When Correct Actions Are Not Enough: Regime Admissibility in Long-Horizon Adaptive Systems

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Abstract

Long-horizon adaptive systems frequently fail not because of individual erroneous actions, but due to prolonged operation within organizational regimes that silently undermine structural viability. Existing control and learning frameworks primarily regulate behavior through action-level optimization, constraints, or safety mechanisms embedded within the decision process. While effective for enforcing local correctness, such approaches implicitly assume that long-term viability can be preserved as long as individual actions remain admissible and performance metrics remain stable.

This work identifies a conceptual and architectural limitation of that assumption: the absence of a non-causal viability dimension operating at the level of regime admissibility rather than action selection. We argue that viability in adaptive systems cannot be reliably regulated solely through action-level correctness, reward optimization, or constraint enforcement. Instead, long-term sustainability depends on whether certain organizational regimes—modes of internal regulation, responsiveness, or correction—are permitted to operate or persist at all.

We introduce the notion of regime admissibility as an external, non-causal architectural dimension that governs which regimes may be entered or sustained without modifying actions, rewards, objectives, or decision surfaces. This distinction separates long-horizon structural viability from short-horizon behavioral correctness and exposes a class of silent degradation modes in which systems remain locally correct while progressively exhausting structural capacity.

The contribution of this work is conceptual rather than algorithmic. It establishes prior art for the architectural separation between action-level control and regime-level viability regulation, and clarifies why action-centric safety and control mechanisms are insufficient to prevent long-horizon degradation under real-world interaction variability.

This work, together with related publications within the Petronus research program, delineates the author's chosen domain of inquiry and conscious ambition: to articulate the missing structural dimensions required for durable, autonomous systems operating beyond idealized assumptions of stability, observability, and control.

1 Introduction

Adaptive systems operate not merely through isolated actions, but through sustained modes of organization that shape how actions are generated, corrected, and propagated over time. A robot may alternate between passive motion and aggressive correction, a controller may transition between inertial propagation and active stabilization, and a learning agent may oscillate between exploratory behavior and tightly regulated operation. These modes, or organizational regimes, define the internal conditions under which actions occur, rather than the actions themselves.

Despite the central role of such regimes in long-horizon behavior, most existing adaptive architectures regulate viability almost exclusively at the action level. Correctness is enforced by optimizing control inputs, penalizing deviations, shaping reward functions, or constraining trajectories within admissible bounds. Under this paradigm, viability is treated as a byproduct of local action admissibility: if each action is correct, stable, or rewarded, long-term sustainability is assumed to follow.

This assumption breaks down in real-world long-horizon operation. Systems may remain locally correct while persistently operating within organizational regimes that are structurally unsuitable for prolonged use. Correction may become increasingly forced, responsiveness may rely on sustained regulation, or internal dynamics may drift toward states that require continuous intervention. None of these conditions necessarily violate short-horizon performance criteria, yet all contribute to gradual depletion of structural capacity, accumulation of internal stress, or erosion of coherence.

Crucially, such degradation often remains invisible to conventional control and learning metrics. Trajectories may remain within tolerance, errors may be continuously corrected, and rewards may remain stable, creating the appearance of healthy operation. Failure, when it occurs, often appears abrupt precisely because the underlying degradation was not represented, monitored, or regulated at the architectural level.

This work isolates this class of failure modes and argues that they arise from a missing architectural dimension in prevailing adaptive systems: the absence of a regime-level notion of admissibility that operates independently of action-level decision making. Without an explicit distinction between whether a regime should be active at all and how actions are selected within that regime, systems lack the representational capacity to regulate long-horizon viability under variable conditions.

2 The Limits of Action-Centric Viability Regulation

Conventional approaches to safety, stability, and robustness regulate behavior by constraining or reshaping the agent's decision surface. Safety controllers, shields, constrained optimization, and reward shaping all act by restricting which actions may be taken or by penalizing undesirable outcomes.

