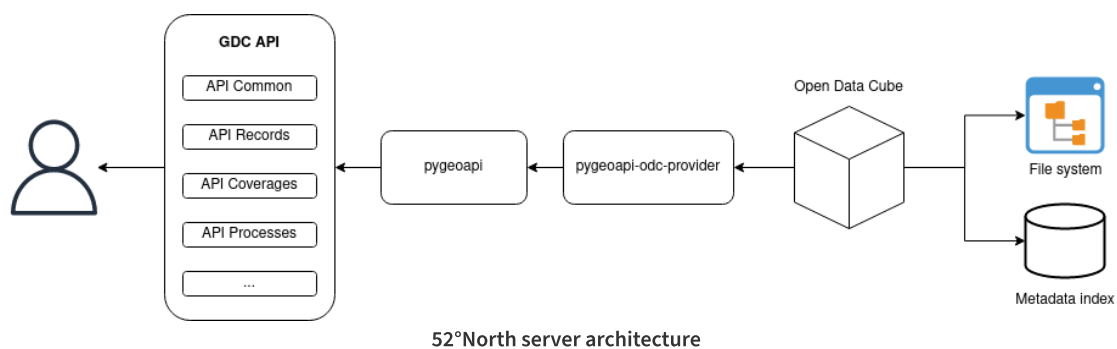
OSS Project(s): pygeoapi, Open Data Cube
Github: https://github.com/52North/pygeoapi-odc-provider

Minor contributions

Our team has also made minor contributions, such as bug reports and bug fixes, to the following projects:

Pygeoapi
GitHub: https://github.com/geopython/pygeoapi/

Eksctl
GitHub: https://github.com/weaveworks/eksctl

Open Data Cube
GitHub: https://github.com/opendatacube/datacube-core/

Education and Mentoring

Developing innovative technologies to advance spatial information infrastructures

52°North staff take an active part in higer education to engage with students to develop their understanding and application of knowledge, concepts and processes. We regularly teach semester-long courses and carry out study projects at the Insitute for Geoinformatics, University of Münster. Furhtermore, our staff prepares and holds guest lectures at, among others, ITC University of Twente, the Bochum University of Applied Sciences and the Technische Universität Dresden.

Courses

In 2021, our staff taught the following courses:

WS 2020/2021 Institute for Geoinformatics, University of Münster: Lecture and Lab about Spatial Information Infrastructures (SII)

SS 2021 Institute for Geoinformatics, University of Münster: Study Project "Copernicus Marine Services for Energy Optimized Cargo Ship Routing"

SS 2021 Bochum University of Applied Sciences: Kollaborative Softwareentwicklung und Qualitätssicherung

Theses Supervision

Supporting higher education, we cooperate with our academic partners in the supervision of theses. These typically have a dircet link to ongoing research at 52°North.

Abdelal, Mohammed (2021): Enhancing Responsiveness and Flexibility in Complex Processing Workflows by Combining Event-Driven and Service-Oriented Architectural Paradigms. Unpublished Master Thesis, Institute for Geoinformatics, University of Münster.

Butzmann, Lukas (2021): Interoperabelität in IoT-Diensten: Standardisierung und Optimierung der Organisation von Datenströmen und Datenmodellierung unter Nutzung des MQTT-Protokolls. Unpublished Master Thesis, Bochum University of Applied Sciences.

Moubayed, Fadi (2021): Interoperable Semantic Integration of Autonomous Ocean Glider Observation Data into a Spatial Data Infrastructure. Unpublished Master Thesis, Institute for Geoinformatics, University of Münster.

Internships

52°North mentors Geoinformatics students to support their personal development and professional careers. We share our knowledge and experience and benefit from their curiosity and creativity. Many Masters and Bachelors programs require a certain amount of practical work. In addition to offering student jobs, we have been providing student internships since 2011. Each intern works on one of our current projects for a period of up to 6 months. During this time, they improve their software engineering skills, acquire knowledge in SDI and OGC standards, learn basic project management techniques, and gain experience in international collaborative software development.

