Interoperability Requirements Analysis

Deliverable D7.1

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Project Duration: 36 months

Project website: https://colours-eccch.eu/

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COLOURS Consortium

No	Short Name	Institution Name	Country
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3	FORTH	IDRYMA TECHNOLOGIAS KAI EREVNAS	Greece
4	NTNU	NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU	Norway
5	FBA	FUNDINGBOX ACCELERATOR SP ZOO	Poland
6	FBC	FUNDINGBOX COMMUNITIES SL	Spain
7	ECE	ERASMUS CENTRE FOR ENTREPRENEURSHIP BV	Netherlands
8	ZVKDS	JAVNI ZAVOD REPUBLIKE SLOVENIJE ZA VARSTVO KULTURNE DEDISCINE	Slovenia
9	BCS	Brakebusch Börries	Germany
10	GMB	GALERIA MESTA BRATISLAVY	Slovakia
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Executive Summary

This deliverable presents the analysis of the technical, semantic, and operational requirements for integrating the COLOURS tools and services into the ECHOES-ECCCH Cloud. It analyses the ECHOES-ECCCH architecture and its core components (AAI, Single Entry Point, HDTO, Knowledge Base and the supporting platform control-plane and domain services), describes the COLOURS integration approach as a single Vertical Application in the ECCCH Application Layer, and defines the interoperability requirements, covering API standards, semantic alignment with the Heritage Digital Twin Ontology (HDTO), metadata and paradata handling, AAI/RBAC integration, hybrid infrastructure needs, and the scalability and hosting considerations of the Vertical Application, together with the dependencies of the COLOURS Vertical Application on ECCCH capabilities. The requirements are derived from the ECHOES D6.2 requirements catalogue and the D6.3 architecture, and are tailored to the COLOURS architecture (COLOURS D3.1) and to the needs collected in WP2, WP3 and WP5. The outcome guides the integration (WP8) and deployment/validation (WP9) phases.

Three results stand out. First, the integration boundary of the COLOURS Vertical Application is narrow and explicit: two data paths cross it, the AAI-brokered login and the publication of semantic output from the CKR to the ECCCH Knowledge Base through the KBMS APIs, together with three operational obligations. Second, the CKR is the only COLOURS component that writes to ECCCH, and only published, public physical-object records become Heritage Digital Twins. Third, internal components such as the message bus are not an interoperability concern and are not constrained by ECCCH.

The result is a catalogue of 39 requirements in four groups: technical/API (COL-API-01 to 12; COL-API-09 is intentionally unassigned), semantic (COL-SEM-01 to 10), AAI/RBAC (COL-AAI-01 to 07) and hybrid infrastructure (COL-INF-01 to 11), each carrying a minimum interoperability level, a MoSCoW priority, the target ECCCH component and a verification method traceable to the ECHOES D6.2 requirements catalogue, together with a list of 12 dependencies (COL-DEP-01 to 12) on ECCCH capabilities that D7.2 uses as test preconditions. The working assumptions and fallbacks for the information still pending from ECHOES are given in Table 9.

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Introduction

This deliverable (D7.1) is the main output of Task 7.1 "Interoperability Requirements Analysis" of Work Package 7 (ECHOES-ECCCH Interoperability & Integration: Requirements & Planning, M7–M12, lead FORTH). It identifies and defines the technical, semantic, and operational requirements for integrating the COLOURS tools and services into the ECHOES-ECCCH Cloud.

Together with D7.2 "Integration and Test Plan" (lead FhG, also due M12), it prepares the semantic adaptation and cloud implementation phase (WP8, M13–M24) and the deployment and validation phase (WP9, M25–M33), in which the COLOURS toolset will be deployed as a Vertical Application in the ECHOES-ECCCH Application Layer.

Relation to other work packages and deliverables

WP3 / D3.1 "Specification of digital restoration tools" (May 2026) provides the tool specifications and the common ECCCH integration strategy that this document builds upon. WP4 provides the hybrid collaborative simulation environment (ATON-based) that is part of the integration scope. The requirements defined here feed D7.2 (integration and test plan), D8.1 (deployment plan, M24) and D9.1 (cloud deployment, M33). Together with the other M12 deliverables of WP2, WP3 and WP5 (D2.1, D2.2, D3.1, D3.2, D5.1, D5.2) and D7.2, D7.1 verifies milestone MS2 “Requirements, tech adaptation and exploitation strategy”. D2.1 (analysis of needs and requirements) identifies the COLOURS target communities, from which the COLOURS VO role groups are to be derived, and records the sector’s concerns about data ownership, privacy and intellectual property in cloud infrastructures, which shape the publication scope of the CKR. D2.2 sets the needs and requirements of the on-cloud collaborative environment, the Collaborative Simulation Environment that is part of the COLOURS VA, including the traceability of interpretations and decisions. D3.2 complements D3.1 for the predictive analysis and simulation tools; in line with the integration boundary defined in this deliverable, these tools exchange data only with the CKR. Within T3.4, D3.3 "Knowledge Repository Design and HDT Mapping" (M18; second iteration M36) documents the design of the CKR and its HDT mapping, adopting the COLOURS HDTs defined in WP8 (T8.1); the CKR-to-HDTO mapping required here (COL-SEM-04) is part of this work. D5.1 and D5.2 define the colour-management protocols whose calibration and colour-processing information must travel with COLOURS outputs as paradata.

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Reference documents

- ECHOES D3.1 — Integration Strategy for datasets, tools and workflows (DOI: 10.5281/zenodo.17751334)
- ECHOES D3.2 — Integration Roadmap (DOI: 10.5281/zenodo.17751669)
- ECHOES D6.2 Interoperability Requirements and Guidelines (DOI: 10.5281/zenodo.18656367 and companion wiki https://echoes-eccch-technical.github.io/internal-documentation/)
- ECHOES D6.3 — Architecture for Data and Cloud Components (M24 architecture baseline) (DOI: 10.5281/zenodo.20444205)
- ECHOES D8.1 — Concepts for Vertical Applications (DOI: 10.5281/zenodo.20447313)
- ECHOES D9.1 — Evaluation Framework (DOI: 10.5281/zenodo.20448152)
- ECHOES D7.1 — The Digital Commons: Heritage Digital Twin Ontology (DOI: 10.5281/zenodo.20445937)
- ECHOES Heritage Digital Twin Ontology v1.1 (https://isl.ics.forth.gr/ontology/echoes/html/HDT_v1.1.html)
- COLOURS D3.1 — Specification of digital restoration tools
- COLOURS D2.1 — Analysis of needs and requirements for advanced digital tools to support conservation
- COLOURS D2.2 — Analysis of needs and requirements for an on-cloud collaborative environment to support conservation-restoration workflows
- COLOURS D3.2 — Predictive analysis and simulation
- COLOURS D5.1 — Colour management protocols and recommendations for digitisation and visualisation
- COLOURS D5.2 — Specification of spectral-based colour management protocols for ECHOES ECCCH
- COLOURS Grant Agreement 101233413, Annex 1 (WP7–WP9 descriptions)
- EITF integration tracking (https://github.com/ECHOES-ECCCH-TECHNICAL) — repository access is granted by the EITF on request
- EITF Integration Handbook (https://github.com/ECHOES-ECCCH-TECHNICAL/integration-task-force) — repository access is granted by the EITF on request
- PERCEIVE Platform documentation — reference for the COLOURS Platform / VA architecture (https://perceive.ics.forth.gr/docs/)
- PERCEIVE D5.1 — PERCEIVE Platform Specifications, v1.0, 28/12/2023 (DOI: 10.5281/zenodo.16903587)
- PERCEIVE D5.2 — PERCEIVE Platform, v2.0 (final), 31/01/2026 (DOI: 10.5281/zenodo.19366551)

