



BORDERLINK

POLICY BRIEFING

LEVERAGING THE HORIZON EUROPE BORDERLINK FEDERATED X-RAY IMAGE DATABASE AS A STRATEGIC ASSET FOR THE EU CUSTOMS AUTHORITY AND THE EU CUSTOMS DATA HUB

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1. Abstract

The European Commission's [customs reform package](#), tabled on 17 May 2023, sets out an ambitious vision for a more integrated, data-driven customs union. At its centre are two new institutions: the EU Customs Authority (EUCA) and the EU Customs Data Hub, a single centralised IT environment intended to replace the fragmented landscape of 27 national customs IT systems.

In parallel, the Horizon Europe funded [BORDERLINK](#) project (Grant Agreement N°101167589) is developing a federated database architecture that allows customs and border authorities to discover, request and share X-ray screening imagery across Member States, while data ownership and storage remain under national control. Alongside the database, the project includes a complementary innovation: a library of synthetic X-ray threat images that provides a privacy-safe, immediately shareable dataset for training and AI development. Together, these innovations directly address several of the operational and governance challenges the customs reform is designed to solve.

This briefing examines how the BORDERLINK federated database could serve as a strategic tool for the planned EUCA and how it might interface with the EU Customs Data Hub. It identifies the policy and regulatory steps required to enable adoption and demonstrates that much of the governance groundwork has already been completed within the project.

2. EU Customs Reform

More than 100,000 customs officers working across the EU handle duties ranging from standards enforcement and anti-smuggling operations to the collection of nearly €24 billion in annual customs revenue. Despite the customs union being one of the EU's oldest achievements, the operational environment remains fragmented. In 2022, an economic operator wishing to complete all customs formalities across the EU would have needed to connect with 189 separate national IT systems. This fragmentation creates high compliance costs for traders, inconsistent risk assessment between Member States, and opportunities for criminal exploitation through “border shopping,” where illicit goods are routed through the point of entry with the lowest detection risk.

2.1. EU Customs Authority

The EUCA is being established in close cooperation with Member States, with preparatory activities commencing in 2027. Its mandate centres on four pillars: coordination between



national customs administrations, capacity building, data management through the Customs Data Hub, and risk coordination.

2.2. EU Customs Data Hub

The Data Hub is described in the Commission’s proposal as “the face and the engine” of the new customs union. It would consolidate the fragmented digital space into a single centralised IT environment, sparing traders the need to interact with 27 different national systems. The Hub would ensure the integrity, traceability and non-repudiation of data submitted to or collected by customs authorities.

The rollout follows a phased timeline: the Data Hub becomes operational for e-commerce in 2028, all traders may use the system optionally from 2032, and use becomes mandatory from 2038. The Commission estimates that maintaining the Data Hub requires an annual investment of approximately €2 billion, but that centralisation would allow Member States to save more than €20 billion in total IT expenses over 15 years. Data held in the Hub would be accessible to the Commission, national customs authorities, OLAF, EPPO, Europol, Frontex, and Member States’ tax and market surveillance authorities.

3. BORDERLINK Federated Database

3.1. Architecture and Design

The BORDERLINK federated database, designed and built by Rapiscan, introduces a secure and privacy-preserving mechanism for customs and border authorities to discover and share X-ray imagery across borders while data remains under national control. At the heart of the innovation is a federated architecture that connects autonomous national databases through a single web portal. Rather than centralising image data, the system allows authorised users to search metadata catalogues across participating Member States. Images are viewable only when explicitly requested by an authorised user, and only if authentication and local access permissions allow it. Every image download is intentional, auditable, and fully controlled by the data-owning authority. No image data is stored or cached in the central federation layer.

The architecture has been developed against a formal Verification, Compliance and Requirements Matrix (VCRM) that defines mandatory security, access control, data integrity, and audit requirements. Key design constraints include: separate autonomous nodes for each participating authority, role-based access control across all components, multi-factor authentication, token-based access with expiration and scope, encrypted inter-system



communication, comprehensive logging of all queries and access attempts, and the inability of the federated layer to permanently store or cache any retrieved data.

3.2. Synthetic Threat Image Library

Alongside the federated database, BORDERLINK includes a complementary innovation: a library of synthetic X-ray images containing realistic threat scenarios, developed by Rapiscan using Threat Image Projection (TIP) technology.