Fabian Wessel is a 7th semester Geoinformatics student at the University of Applied Science Bochum. Originally from Gescher - a small town 40 km west of Münster near the Dutch border - he started his studies in Bochum at the end of 2018. The University of Applied Science Bochum requires that students complete a 12 week internship for their Geoinformatics Bachelor's degree. Prof. Dr. Andreas Wytzisk-Arens (52°North / University of Applied Science Bochum) recommended Fabian do his internship at 52°North to learn more about a software developer's work routine.

Fabian Wessel

From August to October 2021, Fabian worked on the Sensor Web and the EnviroCar projects. He created a new beginners' 52°North Sensor Web software tutorial for the Sensor Web project (link?). In the EnviroCar project, he fixed multiple bugs in the Android App, helping to prepare it for a new release version. He also analyzed how to replace the deprecated library Butterknife with ViewBinding or DataBinding. In order to ease future development, Fabian used the GitHub Actions tool to create a CI/CD workflow for the EnviroCar projekt. Thus introducing ongoing automation and continuous monitoring throughout the app lifecycle.

During his internship, Fabian learned a lot about the workflow in an Open Source project. The future geoinformatics specialist improved his Java programming skills and got to know new Android libraries. He also became acquainted with the 52°North software stack. "The internship was a great experience! I got insight into the daily life of a software developer and had nice colleagues, who were always willing to help if I had problems. I really liked the flexibility. I could work from home and/or in the office. The working atmosphere was very welcoming, so I felt like part of the team after a short time."

Apart from finishing his Bachelor's degree, Fabian has not yet decided on his future plans. He may do a Masters degree at the University of Applied Science Bochum or directly join the labor force.jAVAps

Google Summer of Code

Helping to change the world one line of code at a time

Google Summer of Code (GSoC) is a global program that focuses on introducing student developers to open source software development. Students receive stipends to work on a ten week (175 hours) programming project with an open source organization while on break from university. At 52°North, we pair the students with mentors and embed their work in the context of ongoing research projects. Hence, GSoC students gain valuable exposure to real-world software development scenarios and have the opportunity to work in areas related to their academic pursuits. In turn, we are able to improve our software projects, as well as identify and draw in new developers more easily.

We have been a successful mentoring organization since 2012. In 2021, we were one of 202 open source organizations chosen to host three of the 1,203 student projects.

enviroCar App for iOS users (Khyati Saini)

Khyati Saini is a second-year undergraduate at NIT Hamirpur, India. He and D Ajay Kumar both worked on different aspects of laying the foundation for a platform-independent enviroCar mobile app to make it accessible to iOS users as well. Khyati focused on creating Bluetooth features.

Using various flutter packages, Khyati was able to connect to the OBD-II adapter via Bluetooth. He subsequently used google_maps_flutter to integrate the Google maps widget in iOS and Android applications. The provider package enabled background GPS tracking and the recorded track data was stored in a Hive database.
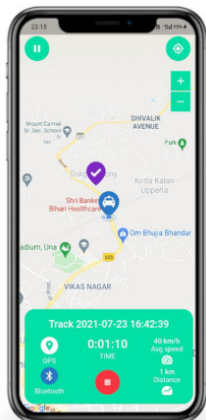
Recording the track (GPS tracking)
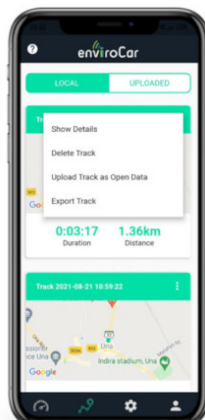
Tracklist screen to display Local and Remote tracks
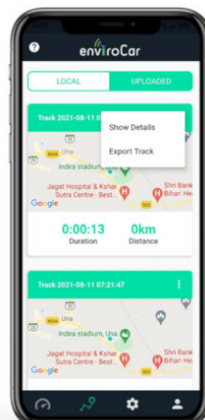
Khyati also addressed other issues, such as background services to determine the status of the location services and Bluetooth. He updated and created new widgets to improve the UI.

