

Submission

NFDI4Ing Letter of Intent
for Renewal Proposal in 2024



Please address the following aspects in your letter of intent

1 Binding letter of intent as advance notification of a full renewal proposal

<input checked="" type="checkbox"/>	Binding letter of intent (required as advance notification for renewal proposals in 2024)
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2 Formal details

- **Name of the consortium**
Nationale Forschungsdateninfrastruktur für die Ingenieurwissenschaften
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 - Fluid Systems (FST)
 - University and State Library Darmstadt (ULB)
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- DataCite e.V.

- Dekane- und Abteilungsleiterkonferenz für Architektur, Raumplanung und Landschaftsarchitektur in der Bundesrepublik Deutschland (DARL)

- Deutsches Forschungsnetz (DFN-Verein)

- Deutsches Forschungszentrum für Künstliche Intelligenz (DFKI)

- Forschungszentrum Jülich (Institute of Energy and Climate Research, PD Dr. Hartmut Schlenz)

- Forschungszentrum Jülich (Jülich Supercomputing Centre)

- Fraunhofer Institut für Produktionstechnologie (IPT)

- ***Friedrich-Schiller-Universität Jena (Thüringer Kompetenznetzwerk Forschungsdatenmanagement)***

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- Helmholtz-Zentrum hereon GmbH

- Hochschule Darmstadt, University of applied sciences

- Hochschule Fulda

- Hochschule für Technik Stuttgart

- Hochschule für Technik und Wirtschaft Dresden (HTW)

- Hochschule Karlsruhe

- Hochschule RheinMain

- **Hochschule Trier**

- International Data Spaces e.V.

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- Leibniz Universität Hannover (Exzellenzcluster PhoenixD)

- Leibniz Universität Hannover (SFB TerraQ)

- Leibniz Universität Hannover (Exzellencluster QuantumFrontiers)

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3 Objectives, work programme and research environment in the second funding period

3.1 Research area of the proposed consortium (according to DFG classification system):

4.11 Production Technology

4.12 Mechanics and Constructive Mechanical Engineering

4.21 Process Engineering, Technical Chemistry

4.22 Fluid Mechanics, Technical Thermodynamics and Thermal Energy Engineering

4.31 Materials Engineering

4.32 Materials Science

4.41 Systems Engineering

4.42 Electrical Engineering and Information Technology

4.43 Computer Science

4.51 Construction Engineering and Architecture

3.2 Concise summary of the consortium's main objectives and task areas

We intend to consolidate and scale our ongoing efforts of transforming the engineering sciences towards being more open, more efficient, and better connected. As new methods begin to revolutionise science, we extend our support portfolio for data-driven workflows. Our target audience remains unchanged and encompasses engineers in all domains of research. That being said, we adapt our successful concept of orthogonal archetypes to gained insights and anticipated trends. An overview of our task areas is given below.



