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Extended Abstract

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Taking a Holistic View on FAIR Digital Objects

Applying Advanced Modeling with Base Service Infrastructure and Tooling

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Abstract. FAIR Digital Objects implement the Digital Object model to enable FAIRification of data ecosystems. They are defined data structures with specified traits, yet interpretations differ on definitions, technologies, and procedures. This work focuses on FAIR Digital Objects as representations of concrete data resources, making them effectively connected, operation-ready abstractions on a meta-level. This meta-level is carried by a set of base-service infrastructure components and advanced tooling. Using the Digital Object Interface Protocol as a gateway, this approach enables uniform, client-side operations across heterogeneous data ecosystems. These conceptual and implementation-specific aspects result in a holistic view on what FAIR Digital Objects are and how they are usable in the context of given data ecosystems.

Keywords: FAIR Digital Objects, Modeling, Base Service Infrastructure, DOIP

1. Extended Abstract

1.1 Introduction and Related Work

Different interpretations of Digital Objects[1] and the FDO Forum specifications [2], [3] have resulted in multiple technology-specific models that place FDOs within different layers of existing data ecosystems, e.g., (webby) FDOs as RO-Crates [4], as Nanopublications [5], or as digital specimen [6]. This work adopts a meta-level view as described in [7]: FDOs are abstract entities composed of technical components that represent existing resources. Instead of integrating FDOs within existing data ecosystems, the data resources are practically projected to this meta-level as FDOs. Uniform interfaces for this level then let clients act on heterogeneous data resources across ecosystems without the expense of dealing with ecosystem-specific technical details. Required base-infrastructure for this meta-level has been already addressed in earlier works, e.g. [8]. A crucial aspect to make such a meta-level work are the operations for FDOs, which have been recently specified and discussed with respect to typing mechanisms in analogy to OOP principles [9]. A prototypical framework that applies the modeling of FDOs on a meta-level in conjunction with operations associated via the proposed typing mechanisms has been described in [10]. This work puts the conceptual modeling aspects, the developments of FDO typing mechanisms, and implementation work with the given base-service and tooling infrastructure into an holistic view. This gives a reproducible impression on what FDOs are already capable of and in which direction they can be strategically developed.

1.2 Model Overview

We briefly summarize the technical aspects of an FDO in the context of their role as abstract data representations on a meta-level:

- Type System Traits: FDOs are formally described through a typed metadata language where different typing mechanisms assign typed elements in FDOs to operations and ultimately characterize the FDO.
- Abstraction and Encapsulation Traits: Each FDO encapsulates attributes, a bit-sequence interface, and operations for the (meta)data, while the instantiated Profile abstracts implementation and standardizes representation.
- Graph-structure Traits: Every FDO has identity and attributes and can relate to other (FDO) entities, similar to Entity–Relationship modeling. FDO–FDO links act similar to Linked Data principles but add PID-based persistence and typed records, with typed edges for machine interpretation. This allows connections of (meta)data resources, and implementations of type-associated operations.

In general, an FDO information record must contain only the technical and syntactical information that is required to read the bit sequence. Use case-specific information for its interpretation is assessed through entity-relationships and a set of operations to access and process generic and use-case specific information in a machine-actionable way, given by the abstraction and encapsulation traits.

Paradigm example: consider an FDO F_1 for image data and an FDO F_2 with schema-based, use case specific metadata about F_1. F_1's record contains no use case fields, but links to F_2. F_2's record includes its own kernel metadata so its bit sequence is interpretable, and that sequence carries the use case metadata about F_1. This information can be processed by all associated operations.

1.3 Infrastructure Components

The base-services and tooling that make up the meta-level are essentially a PID service, e.g., the Handle Registry [11]; Data Type Registries, e.g. the ePIC DTR [12]; some manager service that unifies the effective handling of CRU(D) actions for FDOs, along with tooling for querying of the FDO space including FDO-FDO relationships, and the assessment of operations for each FDO, e.g., the Typed PID Maker Adapter [10].

1.4 Getting Practical

Given the base-service infrastructure and rule set that form a meta-level in which FDOs exist, every data resource that is represented as FDO can be treated in a uniform way. To make this functionality available to clients, a gateway is required that abstracts the technical implementation of services and tooling that connect to the meta-level (s. Figure 1). In the corresponding talk of this manuscript, we provide an example of how the meta-level of FDOs can be leveraged by a Digital Object Interface Protocol (DOIP)-supported gateway, consisting of the described infrastructure components of base-services and advanced tooling. This addresses how advanced technical solutions for meta-level FDOs already are and that main gaps currently exist with respect to wide adoption and provision of oragnizational resources.