"It was a great learning experience. The weekly meets helped me improve my presentation skills and expressing my ideas became easier. The project progress management tools helped me stay organized and always proposed a plan to proceed further."

Blog: enviroCar app for IOS Users

enviroCar Platform Independent App Groundwork (D Ajay Kumar)

D Ajay Kumar, a sophomore at Punjab Engineering College, India, also devoted his 10 weeks to creating a cross-platform enviroCar app that would run on both Android as well as iOS devices. Whereas Khyati worked on Bluetooth features, D Ajay's particular focus was on creating and setting up the rest of the app, i.e. the user interface (UI), core features, data storage and sharing.

Work on the UI entailed creating widgets that did not strictly follow either Google's Material Design or Apple's Flat Design, but touched upon both of them while maintaining its own unique style. Subsequently, D Ajay added some core features to improve the app's performance, readability and development process. He concentrated on catching all the exceptions and errors that could occur while making HTTP calls and providing an appropriate message.

During the project's final phase, D Ajay addressed the issue of data management and created additional UI components, e.g., graph widgets to display statistical data of tracks. He also added a couple of features that were newly implemented in the Android app, e.g., a walkthrough on the dashboard screen for new users and the dark theme.

Graph Widgets   Dark Theme

"I absolutely love working in teams and making cross-platform mobile applications. My first GSoC … was full of learning and trying out new things, tackling challenges and pushing our boundaries to achieve quality results within the set deadlines. My GSoC journey may have ended here, but it's just the beginning of my open source journey."

Blog: enviroCar platform-independent app groundwork

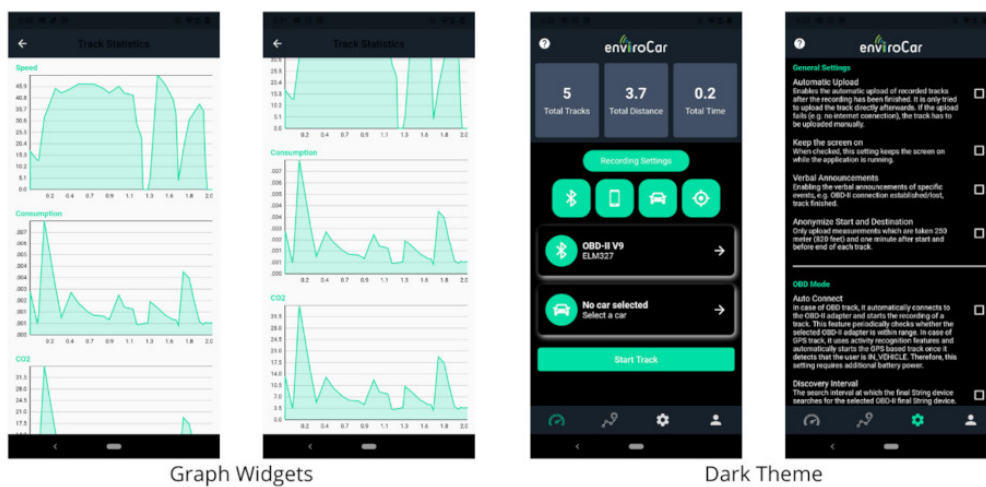**Improving User Experience in enviroCar Android (Sai Karthikeya)**

Sai Karthikeya is a sophomore studying Computer Science at a college affiliated with the Osmania University Hyderabad, India. His project covered improvements to the enviroCar Android app user experience. This included

    Solving some of the critical bugs and improving the user experience
    Adding new features and improving the existing features regarding the user interface and app responsiveness.
    Removing the deprecated use of libraries and enhancing the design of layouts.