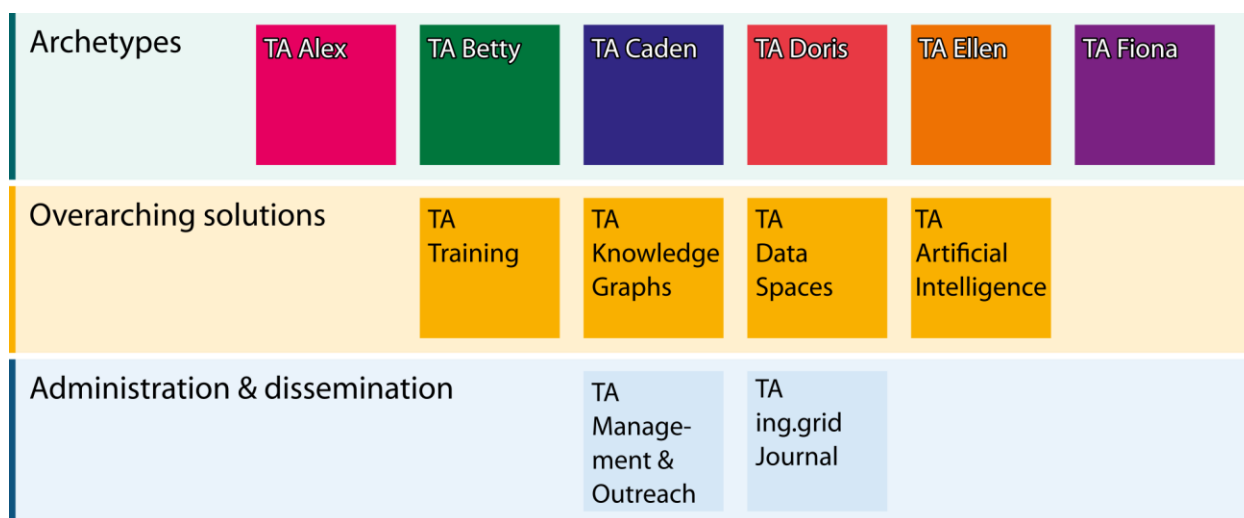


Figure 1: Overview of the reworked task structure

Compared to the first period of NFDI4Ing, we acknowledge the overlap and resulting synergies between two former archetypes, Frank and Golo. We consolidate these two into the new archetype Fiona. Moreover, we transform the formerly monolithic Base Services into four new task areas devoted to overarching solutions. Furthermore, we assign centralised outreach tasks to the management and promote the NFDI4Ing diamond open access journal ing.grid into its own task area. While the first period of NFDI4Ing has been dominated by the development of services according to needs of the community, the second period will shift focus to the perpetuation of services, their scaling, and their connectivity with other services of NFDI and beyond. To ensure services work effectively for the community while shifting focus, NFDI4Ing will assign a Liaison Officer to each task area, thereby establishing a direct personal link between the task area and the community.

Generally speaking, NFDI4Ing will hone further in on the closing of data cycles, minimising both friction loss and redundant work by eliminating dead ends in the scientific information flow. As a foundation, NFDI4Ing will leverage self-contained data entities embedded in knowledge graphs. Furthermore, NFDI4Ing will be implementing FAIR digital objects and established vocabularies, thus ensuring that research data is FAIR and AI-ready. The following ten guiding principles summarise NFDI4Ing's main approach:

- I. We know our users and our Germany-wide community and *vice versa*
- II. All our offers serve all engineering scientists at German research institutions
- III. We standardise and automate the research data management (RDM) processes wherever possible and support the scientists represented by the archetypes with an NFDI4Ing RDM Copilot
- IV. We close data cycles



- V. All research data managed by NFDI4Ing's concepts and services will be FAIR and AI-ready in 2030
- VI. We empower engineering research institutions and universities to include RDM and NFDI4Ing's solutions in their curricula as well as their examination and doctoral regulations
- VII. The usage of our concepts and services increases the scientific reputation (researchers) and the academic credit (students, doctoral candidates) of our users
- VIII. We deepen our collaboration with industry stakeholders and ISO/DIN
- IX. We contribute to the vision of One NFDI
- X. We feel responsible for the long-term sustainability of RDM in engineering

3.3 Brief description of the proposed use of existing infrastructures, tools and services that are essential in order to fulfil the planned consortium's objectives

Within the first period, NFDI4Ing has newly developed or extended software tools, services, and infrastructure. NFDI4Ing has also developed conceptual products such as informative websites, training materials, white papers, and guidelines. This growing portfolio is the basis of NFDI4Ing's further development towards FAIR, sustainable, and AI-ready solutions. On top of this, NFDI4Ing's extensive competence building efforts are at the forefront of and a forerunner to cultural change in engineering sciences.

A straightforward way of addressing all engineering scientists at German research institutions and of contributing to the vision of One NFDI is to integrate, wherever possible, offerings of BASE4NFDI. For instance, *RDMO* is already linked to DMP4NFDI, *ORKG* is already linked to KG4NFDI, and *JupyterHub* is already linked to Jupyter4NFDI. Also, our domain-specific *Terminology Service* is already linked to IAM4NFDI, PID4NFDI, and TS4NFDI. These integration efforts are not limited to the offerings of BASE4NFDI, but extend to existing RDM infrastructure at co-applicant institutions. Examples are *COSCINE*, *RADAR*, and *Suresoft*. They also extend to Federal State Initiatives for RDM such as, for example, HeFDI, FDM.NRW, and SaxFDM.

Seen from a different vantage point, NFDI4Ing services will contribute to the closure of data cycles. We now proceed to name a few examples of services developed in the first period that will be integrated into comprehensive solutions. *Betty's (Re)Search Engine* links research software it finds on platforms like GitHub to corresponding publications. *Data Collections Explorer* provides an overview of domain specific data repositories, archives, databases, and data sets. *Data Transfer Federation* enables users to access data in either dedicated solutions or services associated with HPC. *HOMER* retrieves metadata from HPC systems and HDF5 files. *Ing.est* extracts metadata from multiple file formats. *KaDI4Mat* facilitates the exchange of research data for simulation and sample tracking. *PlotSerializer* enables storing relevant data with published plots. *pyKraken* handles self-documenting file formats. *Metadata Crawler*, *machine-actionable*



digital data sheets, and *hardware documentation services* allow for software documentation. Last but not least, *SciMesh*, *metadata4ing*, and *DataDesc* allow to document scientific workflows, provenance, and data-formats in form of a knowledge graph.

Our newly structured layer of task areas named overarching solutions plays an important role in establishing long-term sustainability and in providing a basis for automation. As mentioned above, all services are accompanied by extensive competence building efforts. NFDI4Ing strives for the standardisation of *engineering-specific RDM* training within a *GitLab-Infrastructure* and *Knowledge Base* complete with Best Practices, How-To Instructions, Data Quality Metrics, and Guidelines for Text and Data Mining. Importantly, NFDI4Ing fosters the reputation of data and software publications with the innovative platform *ing.grid* in an open peer review process. Finally, NFDI4Ing aims to extend its services and solutions for and with industry partners and plans collaborations with ISO/DIN.