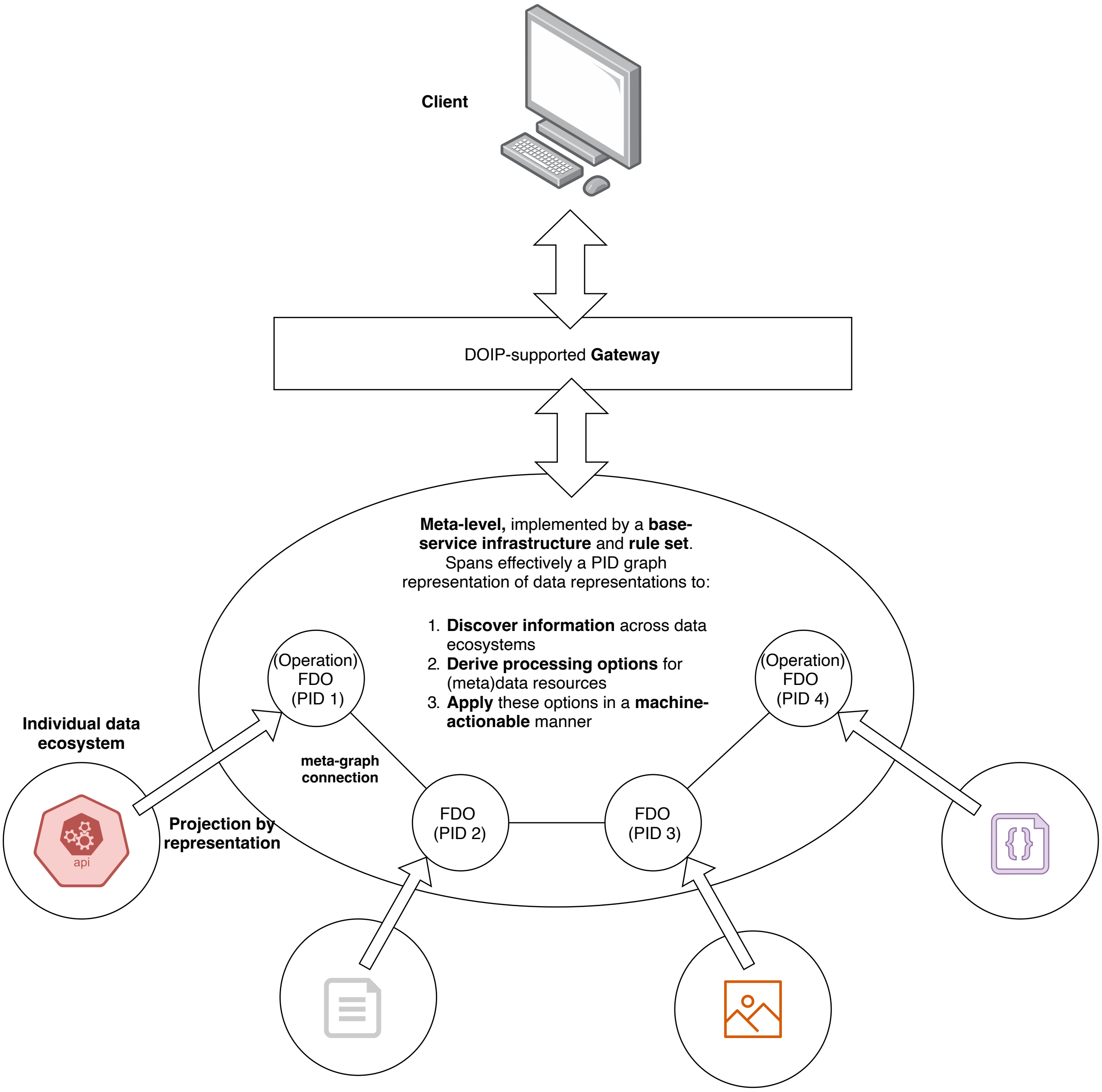

Figure 1. *Illustration of the Meta-level of FAIR Digital Objects and its access via a DOIP-supported Gateway.*

Underlying and related material

Author contributions

Nicolas Blumenröhr: Conceptualization, Methodology, Software Development, Writing, Visualization

Competing interests

The authors declare that they have no competing interests.

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