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The ECHOES-ECCCH Ecosystem

ECCCH (European Collaborative Cloud for Cultural Heritage) is being built by the sister project ECHOES (GA 101157364). Its target architecture (ECHOES D6.3, the M24 baseline) is a layered model that separates access and trust, platform control-plane responsibilities, execution, knowledge, storage, and applications/integration. A common access boundary: the Cloud Web UI, the Single Entry Point and the Access Edge / API Gateway, together with the shared AAI, provides a unified trust and entry context. Behind it, the platform control plane resolves policy and context, while dedicated domain services own their respective sources of truth: the AAI for identity and entitlements, KBMS for semantic content in the Knowledge Base, and the Storage Registry / Data API for storage targets and policy. Vertical Applications such as COLOURS sit in the applications/integration edge and interact with these capabilities through documented platform contracts. The components most relevant to COLOURS integration are summarised below.

Core components

- **AAI:** Authentication and Authorization Infrastructure, based on RCIAM (GRNET), following AARC blueprint guidelines. Common identity, authentication and entitlement (VO/group) management for all integrated nodes; authorization over ECCCH-governed resources is resolved by the platform control plane and domain services.
- **SEP:** Single Entry Point per ECHOES D6.3, a composite common access capability / access boundary of the Cloud (unifying browser-facing access, protected service exposure and authorised entry into platform capabilities). It is realised together with the Access Edge / API Gateway and the shared AAI. It is not yet clear whether ECCCH will provide an end-user web UI: users accessing COLOURS need a UI for login and service selection, which COLOURS provides through the COLOURS Portal until/unless ECCCH offers an equivalent.
- **HDTO:** Heritage Digital Twin Ontology, based on CIDOC-CRM, CRMdig and CRMinf. Central semantic model for digital twins.
- **KB:** Knowledge Base federated knowledge graph. Persistent knowledge layer including metadata, digital twins, user-related slices and PID allocation.
- **Access Edge / API Gateway:** The technical ingress and trust-enforcement boundary of the Cloud: request routing, token validation and transport termination for authorised entry into platform capabilities.
- **Platform control plane / AEM (Access-Entitlement Mapper):** Resolves the effective access and operation context for platform-facing requests by combining the trusted AAI context with domain governance metadata.

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Authorization is not centralised in the AEM; domain services enforce the rules that belong to their own scope.

- **KBMS:** Knowledge Base Management governs semantic content in the Knowledge Base: semantic write discipline, graph/workspace constraints and publication rules; authoritative for HDT semantic representations and controlled vocabularies.
- **Storage Registry / Data API:** Authoritative for storage target definitions, protocols, policy state, usage, quota and activation status.

The EITF and the integration process

Integration into ECCCH is governed by the ECHOES Integration Task Force (EITF). An Integration Unit (IU) is a pair consisting of a resource to be integrated and a target cloud component. Sister projects propose IUs; each COLOURS integration point must be expressed as one or more IUs.

The integration follows a six-step workflow: identification of candidate resources (resulting in the creation of Integration Units) → interoperability self-assessment → technical onboarding → integration validation → release and monitoring → user evaluation. The workflow is described in ECHOES D3.2. Work is organised in Integration Cycles of 3–6 months (first cycles Dec 2025 – Jun 2027; roadmap review Jul 2027 – Nov 2028), tracked via the EITF tracking tool on GitHub (https://github.com/ECHOES-ECCCH-TECHNICAL/integration-task-force).
COLOURS registered its Integration Units for integration cycle 4, which starts in October 2026; the requirements of this deliverable apply to that cycle and are reassessed at each subsequent cycle.

Vertical Applications

Vertical Applications (VAs) are part of the core ECHOES architecture and operate in the ECCCH Application Layer. As currently understood, most sister projects will use a Vertical Application approach to integrate into ECCCH. COLOURS will be integrated as a single Vertical Application. At this stage, the deployment model, any shared adapter components and the expected depth of integration for Vertical Applications are still to be confirmed by ECHOES (see the section "Pending information from ECHOES" below). An adapter could take the form of a dedicated component or a group of API endpoints, depending on the integration need. ECHOES D8.1 positions Vertical Applications at the application-facing integration edge of the architecture: they consume the shared access, control-plane, execution, knowledge and storage services, but do not become alternative control-plane components or independent semantic authorities, and they must not hard-code physical storage or publication targets. The three ECHOES WP8 applications

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(OCRA, VTL, CIT) are offered there as reference implementations for sister-project applications; the COLOURS VA follows the same pattern.

COLOURS Integration Approach

Single Vertical Application strategy

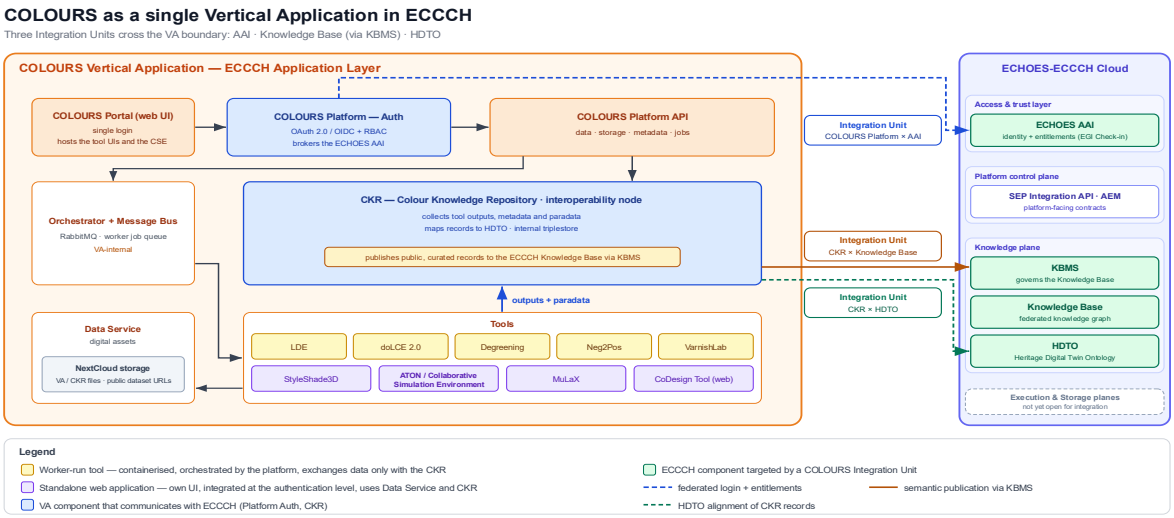


Figure 1. COLOURS as a single Vertical Application in the ECCCH Application Layer. Three Integration Units cross the VA boundary: COLOURS Platform × AAI, CKR × Knowledge Base (via KBMS) and CKR × HDTO. 1. COLOURS as a single Vertical Application in the ECCCH Application Layer. Three Integration Units cross the VA boundary: COLOURS Platform × AAI, CKR × Knowledge Base (via KBMS) and CKR × HDTO.

All COLOURS tools, microservices, and specialized modules are bundled and deployed as a single, cohesive Vertical Application operating within the ECHOES-ECCCH Application Layer. A unified web interface, built as an extension of the PERCEIVE Portal framework, serves as the front-end entry point.

