

Decision Support Layer Spec

The Decision Support Layer is the final translation stage between fused telemetry and agent or human action. It converts a fused_record from e5-fusion-logic-map plus fired alerts from e5-alert-design-spec into concrete recommendations, autonomous triggers, or escalation requests — and it preserves the full evidence chain in s3-provenance-metadata-schema so that every decision can be traced back to the sensor readings that caused it. Critically, this layer blocks action on weak signals: any recommendation derived from a fused record with confidence_band: low or unknown is quarantined until a human reviews it, using s1-threshold-escalation-spec as the gate authority. This prevents a degraded sensor network from silently driving consequential actions.

1. Layer Responsibilities

- 1. Recommendation generation. Translate a fused telemetry state into a structured recommendation for an agent or human operator.
- 2. Signal-strength gate. Block or quarantine recommendations when the underlying fused record falls below the declared confidence threshold for the decision class.
- 3. Evidence preservation. Write a provenance record to s3-provenance-metadata-schema for every recommendation, trigger, or blocked action.
- 4. Action dispatch. Route approved recommendations to the correct agent action or escalation channel.
- 5. Audit surface. Maintain a queryable log of all decisions, their confidence basis, and their outcomes for operator review and S2 evaluation.

2. Decision Classes

A decision class is a named category of output this layer can produce. Each class has a declared minimum confidence_band required, a reversibility class, and an S1 gate requirement.

decision_class	Description	min_confidence_band	reversibility	S1 gate required
monitoring-log	Append observation to monitoring log; no operational action	low	reversible	None
status-update	Update the operational dashboard or status page	low	reversible	None
operator-notify	Push a structured notification to an operator queue	medium	reversible	Async post-hoc review
agent-trigger	Initiate an autonomous agent task (e.g., schedule a sensor maintenance check)	medium	reversible	Async post-hoc review

decision_class	Description	min_confidence_band	reversibility	S1 gate required
escalation-request	Route to human escalation tier per s1-threshold-escalation-spec	medium	reversible	HITL gate (Tier 1/2/3 per severity)
physical-action-recommendation	Recommend a physical intervention requiring human authorization	high	irreversible	HITL gate mandatory

No physical-action-recommendation is ever dispatched autonomously. It is always staged as a human-readable proposal requiring explicit approval, consistent with the irreversible-impact boundary in s1-fallback-architecture-blueprint.

3. Signal-Strength Gate

Every recommendation passes through a signal-strength gate before dispatch. The gate applies s1-threshold-escalation-spec logic to the fused record's confidence_band.

```
gate outcome = f(decision_class.min_confidence_band, fused_record.confidence_band)
```

fused confidence_band	decision_class min = low	decision_class min = medium	decision_class min = high
high	PASS — dispatch	PASS — dispatch	PASS — dispatch
medium	PASS — dispatch	PASS — dispatch	HOLD — quarantine for HITL
low	PASS — dispatch	HOLD — quarantine for HITL	HOLD — quarantine for HITL
unknown	HOLD — halt run	HOLD — halt run	HOLD — halt run

HOLD means the recommendation is written to the provenance store with status: quarantined and routed to the operator review queue. The agent does not invent a substitute decision and does not act autonomously.

HALT (triggered by confidence_band: unknown) means the decision layer emits a low-confidence-routing failure mode event per s1-failure-mode-register and stops the current decision run. No recommendation is produced. The operational state is frozen at the last non-unknown fused view.

4. Recommendation Schema

```
recommendation:
  recommendation_id: <UUID v4>
  decision_class: <enum from §2>
  alert_id: <resolves to e5-alert-design-spec; null if triggered by threshold trend rather than a fired alert>
```

```
fused_record_ref:
  measurement_type: <string>
  fusion_window_end_utc: <ISO 8601 Z>
  fused_value: <number>
  unit: <string>
confidence_band: <inherited from fused_record>
confidence_score: <optional; 0.0-1.0>
gate_outcome: <pass|hold|halt>
gate_rule_applied: <"min-band-gate" | "unknown-halt">
recommended_action: <free text; structured instructions>
suggested_fallback: <S1 fallback id or "none"; inherited from alert>
decision_origin: sensor-triggered
evidence_pointer: <URI to provenance record>
timestamp_utc: <ISO 8601 Z>
status: <dispatched|quarantined|halted|superseded>
```

decision_origin: sensor-triggered is the extended v0.2.0 glossary value locking this as a telemetry-initiated decision. S3 consumers that are base-enum-only treat it as agent per the backward-compatibility rule in glossary.

5. Evidence Preservation

Every recommendation — whether dispatched, quarantined, or halted — generates a provenance record in s3-provenance-metadata-schema. This is non-negotiable. A dispatched recommendation without a provenance record is a gate-failing provenance violation.