3.4 Interfaces to other NFDI consortia: brief description of existing agreements for collaboration and/or plans for future collaboration

During the first period, NFDI4Ing has engaged in more than 20 direct collaborations with other

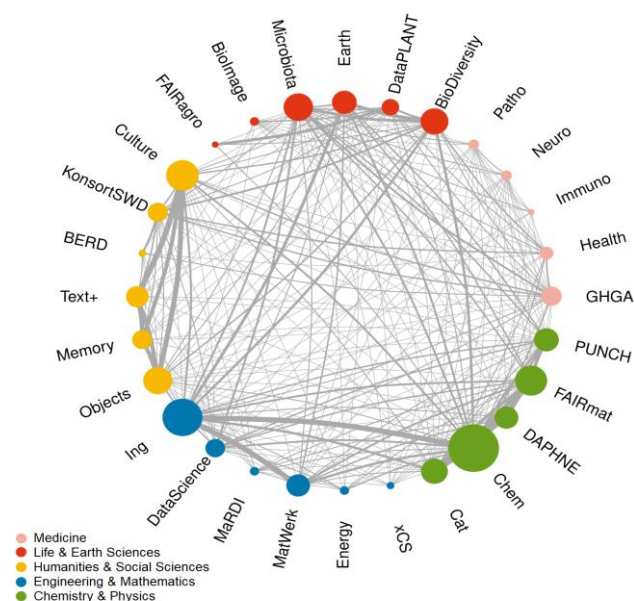


Figure 2: Direct collaborations between consortia. Figure taken with permission from <https://doi.org/10.5281/zenodo.8296725>

consortia. Direct collaborations reported up to August 29, 2023, are illustrated on the left. Since then, they have grown in number and include the organisation of events, the running of interest groups, the joint development of services, and the forging of alliances. Examples are, respectively, networking events such as RWTH4NFDI, participation in the *ELN consortium*, active development of *Kadi4Mat* jointly with users from other consortia, and our memorandum of understanding with NFDI4Chem regarding *RDMO*. Also, members of NFDI4Ing have participated in various entities and initiatives of the NFDI association. Those efforts will be continued and deepened as more NFDI4Ing and Base4NFDI services come into their productive phase and are actively (re-)used and enhanced by feedback from their target users and communities.



4 International and national networking

On a global scale, NFDI4Ing currently participates in a total of 27 international communities, including RDA, IDSA, CESAER, DataCite e.V., SSHOC, and OpenAire. Moreover, NFDI4Ing is active in EOSC Association, EOSC Working Groups, and related forums such as EUDAT CDI and AARC blueprint architecture for federated identity and access management. The latter forms the basis for NFDI AAI to be developed within the context of Base4NFDI. The consortium features an advisory board with international members, including representatives of science and industry. NFDI4Ing has also launched *ing.grid*, an international open access journal that fosters FAIR RDM practices in the engineering sciences. One spotlight of NFDI4Ing's international visibility has been the NFDI4Ing Conference 2022, where one-sixth of the speakers and audience were international. In cooperation with DataCite e.V., NFDI4Ing has developed an interactive NFDI instrument dashboard to visualise connections in the PID graph, representing relationships between instruments and associated digital resources. Terminologies have been brought forward in 2023 at the CIRP General Assembly in Dublin, where NFDI4Ing's spokesperson R. Schmitt served as chairman of the CIRP's Terminology Committee. Together with partners from PoliMI and University of Nantes, vocabulary modelling according to W3 Standards has been introduced. Our objective is to use CIRP dictionaries in English, French, Italian, and German as a base on the *Terminology Service* for the design of ontologies in production engineering.

In the Czech Republic, an initiative comparable to the NFDI has been launched in 2024 and will be actively supported by a working group centered on NFDI4Ing's *Kadi4Mat* team and task area CADEN. This features a collaboration between the Czech initiatives "National Repository Platform" and "Open Science 1" with the additional support of Skills4EOSC to share knowledge in the field of RDM and to build a community around *Kadi4Mat's* research data infrastructure. In the USA, NFDI4Ing actively participates in the Phase Field Schema working group of Materials Research Data Alliance (MaRDA) and shares competences to build an ontology in the domain of material science.

For the second period, we will establish long-term collaborations with industry stakeholders. To achieve this, we will integrate relevant stakeholders in our archetype task areas, along with data custody models. Evolving from the efforts in the NFDI sections and respective working groups, NFDI4Ing will continue to contribute substantially to the DALIA Knowledge Base for "FAIR data usage and supply" and to basic service proposals in the framework of Base4NFDI. Furthermore, NFDI4Ing will continue its engagement within RDA's engineering interest group RDM4Eng which was initiated by NFDI4Ing. Productive services relevant to the international engineering community will be regularly presented at RDA-hosted events and discussed with the communities there, such as, e.g., FAIRsharing.org, which provides feedback that is incorporated into further service development.