The tools differ, currently, in how deeply they are integrated with the platform: the LDE is already tightly integrated, it is executed as a worker process managed by the platform, with the platform UI responsible for configuring runs and presenting results. On the other hand, MuLaX is currently only loosely integrated. During the COLOURS project, all tools, deployed in the VA, will be tightly integrated with the platform: whether run as platform-managed workers or as standalone web applications (StyleShade3D, the ATON-based Collaborative Simulation Environment), they will use the platform's authentication mechanisms and publish their outputs to the CKR through the COLOURS Platform API.

The boundary between the Vertical Application and the Cloud is narrow and explicit. A worker task is started only by a user authenticated through the ECHOES AAI. Once running, the worker consumes data from the CKR and writes its results

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back to the CKR. No COLOURS worker calls an ECCCH interface. The ECCCH-facing surface of the COLOURS VA therefore consists of two main paths: the AAI-brokered login and entitlement context on the one hand, and the component that publishes semantic output from the CKR into the ECCCH Knowledge Base through the KBMS APIs on the other. Three further obligations carry no VA data and are specified separately: registration and re-validation of the integrated resources with the EITF (COL-API-01, COL-INF-07, COL-INF-11), user feedback sent from the Portal to the central ECHOES survey endpoint (COL-API-12), and an observability interface for the ECHOES analytics framework (COL-INF-09). Everything else (the message bus, the worker fabric, the internal service topology, etc.) sits behind that boundary and is not exposed to, or constrained by, ECCCH. This delimitation defines the scope of the requirements in the following chapter and of the integration testing planned in D7.2.

COLOURS Platform API

Every tool interfaces programmatically with the core platform via the COLOURS Platform API (the evolution of the PERCEIVE Platform API) which provides the web UI/OAuth integration, data transfer and storage APIs, and worker management for job execution. The API enforces automated pipelines that upload all generated data, metadata, and scientific paradata into the CKR. The complete platform documentation (architecture, worker architecture, authentication/RBAC, per-service API reference) is available at https://perceive.ics.forth.gr/docs/.

CKR as the interoperability node

The Colour Knowledge Repository (CKR) serves as the central interoperability node of the COLOURS VA towards the ECCCH ecosystem. Uploaded metadata is transformed into RDF triples mapped to the HDTO and held in an underlying triplestore (Virtuoso). Storing tool outputs, metadata and paradata into the CKR is an internal operation of the VA. These data are subsequently shared with ECCCH through API calls. NextCloud is the internal file storage of the CKR and the COLOURS VA and is not an ECCCH storage target; binaries referenced from published records are served through stable public URLs on COLOURS storage. COLOURS publishes its semantic output into the ECCCH Knowledge Base through the KBMS APIs, which per ECHOES D6.3 is a KBMS-led, platform-resolved path.

Relation to the GA and to D3.1. Task T8.1 foresees CIDOC-CRM-based ontologies held in an open-source triplestore with a SPARQL endpoint, and COLOURS D3.1 describes CKR SPARQL endpoints through which ECCCH search functions could discover COLOURS content. The CKR keeps its triplestore (Virtuoso) and the CKR-to-HDTO mapping. In the current phase, however, COLOURS content reaches ECCCH by publication through the KBMS APIs, which is the platform-governed

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path for semantic writes (ECHOES D6.3), and discovery of the published content is expected to be provided through the Knowledge Base (COL-DEP-11). A COLOURS-hosted public SPARQL endpoint is therefore not registered as an integration point in integration cycle 4. ECHOES D6.2 gates a persistent RDF query endpoint at level 3 (REQ-SEM-004, see COL-SEM-08). Exposing the endpoint remains an option for a later integration cycle.

Interoperability Requirements

This section enumerates the concrete, testable interoperability requirements for the COLOURS Vertical Application. They are organised by function:

- technical/API
- semantic
- AAI/RBAC
- hybrid infrastructure
- scalability and hosting - treated as an architectural analysis rather than as requirements (see "Scalability and hosting considerations" below)

The requirements are derived from and traceable to the ECHOES D6.2 Interoperability Requirements & Guidelines catalogue, tailored to the COLOURS architecture. Each requirement carries a minimum interoperability level using the cumulative L1→L2→L3 model of ECHOES D6.2/D3.1; **L2** (Strategic — semantic and technical federation with centralised authentication) is the practical baseline for COLOURS resources, with selected L3 targets where noted.

Priority follows MoSCoW (MUST / SHOULD / COULD). Each requirement carries exactly one priority keyword, summarised in the P column (M = MUST, S = SHOULD, C = COULD). Table columns: requirement ID and minimum level · priority · normative statement · target ECCCH component · verification method and the originating D6.2 requirement. Verification classes follow D6.2 §6 (static / dynamic / operational / manual audit).

Technical and API requirements

Requirements for the COLOURS Platform API and tool/service endpoints. Baseline L2 (OpenAPI-described, versioned, health-instrumented). COL-API-02 to COL-API-06, COL-API-08 and COL-API-11 apply to any COLOURS API that is registered with the EITF as an integrated resource or exposed publicly for machine access. In integration cycle 4 no COLOURS API is exposed to ECCCH: the ECCCH-facing surface is limited to the AAI-brokered login and KBMS publication. If such an API is registered later, the full D6.2 L2 API package applies, including contract conformance testing (REQ-API-003), no breaking changes within a major version

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(REQ-API-015) and contract-drift detection in the delivery pipeline (REQ-MON-009). Until then, COL-API-01 is met through the service description registered with the EITF for the COLOURS Platform resource.

Table 1: Technical and API requirements (COL-API).

Req. ID · min. level	P	Requirement (normative statement)	Target ECCCH component	Verification & D6.2 ref
COL-API-01 · L1	**M**	The COLOURS Platform API MUST publish a stable service identifier and human-readable service description.	SEP / Access Edge	Static: service metadata + docs (D6.2 REQ-API-001)
COL-API-02 · L2	**M**	In-scope COLOURS APIs (see above) MUST publish a machine-readable contract as OpenAPI 3.x.	SEP / API Gateway	Static: OpenAPI parses (REQ-API-002)
COL-API-03 · L2	**M**	APIs MUST return predictable HTTP status codes and a machine-readable error object for non-2xx responses.	API Gateway	Dynamic: error schema + negative tests (REQ-API-007)
COL-API-04 · L2	**M**	Public COLOURS API interfaces MUST implement explicit versioning and publish a deprecation policy.	API Gateway	Static: versioning scheme + changelog (REQ-API-013/014)
COL-API-05 · L2	**M**	Collection/discovery endpoints MUST support pagination.	Data API	Dynamic: OpenAPI + runtime tests (REQ-API-010)
COL-API-06 · L2	**S**	Collection/discovery endpoints SHOULD provide server-side filtering and sorting.	Data API	Dynamic: OpenAPI/docs + runtime tests where implemented (REQ-API-011)
COL-API-07 · L2	**M**	Platform services MUST expose health and readiness endpoints.	Monitoring stack	Dynamic: /health, /ready (REQ-API-016/017)
COL-API-08 · L2	**S**	Platform services SHOULD expose a deployed-version endpoint.	Monitoring stack	Dynamic: /version or runtime metadata (REQ-API-018)
COL-API-10 · L2	**M**	Assets and semantic outputs destined for ECCCH MUST be written through platform-facing APIs (save asset / save semantic output / publish); COLOURS MUST NOT hard-code storage or repository targets. Asset writes apply only once the ECCCH storage plane is open for integration.	AEM · Storage Registry · KBMS	Dynamic: API call traces (D6.3 §4.6)
COL-API-11 · L2	**S**	APIs SHOULD implement stability safeguards (rate limiting, request-size and timeout policies) for federated usage.	API Gateway	Static: documented policies + config (REQ-API-021)
COL-API-12 · L2	**M**	The COLOURS Portal MUST provide a visible, standardised user-feedback trigger that presents an informed-consent notice before data capture, supports a quick review with optional opt-in to a detailed questionnaire, and transmits feedback to the central ECHOES survey endpoint (PSNC); authenticated submissions carry a pseudonymous identifier derived from the OIDC subject, guest submissions are anonymous.	ECHOES survey endpoint (PSNC)	Manual audit: UI walkthrough + network trace of a submission (REQ-APP-001, level-gating L2+; D6.2 §6.2.1)