These methods are inherently causal. The agent's behavior is modified in response to constraints or penalties, and viability considerations are embedded directly into the action-selection or optimization process. While this coupling can enforce local safety properties, it also tightly binds viability regulation to the agent's internal logic.

More importantly, such approaches implicitly treat viability as an action-level property. If no individual action violates constraints and performance metrics remain within bounds, the system is assumed to be viable. This overlooks the fact that viability degradation often arises not from isolated actions, but from sustained operation in structurally inappropriate regimes.

As a result, systems can satisfy all local safety and performance criteria while silently accumulating long-term degradation.

3 Regimes as the Primary Unit of Long-Horizon Risk

A regime represents a mode of organization governing how actions are generated, corrected, and sustained. Examples include inertial propagation with minimal correction, aggressive regulation with frequent intervention, or tightly constrained operation under continuous oversight. These regimes differ not only in behavior, but in how they load the system structurally over time.

Crucially, regimes are not interchangeable. Transitions between regimes are not commutative, and prolonged occupation of certain regimes may be structurally expensive even when actions remain locally correct. Long-term risk therefore depends less on individual actions than on which regimes are allowed to persist.

Existing architectures lack a representational mechanism to express this distinction. Regimes are treated as internal states or emergent behaviors, but their admissibility is not regulated independently of action-level control.

4 Regime Admissibility as a Separate Architectural Dimension

This work introduces regime admissibility as a distinct architectural dimension for regulating viability in adaptive systems. Regime admissibility concerns whether a particular mode of organization is permitted to operate at a given time, independently of how actions are selected, optimized, or executed within that mode.

Crucially, regime admissibility is not equivalent to action-level constraints. It does not specify which actions are allowed or forbidden, nor does it reshape trajectories, policies, or control laws. Instead, it governs which organizational regimes may be entered, sustained, or excluded altogether. Within any admissible regime, the agent remains fully autonomous with respect to action selection and internal decision-making.

By separating regime permissibility from action selection, viability regulation is lifted from the level of individual decisions to the level of organizational structure. Long-horizon sustainability is therefore governed not by modifying how the agent decides, but by constraining which modes of organization are available for operation. This separation establishes regime admissibility as an architectural concern orthogonal to control logic, optimization criteria, and learning dynamics.

5 Non-Causal Application of Regime Admissibility

A defining characteristic of regime admissibility is its non-causal relationship to the agent's decision process. The agent does not receive information explaining why a regime is admissible or inadmissible, does not observe the criteria used for admissibility evaluation, and does not optimize for viability or regime access.

No rewards, penalties, gradients, losses, or auxiliary signals associated with regime admissibility are provided to the agent. As a result, admissibility cannot be exploited as an implicit objective, proxy reward, or optimization target. From the agent's perspective, admissibility remains opaque: regimes may become unavailable or persist without any causal explanation embedded in the decision-making process.

This non-causal application prevents viability regulation from collapsing into a secondary control or learning objective. It avoids feedback amplification, meta-optimization effects, and unintended behavioral distortions that commonly arise when safety or viability signals are embedded within reward functions or action-selection mechanisms. Regime admissibility thus governs long-horizon structure without contaminating the agent's decision surface.

6 Silent Degradation and the Need for Regime-Level Regulation

In the absence of explicit regime-level admissibility, adaptive systems are vulnerable to silent degradation. Systems may operate for extended periods within organizational regimes that require sustained correction, high intervention density, or continuous compensation, gradually consuming structural capacity and undermining long-term viability.

Because action-level behavior remains correct and conventional performance metrics remain within acceptable bounds, no internal signal indicates that degradation is occurring. Trajectories may remain stable, errors may be continuously corrected, and rewards may remain satisfactory. Failure, when it occurs, therefore appears abrupt, not because degradation was absent, but because it was never represented at the architectural level.