TIP involves synthetically inserting X-ray scans of threat items into genuine scans of vehicles and cargo containers. Threat items are generated through two methods: laboratory scans of physical objects at multiple orientations, and computer-generated imagery using 3D modelling. The resulting images simulate realistic smuggling scenarios across threat categories including firearms, drugs, ammunition, alcohol, tobacco, trafficked persons, and endangered animals, created in collaboration with customs end users in Ireland, the United Kingdom, Norway, and Hungary.

The project targets at least 50 distinct threat items and at least 1,000 complete synthetic X-ray images, stored in the World Customs Organisation's UFF 3.0 format. A proportion of images include corresponding annotation masks to support AI model training. The synthetic library feeds directly into the federated database: images are uploaded to Rapiscan's node and made discoverable by other Member States' customs authorities through the federation interface. Because these images are entirely synthetic, they contain no nationally sensitive data, no personal information, and no sensitive operational metadata, making them freely shareable and privacy safe.

3.3. Rapiscan's Horizon Europe Portfolio

The federated database sits within a broader portfolio of Horizon Europe projects in which Rapiscan Systems is an active partner. Under the [ODYSSEUS](#) project (Grant Agreement N°101073910), Rapiscan developed advanced X-ray screening technologies for occupied vehicle inspection, including AI-driven occupancy detection and ultra-low dose imaging. ODYSSEUS white papers have addressed the legislative context for these technologies across radiation exposure, the EU AI Act, the Schengen Border Code, and personal data considerations.

Concurrently, under the [ORION](#) project (Grant Agreement N°101225611), Rapiscan is developing next-generation rapidly deployable vehicle screening solutions with new transmission detector arrays and material separation capabilities, with planned pilot deployments at border crossing points in Romania. ORION brings together 21 partners with



end users from six countries and runs until August 2028, overlapping with BORDERLINK's development timeline.

This sustained engagement across three concurrent Horizon Europe programmes positions Rapiscan as a long-term innovation partner with direct end-user relationships across multiple Member States.

4. Strategic Alignment with the EUCA Mission

The federated database model aligns with several core elements of the EUCA's mandate.

Data sovereignty with coordinated access

A central challenge for the customs reform is balancing EU-wide coordination with Member States' control of operational data. The federated model addresses this directly: data remains stored nationally, each authority applies its own access-control policies, and the federation layer provides only the discovery and request mechanism.

Risk management and intelligence sharing

The EUCA is mandated to develop common EU risk criteria and priority control areas. Access to a cross-border pool of X-ray screening images would directly support this objective. Patterns of concealment, emerging smuggling techniques, and commodity-specific risk indicators visible in one Member State's imagery could inform risk assessments across the European Union.

Capacity building and training

The EUCA's mandate includes preparing common training content for customs officers. A federated image database, populated by synthetic and member state threats, would provide shared training resources and case studies for cargo patterns and smuggling modalities outside of host Member States.

AI development and analytical capability

The customs reform emphasises data-driven decision-making. Access to diverse, multi-source X-ray imagery is critical for developing AI-based detection tools. The synthetic image library provides an immediate, privacy-safe dataset, enabling technology providers and customs authorities to develop and benchmark detection algorithms ahead of deployment on real operational data.

This "synthetic-first" approach demonstrates the federation's functionality while building user confidence, without requiring Member States to share sensitive data during early adoption.



Reducing proliferation of national IT systems

The Commission identified the proliferation of disconnected national IT systems as a fundamental obstacle. The federated database addresses this for X-ray imagery by providing a single, interoperable application connecting multiple national databases through standardised interfaces and common metadata fields.

5. Interfacing with the EU Customs Data Hub

5.1. Metadata Integration

The most natural interface between the federated database and the Data Hub would be at the metadata level. BORDERLINK is developing common metadata fields including scan type, commodity category, equipment specifications, detection outcomes, illicit goods classification, concealment location, and seizure quantities. These descriptors could be made available to the Data Hub's risk analysis engine without transferring images themselves, enriching the Hub's risk picture with screening intelligence from across the Union, potentially increasing detection capability for fraudulent or trafficked goods. This would also position the Data Hub to support future integration of X-ray screening data as the EU customs framework evolves towards richer, data-driven inspection modalities.

5.2. Complementary Architecture

The federated database is not intended to replace or duplicate the Customs Data Hub. The Hub centralises trade and customs declaration data; the federated database provides controlled access to operational screening imagery. The two systems serve complementary functions, with metadata links providing the connection point. Screening metadata flows between Member States via the federated layer, preserving data sovereignty while avoiding the technical and financial burden of centralising high-volume X-ray imagery within the Hub.

