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Loko Control Plane

A compact reference note on custody-grade provenance as an administrable gate.

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Summary

Custody-grade provenance is transitioning from “nice to have” into a procurement and evidentiary primitive. The shift is not driven by product preference. It is driven by the institutional need for proof that survives independent interrogation, offline verification, and adversarial review.

Loko is an admissibility control plane. It formalizes a pass/fail boundary for sensor capture and AI inference:

Integrity first. Inference second.

The control plane does not compete as a sensor, a VMS, or a model. It governs them. It produces artifacts that third parties can verify without trusting the vendor, and it provides explicit downgrade states when systems cannot meet the highest bar.

When this predicate becomes standardized in RFP language, court posture, and audit practice, “default compliance path” becomes a control surface. Control surfaces swing markets because they determine which outputs qualify as evidence and which remain narrative.

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The Ground is Shifting

Across federal standards work, judicial and evidentiary venues, state stakeholders, and EU implementation channels, one pattern is converging: systems are being evaluated less on what they claim and more on what they can prove.

The requirements that survive scrutiny are consistent:

- Independent verification, without vendor dependency
- Deterministic failure under tamper or omission
- Offline verification capability
- Deterministic replay that reproduces boundaries and discontinuities
- Traceability of inference outputs back to committed inputs and declared execution context

This convergence is difficult to slow because it is administrable. It can be expressed as conformance classes and acceptance tests, enforced in procurement, and defended in adversarial environments.

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The Predicate

Step 1: Integrity first
The capture chain must produce committed evidence, not a narrative.

- Deterministic segmentation (time or frame-count windows)
- Segment digests computed during the capture path
- Continuity chaining across segments
- Signed manifests that record boundaries, digests, time source metadata, and key identifiers
- Verification that fails on byte changes, missing content, or reordering

Step 2: Inference second
Inference must produce bound proof, not outputs detached from their origin.

- Model identity declared and committed
- Execution context identity declared (runtime and environment identifiers)
- Inference records referencing the exact committed input segments consumed
- Output artifacts committed and signed
- Verifier can trace outputs back to input segment digests and flag context mismatches

The separability is intentional: Step 1 is broadly applicable; Step 2 becomes mandatory when analytics are in scope. This is what makes the gate adoptable at scale.

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Conformance Classes and Acceptance Tests

Custody-grade provenance becomes real when it is scored.

Conformance is declared by class:

- Class A: Capture Integrity
- Class B: Inference Provenance
- Class C: Replay and Audit
- Class D: Multi-Feed Orchestration
- Class E: Operational Security

Minimum custody-grade evidence requires Class A + Class C.
If AI analytics are in scope, Class B is required.

If multiple sensors must be correlated, Class D is required.

Class E hardens operations per policy.

Acceptance tests define the pass/fail boundary:

- AT1 Byte flip: modify one byte, verification must fail
- AT2 Missing segment: remove segment payload, must fail and report missing content
- AT3 Reorder: reorder segments, chain verification must fail
- AT4 Replay consistency: independent machines reproduce identical boundaries
- AT5 Inference trace: outputs trace to exact input segment digests
- AT6 Offline verification: verification succeeds without network dependency
- AT7 Key rotation: older packages remain verifiable under policy
- AT8 Multi-feed alignment: deterministic correlation or fail

When these tests appear in RFPs and evidentiary practice, provenance stops being a feature and becomes a gate.

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What the Control Plane Outputs

A control plane is defined by outputs, not claims.

Loko outputs operable artifacts:

- **Evidence Packages:** portable bundles of media, manifests, provenance objects, and verification material
- **Independent Verification:** verifier recomputes digests, validates chains and signatures, produces explicit pass/fail reports
- **Deterministic Replay:** timeline reconstruction from manifest boundaries, reproducible across independent machines
- **Audit and Handling Ledger:** access, replay, export, and policy outcomes recorded for third-party review
- **Explicit downgrade states:** when systems cannot meet the highest bar, usability remains but trust level is explicit and governable

Loko sits above heterogeneous sensors, models, and clouds. It does not replace data planes. It governs them.

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Proof of Operability:

Reference Workflow

This workflow is intentionally concrete: **capture → commitment → packaging → offline verify → deterministic replay → inference trace.**

Capture: Sensor streams are captured and deterministically segmented into fixed time or frame-count windows (“Segments”).

Commitment: For each Segment, a cryptographic digest is computed during the capture path and chained to the prior Segment. A signed Manifest records boundaries, digests, continuity links, time source metadata, and key identifiers.

Packaging: Segments, the signed Manifest, provenance objects, and verification material are assembled into an Evidence Package suitable for transfer and case attachment.

Offline verify: On an air-gapped machine, a verifier recomputes digests, validates chain continuity, validates Manifest signatures, detects missing content, and produces a pass/fail report with specific error reasons.

Deterministic replay: A replay client reconstructs review timelines deterministically from Manifest boundaries. Independent machines reproduce identical segment boundaries and discontinuity markers. Replay and export events are recorded in an integrity-protected audit and handling ledger.

Inference trace (when analytics are used): Inference artifacts include model identity and execution context identity and are bound to the exact input Segments consumed. A verifier traces outputs back to segment digests and timestamps and flags context mismatches.

Conformance Mapping

- Class A (Capture Integrity): satisfied by segmentation, capture-time digests, chain continuity, signed Manifest, time source disclosure, completeness checks, and key identifiers
- Class B (Inference Provenance): satisfied when step 6 is executed via model identity, execution context identity, input binding, and traceable provenance
- Class C (Replay and Audit): satisfied by independent verifier tooling, offline verification, deterministic replay, audit and handling ledger, export traceability, and verification reports
- Class D (Multi-Feed Orchestration): satisfied when multiple feeds share aligned segmentation indices and a unified session manifest preserving time alignment
- Class E (Operational Security): satisfied when key management, access controls, configuration integrity, secure time handling, and retention/legal hold policy are enforced

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Implications

Once custody-grade provenance is standardized, admissibility becomes a procurement primitive.

The entity that owns the easiest path to pass the acceptance tests becomes the default compliance route.

If a rival controls the predicate, everyone else integrates downstream of their semantics, tooling, and audit surfaces.

Evidence does not persuade.
It either survives scrutiny or it does not.