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Semantic interoperability requirements

Alignment of HDTs and metadata structures with the HDTO; handling of paradata and provenance for all generated artefacts. Paradata is inserted, via the COLOURS Platform API, into the CKR (an internal VA operation). Tool predictions (e.g., LDE predictions) are recorded as Proposition Sets within instances of HC2 Heritage Digital Twin. The requirements also reflect the needs collected in WP2 and WP5: interpretations and decisions recorded in the Collaborative Simulation Environment must remain traceable to their author, date, supporting evidence and confidence (COLOURS D2.2), and colour-derived results must carry the colour-management information defined in WP5, such as calibration references and illuminant/observer settings (COLOURS D5.1, D5.2).

Requirements for metadata, semantic representation and paradata handled by the CKR and pushed to ECCCH. Baseline L2 (HDTO-aligned, JSON-LD); RDF/SHACL at L3. Traceable to D6.2 §3.2.1 (Data Organization) and ECHOES D7.1 'The Digital Commons' (HDTO).

Table 2: Semantic interoperability requirements (COL-SEM).

Req. ID · min. level	P	Requirement (normative statement)	Target ECCCH component	Verification & D6.2 ref
COL-SEM-01 · L1	**M**	Every COLOURS resource (dataset, tool output, semantic artefact) MUST provide machine-readable discovery metadata: title, description, provider/owner, contact point, licence, version / last-modified date.	KB catalogue	Static: metadata record (D6.2 REQ-META-001/002)
COL-SEM-02 · L1	**M**	Each resource MUST be assigned a globally unique, stable identifier; superseded relationships MUST be expressed explicitly (L2+).	KB / PID service	Static: identifier in metadata (REQ-META-003/004)
COL-SEM-03 · L2	**M**	CKR metadata MUST be provided in JSON-LD, or via a deterministic transformation into JSON-LD. The metadata schema/profile used by the CKR MUST be declared, and any JSON-LD @context used MUST be resolvable and versioned.	HDTO / KB	Static: JSON-LD + transformation test + schema declaration + @context resolution (REQ-META-005/006, REQ-SEM-009)
COL-SEM-04 · L2	**M**	COLOURS semantic outputs MUST align to the HDTO (HDT / CIDOC-CRM / CRMdig / CRMinf); controlled-vocabulary identifiers MUST be used where fields represent controlled concepts. The CKR-to-HDTO mapping MUST be maintained as a machine-readable, versioned artefact that references the source schema and HDTO versions. Where COLOURS controls vocabularies, their identifiers MUST be stable and dereferenceable; multilingual labels, where provided, MUST carry language tags.	HDTO / KB	Static: mapping artefact + vocabulary IDs (REQ-SEM-001/002/003/008)
COL-SEM-05 · L2	**M**	Tool predictions (e.g., LDE predictions) published to ECCCH MUST be recorded as Proposition Sets within HC2 Heritage Digital Twin instances, with provenance/paradata kept machine-readable and separable.	HDTO / KB	Static: data model + mapping changelog (REQ-SEM-006, REQ-PROV-001)

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COL-SEM-06 · L2	**M**	Paradata (software/algorithm versions, parameters, calibration, operators, timestamps, source inputs) MUST accompany every derived artefact published to ECCCH; operators are identified by persistent (e.g., ORCID) or pseudonymous identifiers.	CKR / KB	Static: paradata records (REQ-MD-07, REQ-PROV-001/003)
COL-SEM-07 · L2	**M**	Data authorship/provenance MUST use persistent, resolvable identifiers where available (e.g., ORCID for individuals, ROR for organizations); a licence MUST be attachable to every dataset.	KB	Static: metadata (REQ-MD-03/04)
COL-SEM-08 · L3	**M**	Where L3 is claimed for a COLOURS semantic artefact, CKR RDF assets MUST provide SHACL shapes and MUST validate against them, and URIs MUST remain stable, with deprecation and replacement information published whenever meaning changes. Full L3 additionally requires a persistent RDF query endpoint (REQ-SEM-004), which is out of scope for the current phase.	KB / KBMS	Static: SHACL shapes + validation report + URI policy (REQ-SEM-004/005/010, all L3 in D6.2)
COL-SEM-09 · L2	**M**	Semantic output published to the ECCCH Knowledge Base MUST conform to the structural and vocabulary constraints enforced by KBMS on semantic write; rejected or partially accepted writes MUST be surfaced and reconciled by COLOURS rather than silently discarded.	KBMS / Knowledge Base	Dynamic: KBMS write acceptance + error-handling test (ECHOES D6.3, KBMS semantic write discipline)
COL-SEM-10 · L2	**M**	Only CKR records in state "published" with public visibility are eligible for publication to the ECCCH Knowledge Base; CKR drafts MUST NOT be synchronised with ECCCH. A re-published CKR record MUST be propagated as a new released version of the same HDT lineage, with the superseded version referenced explicitly, and MUST NOT create a new HDT or overwrite the published one in place.	KBMS / Knowledge Base	Static: publication-eligibility rules; dynamic: publish / re-publish test (ECHOES D6.3 §5.6.1–5.6.2; cf. COL-SEM-02)

AAI and RBAC requirements

Authentication and identity are federated to the ECHOES-ECCCH AAI (EGI Check-in / RCIAM, following the AARC blueprint), which is the authoritative source for user identity, authentication state, and Virtual Organization (VO) / group entitlements attached to the trusted token context. The COLOURS Platform already implements OAuth 2.0 with a modular external-provider model (currently local accounts and ORCID) and will be extended to consume the ECHOES AAI as an upstream identity provider: it brokers login and continues to issue the platform tokens that COLOURS internal services validate.

All COLOURS tools are accessed through the COLOURS Platform (single login), so individual tools, including the ATON-based applications (the Collaborative Simulation Environment and MuLaX), do not maintain standalone user directories or authentication endpoints and rely on the platform's authentication mechanisms.

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Authorization responsibility is layered, following the source-of-truth separation defined in the ECHOES-ECCCH architecture (ECHOES D6.3, §§3.4–3.5, 4.6, 6.2–6.3). Identity and entitlements are owned centrally by the AAI. Authorization over ECCCH-governed resources (the Knowledge Base, semantic writes, and publication) is resolved and enforced centrally by ECCCH platform and domain services.