Regime admissibility addresses this gap by regulating which modes of organization may be sustained over time, independently of action-level correctness. By preventing prolonged occupation of structurally destructive regimes—even when local behavior appears acceptable—regime-level regulation provides a representational foundation for long-horizon viability that cannot be achieved through action-centric control or optimization alone.

7 Distinction from Safety Controllers and Shields

Safety controllers, shields, and constraint-based mechanisms operate by restricting actions within the agent's decision space. They intervene causally in the control process by forbidding, modifying, or reshaping actions that violate predefined constraints. In doing so, they directly influence behavior at the point of decision, often by embedding safety criteria into the policy, reward structure, optimization objective, or action-selection logic.

Such mechanisms are inherently causal: the agent's future behavior is altered as a direct consequence of the safety logic, and the agent may implicitly or explicitly adapt to these constraints over time. While effective for enforcing local safety conditions or preventing immediate violations, these approaches entangle viability considerations with action selection and increase the density of feedback within the decision loop.

Regime admissibility differs fundamentally from this paradigm. It does not constrain individual actions, does not modify policies, and does not embed viability criteria into optimization, rewards, or losses. The agent continues to operate autonomously within any admissible regime, selecting actions exactly as it would in the absence of viability regulation. No action is labeled safe or unsafe, and no corrective signal is introduced at the level of decision-making.

Instead, regime admissibility operates at a higher organizational level. It governs which modes of organization may exist or persist at all, rather than how behavior is expressed within those modes. Viability is regulated by permitting or excluding entire regimes of operation, not by shaping the agent's choices within a regime. From the agent's perspective, the internal decision surface remains unchanged.

This separation places regime admissibility outside the scope of conventional safety mechanisms. It establishes viability regulation as an architectural principle distinct from control, optimization, or constraint enforcement. By decoupling long-horizon structural considerations from action-level causality, regime admissibility addresses failure modes that action-centric safety mechanisms are not designed to capture, particularly those arising from prolonged occupation of structurally unsuitable regimes despite locally correct behavior.

8 Scope and Non-Disclosure Boundary

This work does not specify how regime admissibility is evaluated, how regimes are identified, or how admissibility decisions are implemented. It does not propose algorithms, thresholds, metrics, or control logic. The purpose of this disclosure is to establish the architectural necessity and conceptual validity of regime-level, non-causal viability regulation.

Any system that distinguishes between action correctness and regime admissibility, and that regulates long-horizon viability by controlling which regimes may operate independently of action selection, operates within the conceptual space defined here.

9 Conclusion

This work establishes regime admissibility as a fundamental, non-causal architectural dimension for regulating long-horizon viability in adaptive systems. It demonstrates that action-centric safety, control, and optimization mechanisms are insufficient to address a critical class of failure modes arising from prolonged operation within organizational regimes that are structurally misaligned with long-term sustainability.

We show that adaptive systems may remain locally correct—exhibiting acceptable trajectories, bounded errors, and stable performance—while nonetheless undergoing gradual, unobserved degradation due to persistent occupation of inappropriate regimes. Such degradation does not arise from individual actions, but from regime-level patterns of organization that shape how correction, regulation, and intervention are sustained over time.

By separating viability regulation from action selection and embedding it at the level of regime permissibility, this work defines a distinct architectural axis along which long-horizon sustainability can be governed without modifying control policies, reward structures, or decision surfaces. Regime admissibility operates externally to the agent's causal decision process, preserving autonomy while constraining the organizational modes under which that autonomy is exercised.

This distinction establishes a new conceptual boundary for the design and analysis of durable adaptive architectures. It reframes long-horizon risk as a question of which regimes are allowed to persist, rather than how well individual actions are optimized. Recognizing regime admissibility as an independent architectural dimension is therefore a prerequisite for understanding, diagnosing, and ultimately preventing silent long-horizon degradation in adaptive systems operating under real-world uncertainty.

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