Structural Diagnostic Report

ai.04 — Runtime Control Coherence

Scenario S1: Multi-Layer Runtime Control Stack

Document Type:	Structural Diagnostic Scenario Report
Application ID:	ai.04
Scenario ID:	ai.04.S1
Schema Version:	0.5.1

Source:	SORT AI Structural Diagnostics Demo
Application:	ai.04 Runtime Control Coherence
Scenario:	S1
Version:	1.0.1
Generated:	2026-01-18
Web:	https://independent-research-systems-modeling.com

Scope and Limits: *This report presents a structural diagnostic scenario analysis based on pre-computed, normalized projection runs. It is not a complete Architecture Risk Assessment and does not contain implementation guidance.*

1. Scenario Overview

System Class

Deep runtime control stack with autonomous scheduler, orchestrator, runtime, and policy enforcement layers operating as independent decision-making units.

Scale Abstraction

Coordination-overhead-dominated regime with dozens to hundreds of control loops making sub-second decisions across multiple abstraction layers.

Operational Context

Mixed training and inference workloads with multi-objective scheduling and declarative orchestration. Each control layer optimizes according to its local objectives without explicit cross-layer coordination mechanisms.

2. Observed Structural Pattern

The following structural effects emerge from the interaction of correctly functioning control layers operating at scale:

- Scheduler decisions create conditions that trigger orchestrator compensations, which in turn invalidate scheduler assumptions, producing circular interference patterns.
- Policy enforcement introduces latency that affects scheduling decisions, creating feedback loops invisible to individual layers.
- Local optimization at each layer produces globally suboptimal outcomes that no single layer can detect or correct through its own monitoring.
- Decision frequency at different layers creates temporal coupling that standard monitoring cannot observe, as each layer operates on different time horizons.
- The problem emerges between correctly operating control loops, not within any individual layer — each component reports nominal operation while system-level efficiency degrades.

3. Stability Assessment

Baseline Structural Condition

System operates in incoherent regime. Control layers each report nominal operation while system-level coordination overhead dominates resource consumption. Stability reserve is negative and accumulating.

Observed Instability Class

Incoherent — characterized by emergent coordination failures from locally correct optimizations operating without cross-layer visibility.

Post-Projection Stability Class

Coherent — cross-layer decision conflicts addressed through coherence-informed coordination. Stability reserve restored to adequate levels.

Transition Type

Coherence restoration from fragmented to cross-layer aligned operating conditions.

4. Aggregated Indicators

All values are normalized ratios. No absolute values or reconstructable parameters are provided.

Indicator	Baseline	Comparison	Direction
Effective Throughput Ratio	0.58	0.81	Improvement
Control Overhead Fraction	0.37	0.14	Improvement
Decision Conflict Rate	0.24	0.06	Improvement
Cross-Layer Coherence Index	0.41	0.84	Improvement
Compensatory Action Rate	0.31	0.09	Improvement
Planning Accuracy Ratio	0.52	0.79	Improvement

5. Interpretation

Systemic Relevance

The observed incoherence pattern is systemically relevant because it represents a structural property of multi-layer autonomous control systems rather than a configuration error in any individual layer. Control interference emerges from correct components optimizing locally in structural isolation, not from misconfigured policies. This distinction fundamentally changes the appropriate response strategy.

Detection Challenge

This instability class remains undetected in practice because per-layer metrics show healthy operation throughout the degradation process. The problem exists in the coupling between control layers, not in the layers themselves. Monitoring systems designed to observe individual layer performance cannot detect cross-layer interference until coordination overhead becomes economically severe.

Control overhead grows, planning accuracy declines, and compensatory actions increase — yet each individual control layer reports nominal performance when examined in isolation.

6. Decision Relevance

If multi-layer control stacks show degrading efficiency despite each layer reporting nominal performance, the underlying cause is likely structural control incoherence rather than insufficient sophistication in any individual layer.

Adding more sophisticated control logic increases the coupling surface area and may accelerate incoherence rather than resolve it. Layer-by-layer optimization addresses symptoms while potentially worsening the structural condition.

Structural visibility into cross-layer coordination dynamics enables targeted intervention at coupling boundaries rather than requiring increasingly complex control policies with uncertain returns.

Related Document: SORT AI Runtime Control Application Context Brief

---

Such structural findings are typically contextualized through a scoped architecture risk assessment.