Role-based access control for COLOURS' own tools, views and worker orders remains the responsibility of the COLOURS Platform but must be derived from the AAI-provided entitlements and must not constitute a second, competing IAM model. COLOURS therefore requires a Virtual Organization (VO) in the ECCCH AAI, with groups implementing COLOURS user roles that map to the platform's RBAC roles.

Table 3: Division of responsibility for identity, authorization and access control between ECHOES-ECCCH and the COLOURS Vertical Application (VA).

Concern	Owner / authoritative	Notes
Identity & authentication	**ECHOES AAI (EGI Check-in / RCIAM) — central**	Federated single sign-on; single source of truth. VA holds no user directory.
VO & group entitlements	**ECHOES AAI — central**	COLOURS VO and role groups are defined in the AAI and carried in the token.
Authorization over ECCCH-governed resources (Knowledge Base / semantic writes, publication)	**ECCCH platform & domain services (AEM + domain services) — central**	VA calls platform APIs (save asset / save semantic output / publish); the platform resolves and enforces the decision. VA is not a source of truth for these permissions.
RBAC for COLOURS' own tools, views and worker orders	**COLOURS Platform (VA) — VA responsibility**	Not provided by ECHOES. Enforced by the platform but derived from AAI entitlements; must not be a second full IAM model.
Tool / worker service access	**COLOURS Platform (VA)**	Existing OAuth 2.0 client-credentials flow for stateless workers; unchanged.

The following formalises the AAI/RBAC requirements (baseline L2; traceable to D6.2 §3.2.4 Security and D6.3 §6.2 AAI & entitlement model):

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Table 4: AAI and RBAC requirements (COL-AAI).

Req. ID · min. level	P	Requirement (normative statement)	Target ECCCH component	Verification & D6.2 ref
COL-AAI-01 · L2	**M**	For restricted resources, COLOURS MUST authenticate users through the ECHOES AAI via OIDC; the COLOURS Platform brokers the AAI as an upstream provider and issues the platform tokens validated internally. Tokens received from the AAI MUST be validated for issuer, audience, expiry and signature.	AAI (EGI Check-in)	Dynamic: OIDC auth-flow test (REQ-SEC-004)
COL-AAI-02 · L2	**M**	COLOURS MUST NOT maintain a competing IAM; RBAC roles for COLOURS' own tools/UI MUST be derived from AAI entitlements (COLOURS VO + groups).	AAI / AEM	Static: entitlement→role mapping doc
COL-AAI-03 · L2	**M**	Authorization over ECCCH-governed resources (KB/semantic writes, publication) MUST defer to ECCCH (AEM + domain services); COLOURS enforces RBAC only within its own scope. Within that scope, COLOURS MUST enforce authorization consistently on all restricted endpoints, with no bypass routes, and MUST fail closed when AAI or entitlement information is unavailable.	AEM + domain services	Static: access-model documentation; dynamic: authz tests (REQ-SEC-005; D6.2 §6 check SEC-11)
COL-AAI-04 · L2	**M**	A COLOURS Virtual Organization and role groups MUST be defined in the ECCCH AAI. (Open item: role groups to be derived from the COLOURS target communities identified in D2.1.)	AAI	Static: VO/group configuration
COL-AAI-05 · L1	**M**	COLOURS code and deployment artefacts MUST NOT contain hard-coded secrets/credentials, and network services MUST enforce TLS.	(VA-internal)	Dynamic: CI secret scan; TLS config (REQ-SEC-001/002)
COL-AAI-06 · L2	**M**	The COLOURS component that publishes semantic output to the ECCCH Knowledge Base MUST authenticate with the identity KBMS requires (service identity or delegated user token, open item COL-DEP-04); if a service identity is used, it MUST be registered, least-privilege (OAuth 2.0 client credentials) and scoped to the COLOURS VO; credentials MUST be externalised and rotatable and MUST NOT be embedded in code or container images. COLOURS workers do not call ECCCH interfaces and are out of scope of this requirement.	AAI / KBMS	Static: client registration + secret-handling policy (D6.2 §4, L2+ identity & security checklist)
COL-AAI-07 · L1	**M**	COLOURS MUST document the access model of each integrated resource, classifying its endpoints as public, restricted or internal, and stating the expected authentication mechanism for restricted access.	AAI / EITF	Static: endpoint inventory + access-model documentation (REQ-SEC-003)

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Hybrid infrastructure requirements

NextCloud serves as internal file storage for the CKR and the COLOURS VA and is not an ECCCH storage target; binaries referenced from published records are served through stable public URLs on COLOURS storage, while ECCCH-facing storage, wherever needed, is resolved through the platform Data API.

Relation to the GA. Tasks T7.1 and T8.1 foresee compatibility with NextCloud during the initial transition phase and planning for an eventual migration to the ECHOES-ECCCH Knowledge Base. COLOURS meets this as follows. Semantic content (metadata, HDTs and paradata) moves to the Knowledge Base through the KBMS APIs from the first integration cycle, so that the Knowledge Base, not NextCloud, becomes the home of the published knowledge. Large binaries (images, 3D models, spectral datasets) remain on NextCloud and are referenced from the Knowledge Base through stable public URLs, because there is currently no guarantee of storage capacity for datasets of this size in the Knowledge Base and the ECCCH storage plane is not yet open for integration (ECHOES D6.3, Appendix A). Migration of binaries to ECCCH storage through the platform Data API remains an option; it will be reassessed in each EITF integration cycle and in D8.1 once the storage plane opens (COL-INF-04).

Requirements for deployment, storage and repository integration. Baseline L2 (reproducible, containerised, documented). Traceable to D6.2 §3.2.2–3.2.3 (Data services, Deployment) and D6.3 (storage resolved by the platform).

Table 5: Hybrid infrastructure requirements (COL-INF).

Req. ID · min. level	P	Requirement (normative statement)	Target ECCCH component	Verification & D6.2 ref
COL-INF-01 · L2	**M**	COLOURS services MUST provide deployment and operability documentation sufficient to reproduce the runtime environment and support portability across infrastructures. Environment-specific configuration, including endpoints and credentials, MUST be externalised and not hard-coded into code or images; secrets of hosted services MUST be stored securely and be rotatable.	(VA-internal; SEP-facing)	Static: README/runbook + dependency list (REQ-DEP-004/005; D6.2 §6 check SEC-18)
COL-INF-02 · L2	**M**	COLOURS MUST provide a repeatable, scripted deployment procedure (IaC); deployable artefacts MUST be versioned and immutable once published.	(VA-internal)	Static: IaC scripts + registry/release history (REQ-DEP-007/008)
COL-INF-03 · L2	**S**	Shared-environment services SHOULD be containerised; COLOURS worker tools already run as Docker containers.	(VA-internal)	Static: container images (REQ-DEP-009)
COL-INF-04 · L2	**M**	NextCloud remains the internal file storage of the CKR and the VA and MUST NOT be used as an ECCCH storage target; binaries referenced from published records MUST be served through stable public URLs on COLOURS	Storage Registry / Data API	Static: architecture + dynamic: API traces (D6.3)

