

From Content Fingerprint to FAIR Digital Object

The ISCC Protocol as a Content-Based Discovery Layer for the FDO Ecosystem

Titusz Pan¹ , and
Dr. Martin Etzrodt¹ 

¹ISCC Foundation

*Correspondence: Dr. Martin Etzrodt, me@iscc.foundation

Abstract. The FAIR Digital Object (FDO) framework provides a robust, abstract model for machine-actionable data. A key challenge remains in applying this framework to web-scale, decentralized ecosystems, particularly for digital content identification. This paper introduces the ISCC Discovery Protocol (IDP), a new federated protocol built upon the International Standard Content Code (ISCC, ISO 24138:2024). While ISCC provides a content-derived “fingerprint” for media, the IDP provides a mechanism for creating persistent, resolvable “Declaration Events” about that content. We demonstrate that this protocol provides a practical and scalable implementation of a federated FDO system, one that uniquely adds a powerful content-based discovery layer to the FDO ecosystem.

Keywords: FAIR Digital Objects, ISCC, Content Identification, ISO 24138, Persistent Identifiers, Federated Systems, Content Discovery

1. Introduction

The FAIR Digital Object (FDO) framework provides a robust, abstract model for machine-actionable data. A key challenge remains in applying this framework to web-scale, decentralized ecosystems, particularly for digital content identification.

This paper introduces the ISCC Discovery Protocol (IDP) [1], [2], a new federated protocol built upon the International Standard Content Code (ISCC, ISO 24138:2024 [3]). While ISCC provides a content-derived “fingerprint” for media, the IDP provides a mechanism for creating persistent, resolvable “Declaration Events” about that content. We demonstrate that this protocol provides a practical and scalable implementation of a federated FDO system, one that uniquely adds a powerful content-based discovery layer to the FDO ecosystem.

2. The ISCC Protocol as an FDO Implementation

The core of the IDP is the Declaration Event, which functions as the FDO. This event—a cryptographically signed IsccNote that records who declared what content at what time—is identified by a globally unique, persistent, and resolvable ISCC-ID.

This ISCC-ID serves as the FDO's PID. Upon resolution, it returns a verifiable IsccReceipt, which functions as the FDO-Record.

Critically, the ISCC-CODE (the content fingerprint) is not the PID; it is a key meta-data attribute within the FDO-Record. This architecture allows the FDO-Record to be a lightweight, verifiable claim, while the ISCC-CODE attribute enables powerful content-based and similarity-based discovery.

3. Alignment with Core FDO Principles

This "Declaration Event as FDO" model naturally aligns with the FDO specifications:

- **Identifier Uniqueness (FDOR-GR1):** The ISCC-ID is a unique PID assigned to a single declaration. The protocol allows for multiple declarations about the same content, resulting in multiple FDOs (and multiple PIDs), which directly supports the "one or more PIDs" concept.
- **Ownership and Security (FDO-PIDR5):** The protocol aligns with FDO-PIDR5's ownership model. The "declarer" (owner of the public key) is the sole owner of their IsccReceipt (the FDO-Record) and the only actor who can manage it.
- **Federated Trust Model:** The IDP's network of "ISCC-HUBs" operates on a "trust through transparency" model. Rather than a single central authority, it embraces competing claims as a visible, auditable feature. This represents a robust, real-world implementation of a decentralized FDO registry system.

4. Enriching the FDO Ecosystem with Content-Based Discovery

The FDO framework excels at resolving known PIDs to retrieve FDO-Records. The IDP introduces a powerful new discovery vector for when the PID is unknown.

The ISCC-CODE attribute functions as a fingerprint-based query key. This enables a "reverse lookup" workflow:

1. A user or machine generates an ISCC-CODE from a local digital object (e.g., an image, document, or audio file).
2. The agent queries the federated network of ISCC-HUBs (acting as FDO Registries) with this ISCC-CODE.
3. The network returns a set of all ISCC-IDs (PIDs) that correspond to FDOs containing that ISCC-CODE attribute.

This simple mechanism transforms the FDO ecosystem from a purely PID-resolvable system to a content-discoverable one. It allows any machine to find all registered FDOs—and by extension, all related metadata and services—starting from nothing but the content itself. Furthermore, the inherent design of ISCC-CODEs enables similarity-based discovery, allowing agents to find related FDOs even for modified or derivative content.

5. Conclusion and Implications

This work provides a critical bridge between two major data interoperability paradigms: the content-derived world of ISCC and the formal assigned-identifier world of FDO.

We demonstrate that the IDP is a powerful, ISO-standard based, and federated system that can be implemented as an FDO system. It contributes a vital, missing

piece to the ecosystem: a scalable, content-first discovery layer. This synthesis offers a clear path for managing web-scale digital content (including AI-generated media) as FAIR Digital Objects, leveraging ISCC's content-aware network and FDO's machine-actionable framework.

Data availability statement

All code can be found at <https://github.com/iscc>

Underlying and related material

The ISCC Discovery Protocol concept document is available at: <https://docs.google.com/document/d/1JdQrrBDfDPnQ08kM-onf4s0DwcntRLQVRBmbw1JImGo/edit>

The ISCC ISO standard (ISO 24138:2024) is available at: <https://www.iso.org/standard/77899.html>

AI use disclosure

We use AI tools, predominantly Claude.ai (Anthropic) and Google Gemini for research and development of the ISCC and IDP. Furthermore these tools were used for drafting and validation of the manuscript.

Author contributions

Titusz Pan: Conceptualization, Methodology, Software, Writing – review & editing. Martin Etzrodt: Writing – original draft, Writing – review & editing.

Competing interests

The authors declare the following competing interests: Martin Etzrodt is member of the ISCC Foundation board of directors. The ISCC Foundation is a non-profit organization that develops free and open source software. All code is available in public GitHub repositories. Titusz Pan is member of the ISCC Foundation board of directors. He is also founder and CTO of Amlet AI, that makes use of the ISCC Discovery Protocol.

Funding

No external funding was received for this work.

References

References

- [1] T. Pan, *Iscc - discovery protocol - concept*, Working document, 2025. Accessed: Oct. 29, 2025. [Online]. Available: <https://docs.google.com/document/d/1JdQrrBDfDPnQ08kM-onf4s0DwcntRLQVRBmbw1JImGo/edit?tab=t.0#heading=h.ig6l9r1h6oh8>.
- [2] ISCC Foundation, *Iscc - international standard content code*, GitHub Repository, 2025. Accessed: Oct. 29, 2025. [Online]. Available: <https://github.com/iscc>.

- [3] “Information and documentation — international standard content code,” International Organization for Standardization, Standard, 2024. [Online]. Available: <https://www.iso.org/standard/77899.html>.