5.1 Provenance record shape

```
provenance_record:
  record_id: <UUID v7>
  timestamp_utc: <ISO 8601 Z>
  agent_id: <the sensor-fusion agent id>
  decision_origin: sensor-triggered
  evidence_pointer: <URI pointing to the fused_record + alert payload + gate outcome>
  rationale: >
    <One-sentence human-readable rationale, e.g.:
    "Fused water-level reading of 1.03 m (confidence: medium) crossed the pond-level-high
    threshold; Tier 2 operator escalation recommended per s1-threshold-escalation-spec.">
```

The evidence_pointer resolves to a stored bundle containing:

- The fused_record (from e5-fusion-logic-map)
- The fired alert payload (from e5-alert-design-spec)
- The C6 emission record
- The gate outcome record
- The normalized source records that contributed to the fused value

Heavy payloads (full sensor records) use the {ref, hash, field} hash-and-ref pattern from C5/C3 — they are not inlined into the provenance record.

5.2 Quarantine provenance

A HOLD outcome writes a quarantine record with status: quarantined and the reason (min-band-gate). When a human reviewer acts on a quarantined recommendation, their decision is recorded as a separate provenance record with decision_origin: human-override or escalation, linked to the quarantine record via a shared correlation_id.

6. Action Dispatch

After a PASS gate outcome, the recommendation is dispatched to the appropriate channel:

decision_class	Dispatch target
monitoring-log	Append to the pipeline monitoring log store
status-update	Write to the operational dashboard state store
operator-notify	Push structured JSON to the operator notification queue
agent-trigger	Emit a trigger event to the declared agent workflow endpoint
escalation-request	Route to the S1 HITL review queue per tier; emit C6 payload
physical-action-recommendation	Stage in the human-approval queue; never auto-dispatch

All dispatch actions are logged. A dispatch failure (queue unavailable, webhook timeout) applies the s1-fallback-architecture-blueprint retry policy and escalates if retries are exhausted.

7. Blocking Rules

The following conditions block any dispatch regardless of gate outcome:

1. confidence_band: unknown in the fused record. Halt the decision run entirely.
2. The recommendation carries decision_class: physical-action-recommendation and no human has pre-authorized it. Stage only; never dispatch.
3. The alert it references has suppression_applied: true. A suppressed alert cannot drive a downstream dispatch. Log the attempted dispatch as a suppression-bypass-blocked event.
4. The fused_record.stale_sources list contains the sole authoritative source for the measurement type. Downgrade to monitoring-log class if the original class was operator-notify or higher; log the demotion.

8. Worked Example — Escalation from Rising Water Level (illustrative)

Inputs:

- fused_record: measurement_type: water-level, fused_value: 1.03 m, confidence_band: medium, fusion_window_end_utc: 2026-05-29T19:33:00Z

- Fired alert: rule_id: pond-level-high, severity: high, suggested_fallback: increase-monitoring-frequency

Signal-strength gate:

- decision_class: escalation-request, min_confidence_band: medium
- Fused band = medium → gate outcome = PASS

Recommendation produced:

```
recommendation:
  recommendation_id: a4f2e1d3-0b9c-4a7f-8e6d-2c1b5a3f7e9d
  decision_class: escalation-request
  alert_id: <fired alert UUID>
  fused_record_ref:
    measurement_type: water-level
    fusion_window_end_utc: "2026-05-29T19:33:00Z"
    fused_value: 1.03
    unit: meters above NAVD88
  confidence_band: medium
  confidence_score: 0.72
  gate_outcome: pass
  gate_rule_applied: min-band-gate
  recommended_action: >
    Notify district clerk (Tier 2) that stormwater pond level has reached 1.03 m NAVD88,
    above the 1.00 m advisory threshold. Recommend initiating visual inspection of pond berm
    and downstream culvert capacity.
  suggested_fallback: increase-monitoring-frequency
  decision_origin: sensor-triggered
  evidence_pointer: "s3://provenance-store/sensor-fusion/2026-05-29/a4f2e1d3.json"
  timestamp_utc: "2026-05-29T19:33:05Z"
  status: dispatched
```

Provenance record written to s3-provenance-metadata-schema:

```
record_id: <UUID v7>
timestamp_utc: "2026-05-29T19:33:05Z"
agent_id: ecoguardian-30a-fusion
decision_origin: sensor-triggered
evidence_pointer: "s3://provenance-store/sensor-fusion/2026-05-29/a4f2e1d3.json"
rationale: >
  Fused water-level reading of 1.03 m (confidence: medium) crossed the pond-level-high
  threshold; Tier 2 operator escalation dispatched per s1-threshold-escalation-spec.
```

The district clerk receives the operator-notify. If the clerk confirms action is required, they record a human-override event. If they determine the reading is a sensor artifact and dismiss it, that dismissal is also a provenance record — the decision history is complete regardless of outcome.

9. Versioning

Adding a new decision_class is MINOR. Changing the signal-strength gate thresholds (the PASS/HOLD table in §3) is MINOR but requires re-evaluation of the recommendation log for any decisions that would change outcome. Removing a decision class or changing the provenance record shape is MAJOR, governed by interface-contracts and coordinated with s3-provenance-metadata-schema.