Sai was able to significantly reduce the number of issues with his bug fixing. He also worked on design consistency, for example, among dialogs and revised a number of incorrect messages. To improve the UX, Sai introduced several automatic actions, such as automatic selection of a new car type. He added several new features, such as a dark theme, location permissions, countdown timers.
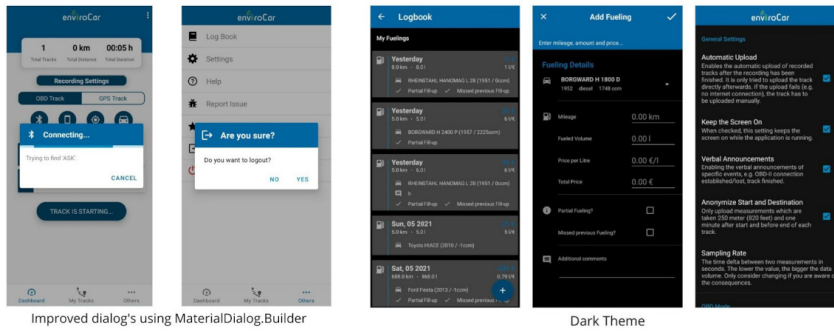
Improved dialog's using MaterialDialog.Builder   Dark Theme

Getting rid of deprecated libraries was an important aspect of the project. Sai updated all the libraries in build.gradle. He changed the alert dialogs implementation by replacing the deprecated Materialdialog.builder with MaterialAlertDialogBuilder and improved the design of the dialogs.

"I will continue to contribute to the enviroCar Android app by resolving issues and maintaining the GitHub issues as well as helping new developers in contributing to the app. I want to thank 52°North for giving me this great opportunity to spend my summer and contribute to the enviroCar project as part of GSoC 2021."

Blog: Improving UX in enviroCar Android

Dissemination and Outreach

Research - develop - publish

At 52°North, we disseminate project and research results, i.e., software and architecture developments, concepts and methodologies, via various platforms. This includes publications, blog posts, presenting at conferences, as well as organizing workshops and seminars.

Publications

Sharing research results and developments

Autermann, Christian, Simon **Jirka**, and Dick Schaap. "Interoperable Provision of Research Vessel Tracking Data via OGC SensorThings API and Sensor Observation Service." In IMDIS 2021 - International Conference on Marine Data and Information Systems - Book of Abstracts, Vol. 62:300–301. Bollettino Di Geofisica. Online: Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, 2021. https://imdis.seadatanet.org/content/download/151922/file/IMDIS2021_proceedings.pdf.

de Wall, Arne, Albert **Remke**, Bodo Bernsdorf, Thore Fechner, Alexandra Bicsan, and Adrian Klink. "SenSituMon – Integration von Satelliten- und In-situ-Sensordaten zur Verbesserung der automatisierten großräumigen Überwachung von Überflutungen." zfv – Zeitschrift für Geodäsie, Geoinformation und Landmanagement, no. 3/2021 (2021): 168–78. https://doi.org/10.12902/zfv-0343-2021.

Drost, Sebastian. "WaCoDiS & CODE-DE: The future (of Earth Observation data processing) is now." 52°North, 16 April 2021. https://blog.52north.org/2021/04/16/wacodis-code-de-the-future-of-earth-observation-data-processing-is-now/

Drost, Sebastian, Arne **Vogt**, Christian Danowski-Buhren, Simon **Jirka**, Verena Kirstein, Kian Pakzad, and Matthes **Rieke**. "WaCoDiS: Automated Earth Observation Data Processing within an Event-Driven Architecture for Water Monitoring." Computers & Geosciences, 2021, 105003. https://doi.org/10.1016/j.cageo.2021.105003.