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		storage; ECCCH-facing storage, wherever needed, MUST be resolved through the platform Data API once the ECCCH storage plane is open for integration.		
COL-INF-05 · L2	**S**	InvenioRDM-backed metadata SHOULD be exposed via stable, versioned, persistent HTTP(S) URLs, decoupled from data, and searchable with pagination/filtering.	Data API / catalogue	Dynamic: endpoint tests (REQ-DS-005/006)
COL-INF-06 · L2	**M**	Stateful services MUST document backup/recovery, MUST declare external runtime dependencies and MUST handle dependency failure gracefully.	(VA-internal)	Static: backup docs + dependency list (REQ-DEP-013/015)
COL-INF-07 · L1	**M**	COLOURS services MUST apply a logging policy that captures security-relevant events without leaking secrets, tokens or credentials, and COLOURS MUST declare a responsible party and an incident contact for its integrated resources.	(VA-internal; declared to the EITF)	Static: logging policy + declared contact (REQ-DEP-011, REQ-MON-001 — both Mandatory in D6.2)
COL-INF-08 · L2	**M**	COLOURS services MUST emit structured logs with correlation identifiers.	(VA-internal; declared to the EITF)	Operational: structured-log sample (REQ-MON-004)
COL-INF-09 · L2	**M**	COLOURS services MUST provide a standardised observability interface (OpenTelemetry/OTLP) allowing the ECHOES analytics framework to query and retrieve logs, metrics and traces, or MUST grant secure access to existing equivalent streams.	(VA-internal; declared to the EITF)	Operational: reachable observability endpoint or verified access grant (REQ-MON-013)
COL-INF-10 · L2	**M**	COLOURS services MUST be monitored for availability and error rate, with automated probes against the health/readiness endpoints (COL-API-07) and alerting on sustained failures.	(VA-internal; declared to the EITF)	Operational: monitoring configuration, alert conditions and probe results (REQ-MON-002/003)
COL-INF-11 · L2	**M**	COLOURS MUST trigger re-validation of its integrated resources with the EITF on major releases, schema or mapping changes and AAI or policy changes, and MUST provide a remediation plan, or accept a level downgrade, on critical conformance failures.	EITF	Manual audit: documented re-validation trigger process (REQ-MON-011/012)

Scalability and hosting considerations

Task 7.1 requires addressing scalability and hosting, including the potential adaptation of the current RabbitMQ-based middleware to other standards such as Apache Kafka, Apache Pulsar or NATS. Unlike the preceding sections it defines no normative requirements, because the analysis concludes that the choice of middleware is an internal architectural concern of the COLOURS Vertical Application and not an interoperability constraint.

The COLOURS Platform is the continuation of the PERCEIVE Platform, whose architecture, hosting model and runtime were selected through feasibility and trade-off studies (PERCEIVE D5.2) and whose scalability was verified against defined KPIs (PERCEIVE D5.2 v2.0). The COLOURS Platform retains that architecture as the internals of the Vertical Application.

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ECCCH integrates a Vertical Application as a black box (ECHOES D6.3). The data-carrying integration surface consists of the interfaces the VA presents to, and consumes from, the Cloud: authentication through the AAI and publication of semantic output to the Knowledge Base through the KBMS APIs; storage access through the platform Data API is added only once the ECCCH storage plane is open for integration (COL-INF-04). The internal composition of the VA behind that surface is neither observable nor constrained by ECCCH. Accordingly, no ECCCH interface prescribes a messaging technology and the ECHOES D6.2 requirements catalogue contains no requirement addressing the choice of broker. All the ECCCH VAs retain their frontend, backend, database and domain logic, while application-specific requirements are hidden behind the platform-facing contracts of the SEP Integration API. In the same way, the COLOURS Orchestrator is neither exposed to nor aligned with the ECCCH execution plane in this phase; ECCCH-managed execution is not yet open for integration and may be revisited in a later integration cycle.

The responsibilities that an ECCCH VA should not independently reproduce include:

1. physical repository and storage-target selection;
2. controlled upload and storage routing;
3. durable operation state;
4. stable identifiers and the platform-level HDT lifecycle;
5. platform-wide interpretation of trusted identity and effective operation context.

The COLOURS execution model confirms those boundaries. A worker task is started only by an authenticated user; once running, the worker consumes data from the Colour Knowledge Repository and publishes its results back to the CKR. No COLOURS worker calls an ECCCH interface. The ECCCH-facing surface of the execution path is therefore limited, as far as data exchange is concerned, to the user's AAI-brokered login and to the component that publishes semantic output from the CKR to the Knowledge Base, both of which are governed by the requirements defined in the AAI/RBAC and semantic interoperability sections above.

COLOURS therefore retains RabbitMQ for the integration phase. Migration to Kafka, Pulsar or NATS remains an option to be assessed against internal criteria rather than against any interoperability constraint. That assessment belongs to

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the implementation phase and is carried forward into WP8 and D8.1 (Deployment Plan). Should such a migration take place, it is invisible to ECCCH provided the interfaces specified in the preceding sections of this chapter continue to be satisfied, and it does not alter the requirements defined in this deliverable.

What does carry interoperability relevance is the operational behaviour COLOURS exposes as an integrated resource, irrespective of the middleware beneath it: reproducible and versioned deployment, a declared responsible party and incident contact, logging that does not leak secrets, and availability and error monitoring sufficient to detect degradation. These are specified as requirements COL-INF-01 to COL-INF-11 in the hybrid infrastructure section rather than as middleware requirements.

Component-specific integration requirements

Per-tool specifications were defined in COLOURS D3.1, and the predictive analysis and simulation technologies in COLOURS D3.2. COLOURS Tools do not have a direct interface with ECCCH. They share data (generated data, metadata, paradata) through the CKR.

Table 6 lists all ten entries of COLOURS D3.1 with their origin and their integration mode, following the two integration styles shown in Figure 1: platform-managed workers and standalone web applications. Origins and integration modes follow COLOURS D3.1; the classification into platform-managed workers and standalone web applications is the one used in this deliverable. The CKR is listed for completeness; it is the repository and interoperability node rather than a restoration tool.

Table 6: COLOURS D3.1 tools and the CKR: origin and integration mode in the COLOURS Vertical Application.

Tool (D3.1 order)	Origin	Integration mode in the COLOURS VA
LDE (Light Damage Estimator)	PERCEIVE	Platform-managed worker (cloud microservice); outputs and paradata pushed to the CKR via the COLOURS Platform API.
doLCE 2.0 (Lenticular Colour Reconstruction)	PERCEIVE	Platform-managed worker (cloud microservice); outputs and paradata pushed to the CKR via the COLOURS Platform API.
StyleShade3D	PERCEIVE (merges the GA Semantic 3D Atlas Generator and Stylizer)	Standalone web application (containerised within the VA); platform authentication; outputs pushed to the CKR via the COLOURS Platform API.
ATON Framework / Collaborative Simulation Environment (CSE, WP4)	Existing ATON framework (CNR); the CSE is developed on it in WP4	Standalone web application; platform authentication; accesses CKR data and communicates with the other COLOURS tools and services via REST APIs.
MuLaX	PERCEIVE	Standalone ATON-based web application (plug&play ATON app), platform authentication; analyses pushed to the CKR via the COLOURS Platform API.
Degreening Tool	PERCEIVE	Platform-managed worker (cloud microservice); outputs and paradata pushed to the CKR via the COLOURS Platform API.

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Tool (D3.1 order)	Origin	Integration mode in the COLOURS VA
Neg2Pos (Negative to Positive Tool)	New	Platform-managed worker (cloud microservice); outputs and paradata pushed to the CKR via the COLOURS Platform API.
CoDesign Tool	PERCEIVE (CNR ISPC, FhG IGD)	Web version: web application integrated in the COLOURS environment; platform authentication. Paper version: printable material, outside the VA scope.
VarnishLab (Varnish Removal / Revarnish Tool)	New	Platform-managed worker (cloud microservice); outputs and paradata pushed to the CKR via the COLOURS Platform API.
Colour Knowledge Repository (CKR)	PERCEIVE repository, extended	Repository and interoperability node (not a restoration tool); the only COLOURS component that publishes to ECCCH, through the KBMS APIs.

