T-02: Provenance & Quality Layer

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W3C PROV-O
The W3C Provenance Ontology. Every data submission, validation event, and agent action is recorded as a PROV-O graph: `prov:Entity` (the data), `prov:Activity` (what happened), `prov:Agent` (who did it), `prov:wasGeneratedBy`, `prov:wasAttributedTo`.

ISO 8000-220:2025 — Data Quality
International standard for data quality management. Used for metadata quality dimensions: completeness, accuracy, consistency, timeliness. CTH maps these to field-specific thresholds in the SHACL profile.

cth:FieldDataQuality SHACL Profile (CTH-original)
SHACL shapes that enforce EUDR-specific and Andean-specific quality rules at ingestion. Key shapes:

Shape	Rule	Rationale
cth:GpsPrecision	Polygon vertices must have ?6 decimal place precision	EUDR Article 9 requires parcel identification; 5dp = ~1m accuracy; 6dp = ~10cm
cth:DeforestationDataVintage	IDEAM reference raster must be ?24 months old	EUDR requires current deforestation status; stale data invalidates DDS
cth:IotCalibration	IoT soil/weather sensors must have calibration certificate ?180 days old	Sensor drift; CSRD ESRS E4 requires traceable measurement
cth:AndeanGpsLock	GPS receiver must record ?90 second lock wait per polygon vertex	Mountain terrain + tree canopy causes GPS multipath error; 90s reduces error below EUDR threshold

Ledger Integrity

The governance ledger is an append-only Postgres table with rolling SHA-256 hashes. Each entry hashes the previous entry's hash (blockchain-like chain). KERI (Key Event Receipt Infrastructure) anchoring is used for cross-organisational verifiability — validators can independently verify ledger integrity without trusting CTH's infrastructure.

Revisión #1
Creado 2026-05-27 13:47:45 UTC por Angelica Diaz
Actualizado 2026-05-27 13:47:45 UTC por Angelica Diaz