Gräler, Benedikt. "Spatial Information Infrastructures to Reduce the Global Maritime Transport Emissions." Oral presented at the Open Data Science Europe Workshop, Wageningen, The Netherlands, September 6 - 10, 2021. Abstract, Video Recording

Gräler, Benedikt, Matthes **Rieke**, Simon **Jirka**. "Von den Daten zur Information – verteilte und effiziente Prozessierung von Geodaten." Oral presented at the 9. Deutsches GeoForum 2021, hybrid. November 25, 2021. https://geoforum.ddgi.de/wp-content/uploads/2021/12/T-3.2-20211125-9DGF-52-North-Von-den-Daten.pdf

Jirka, Simon. "Sediment- Und Schadstoffeinträge in Fließgewässer Mit Copernicus Diensten Bestimmen." Oral presented at the Nationales Forum für Fernerkundung und Copernicus 2021, Online, March 23 - 24, 2021. https://www.d-copernicus.de/fileadmin/Content/pdf/Forum_2021/Pr%C3%A4sentation_-_WaCoDiS.pdf

Jirka, Simon, Christian **Autermann**, Jan **Speckamp**, and Matthes **Rieke**. "SensorThings API and the OGC API Family of Standards: A New Generation of Interoperability Standards for Research Data Infrastructures to Further Improve the Sharing of Ocean Observation Data." In Proceedings of the 9th EuroGOOS International Conference - Advances in Operational Oceanography: Expanding Europe's Observing and Forecasting Capacity, 43–50. Online: EuroGOOS AISBL, 2021. https://doi.org/10.13155/83160.

Jirka, Simon. "Towards a Digital Twin of the Ocean - Challenges and Lessons Learned from Ocean Data Infrastructures." Oral presented at the Digital Ocean Convention 2021, Rostock, Germany, August 25 - 26, 2021.

Jirka, Simon, Matthes **Rieke**, Albert **Remke**, Benedikt **Gräler**, and Arne **de Wall**. "Integration von In-Situ- Und (Copernicus) Remote-Sensing-Daten in Informationsinfrastrukturen Zur Umweltbeobachtung." In Tagungsband Des 26. Workshops Des Arbeitskreises "'Umweltinformationssysteme'" Der Fachgruppe " 'Informatik Im Umweltschutz'" Der Gesellschaft Für Informatik (GI) 2019. Umweltinformatik. Münster, Germany: Shaker Verlag, 2021. https://www.shaker.de/de/content/catalogue/index.asp?lang=de&ID=8&ISBN=978-3-8440-8231-9.

Jirka, Simon, Benedikt **Gräler**, Matthes **Rieke**, and Christian **Autermann**. "Cloud-based Research Data Infrastructures Integrating In-Situ and Remote Sensing Data." PICO Oral presented at the EGU General Assembly 2021, Online, April 19 - 30, 2021 EGU21-14441, https://doi.org/10.5194/egusphere-egu21-14441.

Kirstein, Verena, Larissa Bitterich, Sebastian **Drost**, Arne Vogt und Kian Pakzad. "Copernicus Dienste Für Die Wasserwirtschaft – Ergebnisse Aus Dem Projekt WaCoDiS." Copernicus Dienste Für Die Wasserwirtschaft – Ergebnisse Aus Dem Projekt WaCoDiS 2021, no. 8 (August 2021): 486–91. https://doi.org/10.3243/kwe2021.08.001.

Marzi, Jochen, Benedikt **Gräler**, Stefan Harries. "Ein holistischer Ansatz zur Optimierung des Energieverbrauchs von Schiffen", Oral presented at the 6. Schiff&Hafen-Konferenz Maritim 4.0, Hamburg, Germany, October 14, 2021.

Maso, Joan , Andy Cobley, Valantis Tsiakos, Nikolaos Tousert, Theodoros Theodoropoulos, Simon **Jirka**, Sven Schade, Andreas Matheus, Stefano Tamascelli, Friederike Klan and Trupti Padiya. "OGC Citizen Science Interoperability Experiment Engineering Report." OGC Public Engineering Report OGC 19-083 http://www.opengis.net/doc/PER/CitSciIE-1.

Noël, Christophe, Matthes **Rieke**, Pedro Goncalves, Fabrice Brito and Guilhem Legal. "OGC Testbed-16: Earth Observation Application Packages with Jupyter Notebooks." OGC Public Engineering Report OGC 20-035 http://www.opengis.net/doc/PER/t16-D027.