Colour Knowledge Repository (CKR)

The CKR is the only COLOURS component that writes to ECCCH. Publication of semantic output into the ECCCH Knowledge Base is done through the KBMS APIs. This section:

- presents what is published and when and how it maps onto the HDTO
- describes the publication path
- lists the ECCCH capabilities on which the COLOURS VA depends.

What is published, and when

Two lifecycles have to be distinguished. The CKR has an editorial lifecycle of its own (draft → published, with an optional embargo) that is governed by the CKR community curators. ECCCH has a platform-managed HDT lifecycle (working, staged, published, archived, retired - ECHOES D6.3 §5.6.1) whose transitions are owned by the platform components, not by the Vertical Application (ECHOES D8.1 §5.3). COLOURS does not reproduce the second lifecycle: CKR drafts stay in the CKR and are never synchronised with ECCCH. The governed platform boundary is crossed only when a CKR record is published. Keeping drafts inside the CKR also responds to the concerns about data ownership, privacy and intellectual property in cloud infrastructures recorded by the WP2 stakeholder analysis (COLOURS D2.1).

Only published CKR records with public visibility and resource type "Physical object" are published to the ECCCH Knowledge Base. Publication is semi-automatic: it is triggered by the CKR community curators upon review and acceptance of the physical-object record and executed by the CKR through the KBMS save and publish path described below. Embargoed records are published when the embargo ends, i.e. when the record becomes openly available. Other CKR record classes that refer to a physical object (i.e. analytical and diagnostic raw data of colour-sensitive artefacts, synthetically generated and predictive

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simulation data of colour change, spectral colour-management protocols, case-study datasets etc.) are not published as HDTs of their own, they enrich the Heritage Entity of the object they refer to.

Once published, an HDT is an immutable, release-grade snapshot (ECHOES D6.3 §5.6.2). Further work on the same object (a new CKR version of the record, or new enriching records) is propagated as a new released version of the same HDT lineage, with the superseded version referenced explicitly. It is never an in-place overwrite and never a new HDT. This is formalised as COL-SEM-10 in the semantic interoperability requirements table (Table 2).

Table 7: Mapping of CKR record states and events onto the ECCCH HDT lifecycle.

CKR record state / event	Effect on the ECCCH side	HDTO target
Draft (any visibility)	None: drafts are never synchronised with ECCCH.	—
Published · public · resource type "Physical object"	HDT created through the governed save HDT and publish HDT paths (ECHOES D6.3 §5.3), triggered by the CKR curators after review.	HC1 Heritage Entity and its HC2 Heritage Digital Twin
Published · embargoed	None until the embargo ends; then as above.	—
Published · other resource types referring to a physical object (raw analytical data, simulation data, spectral protocols, case-study datasets)	Enrichment of the existing HDT, released as a new version of the same lineage.	Digital representations of, or Proposition Sets attached to, the HC2 instance
New version of an already published record	New released version of the HDT lineage; the previous version is marked as superseded (ECHOES D6.3 §5.6.2; COL-SEM-02, COL-SEM-10).	Same lineage
Record withdrawn or access-restricted after publication	Governed retirement path (ECHOES D6.3 §5.3: delete / recover / retire).	—

HDTO mapping

A published physical-object record is mapped to an HC1 Heritage Entity, and the digital twin of that object to an HC2 Heritage Digital Twin. The enriching record classes listed above become digital representations of, or Proposition Sets attached to, the HC2 instance; tool predictions (e.g., LDE predictions) are recorded as Proposition Sets, with their provenance and paradata kept machine-readable and separable (COL-SEM-05, COL-SEM-06). The complete mapping of CKR resource types onto HDTO classes is implemented in the CKR under T3.4 and documented in D3.3 (M18), adopting the COLOURS HDTs defined in WP8 (T8.1); D7.1 fixes only the entry points above. Colour-management metadata (e.g., ICC profile or colour space, calibration targets), for which the current CKR metadata schema has no dedicated fields (COLOURS D5.1), is part of this mapping work and follows the protocols specified in COLOURS D5.2.

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Publication path

Communication with the ECHOES cloud takes place at two levels (ECHOES D6.3 §4.6). The core cloud components communicate over internal interfaces. External systems (sister-project Vertical Applications and authorised tools) reach the cloud only through the platform-facing contracts exposed by the SEP Integration API, which give access to selected cloud capabilities without exposing their internal implementation. For the Knowledge Base, the KBMS API is that platform-facing contract as it translates platform-level operations into Knowledge Base operations.

Steps for saving and publishing an HDT from the COLOURS Vertical Application (ECHOES D6.3 §5.3, Figure 10)

1. The CKR submits the request through the common platform interface exposed by the SEP Integration API.
2. AEM (Access / Entitlement Mapper, central resolver of rights, targets, and quota context) evaluates permissions, determines the allowed or default targets, and provides the relevant quota context.
3. The Processing Manager opens a managed operation and records it in the Operation Registry.
4. If the operation includes binary assets, the Non-Semantic Data & Integration Manager opens an upload session, while the Storage Registry identifies the appropriate target. Most assets/files are expected to remain in the CKR or NextCloud storage space.
5. The KBMS performs the semantic save and the Administrative Repository captures the governance context.
6. The Processing Manager then closes the operation, and its status can be retrieved by the portal or the calling application from the Operation Registry.

COLOURS Vertical Application requirements from the ECCCH infrastructure

COLOURS depends on the ECCCH infrastructure providing stable services and APIs in the following areas. The individual dependencies are consolidated in the table at the end of this section, each linked to the COLOURS requirement that relies on it, so that D7.2 can use them as test preconditions.

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1. Access and identity

The COLOURS platform as a VA requires integration with the ECCCH AAI/SSO infrastructure for production use. ORCID-based accounts are currently used, but production access to ECCCH services should rely on the shared federated trust model and the common OAuth2/OpenID-based access-control approach.

COLOURS will continue to manage its own project-level roles. However, ECCCH platform-level rights, publication rights, access to protected resources, and visibility of platform-managed objects must be governed by ECCCH.

2. Discovery and retrieval of HDT-related resources

There might be a need to discover and retrieve other HDT resources from the ECCCH Knowledge Base and related platform services. This is an ECCCH platform-governed query and retrieval process. There is no need for direct low-level access to the ECCCH Knowledge Base triplestore. An API access is preferable.

3. Storage and asset handling

Dataset storage will be handled locally/internally by COLOURS. Some COLOURS tools require streaming and visualisation support for high-resolution images and 3D models. Binaries remain on COLOURS storage (NextCloud) and are referenced through stable public URLs. ECCCH storage, including personal user storage space, would be used only through the platform Data API once the ECCCH storage plane is open for integration (COL-INF-04). HDT asset references must remain with the ECCCH.

4. Semantic save and publication

The CKR manages metadata records. They become ECCCH-managed semantic or binary resources only when the relevant save, registration or publication is invoked. Local-level persistence is different from ECCCH-level semantic persistence.

5. Managing asynchronous processing

COLOURS will manage asynchronous processing internally. There are no specific requirements expected from the ECCCH. Any requirements e.g. for preprocessing, orchestration, chained operations, 3D conversion, derivative generation, export, visual analysis, logging etc. will be handled by the COLOURS platform and tools.