5.3. Governance Readiness

A cross-reference of the BORDERLINK VCRM against the governance principles in the Data Hub proposal reveals strong pre-existing alignment. This alignment suggests that the gap between the current BORDERLINK architecture and a production-ready system integrated with the EU Customs Data Hub is narrower than might be assumed for a Horizon Europe research prototype.



6. Policy and Regulatory Considerations

6.1. EU Artificial Intelligence Act

The federated database is a data-sharing infrastructure, not an AI system. Database end-users that deploy AI tools based on its data remain responsible for AI Act compliance within their respective jurisdictions.

6.2. Standardisation

For the federated database to operate across 27 Member States using equipment from different manufacturers, common standards for image formats, metadata fields, and quality thresholds must be agreed. The BORDERLINK project's adoption of WCO UFF 3.0, creation of a unified data model and database schema framework provides a unified starting point. The EUCA, through its mandate to develop and manage the Data Hub (Article 209 of the proposal), has the institutional authority to formalise these standards.

6.3. Access Control and Authorisation

The federated model requires a harmonised framework for user authentication and authorisation across Member States, including user roles, access tiers, audit requirements, and conditions for image transfer. The Data Hub proposal already provides for tiered access differentiated by institutional role. A parallel framework for X-ray imagery, aligned with these provisions, would need to be developed. The BORDERLINK VCRM provides a tested foundation for this framework.

6.4. The Horizon Europe Review Mechanism

The Horizon Europe programme includes structured review mechanisms that allow EU institutions to provide feedback on funded projects. The EUCA could use this channel to provide input to the BORDERLINK consortium during the second innovation cycle, shaping the architecture, metadata standards, and governance model to align with Data Hub requirements. This represents a low-cost way for the EUCA to influence development without committing to procurement decisions.

7. Key Findings

Key Finding 1: Architectural alignment with the EUCA model

The federated database architecture directly addresses the EUCA's dual requirement for centralised coordination and national data sovereignty. Data remains under Member State



control while the federation layer enables EU-wide discovery, access, and risk analysis, supporting the phased implementation approach adopted for the customs reform.

Key Finding 2: Ready-made innovation from Horizon Europe investment

BORDERLINK provides both a functional federated database architecture and a complementary synthetic threat image library, developed with end-user input and Horizon Europe funding. The synthetic library offers a privacy-safe, immediately shareable dataset that can populate the federation from day one, demonstrating capabilities without requiring Member States to share operational data.

Key Finding 3: Governance groundwork is largely complete

The BORDERLINK VCRM already addresses the core governance requirements implicit in the Data Hub proposal, including data sovereignty, role-based access control, audit and traceability, encrypted communications, and metadata standardisation.

Key Finding 4: A structured policy input channel exists

The Horizon Europe review mechanism provides a formal route for the EUCA to contribute requirements and feedback during BORDERLINK's second innovation cycle, enabling early alignment on standards and interoperability without procurement commitments.

Key Finding 5: Complementary integration with the Customs Data Hub

The federated database and the EU Customs Data Hub serve different but complementary functions. Metadata-level integration would enrich the Hub's risk analysis engine with screening intelligence, without centralising high-volume image data within the Hub itself.

8. Conclusion

The BORDERLINK federated X-ray image database presents a timely and practical opportunity to support the EU's transition toward a more integrated, data-driven customs architecture. By enabling controlled image sharing while preserving national data sovereignty, the federated model aligns closely with the operational, legal, and strategic requirements of the planned EU Customs Authority.

The customs reform's phased timeline, with the EUCA becoming operational from 2028 and the Data Hub expanding to all traders by 2032, creates a window in which the BORDERLINK architecture can be refined, piloted, and prepared for integration. The synthetic threat image library offers an immediate mechanism to demonstrate the federation's value and build confidence among Member States without requiring the sharing of sensitive operational data. The project's formal VCRM demonstrates that much of the governance infrastructure required for integration with the Data Hub is already in place.



Realising this opportunity requires a focused effort in agreeing common metadata standards for interoperability within the EU Customs Data Hub. The Horizon Europe review mechanism offers a structured, low-risk channel for the EUCA to shape this development during the project's second innovation cycle. Early coordination between the EUCA, the BORDERLINK consortium, and the Commission's Data Hub development team would help ensure these foundations are in place before the broader customs infrastructure reaches full operational maturity.