Pross, Benjamin. "An Introduction to the OGC API - Processes and Practical Examples." Oral presented at APACHECON@HOME 2021, virtual, September 21 - 23, 2021. https://www.apachecon.com/acah2021/tracks/geospatial.html.

Pross, Benjamin. "Status of OGC API – Processes." Oral presented at the 118th OGC Technical Committee Meeting, virtual, March 22 - 26, 2021.

Pross, Benjamin. "OGC API – Processes Update." Oral presented at the 119th OGC Technical Committee Meeting, virtual, June 14 - 18, 2021.

Pross, Benjamin. "OGC API – Processes Update." Oral presented at the 120th OGC Technical Committee Meeting, virtual, September 13 - 20, 2021.

Pross, Benjamin. "Update on work done in Testbed 17 CITE Thread." Oral presented at the 120th OGC Technical Committee Meeting, virtual, September 13 - 20, 2021.

Remke, Albert. "GeoIT Round Table NRW - Copernicus Relay." Oral presented at the Copernicus Relay Workshop, online, September 14, 2021. https://www.geoportal.nrw/sites/default/files/2021-09-14_A1_A_Remke_A_Caffier_GeoIT-RT_CopernicusRelay_V02.pdf.

Rieke, Matthes. "GeoNode and Kubernetes – a good match?" 52°North, 12 April 2021. https://blog.52north.org/2021/04/12/geonode-and-kubernetes-a-good-match/.

Rieke, Matthes. "Verteilte und Effiziente Prozessierung von Geo-Daten mit KI-Methoden." Oral presented at the Münchner GI-Runde, online, March 23 - 24, 2021.

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Affiliations

Joining forces with the Geo-IT community

The Open Geospatial Consortium (OGC) is an international consortium of businesses, government agencies and research organizations creating open standards to support the provision and use of geospatial information. 52°North is an OGC member with the status of a non-profit research organization. We contribute to the standards development and consensus process as well as the OGC Innovation Program with its Testbeds, Pilots and Interoperability Experiments.

Contact: https://www.opengeospatial.org

The Association of Geographic Information Laboratories in Europe (AGILE) promotes academic teaching and research on GIS in Europe and stimulates and supports networking activities between member laboratories. Furthermore, AGILE contributes to shaping the European GI research agenda. 52°North actively participates in the permanent scientific forum and contributes to the annual AGILE conferences.

Contact: https://agile-online.org

The European Citizen Science Association (ECSA) is a non-profit association that fosters the Citizen Science movement in Europe. It performs research on Citizen Science and initiates and supports Citizen Science projects. 52°North contributes to the ECSA initiatives and hosts the enviroCar Citizen Science platform for road traffic analysis.

Contact: https://ecsa.citizen-science.net/

FOSSGIS e.V. is a German non-profit association that promotes open source software and open data. 52°North participates regularly in the annual FOSSGIS conferences to promote and discuss its open source software projects within the OS community.

Contact: https://www.fossgis.de

Deutscher Dachverband für Geoinformation (DDGI) is the German national umbrella organization for institutions from the public and private sector as well as academia that have stakes in improving the availability and use of geospatial information. 52°North contributes to discussions and networking activities by participating in DDGI working groups and events.

Contact: https://www.ddgi.de

GDI DE (Geospatial Data Infrastructure Germany), GeoIT RT NRW (Geospatial Information Technologies Round Table North-Rhine Westphalia) and Geonetzwerk Münsterland (Geonetwork in the Münster Region) are associations on national, state and local levels that support the availability and use of geospatial information by stimulating the development of the spatial data infrastructure in their respective stakeholder communities. 52°North supports the goals of these associations and contributes to their activities by participating in expert groups and events. 52°North is a member of the GeoIT RT NRW and Geonetzwerk Münsterland steering committees.

Contact: https://www.gdi-de.org
https://www.geoportal.nrw/geoit_round_table
http://www.geonetzwerk-muensterland.de

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