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6. Deployment and operation

The COLOURS platform and CKR are containerized and will be deployed as a provider-operated Vertical Application. There are no specific requirements expected from the ECCCH.

Table 8: Dependencies of the COLOURS Vertical Application on ECCCH capabilities. Each dependency names the ECHOES D6.3 component expected to provide it and the COLOURS requirement(s) that rely on it.

ID	ECCCH capability required by the COLOURS VA	Providing ECCCH component (D6.3)	Dependent COLOURS requirement(s)
COL-DEP-01	Federated login / SSO for COLOURS users through the ECHOES AAI (OIDC), including users without institutional accounts (ORCID).	AAI (EGI Check-in / RCIAM)	COL-AAI-01
COL-DEP-02	Stable access context (session continuity) across the COLOURS VA and ECCCH services.	AAI / SEP	COL-AAI-01
COL-DEP-03	A COLOURS Virtual Organization with role groups, and entitlements usable for mapping COLOURS roles to ECCCH permissions.	AAI / AEM	COL-AAI-02, COL-AAI-04
COL-DEP-04	Tokens or claims usable by the COLOURS publication component when invoking ECCCH APIs (registered service identity or delegated user token — open).	AAI / AEM	COL-AAI-06
COL-DEP-05	Platform-facing KBMS API for saving and publishing semantic data (save HDT, publish HDT).	SEP Integration API → AEM → Processing Manager → KBMS	COL-API-10, COL-SEM-09, COL-SEM-10
COL-DEP-06	HDTO-aligned association mechanisms to attach enrichment (digital representations, Proposition Sets) to an existing Heritage Entity.	KBMS / HDTO	COL-SEM-04, COL-SEM-05
COL-DEP-07	Published validation rules and minimum-metadata requirements for semantic writes, and machine-readable rejection or partial-acceptance reports.	KBMS	COL-SEM-09
COL-DEP-08	Provenance and review context recorded on save and publish (creator, project, asset, version, review).	KBMS / Administrative Repository	COL-SEM-06, COL-SEM-07
COL-DEP-09	Stable identifiers (URI / PID) assigned or resolved for published HDTs and for referenced assets.	Knowledge Base / PID service	COL-SEM-02, COL-INF-05
COL-DEP-10	Versioning of published HDTs as immutable snapshots with explicit supersession.	KBMS (D6.3 §5.6.2)	COL-SEM-02, COL-SEM-10
COL-DEP-11	Discoverability of published COLOURS outputs in the Knowledge Base / Digital Commons.	Knowledge Base / Resource Manager	COL-SEM-01
COL-DEP-12	Status of a managed operation retrievable by the calling application.	Processing Manager / Operation Registry	COL-API-10

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Pending information from ECHOES

ECCCH is under active development, and ECHOES D6.3 describes a target baseline whose availability at M24 is only partial. The items listed in Table 9 depend on decisions or services that ECHOES has not yet published and that are outside the control of the COLOURS consortium. For each item, this deliverable adopts a working assumption and identifies a fallback, so that WP8 can proceed without waiting for ECHOES. The requirements and design choices apply to EITF integration cycle 4 (from October 2026) and will be reassessed at each integration cycle as the items are resolved.

Table 9: Information pending from ECHOES, working assumptions and fallbacks.

Pending item	Working assumption in D7.1	Fallback if unresolved
Publication identity (COL-DEP-04, COL-AAI-06): whether KBMS accepts a COLOURS service identity or requires the user's token.	A registered, least-privilege service identity scoped to the COLOURS VO.	A delegated user token obtained through the Platform-brokered AAI login, with publication run in the curator's session. In both cases authorship travels in the payload (COL-SEM-07).
Validation and query rules (COL-DEP-07, COL-SEM-09): KBMS validation rules, minimum metadata, rejection reports, and how ECCCH users read COLOURS content.	Payloads are pre-validated against the CKR-to-HDTO mapping and the D6.2 minimum metadata.	Rejected or partially accepted writes are reconciled by COLOURS (COL-SEM-09); the pre-validation is tightened once the KBMS rules are published.
Working-state space (COL-SEM-10): availability and access rules of private working forms of an HDT for Vertical Applications.	CKR drafts stay in the CKR; only final, published records are sent to ECCCH.	None needed. A KBMS private working space would be an optional later extension.
Storage and computing services (COL-INF-04): storage policy and compute allocation; storage and deployment are not yet open for integration.	Binaries stay on NextCloud with stable public URLs; the Knowledge Base holds the HDTs and references to the binaries.	Same. Asset writes through the platform Data API, and the NextCloud migration planned in the GA, are reassessed when the storage plane opens.
Web interface (COL-DEP-02): availability of the ECCCH Cloud Web UI and session continuity with the COLOURS Portal.	The COLOURS Portal is the user entry point and brokers the AAI login.	Same. Session continuity with an ECCCH web UI is added when one is offered.
AAI role model (COL-DEP-03, COL-AAI-04): VO structure, role mapping and tenant rules.	A COLOURS VO with groups derived from the target communities of D2.1.	A minimal group set mapped to the platform RBAC roles, extended in later cycles.
PID assignment (COL-DEP-09): operating model and minting authority for persistent identifiers of published HDTs.	CKR-stable identifiers are carried as record identifiers.	The ECCCH-minted PID is added as an additional identifier when it becomes available.

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Conclusions

This deliverable has translated the ECHOES-ECCCH architecture (ECHOES D6.3), the ECHOES interoperability requirements catalogue (D6.2), the Heritage Digital Twin Ontology (ECHOES D7.1) and the EITF integration process into the interoperability requirements of the COLOURS Vertical Application. Three conclusions stand out.

First, the integration boundary is narrow and explicit. Two data paths cross the boundary, registered with the EITF as three Integration Units: login (Platform × AAI) and semantic publication (CKR × KB via KBMS, with CKR × HDTO covering the published records' conformance to the HDTO). Workers, the message bus and internal storage stay behind the boundary. This scopes the integration testing of D7.2. Three further obligations carry no VA data: registration and re-validation with the EITF, user feedback to the central ECHOES survey endpoint, and an observability interface for the ECHOES analytics framework (COL-API-01, COL-API-12, COL-INF-07, COL-INF-09, COL-INF-11). The assumptions that depend on information still pending from ECHOES are listed in Table 9.

Second, the 39 requirements (11 technical/API, 10 semantic, 7 AAI/RBAC, 11 hybrid infrastructure) each carry a minimum interoperability level, a MoSCoW priority, a target ECCCH component and a verification method traceable to ECHOES D6.2; 12 dependencies on ECCCH capabilities (COL-DEP) serve D7.2 as test preconditions. Level 2 (Strategic) is the baseline, as registered with the EITF for the three COLOURS Integration Units. The COL-* identifiers are the traceability key for D7.2.

Third, the CKR is the only COLOURS component that writes to ECCCH: only published, public physical-object records become HDTs through the governed KBMS save and publish path, drafts are never synchronised, and re-publication creates a new released version of the same HDT lineage.

These results feed D7.2 (Integration and Test Plan) and WP8 (T8.1 HDTO mapping, T8.2 AAI integration, T8.3 API adaptation and the KBMS publication component), planned in D8.1 and validated in WP9. As ECCCH is under active development, the requirements will be revisited at each EITF integration cycle.

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